On the nature of consciousness and empirical methods to study non-conscious processes.[1]

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Abstract

Understanding the nature of Consciousness is currently seen as the biggest challenge to modern science. Subjective experience seems not explainable within our present knowledge of nature. It is generally assumed that human information processing is largely non-conscious and conscious processes are only the top of the iceberg. By studying non-conscious processes we may be able to solve parts of the mystery. Empirical methods do seem to indicate that non-conscious processes are not only responsible for the details of the information processing like colour, form or movement discrimination but are also involved in complex cognitive and emotional processing. This is illustrated by a number of empirical examples. It is concluded that insights in the non-conscious part of our life increases the paradoxical nature of Consciousness.

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Introduction

The nature of Consciousness seems to be the last remaining challenge for science. It is illustrative to quote from a recent article in the NYT which covered a conference on the science of Consciousness which I attended two weeks ago.

New York Times: April 16, 1996

Arizona Conference Grapples With Mysteries of Human Consciousness

By SANDRA BLAKESLEE

[T] UCSON, Ariz. -- Like the proverbial blind men trying to identify by sense of touch a large, thick-hided animal with a trunk at one end and a tail at the other, some of the world's top scientists, philosophers and far-out thinkers gathered here last week to contribute their different perspectives on the elephant of consciousness.

Can machines be conscious? The question elicited a spirited debate between those who said, Of course, it's just a matter of time and clever engineering, and others who replied: Never! It's bad enough that you think consciousness can arise from gray lumps of tissue. It is inconceivable that sentience could ever emerge from wholly insentient matter.

Then there were less contentious questions. Does free will exist? Can consciousness exist without emotions? Are animals conscious? What happens to your conscious mind when you fall into a deep sleep?

And the most debated question of all: is consciousness something very special and unique or is it just the natural byproduct of a complex brain, emerging like wind from intricate weather patterns? .....

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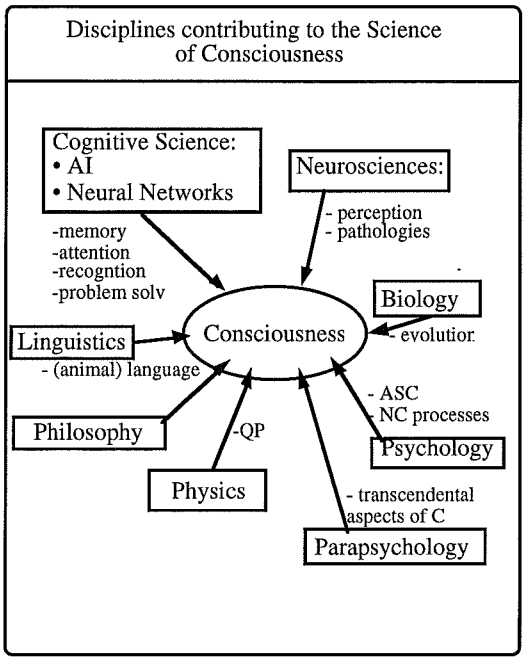
More than 1000 scientist of many different disciplines discussed the small steps towards understanding the phenomenon-of Consciousness. I will pass around the book of abstracts to give you a flavour of the multitude of different approaches.



So it will be clear to you that this presentation can only give a very limited view on the immense effort that is currently going on in all the different related fields. Rather than that I will restrict myself to the (mostly cognitive) psychological perspective. In seminars 3 and 4 I will extend that perspective to the field of parapsychology and will touch upon the relation between (quantum) physics and Consciousness.

