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PERSPECTIVE

What is "the unconscious," and where is it located in the brain? A neuropsychoanalytic perspective

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This is a brief overview of my "neuropsychoanalytic" perspective on the unconscious. It should make clear how much psychoanalysis has to gain from incorporating the findings of neuroscientific disciplines studying the same part of nature—the workings of the human mind. I hope it makes equally clear what useful new perspectives can be cast on current issues in cognitive neuroscience, if they, in turn, incorporate the findings of psychoanalysis.

Keywords: unconscious; Freud; psychoanalysis; human mind; consciousness; cognitive neuroscience

Since this is a perspective article, I will take the liberty of stating my views somewhat dogmatically. This permits brevity. Five years ago, I published a longer article,[1] in which I laid out some proposals that seemed to have fundamental implications for the theoretical formulations that are the basis of the psychoanalytic "talking cure."[2] This, in my view, should alter what psychoanalytic clinicians do. If Freud made a mistake in his basic model of how the mind works, it must have knock-on effects when the model is applied clinically.

The mistake in Freud's theoretical model that I am referring to is a conflation of what he called the "id" with what he called the "system unconscious." I argued in my paper that the part of the brain that performs the functions that Freud attributed to the id—that is to say, the part of the brain that generates drives and instincts, and functions according to the "pleasure principle"—is conscious. In fact, it is the fount of all consciousness: the very basis of our sentient being. In my view, the fundamental stuff of consciousness is not *perception* (as Freud claimed) but rather *arousal*.

In cognitive neuroscience today, it is generally accepted that perception is unconscious in itself, as is all cognition (which derives from memory traces of perception). This is not news.[3] In short, what Freud called the "ego"—or the part of the brain that performs the functions that Freud attributed to the ego—is now thought to be intrinsically unconscious; and (I shall argue here) the ego's functions only become conscious when they are activated by the id.

Freud claimed the opposite: according to classical theory, the purpose of the talking cure was to drag the consciousness attaching to perceptual and cognitive representations—principally of words (in what we now called "declarative" memory systems)—*deeper* into the mind, to link them with the inchoate contents of the id, so that the id's unconscious contents can become thinkable. The mistaken assumption underlying this theory, namely that consciousness is an intrinsic property of the cortex, was first revealed in the 1940s, shortly after Freud died. The critical experiments were performed by Moruzzi and Magoun,[4] who showed that consciousness in cats is generated not in the cortex but rather in the upper brain stem, in a region now known as the extended reticulothalamic activating system (ERTAS). Confirmation that the same applied to humans was quickly forthcoming, for example, from Penfield and Jasper,[5] who observed that consciousness is only lost during seizures when epileptogenic activity spreads to what they called the centrencephalic region (i.e., the ERTAS).

The whole situation we are addressing is summed up in the following statement by Freud[6] (p. 24), who, incidentally, started his scientific life as a neuroanatomist:

> What consciousness yields consists essentially of perceptions of excitations coming from the external world and of feelings of pleasure and unpleasure which can only arise from within the mental apparatus; it is therefore possible to assign to the system

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> *Pcpt.-Cs.*[a] a position in space. It must lie on the borderline between outside and inside; it must be turned towards the external world and must envelop the other psychical systems. It will be seen that there is nothing daringly new in these assumptions; we have merely adopted the views on localization held by cerebral anatomy, which locates the "seat" of consciousness in the cerebral cortex—the outermost, enveloping layer of the central organ. Cerebral anatomy has no need to consider why, speaking anatomically, consciousness should be lodged on the surface of the brain instead of being safely housed somewhere in its inmost interior.

Ironically, it turns out that consciousness *is* lodged in the inmost interior of the brain. Consciousness is an endogenous property of the brain; it does not stream in through the senses.

