cocktail party effect See ATTENTION; CAPACITY LIMITS AND CONSCIOUSNESS

cognition, unconscious The unconscious mind was one of the most important ideas of the 20th century, influencing not just scientific and clinical psychology but also literature, art, and popular culture. Sigmund Freud famously characterized the 'discovery' of the unconscious as one of three unpleasant truths that humans had learned about themselves: the first, from Copernicus, that the Earth was not the centre of the universe; the second, from Darwin, that humans are just animals after all; and the third, ostensibly from Freud himself, that the conscious mind was but the tip of the iceberg (though Freud apparently never used this metaphor himself), and that the important determinants of experience, thought, and action were hidden from conscious awareness and conscious control.

In fact, we now understand that Freud was not the discoverer of the unconscious (Ellenberger 1970). The concept had earlier roots in the philosophical work of Leibniz and Kant, and especially that of Herbart, who in the early 19th century introduced the concept of a *limen*, or threshold, which a sensation had to cross in order to be represented in conscious awareness. A little later, Helmholtz argued that conscious perception was influenced by unconscious inferences made as the perceiver constructs a mental representation of a distal stimulus. In 1868, while Freud was still in short trousers, the Romantic movement in philosophy, literature, and the arts set the stage for Hartmann's *Philosophy of the Unconscious* (1868), which argued that the physical universe, life, and individual minds were ruled by an intelligent, dynamic force of which we had no awareness and over which we had no control. And before Freud was out of medical school, Samuel Butler, author of *Erewhon*, drew on Darwin's theory of evolution to argue that unconscious memory was a universal property of all organized matter.

Nevertheless, consciousness dominated the scientific psychology that emerged in the latter part of the 19th century. The psychophysicists, such as Weber and Fechner, focused on mapping the relations between conscious sensation and physical stimulation. The structuralists, such as Wundt and Titchener, sought to analyse complex conscious experiences into their constituent (but conscious) elements. James, in his *Principles of Psychology*, defined psychology as the science of mental life, by which he meant *conscious* mental life—as he made clear in the *Briefer Course*, where he defined psychology as 'the description and explanation of states of consciousness as such'. Against this background, Breuer and Freud's assertion, in the early 1890s, that hysteria is a product of repressed memories of trauma, and Freud's 1900 topographical division of the mind into conscious, preconscious, and unconscious systems, began to insinuate themselves into the way we thought about the mind.

On the basis of his own observations of hysteria, fugue, and hypnosis, James understood, somewhat paradoxically, that there were streams of mental life that proceeded outside conscious awareness. Nevertheless, he warned (in a critique directed against Hartmann) that the distinction between conscious and unconscious mental life was 'the sovereign means for believing what one likes in psychology, and of turning what might become a science into a tumbling-ground for whimsies'. This did not mean that the notion of unconscious mental life should be discarded; but it did mean that any such notion should be accompanied by solid scientific evidence. Unfortunately, as we now understand, Freud's 'evidence' was of the very worst sort: uncorroborated inferences, based more on his own theoretical commitments than on anything his patients said or did, coupled with the assumption that the patient's resistance to Freud's inferences were all the more proof that they were correct—James's 'psychologist's fallacy' writ large. Ever since, the challenge for those who are interested in unconscious mental life has been to reduce the size of the tumbling-ground by tightening up the inference from behaviour to unconscious thought.

Unfortunately, the scientific investigation of unconscious mental life was sidetracked by the behaviourist revolution in psychology, initiated by Watson and consolidated by Skinner, which effectively banished consciousness from psychological discourse, and the unconscious along with it. The 'cognitive revolution' of the 1960s, which overthrew behaviourism, began with research on *attention, short-term memory, and imagery—all aspects of conscious awareness. The development of cognitive psychology led ultimately to a rediscovery of the unconscious as well, but in a form that looked nothing like Freud's vision. As befits an event that took place in the context of the cognitive revolution, the rediscovery of the unconscious began with cognitive processes—the processes by which we acquire knowledge through perception and learning; store knowledge in memory; use, transform, and generate knowledge through reasoning, problem-solving, judgement, and decision-making; and share knowledge through language.