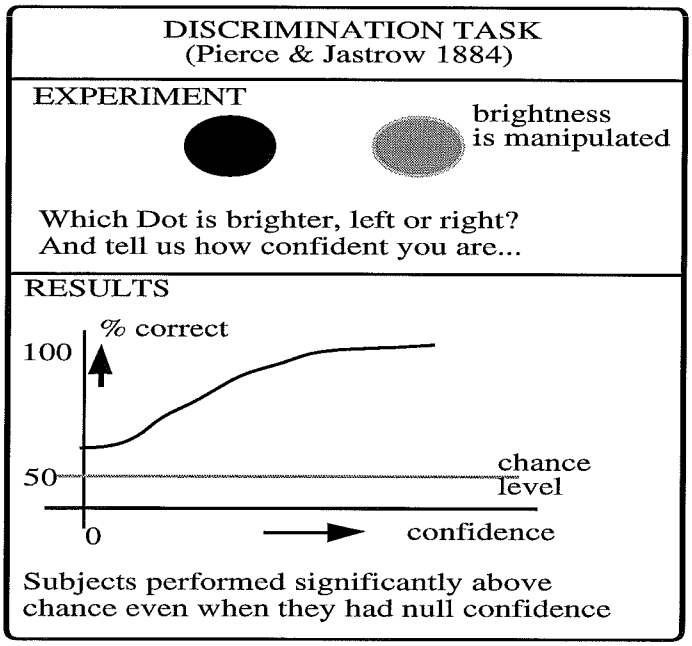
But even from the field of psychology I have to make a selection. The selection I have opted for is to concentrate on empirical approaches rather than semi-theoretical approaches like the whole field of neural networks. The reason is that I want to show that even for a phenomenon-like Consciousness which is beyond any doubt the most private and subjective subject to study, progress can be made by using the hard boiled scientific method of objective enquiry. Whether this ultimately will solve the mystery of Consciousness (if it can be solved) remains to be seen. Personally I have my doubts but let us first consider the findings.

The first finding of Non- Conscious Processes

Psychology is said to be the study of (human) behaviour but it does so by studying supposed intervening processes of that behaviour, most notably memory, sensory perception and emotion.

How do these systems influence behaviour? How do these systems function? These are the questions to be answered.

More than 100 years ago, in 1884 Pierce & Jastrow did the following experiment (fig.1) in their search for the limits of sensory perception. They asked people to choose which of two dots was the brightest. They made the difference in intensity smaller and smaller until the subjects did not see any difference and were forced to guess. They still performed well above chance level.



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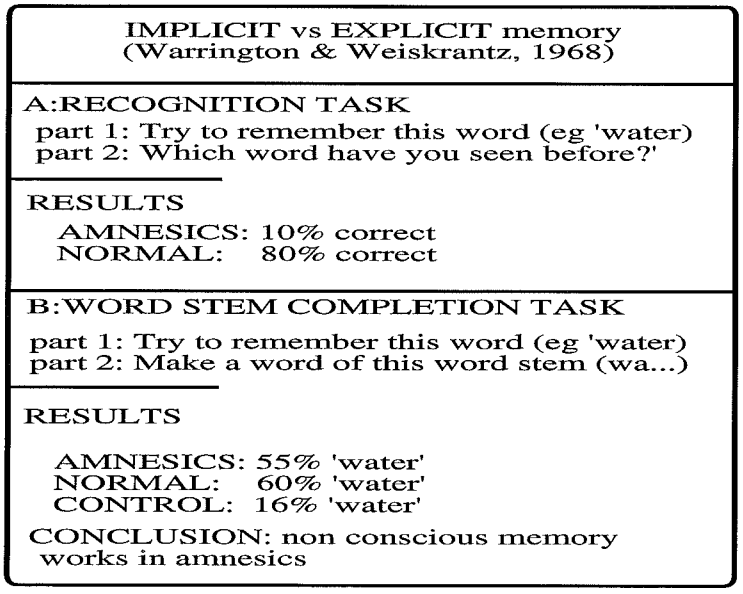
Pierce et al wondered how it could be that behaviour was obviously influenced by sensory perception of which the subject was not aware. This finding however got lost in the behaviourist psychological tradition which denied the possibility that behaviour could be studied by studying intermediate processes. For the behaviourist Consciousness was an irrelevant phenomenon. Some even denied its existence and thus studies which explored the role of non-conscious processes were not to be done.