The full implications of this discovery were slow to emerge, and are only now being fully digested (see Merker[7]). Initially, Moruzzi and Magoun—and just about everybody else—tried to save the old theory by drawing a distinction between the "contents" of consciousness (which they assigned to the cortex) and its "level" (which they assigned to the ERTAS). The so-called level of consciousness (or wakefulness) was therefore measured *quantitatively*—on a 15-point scale—while its contents (perceptual and cognitive awareness) were assessed *qualitatively*. But evidence that "arousal" possesses qualities of its own is easily demonstrated. The level of consciousness really consists of a variety of *states* of consciousness (*cf.* Mesulam[8]). It *feels like something* to be awake. That is why the ERTAS is not a concern of anesthetists alone (or of neurosurgeons); it is of equal concern to psychiatrists. The single neurotransmitter systems that are the targets of the best known psychoactive medications have their source cells in the ERTAS. (Consider, for example, serotonin and dopamine). Thus, it turns out that the contents of consciousness do not consist only in the sensory qualia of our classical exteroceptive modalities; the ERTAS generates interoceptive qualia of its own. These are known as *affects*.

What is more, affect is a *more fundamental* form of consciousness than the form attaching to the classical perceptual modalities. The relationship between the two forms is hierarchical: *cortical consciousness is dependent upon ERTAS arousal*. Thus, whereas even a small amount of damage to the ERTAS causes coma,[9] damage to large swathes of cortex results merely in a loss of "certain forms of information" (Merker,[7] p. 65). The smallest area of brain tissue whose destruction causes total loss of consciousness is located in the periacqueductal gray, stimulation of which, importantly, produces the most extreme states of affective arousal (both pleasurable and unpleasurable, depending on the precise site that is stimulated; see Panksepp[10] and Merker[7]).

That is why decorticate animals are conscious,[11] as are children born without a cortex.[12] These animals and children are totally devoid of cortical representations, yet they are awake and alert and display a wide range of emotional responses to adequate stimuli. This puts paid to the notion that emotions only become conscious if they are registered in the (prefrontal or insular) cortex (*cf.* LeDoux[13] and Craig[14]). There is absolutely no evidence for this. In fact, decorticate animals are *excessively* emotional,[11] as are human beings with damaged prefrontal lobes.[15] Likewise, preserved emotional consciousness can easily be demonstrated in patients whose insular cortex is destroyed.[16]

But Freud shared the views of modern theorists who still try to defend the corticocentric basis of emotion. Thus, he (Freud,[17] pp. 161–162) wrote:

> The process of something becoming conscious is above all linked with the perceptions which our sense organs receive from the external world. From the topographical point of view, therefore, it is a phenomenon which takes place in the outermost cortex of the ego. It is true that we also receive conscious information from the inside of the body—the feelings, which actually exercise a more peremptory influence on our mental life than external perceptions; moreover, in certain circumstances the sense organs themselves transmit feelings, sensations of pain, in addition to the perceptions specific to them. Since, however, these sensations (as we call them in contrast to conscious perceptions) also emanate from the terminal organs and since we regard all these as prolongations or offshoots of the cortical layer, we are still able to maintain the assertion made above [at the beginning of this paragraph]. The only distinction would be that, as regards the terminal organs of sensation and feeling, the body itself would take the place of the external world.

[a]Freud's abbreviation for "perceptual consciousness."

So, even for Freud, affects were only felt once they were "read out" in the cortex, even though there is not a jot of evidence for the view that they are transmitted from terminal organs in the interior of the body to the cortex, via "prolongations or offshoots of the cortical layer."[b] There is, however, growing support for the view that some affects do indeed emanate from inside of the body (see Damasio[18]). Freud thought that affects register "oscillations in the tensions of drive needs" (Freud,[17] p. 198), and he defined "drive" as "the psychical representative of the stimuli originating from within the organism and reaching the mind, as a measure of the demand made upon the mind for work in consequence of its connection with the body" (Freud,[19] p. 122). In other words, bodily "demands made upon the mind for work" are felt as affects. On this basis, Damasio wrote that "Freud's insights on the nature of affect are consonant with the most advanced contemporary neuroscience views" (Damasio,[20] p. 38).