The first milestone in the rediscovery of the unconscious mind was a distinction between **automatic* and *controlled processes*, as exemplified by various phenomena of perception and skilled reading. For example, the perceiver automatically takes distance into account in inferring the size of an object from the size of its retinal

image (this is an example of Helmholtz's 'unconscious inferences'). And in the *Stroop effect, subjects automatically process the meaning of colour words, which makes it difficult for them to name the incongruent colour of the ink in which those words are printed. In contrast to controlled processes, automatic processes are inevitably evoked by the appearance of an effective stimulus; once evoked, they are incorrigibly executed, proceeding to completion in a ballistic fashion; they consume little or no attentional resources; and they can be performed in parallel with other cognitive activities. While controlled processes are performed consciously, automatic processes are unconscious in the strict sense that they are both unavailable to introspective access, known only through inference, and involuntary.

It is one thing to acknowledge that certain cognitive processes are performed unconsciously. As noted earlier, such a notion dates back to Helmholtz, and was revived by Chomsky, at the beginning of the cognitive revolution, to describe the unconscious operation of syntactic rules of language. But it is something else to believe that cognitive *_contents_—specific percepts, memories, and thoughts—could also be represented unconsciously. However, evidence for just such a proposition began to emerge with the discovery of spared *priming and source *amnesia in patients with the amnesic syndrome secondary to damage to the hippocampus and other subcortical structures. This research, in turn, led to a distinction between two expressions of episodic memory, or memory for discrete events: *explicit memory* entails conscious recollection, usually in the form of recall or recognition; by contrast, *implicit memory* refers to any effect of a past event on subsequent experience, thought, or action (Schacter 1987; see AUTONOETIC CONSCIOUSNESS).

Preserved priming in amnesic patients showed that explicit and implicit memory could be dissociated from each other: in this sense, implicit memory may be thought of as unconscious memory. Similar dissociations have now been observed in a wide variety of conditions, including the anterograde and retrograde amnesias produced by electroconvulsive therapy, general *anaesthesia, conscious sedation by benzodiazepines and similar drugs, *dementias such as Alzheimer's disease, the forgetfulness associated with normal ageing, posthypnotic amnesia, and the 'functional' or 'psychogenic' amnesias associated with the psychiatric syndromes known as the dissociative disorders, such as 'hysterical' fugue and *dissociative identity disorder (also known as multiple personality disorder).

Implicit memory refers to the influence of a *past* event on the person's subsequent experience, thought, or action in the absence of, or independent of, the person's conscious *recollection* of that event. This definition can then serve as a model for extending the cognitive unconscious to cognitive domains other than memory. Thus, *implicit perception* refers to the influence of an event in the *current* stimulus environment, in the absence of the person's conscious *perception* of that event (Kihlstrom et al. 1992). Implicit perception is exemplified by so-called subliminal perception (see PERCEPTION, UNCONSCIOUS), as well as the *blindsight of patients with lesions in striate cortex. It has also been observed in conversion disorders (such as 'hysterical' blindness); in the anaesthesias and negative *hallucinations produced by hypnotic suggestion; and in failures of conscious perception associated with certain attentional phenomena, such as unilateral neglect, dichotic listening, parafoveal vision, *inattentional blindness, repetition blindness, and the *attentional blink. In each case, subjects' task performance is influenced by stimuli that they do not consciously see or hear—the essence of unconscious perception.