Implicit Memory

Everything changed about 25 years ago, when researchers in cognitive neuropsychology discovered that severely brain damaged subjects who suffered from amnesia (total loss of memory) and were unable to recall events that only occurred a few minutes ago nevertheless were influenced in their behaviour by the same events.



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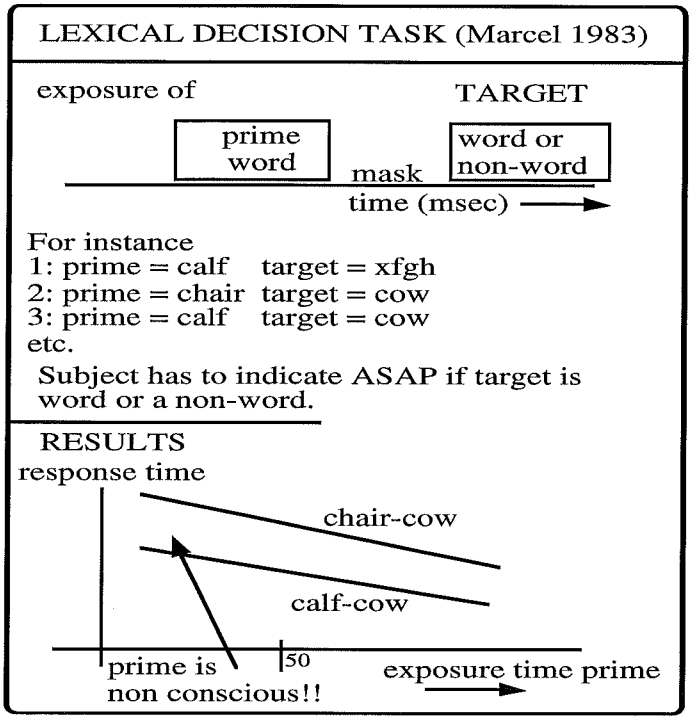
This phenomenon-was labelled implicit memory. Here the subject could not remember consciously by still non-conscious influences of a past episode could be found. The paradigm was called priming. Soon it was established that similar priming effects could be observed in healthy individuals as for instance in the lexical decision task. In this task two stimuli are presented. The first one is called a prime and is generally presented for a short duration. The second one is called the target and is either a real word or a non-word. The subjects task is to decide whether this target is a word. The response time is the dependent variable. The goal of these tasks was to find how the primes influenced these response times thus giving information how words were represented in memory.

Much to the surprise of the researchers it turned out that even when the prime was presented with extreme short exposure times there was still an influence on the task performance.



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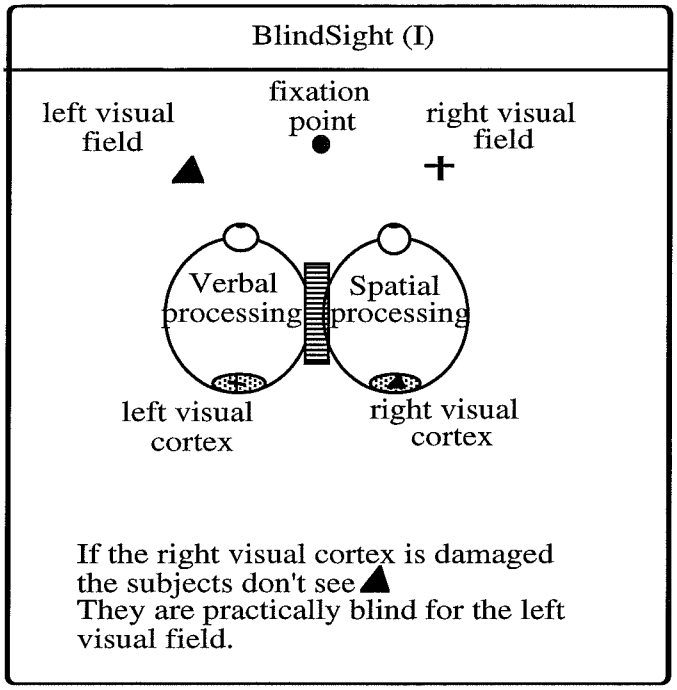
It should be stressed that in this case there is a continuous relation between exposure time and effect. Thus if the prime is given at conscious levels the task performance improves over the subliminal condition. In this type of task non-conscious and conscious processes are on a sort of continuum. But this need not to be so as we will see in due course.

