B.J. Baars (1988) *A Cognitive Theory of Consciousness*. NY: Cambridge University Press.
(www.nsi.edu/users/baars)

Chapter Ten

The functions of consciousness.

"The particulars of the distribution of consciousness, so far as we know them, point to its being efficacious. ... it seems an organ, superadded to other organs which maintain the animal in the struggle for existence; and the presumption of course is that it helps him in some way in the struggle ..."

--- William James (1890)

"Consciousness would appear to be related to the mechanism of the body ... simply as a (by-)product of its working, and to be completely without any power of modifying that working, as a steam whistle which accompanies the work of a locomotive ... is without influence upon its machinery."

--- Thomas Henry Huxley (18xx - quoted in James, 1890, Vol. I, p. 130).

10.0 Introduction.

Readers who have come this far may be a bit skeptical about Thomas Huxley's claim that conscious experience has no function whatever in the workings of the nervous system. But the great number of useful roles played by consciousness may still come as a surprise. The eighteen or so functions presented in this chapter provide only one way of grouping and labeling these useful services --- some of the labels overlap, and there may be some gaps. But it is doubtful whether any shorter list can do justice to the great and varied uses of conscious experience.

The functions listed below (Table 10.1) really belong to the entire GW system, including both conscious and unconscious components. In this architecture conscious experience represents the jewel in the crown, enabling the whole system to function.

10.01 Conscious experience as a biological adaptation.

A basic premise of this book is that, like any other biological adaptation, consciousness is functional. Many biological mechanisms recruit multiple functions: the eyes pick up information in the light, but human eye-contact also communicates social messages like dominance, submission, affection, and plain curiosity. Consciousness, too, has apparently gathered multiple functions in its evolutionary history; we explore some of these functions in this chapter (e.g. Rozin, 1976; Baars, in press, b). But perhaps the most fundamental function is the one we remarked on in Chapter One: the ability to optimize the trade-off between organization and flexibility. Organized responses are highly efficient in well™known situations, but in cases of novelty, flexibility is at a premium. Of course the global workspace architecture is designed to make "canned" solutions available automatically in predictable situations, and to combine all possible knowledge sources in unpredictable circumstances.

In another way, consciousness and related mechanisms pose a great challenge to functional explanations because of the paradoxical limits of conscious capacity (1.zz). Why can't we experience two different "things" at one time? Why is short-term memory limited to half a dozen unrelated items? How could such narrow limits be adaptive? Naively, it would seem wonderful to be able to consciously read one book, write another one, talk to a friend, and appreciate a fine meal, all at the same time. Certainly the nervous system seems big enough to do all these things simultaneously. The usual answers, that the limitations are "physiological," or that we only have two hands and one mouth to work with, are quite unsatisfactory because they simply move‹j ‹ the issue one step backwards --- why have organisms blessed with the most formidable brain in the animal kingdom not developed

hands and mouths able to handle true parallel processing? And why does our ability to process information in parallel increase with automaticity, and decrease with conscious involvement?

Whenever we encounter a biological phenomenon that seems non-functional there are two possible explanations. First, we may be asking the wrong question: perhaps cultural evolution has simply outpaced biological evolution, and we are now expecting the organism to do things it was not adapted to do. It is a good bet that the nervous system was not developed for academic study, since universal education is only a few centuries old in almost all cultures. This may be the reason that learning in school seems so hard, while learning to perceive the world, learning to move, or learning one's native tongue seem effortless by comparison. If we then ask why children find it hard to learn arithmetic or spelling, we are asking a culturally biased question, one that may seem natural today, but which is biological nonsense.

A second reason for apparently non-functional adaptations may be an invisible "design trade-off" between two different factors (e.g. Gould, 1982). When the mammalian ancestors of the whales returned to the ocean, they must have encountered trade-offs between walking and swimming, and over time lost their legs. This may seem non-functional to land animals like ourselves, but the loss was compensated by a great gain in swimming ability. Conscious limited capacity may involve such a trade-off. There may be powerful advantages for a global broadcasting ability that allows access from any component of the nervous system to all other components. A truly global message, if it is to be available to any part of the nervous system, must come only one at a time, because there is only one "whole system" at any moment to receive the message. Thus, in a sense, vertebrates evolved a nervous system with two operating modes: a parallel (unconscious) mode and a serial (conscious and limited-capacity) mode. GW theory gives one interpretation of the interaction between these dual operating modes.

Biological adaptations tend to be accretive (Gould, 1982; Rozin, 1976). The speech system, for example, is "overlaid" on a set of organs that in earlier mammals supports breathing, eating, and simple vocalization. Likewise, it may be that the global broadcasting property of the consciousness system is overlaid on an earlier function that is primarily sensory. This may be why human consciousness has such a penchant for sensory, perceptual, and imaginal contents compared to abstract or non-qualitative events (e.g. 2.xx).