It is certainly true that arousal states are *felt,* and many states of arousal are generated by drive needs. In short, *we become aware of our needs via feelings.* Consider hunger and thirst, for example. According to Damasio,[18] that is what feelings are *for*—which implies that is what *consciousness* is for.[21] Affect is a value system, in terms of which pleasurable feelings signal a state of the body that enhances the chances of survival and reproductive success, and unpleasurable feelings signal the opposite. Significantly, the mechanisms underpinning this—the most fundamental form of consciousness—are located in the upper brain stem and diencephalon. There, bodily "need detectors" (located principally but not exclusively in the medial hypothalamus) activate the basic arousal states that Panksepp[10] calls "homeostatic affects." But there are also more complex types of affect, the source cells and circuits for which are located slightly higher in the brain. These "emotional" affects (such as fear and attachment bonding) and "sensory" affects (such as surprise and disgust) are no less crucial for survival and reproductive success than the homeostatic ones, but they do not simply register the current state of the body. These circuits, which release complex behavioral stereotypes like grooming, fighting, and copulating (and the feelings associated with them), are intrinsic to the brain itself. (This puts paid to the James-Lange theory of emotion.) Emotional circuits, too, arise mainly in the upper brain stem but they also extend higher into the limbic system (see Panksepp[10]). A useful way of distinguishing the types of affect is to differentiate among drives (homeostatic affects), instincts (emotional affects), and reflexes (sensory affects).

The important thing for present purposes, however, is this: all three types of affect are generated by the brain mechanisms that perform the functions that Freud assigned to the id—and they are all *conscious.* In fact, Freud himself always insisted that the notion of unconscious affect was an oxymoron (thereby contradicting his own theory that the id is simultaneously unconscious *and* regulated by the pleasure principle).

To sum up so far: consciousness registers the state of the *subject,* not of the object world. The sentient subject is first and foremost an affective subject. Only then can it *experience* perceptual and cognitive representations. That is why—to state the obvious—there can be no objects of consciousness without a subject of consciousness to experience them. The subject of consciousness is primary. The secondary (perceptual and cognitive) form of consciousness is achieved only when the subject of consciousness *feels* its way into its perceptions and cognitions, which are unconscious in themselves. The pseudopodia of an amoeba, palpating the world, come to mind.[c]

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[b]If affective consciousness truly was a property of the cortex, Freud's "pleasure principle" would be a top-down regulatory principle, which it patently is not (see, e.g., Freud[22]).

[c] *cf.* Freud's description of the process: "Cathectic innervations are sent out and withdrawn in rapid periodic impulses from within [the id] into the completely pervious system *Pcpt.-Cs.* So long as that system is cathected in this manner it receives perceptions (which are accompanied by consciousness) and passes the excitation onwards to the unconscious mnemic systems; but as soon as the cathexis is withdrawn, consciousness is extinguished and the functioning of the system comes to a standstill. It is as though the unconscious stretches out feelers, through the medium of the system *Pcpt.-Cs.*, towards the external world and hastily withdraws them as soon as they have sampled the excitations coming from it" (Freud,[23] p. 231). Note that Freud's "feelers" are *unconscious* until they reach the cortical system *Pcpt.-Cs.* To

Now, we can proceed with our main theme.

Id functions (the hard-wired drives and instincts and reflexes of the upper brain stem and limbic system) are *innate*. They regulate the multiple biological needs of the human organism—which are, incidentally, almost identical with those of other mammals.[10] Each need coincides with a different feeling (e.g., the drive of hunger feels different from sleepiness; the instinct of separation distress feels different from lust; and the reflex of disgust feels different from pain). The ego, by contrast, *learns* from experience. It does so by forging representations (images of regular patterns, mapped onto the cortex from the sensory receptor surfaces, via specific thalamic relay nuclei).