Implicit Perception

The lexical decision task experiment differs from the memory (word stem completion and recognition) experiment I described earlier, in that the stimuli were supposed to be subliminal. Therfore Kihlstrom (Kihlstrom, 1993) proposed to label them implicit perception rather than implicit memory. Typically these experiments used a short duration or otherwise degraded

stimulus. There was a serious debate among psychologists whether these stimuli like the prime words were really not consciously observed or if they were conscious for a short moment but were more or less immediately forgotten (in other words if normal observers became amnesiac for these short duration stimuli).
This debate was to become futile due to the discovery of perception of supraliminal stimuli but where subjects were still unaware of these stimuli. In 1986 Weiskrantz (Weiskrantz, 1986) did a classic study on a phenomenon-that he called blind sight.
His subjects had a damaged right visual cortex and therefore were practically blind in the left visual field (see fig.6a)
However if Weiskrantz requested the subjects to point where they thought the stimulus was, they (after protesting against an impossible task) actually performed amazingly well (see fig. 6b).



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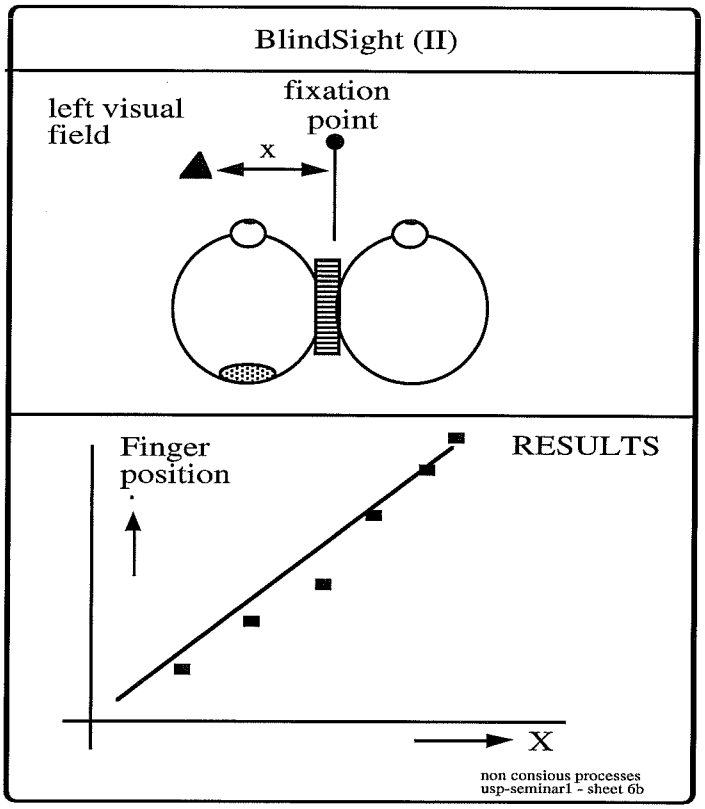
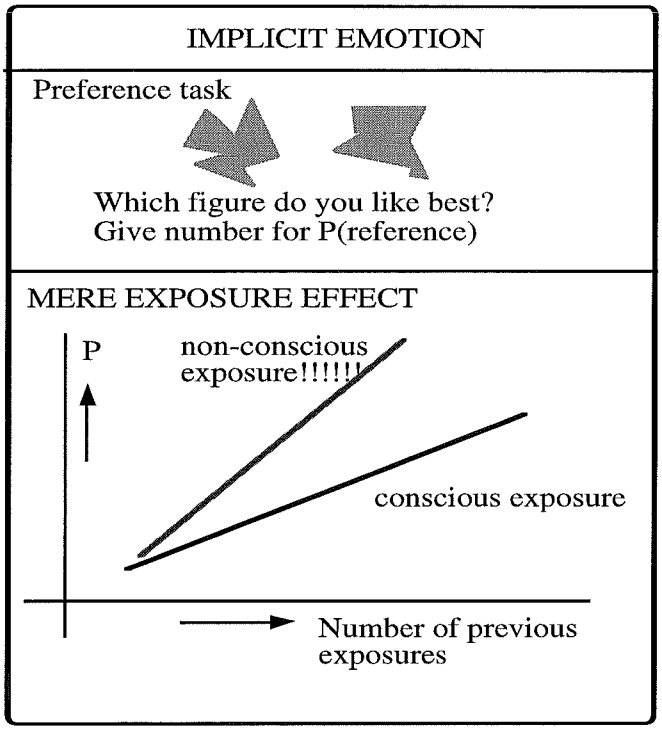
This poses a question: Does blind sight only occur in brain damaged persons or could it also occur in normal people. At the conference in Tucson a paper was presented under the title: *'Too terrible to behold: displays that induce blind sight in normal observers'*.(Braun, 1996) These displays are very complicated so I will not treat these experiments here but the take home message is that it seems rather plausible that implicit perception, i.e. perception without awareness even for supraliminal stimuli is a normal phenomenon.