Source amnesia shades into the phenomenon of *implicit *learning*, in which subjects acquire knowledge, as displayed in subsequent task performance, but are not aware of what they have learned. Although debates over unconscious learning date back to the earliest days of psychology, the term *implicit learning* was more recently coined in the context of experiments on *artificial grammar learning (Reber 1993). In a typical experiment, subjects were asked to memorize a list of letter strings, each of which had been generated by a set of 'grammatical rules'. Despite being unable to articulate the rules themselves, they were able to discriminate new grammatical strings from ungrammatical ones at better-than-chance levels. Later experiments extended this finding to concept learning, covariation detection, *sequence learning, learning the input–output relations in a dynamic system, and other paradigms. In source amnesia, as an aspect of implicit episodic memory, subjects have conscious access to newly acquired knowledge, even though they do not remember the learning experience itself. In implicit learning, newly acquired semantic or procedural knowledge is not consciously accessible, but nevertheless influences the subjects' conscious experience, thought, and action.

There is even some evidence for unconscious thought, defined as the influence on experience, thought, or action of a mental state that is neither a percept nor a memory, such as an idea or an image (Kihlstrom et al. 1996). For example, when subjects confront two problems, one soluble and the other not, they are often able to identify the soluble problem, even though they are not consciously aware of the solution itself. Other research has shown that the correct solution can generate priming effects, even when subjects are unaware of it. Because the solution has never been presented to the subjects, it is neither a percept nor a memory; because it has been

internally generated, it is best considered as a thought. Phenomenologically, *implicit thought* is similar to the *feeling of knowing someone we cannot identify further, or the experience when words seem to be on the tip of the tongue; it may also be involved in intuition and other aspects of creative problem-solving.

With the exception of implicit thought, all the phenomena of the cognitive unconscious are well accepted, although there remains considerable disagreement about their underlying mechanisms. For example, it is not clear whether explicit and implicit memory are mediated by separate brain systems, or whether they reflect different aspects of processing within a single *memory system. The theoretical uncertainty is exacerbated by the fact that most demonstrations of implicit perception and memory involve repetition priming that can be based on an unconscious perceptual representation of the prime, and the extent of unconscious semantic priming, especially in the case of implicit perception, has yet to be resolved. One thing that is clear is that there are a number of different ways to render a percept or memory unconscious; the extent of unconscious influence probably depends on the particular means chosen.

Occasional claims to the contrary notwithstanding, the cognitive unconscious revealed by the experiments of modern psychology has nothing in common with the dynamic unconscious of classic psychoanalytic theory (Westen 1999). To begin with, its contents are 'kinder and gentler' than Freud's primitive, infantile, irrational, sexual, and aggressive 'monsters from the Id'; moreover, unconscious percepts and memories seem to reflect the basic architecture of the cognitive system, rather than being motivated by conflict, anxiety, and repression. Moreover, the processes by which emotions and motives are rendered unconscious seem to bear no resemblance to the constructs of psychoanalytic theory. This is not to say that emotional and motivational states and processes cannot be unconscious. If percepts, memories, and thoughts can be unconscious, so can feelings and desires. Of particular interest is the idea that stereotypes and prejudices can be unconscious, and affect the judgements and behaviours even of people who sincerely believe that they have overcome such attitudes (Greenwald et al. 2002).

Mounting evidence for the role of automatic processes in cognition, and for the influence of unconscious percepts, memories, knowledge, and thoughts, has led to a groundswell of interest in unconscious processes in learning and thinking. For example, many social psychologists have extended the concept of *automaticity to very complex cognitive processes as well as simple perceptual ones—a trend so prominent that automaticity has been dubbed 'the new unconscious' (Hassin et al. 2005). An interesting characteristic of this literature has been the claim that automatic processing pervades everyday life to the virtual exclusion of conscious processing—'the automaticity of everyday life' and 'the unbearable automaticity of being' (e.g. Bargh and Chartrand 1999). This is a far cry from the two-process theories that prevail in cognitive psychology, and earlier applications of automaticity in social psychology, which emphasized the dynamic interplay of conscious and unconscious processes. Along the same lines, Wilson has asserted the power of the 'adaptive unconscious' in learning, problem-solving, and decision-making (Wilson 2002)—a view popularized by Gladwell as 'the power of thinking without thinking' (Gladwell 2005). Similarly, Wegner has argued that conscious will is an illusion, and that the true determinants of conscious thoughts and actions are unconscious (Wegner 2002). For these theorists, automaticity replaces Freud's 'monsters from the Id' as the third unpleasant truth about human nature. Where Descartes asserted that consciousness, including conscious will, separated humans from the other animals, these theorists conclude, regretfully, that we are automatons after all (and it is probably a good thing, too).