The ego, therefore, is fundamentally bound up with *memory*. And we have discovered a good deal about memory since Freud's death, no less than we have about affect. The first thing to say is that the main task of memory (i.e., of the ego) is not to make a permanent record of everything it experiences. It is not a passive recording device. Rather, the task of the ego is to learn how to satisfy the demands of the id in the outside world, that is, *how to meet its vital and reproductive needs* there. So, what the ego must record in memory is: "What am I to do?," "How do I satisfy these needs?," and "How do I meet these demands?" In other words: "How do I manage my feelings?"—since feelings (both homeostatic and emotional ones) represent needs. Thus, the ego's primary task is: "How do I make my needs go away?" (Incidentally, this task is what Freud called the "Nirvana principle"; but I am not going into all those complexities here).

In the language of contemporary computational neuroscience,[24] the fundamental task of the ego is to make *predictions*—to make predictions as to how it can meet its multiple needs in the world. (Predictions are action plans.) Next, its task is to periodically *update* those predictions, on the basis of ongoing experience. This is Freud's "reality principle." In the language of computational neuroscience, therefore, the ego is regulated by the "prediction error."[25] It updates its predictions whenever they do not work—that is, when they *fail* to regulate the id's needs.

To the extent that the ego's predictions actually come to pass, to that extent they are retained in memory (they are "consolidated" instead of forgotten), while the predictions that do *not* work are *updated* ("reconsolidated'). The recently discovered neural mechanism of reconsolidation is incredibly important for our theme.[26,27] This updating process (reconsolidation) requires *conscious* cognition, also known as "working memory"—what Freud called "thinking." (This, incidentally is why frontal patients are overwhelmed by affect; they cannot think properly.) It is in working memory that one *feels one's way* through a problem once more. Through reconsolidation, the ego rethinks its predictions. As Freud put it: "consciousness arises instead of a memory-trace" (Freud,[6] p. 25; *cf.* Solms[28]). As explained above in relation to affect, consciousness is necessary for cognition because it provides the value scales through which good predictions are distinguished from bad ones (pleasures from unpleasures, of which, I say again, there are a great variety).

But working memory is a very *limited resource*, so it has to be used sparingly. For this reason, among others, reconsolidation is generally *resisted*. Stated differently: *we prefer to confirm our predictions* (*cf.* the "self-serving bias," Campbell and Sedikides[29]). In fact, working memory can only hold roughly seven bits of information in mind (in consciousness) at any one point in time. That is why 95% of our goal-directed activities are executed unconsciously.[30] All nonfalsified predictions are repeated (are stored in the corticothalamic "preconscious" and automatically executed), unless and until a prediction error arises. This (prediction error) releases what Friston[24] calls "free energy"—that is, increased *entropy*. In terms of information theory, increased entropy implies increased *uncertainty*; and in arousal terms, uncertainty implies *salience* (see Pfaff[31]). *Prediction error therefore renders preconscious predictions salient again.* Salience is signaled by arousal. An unmet need is what activates ("hypercathects," as Freud put it) the memory traces that were meant to satisfy it. Only ERTAS arousal can produce the level of activation that is necessary for reconsolidation to occur. In this way, prior predictions (what Freud called "wishes") are subjected—reluctantly—to the reality principle, and they are updated.

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reconcile his conception with contemporary knowledge, we should say "the id [not the unconscious] stretches out feelers."

What I have described so far involves *cortical* memory systems. Only cortical memory systems generate representable (consciously thinkable, so-called declarative) images. Typically, the processes I have described involve *iterative* transfers of predictive traces between three memory systems: short-term working memory, long-term "episodic memory," and "semantic memory." Semantic memory is the deepest (most abstracted) of the three.

But the ultimate aim of learning is to *permanently* solve our problems (i.e., to learn how to meet our needs in the world completely). To the extent that this goal is achieved, the predictions can be more *deeply automatized*. The consolidation of such deeply automatized predictions involves transferring them from cortical to *subcortical* memory systems (principally but not exclusively located in the basal ganglia and cerebellum). The best known subcortical memory systems are the "emotional" and "procedural" systems. The crucial thing to note about these systems is that they are nonrepresentational, *nonthinkable* associations; they are "nondeclarative." This means they are *not subject to updating in working memory.*

They are, in effect, indelible. But they are also highly efficient. LeDoux[32] calls them "quick and dirty." This is the neural basis of what Freud[22] called the "primary process." Via these circuits, X simply triggers Y, with nothing in between (no delay, no thinking, and no "secondary process").