Implicit Emotion

If memory and perception are possible without awareness, what about emotion?

In a remarkable study, Kunst-Wilson & Zajonc (Kunst-Wislon & Zajonc, 1980) found evidence for implicit emotions or at least implicit 'affect'. In this study subjects were asked to rate polygons for their attractiveness value. In an earlier part of the experiment the subjects had been exposed to these stimuli. It turns out that the more they were exposed to a stimul,us the higher they rated the stimulus for attractiveness value



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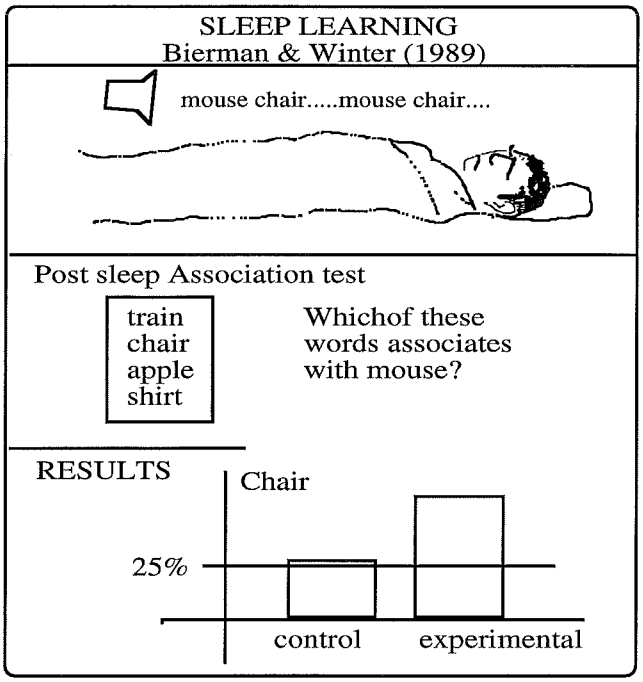
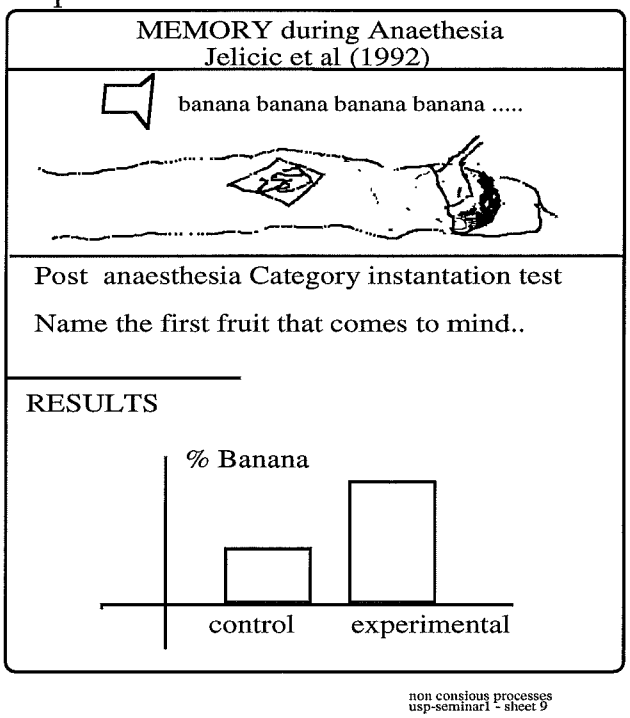
The most remarkable thing in this type of experiment was that in contrast to what was found in the cognitive priming experiments that I discussed before, it turns out that the strongest effects are found when the exposure is subliminal.