The stance, which verges on *epiphenomenalism, or at least conscious inessentialism, partly reflects the 'conscious shyness' of psychologists and other cognitive scientists, living as we still do in the shadow of functional behaviourism (Flanagan 1992)—as well as a sentimental attachment to a crypto-Skinnerian situationism among many social psychologists (Kihlstrom 2008). But while it is clear that consciousness is not necessary for some aspects of perception, memory, learning, or even thinking, it is a stretch too far to conclude that the bulk of cognitive activity is unconscious, and that consciousness plays only a limited role in thought and action. 'Subliminal' perception appears to be analytically limited, and earlier claims for the power of *subliminal advertising were greatly exaggerated (Greenwald 1992). Assertions of the power of implicit learning are rarely accompanied by a methodologically adequate comparison of conscious and unconscious learning strategies—or, for that matter, a properly controlled assessment of subjects' conscious access to what they have learned. Similarly, many experimental demonstrations of automaticity in social behaviour employ very loose definitions of automaticity, confusing the truly automatic with the merely incidental. Nor are there very many studies using techniques such as Jacoby's process-dissociation procedure to actually compare the impact of automatic and controlled processes (Jacoby et al. 1997; see MEMORY, PROCESS-DISSOCIATION PROCEDURE).

So, despite the evidence for unconscious cognition, reports of the death of consciousness appear to be

greatly exaggerated. At the very least, consciousness gives us something to talk about; and it seems to be a logical prerequisite to the various forms of social learning by precept, including sponsored teaching and the social institutions (like universities) that support it, which in turn make cultural evolution the powerful force that it is.

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cognitive control and consciousness In a forced-choice reaction time task, responses are slower after an error. This is one example of dynamic adjustment of behaviour, i.e. control of cognitive processing, which according to Botvinick et al. (2001) refers to a set of functions serving to configure the cognitive system for the performance of tasks. We focus on the question whether cognitive control requires conscious awareness. We wish to emphasize that the question refers not to the awareness of all aspects of the world surrounding the performing organism, but to the conscious awareness of the control process itself, i.e. consciousness of maintaining the task requirements, supporting the processing of information relevant to the goals of the current task, and suppressing irrelevant information (van Veen and Carter 2006).

During the last quarter of the 20th century, the term *control* was contrasted with **automaticity* (e.g. Schneider and Shiffrin 1977). Automatic processes were defined as being effortless, unconscious, and involuntary, and the terms *unconscious* and *automatic* were used by some interchangeably, leading to the conclusion that control should be viewed as constrained to conscious processing. However, it was shown that phenomena considered to be examples of automatic processing, such as the flanker effect and the *Stroop effect, showed a dynamic adjustment to external conditions, corresponding to the notion of control. In particular, some (e.g. Gratton et al. 1992) showed an increase in the flanker effect after an incompatible trial, while others (e.g. Logan et al. 1984) showed sensitivity of the Stroop effect to the various trial types. Consequently, Tzelgov (1997) proposed to distinguish between *monitoring* as the intentional setting of the goal of behaviour and the intentional evaluation of the outputs of a process, and *control*, referring to the sensitivity of a system to changes in inputs, which may reflect a feedback loop.