Following is the most plausible story we can tell about the uses of consciousness, based on the foregoing chapters.

Table 10.1 The major functions of consciousness

1. *Definition and Context-setting*. By relating global input to its contexts, the system underlying consciousness acts to define the input and remove ambiguities. Conscious global messages can also evoke contexts, which then constrain later conscious experiences.

2. *Adaptation and Learning*. Conscious experience is needed to represent and adapt to novel and significant events.

3. *Editing, Flagging, and Debugging*. Unconscious processors can monitor any conscious content, edit it, and try to change it, if it is consciously "flagged" as an error.

4. *Recruiting and Control Functions*. Conscious goals can recruit subgoals and motor systems, to organize and carry out mental and physical actions.

5. *Prioritizing and Access-Control*. Attentional mechanisms exercise conscious and unconscious control over what will become conscious. By relating some particular conscious content to deeper goals, we can raise its access priority, making it conscious more ofen and increasing the chances of successful adaptation to it.

6. *Decision-making or Executive Function*. When automatic systems cannot routinely resolve some choice-point, making it conscious helps recruit unconscious knowledge sources to help make the proper decision. In the case of indecision, we can make a goal conscious to allow widespread recruitment of conscious and unconscious "votes" for or against it.

7. *Analogy-forming Function*. Unconscious systems can search for a partial match between their contents and a globally displayed (conscious) message. This is especially important in representing new information, when no close models of the input are available.

8. *Metacognitive and Self monitoring Function*. Through conscious imagery and inner speech we can reflect upon and control our own conscious and unconscious functioning.

9. *Autoprogramming and Self-maintenance Function*. The deeper layers of context can be considered as a "self-system", which works to maintain maximum stability in the face of changing inner and outer conditions. Conscious experience provide information for the self-system to use in its task of maintaining stability. By "replaying" desirable goals, it can recruit processors able to produce solutions and thereby reprogram the system itself.

10.1 Definitional and Context-setting Function.

In looking through a hollow tube at an isolated corner of a room (1.xx), in listening for the words in a rock song, or in learning to perceive an abstract painting, we engage in conscious observation leading to an experiential transformation. We may experience this transformation directly, simply by attending to the stimulus until it is transformed. But even when we try to understand an easy sentence, rapid transformations are taking place unconsciously: many different unconscious sources of information combine to build a single interpretation of a focal,

rather ambiguous event (Tanenhause, etc.).

If we were forced to choose one premier function of consciousness, it would be the ability of the consciousness system to combine a variety of knowledge sources in order to define a single, coherent experience. Another way to say this is that the system underlying consciousness has the function of relating an event to the three kinds of contexts: to a qualitative context that allows us to experience an event as an object of consciousness, to a conceptual interpretation, and to a goal context that may lead to effective action (Chapters 4, 6, and 7). A word can be experienced without a conceptual context, but such a context is necessary for it to have meaning; and we know that a meaningful word is generally related to some contextual goals, which are not wholly available consciously at the time they guide us. This contextual apparatus is needed to allow even very "simple" things to take place, such as the reader's decision to read the next paragraph.

A related, critical function of consciousness is to evoke relevant contexts in the first place. This is most obvious in the case of conceptual and goal contexts; for example, in the case of the Tip-of-the-Tongue (TOT) phenomenon, where the role of a goal context is quite clear (4.xx). Given the TOT state, we begin to search (unconsciously) for the correct word; this search process, and the goal context of retrieving the word, together will constrain the conscious answers that will come to mind. Context™ setting may not be so clear in more complex cases, like meeting a new person, or encountering a new idea, but conscious experiences in these cases do seem to evoke and create new contexts.

10.2 Adaptation and Learning Function.

Whether consciousness is necessary for learning has led to years of controversy (e.g. Eriksen, 1962; Holender, 1986). But there is little doubt that the more novel the material to be‹j ‹ learned, the more time we must typically spend pondering it consciously before learning to cope with it (5.xx). GW theory suggests that conscious events are broadcast globally to unconscious processors and contexts, which can then adapt to this information. If they cannot adapt immediately, they can act to bring the material to mind at some later time, sometimes many times. Several researchers have shown that personally significant information tends to come to mind again and again, until presumably it is absorbed and adapted to (Singer, 1984; Horowitz, 1975 ab; Klinger, 1971). Obviously we also adapt to the world by action: we can avoid a threatening predator, approach a new source of food, and explore an unusual situation. Action also requires conscious goal images, which must, again, be more consciously available the more novel the action is (7.xx).