So, research on non-conscious processes is revealing that more and more functions that previously had been attributed to Consciousness may be performed completely beyond our ordinary awareness. Where are the limits?

Information processing in Non-Conscious states
For instance : Is it possible to perceive and maybe even learn, during sleep or anaesthesia?
Both research areas are still highly controversial. In a study that I did with a colleague (Bierman & Winter, 1989) we found evidence for learning during sleep (see fig.8)

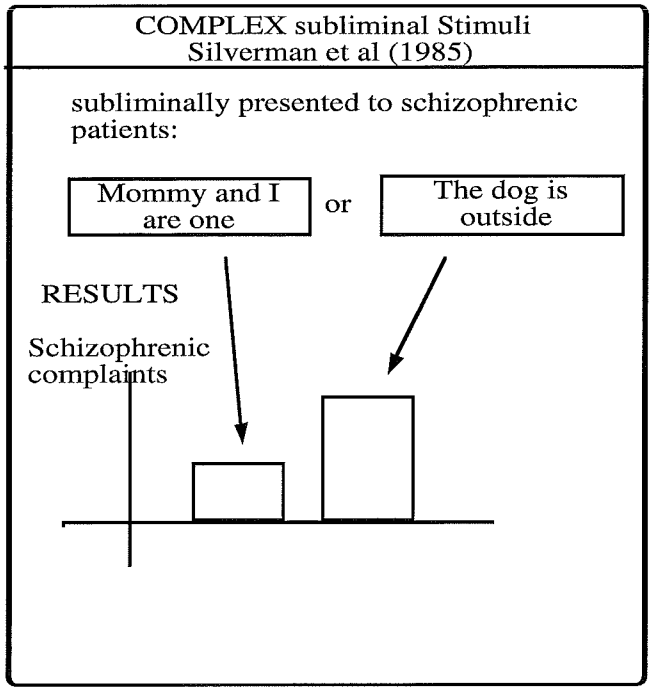


However the effect sizes were small and their statistical significance was marginal. The same can be said of experiments done with subjects who underwent a major operation.



Was Freud right after all?

After having discussed the rather simple phenomena of implicit memory, implicit perception and implicit emotion, I would like to address the question of how complex can information processing be in our non-conscious life. Is it restricted to simple words or may it concern complex conceptual questions? Again this is an area of controversy. In a remarkable series of experiments Silverman et al (Silverman et al, 1985) found evidence for complex information processing. They presented schizophrenics not with a simple words but with complete sentences.