It is important to note that not all automatized memories start out as working memories. The multiple memory systems operate both successively and simultaneously. Some (especially emotional memories, which arise from subcortical associations) are therefore automatized from the outset. Instinct is just another word for innate predictions. Instinctual motor programs are all subcortical, but they need to be supplemented by learning. Fear conditioning is an excellent example. Here, we speak of "single-exposure learning"; for example, we cannot afford to learn twice what happens when we stick our fingers into an electrical socket. (Please note: evolution could not have predicted electric sockets; that is why instincts have to be supplemented by learning.) LeDoux[32] describes such memories as "indelible." Procedural memories, similarly, are "hard to learn and hard to forget." What these two nondeclarative memory systems have in common is this: *they by-pass thinking*. (This happens a lot in earliest childhood, incidentally, while the cortical memory systems are still maturing). But this does not mean that they by-pass *affective* consciousness. Just because we cannot "declare" our automatized predictions does not mean we cannot *feel* their causes and consequences.

Now, we come to the heart of the matter. I have localized Freud's system "preconscious" in the cortex and his system "unconscious" in the nondeclarative memory systems located beneath the cortex, primarily in the basal ganglia and cerebellum. But the unconscious memory systems I have just described are conventionally called the "*cognitive* unconscious," which is contrasted with the "*dynamic* unconscious." Psychoanalysts acknowledge the existence of a cognitive unconscious (they call it the "unconscious ego"), but they point out that it excludes the dynamic processes that Freud discovered (which they call the "repressed" unconscious). Freud thought the repressed unconscious was part of the id. This, as I said at the outset, was his big mistake. The repressed is derived from cognitive (representational) processes, from learning, whereas the id consists of affective (nonrepresentational) processes, and is innate. The parts of the brain that perform the functions that Freud called the "id" are located mainly in the ERTAS and limbic system, whereas the parts that perform the functions he attributed to "the repressed" (or the "system unconscious") are located mainly in the basal ganglia and cerebellum. (There are, of course, multiple interactions between these systems. For example, the amygdala and nucleus accumbens (limbic nuclei) straddle the tail and head of the caudate nucleus (basal ganglia), respectively; and the basal ganglia, in turn, interact constantly with the prefrontal lobes).

In my opinion (which I am stating dogmatically here), the difference between the cognitive and dynamic unconscious is simply this. The cognitive unconscious consists of predictions that are *legitimately* automatized. That is, they are deeply automatized because they fit the bill; they reliably meet the underlying needs they are aimed at. The repressed, by contrast, is illegitimately (or prematurely) automatized. Illegitimate automatization occurs *when the ego is overwhelmed by its problems*—that is, when it *cannot* work out how to satisfy id demands in the world. This happens a lot in childhood, when the ego is feeble. The infamous Oedipus complex provides an excellent example of an insoluble problem: it is an almost inevitable

constellation of compulsive emotional needs, arising simultaneously, which are beyond the reach of the child, and irreconcilable with each other. ("Conflict" is just another word for "insoluble problem"). In such situations, *the child has no other choice but to cut its losses.* It is doomed either (1) to obsess endlessly over a problem that it cannot solve, thereby wasting precious working memory space that could be more usefully deployed for problems it can cope with—such as how do read, write, and calculate—or (2) to make the best of a bad job and automatize the least-bad childish prediction it comes up with, *even though it does not fit the bill.*

This (repression) has the inevitable implication that a deeply automatized prediction does *not* manage the feelings it is aimed at, but there is nothing the subject can do about this, since the essence of repression consists of the fact that the prediction is treated as if it *does* fit the bill, and it is therefore *immune to reconsolidation.* The resultant prediction error is the constant pressure that Freud theorized as the threat of "the return of the repressed." (This, in turn, leads to secondary defenses—that is, to what Freud called "after-pressure").