According to these definitions, monitoring can be considered to be the case of conscious control, that is, the conscious awareness of the representations controlled and the very process of their evaluation. The *global workspace (GW) framework proposed by Dehaene et al. (1998) may be seen as one possible instantiation of the notion of monitoring in neuronal terms. Accordingly, unconscious processing reflects the activity of a set of interconnected modular systems. Conscious processing is possible due to a distributed neural system, which may be seen as a 'workspace' with long-distance connectivity that interconnects the various modules, i.e. the multiple, specialized brain areas. It allows the performance of operations that cannot be accomplished unconsciously and 'are associated with planning a novel strategy, evaluating it, controlling its execution, and correcting possible errors' (Dehaene et al. 1998:11). Within such a framework the anterior cingulate cortex (ACC) and the prefrontal cortex (PFC), two neural structures known to be involved in control, may be seen as parts of the GW and consequently, are supposed to indicate conscious activity.

In contrast, there are models of control that do not assume involvement of consciousness. For example, Bodner and Masson (2001) argue that the operations applied to the prime in order to identify and interpret it result in new memory *representations, which can

later be used without awareness. Jacoby et al. (2003) referred to such passive control as 'automatic'. A computational description of *passive control* is provided by the conflict-monitoring model of the Stroop task (Botvinick et al. 2001), which includes a conflict detection unit (presumed to correspond to the ACC) that triggers the control-application unit (presumed to correspond to the PFC). To be more specific, consider a presentation of an incongruent Stroop stimulus, for example, the word 'BLUE' printed in red ink, with instructions to respond with the colour of the ink. This results in a strong activation to respond with the word presented, and in parallel, the instructions cause activation of the colour the stimulus is written in. The resulting conflict in the response unit is detected by the ACC, which in turn augments the activation of the colour unit in the PFC, leading to the relevant response. Notice that no conscious decisions are involved in this process.

Thus, the question of the relation between consciousness and cognitive control may be restated in terms of whether cognitive control requires conscious monitoring as implied by the GW and similar frameworks, or whether it can be performed without the involvement of consciousness, as hypothesized by the conflict-monitoring model. Mayr (2004) reviewed an experimental framework for analysing the consciousness-based vs consciousness-free approaches to cognitive control by focusing on behavioural and neural (e.g. ACC and ERN activity) indications of control. He proposed to contrast these indications under a condition of conscious awareness vs absence of awareness, of the stimuli presumed to trigger control by generating conflict. For example, in the study of Dehaene et al. (2003), the contrast is between an unmasked (high awareness) condition in which the participants can clearly see the prime, and a *masked (low awareness) condition. After reviewing a few studies that applied such a design, Mayr had to conclude that the emerging picture is still inconclusive. We agree that the proposed approach is very promising, yet some refinements are needed. First, in most cases discussed by Mayr, the manipulation of awareness was achieved by masking a prime stimulus. The critical assumption, that under masking conditions the participants are totally unaware of the masked stimulus and yet process it up to its semantic level, is still controversial (Holender 1986). Second, concerning the casual order: consider the case in which both behavioural and neuronal (i.e. ACC activity) markers of conflict are obtained only when the person is fully aware of the conflict-triggering stimulus. At face value, it seems to indicate that the causal link is from awareness to markers of conflict; however, it could be equally true that the causal link is from the markers of conflict to awareness. Mayr (2004:146) hints at this point by suggesting the 'possibility that rather than consciousness being a necessary condition for conflict related ACC activity, conflict related ACC activity might be the necessary condition for awareness of conflict'. Third, concerning the assumed notion of conscious control: what is supposed to be manipulated in the awareness-control design is the awareness of the conflict. Actually, however, what is manipulated is the awareness of the stimulus generating the conflict. Such awareness may be seen as a precondition for applying deliberate monitoring.

Thus, in order to advance answering the question whether cognitive control requires consciousness, future research should distinguish between awareness of the stimulus that causes the conflict, awareness of the conflict per se and awareness of the very process of control as implied by the notion of monitoring. Furthermore, such research should emphasize the distinction between consciousness as a condition for control processes and consciousness as a result of control processes.

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