10.3 Editing, Flagging and Debugging Function.

Several psychologists have argued that conscious experience plays a role in "debugging" faulty processes (e.g., Mandler, 1975). In particular, it seems that conscious events are monitored by numerous unconscious rule-systems that can compete for access to the Global Workspace if they detect some serious flaw, and which may be able to cooperatively improve the flaw (7.xx). Indeed, we have argued in Chapter 7 that voluntary action is tacitly edited action. On the other side, conscious experience can also be used to "flag" some significant event. The most spectacular example of this is biofeedback training, in which otherwise unconcious events can come under voluntary control simply by having the unconscious event trigger a conscious feedback signal. In this way we can learn to control apparently any population of neurons at least temporarily (2.x). Biofeedback training reveals an extraordinary capacity of the nervous system, one that by itself suggests the existence of global broadcasting.

10.4 Recruiting and Control Function.

Recruiting has much to do with the Flagging Function --- in fact, as soon as we can flag some novel mental event consciously, we may be able to recruit it for voluntary purposes. The ideomotor theory (7.xx) suggests that conscious goal images are necessary to recruit subgoals and motor systems that will achieve‹j ‹ the goal. But of course conscious goal images themselves are under the control of unconscious goal contexts, which serve to generate the goal image in the first place.

The Control Function is similar to the notion of Recruiting of unconscious systems to help in achieving a goal. But consciousness is useful in setting goals in the first place, and in monitoring action feedback for success or failure. To set a goal that is compatible with existing goal contexts, we need to simply become conscious of the goal. Thus: "what is the name of the first President of the United States?" Just being conscious of the question allows the answer to be searched for unconsciously, and candidate answers are returned to consciousness, where they can be checked by multiple unconscious knowledge sources. Feedback checking occurs in essentially all tasks, from striking a tennis ball to checking the loudness of one's voice, to word-retrieval, to mental arithmetic. In all these cases it is useful for errors to become conscious, in order to recruit unconscious error- detection and correction resources.

10.5 Prioritizing and Access Control Functions.

Attention involves access control to consciousness, and assigning priorities is a core issue in access control. Incomplete conscious thoughts tend to evoke conscious. We can apparently use conscious functions to control the likelihood that some piece of information will become conscious more often. Presumably, in the act of voluntarily accessing some information, we also practice the skill of recalling it --- i.e., of making it conscious again (8.0). In vocabulary development we may want to practice certain words to ensure that they will come to mind readily when needed. Recall as the skill of bringing material to consciousness has been studied since Ebbinghaus, but most modern studies ignore the fact that "recall" means "bringing memories to consciousness."

We can change the access priority of information in several ways. One way is to use associative learning techniques, like paired associate learning. If a neutral conscious event is made to signal a horrifying mental image, the neutral event will take on a higher priority (presumably it has more activation, or it is associated with a higher-level goal context), which will make it more easily available to consciousness.

10.6 Decision-Making or Executive Function.

While the global broadcasting system is not an executive mechanism, it can be used by goal systems in an attempt to control thought and action. Chapters 6 - 9 are really devoted to different aspects of this issue. Consciousness can serve as the domain of competition between different goals, as in indecisiveness and conscious, deliberate decisions. In a sense, one can broadcast the goal, "Should I ... ?" followed by "Or shouldn't I ...?" and allow a coalition of systems to build up in support of either alternative, as if they were voting one way or another. The successful coalition presumably supports a goal image that is broadcast without effective competition, and which therefore gains ideomotor control over the action (7.0). This may be called the Decision-Making function of conscious experience.

Goal images do not have to be recallable as conscious in order to influence action. There is considerable reason to believe that fleeting, hard-to-recall goal images can trigger off well-prepared automatisms (1.xx; 7.x). These images then act in an Executive fashion without allowing conscious decision-making; of course, the executive goal images may themselves be generated by complex unconscious goal structures.

10.7 Analogy-Forming Function.

Human beings have a great penchant for analogy and metaphor, and we use this capacity especially to cope with novel or ill-comprehended situations. Lakoff & Johnson () point out that most everyday idioms involve a metaphorical extension from a well-known, concrete situation to one that is abstract or poorly understood. Thus, "the mind is a container," "love is a journey," and "consciousness is the publicity organ of the nervous system." Metaphors are both useful and dangerous. In science we use them constantly, and we must be ready constantly to abandon them when they lead us astray. The Rutherford atom of 19th century physics drew an analogy between the planets around the sun and electrons orbiting a heavy nucleus. Here the similarities and differences are obvious in retrospect; but at the time, of course, one did not know how far the metaphor would work, and where it would have to be abandoned. But it gave one a start. Similarly, whenever we encounter something new, something for which our existing knowledge is inadequate, we look for partial matches between the novel case and existing knowledge. Such partial matches invite metaphors. We can best manipulate those metaphors that are familiar and easy to visualize. Thus we tend to concretize abstract entities and relationships, and thereby transfer our knowledge from one context to another.