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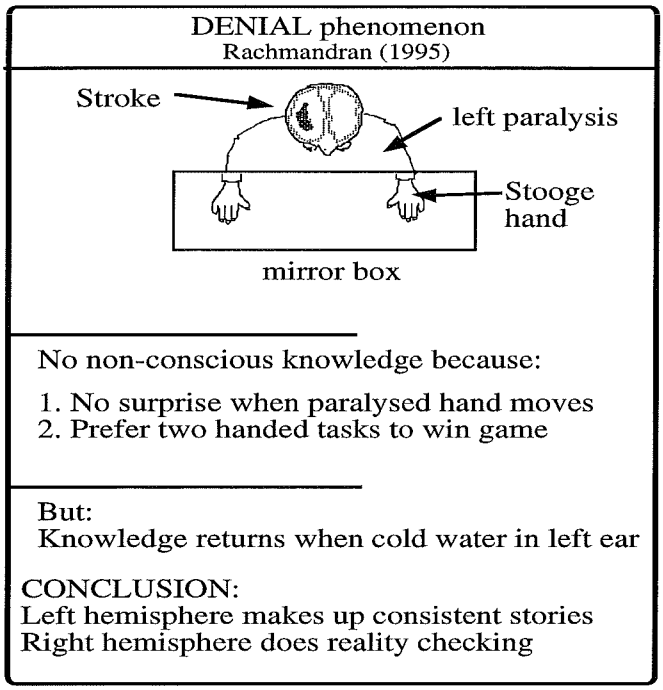
They found significant improvement of the schizophrenic condition with the sentence 'mommy and I are one' compared with a control sentence like ' the dog is outside'. If this is true then it follows that maybe even Freudian notions about the performance of the subconscious were not so crazy after all. But a warning is required. In other studies by e.g. Greenwald (1992) it was clearly shown that subliminal priming with two words (e.g.. enemy loses) did not yield meaningful responses in subjects. Therefore there is still strong doubt about the findings in the Mommy and I are one experiments.

Recently Ramachandran published a number of case studies on the phenomenon-of anosognosia. This is a phenomenon-where subjects who had a stroke in the right hemisphere of the brain and therefore are paralysed on their left arm or leg, completely deny that they are paralysed. Their responses are quite similar to the repression responses that Freud suggested as defense mechanisms to deal with the unacceptable. Such patients would typically say that they are too tired to move their arm or even completely ignore the request to move the arm. Remarkably in this case there seems not to be even an implicit awareness of their denial. In a strange experiment Ramachandran used a box into which the patient's hands were put. But unknowin to them a system of mirrors was installed so that in fact the hands that they then perceived were of a stooge.

When asked to move their paralysed (left) hand the stooge would move the hand but the patient did not show any surprise. In another experiment the patients were asked to choose between two tasks to win a box of chocolates. One task required both hands (Like tying shoelaces) for which one could win a full box. The other task required only one hand (like putting pegs on a pin) and the potential win was smaller. All patients choose the impossible task. But again they denied that they could'nt do the two hand task, even when confronted with their failure!