Where I differ from Freud in this regard is that I do not believe the repressed ever returns; it is only the *affect* (which it fails to regulate) that returns. How many patients actually remember their Oedipal strivings in analysis, for example? In my experience, having consulted widely with analytic colleagues, just about none. This is because nondeclarative memories are nondeclarative. They equally are not, as Freud imagined, "thing presentations" (in fact, thing presentations are no less capable of becoming conscious than word presentations). Nondeclarative memories are purely associative (and permanently unconscious) action tendencies of the kind described above: X simply triggers Y, with nothing in between, as with Pavlov's dogs. No thinking occurs, not even implicitly.

This leads to endless, mindless *repetition*, which is why "transference" is so important in psychoanalytic treatment. Patients cannot rethink the repressed, but they can think about what they are doing now *in consequence* of the repressed. What patients *can* think about—can reproblematize, if it is brought to their attention—is the repetitive *derivatives* of the repressed, which involve cortical representations (of *current* experiences), which can therefore enter working memory and declarative (and reflexive; i.e., frontal lobe) thinking. This, in turn, allows them to be *reconnected with the affects that belong to them*, which enables the ego to come up with better predictions, with more realistic action plans, with the help of an adult brain (and that of the analyst).

After transference "interpretation" comes the hard work of "working through," since the establishment of new procedural memories is a *slow* process. Those who want quicker treatments, and less frequent sessions, will have to learn how learning works.

That is a very quick summary of my neuropsychoanalytic perspective on the unconscious. From all I have said, I hope it is clear why *our patients suffer mainly from feelings.* They do not come to us saying, "Doctor, there is something I'm unconscious of; could you please tell me what it is?" What they say is, "Doctor, I've got this [all-too-conscious] feeling that I don't want; will you please take it away?" Psychopharmacologists try to oblige them on that score. The analytic approach, by contrast, is to help them instead to *understand* their unwelcome feelings, that is, to discern the errant predictions that *cause* them—the unconscious, repressed predictions that our patients are invalidly (and unknowingly) applying to the meeting of their needs (see Solms[33]).

The analytic task is to bring those predictions back to consciousness—to reproblematize them in working memory. This is achieved by redirecting the feelings that the patient suffers from to the repressed predictions that are causing them. But, as I have said, this cannot be done *directly* in the case of nondeclarative memories. It can only be done via derivatives of the repressed—via what is being repeated in the present and can therefore be "declared" and thought about. The unconscious is just that: it is *unconscious*, forevermore. Although we can infer it, we can never experience it. Such inferences (called "reconstructions" in psychoanalysis) help us to better understand the present transference. On the basis of this understanding, all we can hope to achieve are new and better predictions, which must be consolidated alongside the old ones. But since the new ones are *better* at meeting the underlying needs, they are readily employed by the patient, and thus gradually consolidated, evermore deeply, even after the treatment ends. This explains the

well-established "sleeper effect," whereby symptoms continue to improve after the termination of analytic treatments.[34]

There are many other things I would have liked to discuss, such as how we use affects in the so-called countertransference, but that is not my focus in this article. I will end by saying that psychoanalysis is not important; it is *about* something important. It is about "what makes us tick." That is an important question, but it is not the exclusive preserve of psychoanalysis. I hope this brief overview makes clear how much psychoanalysis has to gain from incorporating the findings of other disciplines that are striving to understand the same part of nature: the workings of the human mind. I hope it is equally clear (although I have not emphasized this here) what useful new perspectives can be cast on current issues in cognitive neuroscience if they, in turn, are integrated with the findings of psychoanalysis. Psychoanalysis, with all its faults, recognizes the "peremptory influence" of affect over cognition, and the very existence of the repressed unconscious.

Competing interests

The author declares no competing interests.

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