The GW system is useful at several points along this path.‹j ‹ It helps in detecting partial matches. It allows many systems to attempt to match a global message, and to display their partial matches globally. It supports competition beween different systems to edit the mental model of the event that is to be understood. And, in its preference for imageable, qualitative experiences, it is probably responsible for the bias for concreteness and imageability that we find in human metaphor.

Indeed even when we have accurate abstract representations of some information, we still prefer less accurate prototypes and metaphors. We know that the average chair is not the prototypical square, brown, wooden, lacquered kitchen chair, yet we continue to use the false prototype, apparently because we have easier conscious access to it than to the more realistic abstraction (Rosch, 1975).

10.8 Metacognitive or Self-monitoring Function.

Conscious metacognition depends on the ability of one experience to refer to other experiences. Normally when we speak of consciousness we include the ability to describe and act upon our own conscious contents. Indeed, the operational definition of conscious experience proposed in Chapter 1 is predicated upon this ability (1.x). But conscious metacognition itself requires the global workspace and consciousness (8.xx). Another aspect of

such a self-referring system is our ability to label our own intentions, expectations, and beliefs, all abstract representations that are not experienced directly in the way qualitative percepts or images are. Nevertheless, people constantly refer to their own intentions as if they were discrete objects in the world.

Conscious self-monitoring is perhaps the single most important aspect of metacognition. There is a great deal of evidence for the view that many adults are constantly monitoring their own performance by reference to some set of criteria that can be collectively labeled the "self-concept." We might expect self-monitoring to play a role in the psychology of impulse control --- if one has an impulse to do something questionable, and if one can internal competition against it, to hold the action in abeyance, chances for control are improved. There is direct evidence that impulsive children can be taught to use inner speech in such a self-monitoring fashion, and that this does indeed help to constrain inappropriate actions (Meichenbaum & Goodman, 1971).

10.9 Autoprogramming and Self-maintenance Function.

We can ask the reader to pay attention to the period at the end of this sentence. We can ask someone to retrieve a memory, to solve a puzzle, or to wiggle a finger. We can learn new habits. All this implies the ability of the conscious system to engage in self-programming. In autoprogramming, goal systems make use of conscious experiences to exercise some control over both conscious and unconscious events. Autoprogramming can encounter obstacles, as in attempts to control smoking, over-eating, or other undesired habits, but it is often quite effective. It presumably combines many of the functions discussed before: context-setting, decision-making, self-monitoring, etc.

The smooth functioning of the whole system is dependent upon a stable Dominant Goal Hierarchy, the deeper levels of which apparently correspond to the "self" of common sense psychology. These deeper levels can be violated by external circumstances, just as any other contextual constraints can be. In addition, there is much clinical experience to suggest that the self can encounter violations of internal origin. Maintaining the self™ system may be critical for mental and physical survival, and one tool for doing so may be the attentional control for access to consciousness. The classical notions of repression would seem to fit in here. The evidence for repression as an unconscious process has been questioned (e.g. Holmes, 1972, 1974), but there is no dispute over the great amount of self-serving ideation and control of access to conscious experience that people engage in.

The evidentiary question centers mainly about the issue whether this kind of control is voluntary and conscious or not. GW theory suggests that this is a secondary issue, since predictable voluntary control tends to become automatic with practice. In any case, Self-maintenance through the control of access of information to consciousness seems to be one central role of the consciousness system.

10.99 Summary.

Conscious processes are functional, just as unconscious ones are. Normal psychology involves a rapid, delicate interplay between conscious and unconscious events. Our list of eighteen functions does not exhaust the possibilities: for example, we have not even touched on the uses of sleep and dreaming. They too must surely have some functional role, probably even multiple roles, which are likely to be bound up with the system we have explored in this book. But this issue must be left for future exploration, along with so many others.

No doubt there will be some who continue to advocate the curious doctrine of epiphenomenalism, the idea that conscious‹j ‹ experience has no function whatsoever. All we can do is point to the evidence, and develop further demonstrations that loss of consciousness through habituation, automaticity, distraction, masking, anesthesia, and the like, inhibits or destroys the functions listed here.

Some epiphenomenalists seem to adopt their position to defend the special and unique status of conscious experience. They are right. Consciousness is special. But its wonderful qualities are not isolated from other realities; nor is biological uselessness a special virtue. Consciousness is the vehicle of our individuality, something that makes it of inestimable significance to each of us. But viewed from the outside, as an element in a larger system, the marvel of consciousness is one more wonder in an awesome nervous system, supported by a body that is scarcely less wonderful, evolved and maintained in a biosphere of endless complexity and subtlety, in a universe one of whose most miraculous features, as Einstein has said, is our ability to know it.