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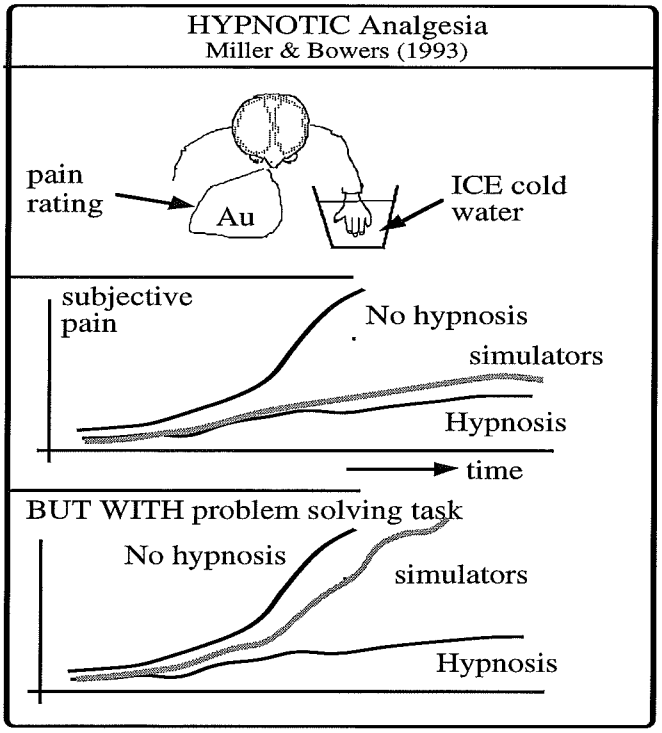
The most incredible thing happened in yet another experiment when Ramachandran applied ice-cold water to the left ear. This is known to induce great neuronal arousal in the right hemisphere. Suddenly the patients did not deny their paralysis any more. This lasted for about 30 minutes. They also referred to the past indicating that they knew all the way that they had been paralysed.

Ramachandran proposes that the left hemisphere at a non-conscious level tries to build a consistent picture of the world (even if repression is needed to keep the picture consistent) while the right hemisphere non-consciously checks for discrepancies between this constructed internal picture and the outer reality. If, due to some stroke, this reality checker is damaged the patients become victims of their own left hemisphere who maintains the consistent picture even if there is considerable data that proof that the picture does not correspond to reality. By applying cold water, the discrepancy detector in the right hemisphere is temporarily restored and enables the patient to build a picture which is more in accord with reality.

Hypnotic analgesia

Many areas that I have presented so far and certainly the ones later in my presentation are controversial. The last experiment that I would like to present to you stems from another controversy namely the interpretation of hypnotic analgesia (the phenomenon-that some hypnotized subjects, given the proper suggestion, report not to experience any pain when a adversive stimuli are administered). That pain experience can be greatly reduced after hypnotic induction is not the controversial issue. It has been shown in many experiments. Most of these used the cold water pressure test where the subjects hand is immersed in ice-cold water. After a few minutes this induces very strong pain sensations under normal conditions. However is the subject is suggested that there will be no pain, the pain reported is much less.

The controverisal question here is if this is really due to hypnosis. It turns out that subjects who are trained to divert their thoughts and are asked to simulate as if they were hypnotised do report exactly the same pain as fully hypnotised subjects.



Miller and Bowers came up with an ingenuous way to decide if hypnosis was merely some state of diverted attention or a state where the pain becomes completely non-conscious due to dissociation of the pain areas of the brain from the cognitive areas. They simply asked subjects to solve some problem while their hands were in cold water. Now it became clear as glass that the hypnotised subjects' performance was not affected by the pain while the simulators simply could not perform the cognitive task. Thus it was unambiguously shown that hypnosis may result in the complete dissociation of specific parts of consciousness.

Conclusion

We may conclude that more and more evidence supports the notion that non-conscious processes are more powerful than we ever imagined. And that the idea that consciousness is just the top of the iceberg of non-conscious processes is not always correct, given the findings in implicit emotions and in hypnosis research. This makes the nature of conscious processes even more paradoxical. Of course it is evident that with *conscious* visual perception we perform better than if we have to rely on implicit perception. However the great mystery is why we have to have a subjective experience attached to this. Evolution could have developed also by making the non-conscious processes more precise. There seems to be no intrinsic reason to doubt that this would have been possible.

The neurological approach, though yielding extraordinary insights in the role of different brain subsystems, does at present give no clue why consciousness developed nor how it is implemented in the brain structure.

As far as I am concerned research on non-conscious processes has resulted in even bigger questionss when it comes to consciousness.
Sorry if this comes as a disappointment. Maybe seminars 3 and 4, which deal with transcendental aspects of consciousness, will give you some idea of the true nature of Consciousness.
(seminar 2 will treat the very mundane subject of the implications of technology for the problem of distance education)

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