

Possible Levels of Animal Consciousness with Reference to Grey Parrots (*Psittacus erithacus*)¹

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SYNOPSIS. Researchers often study nonhuman abilities by assuming their subjects form representations about perceived stimuli and then process such information; why then would consciousness be required, and, if required, at what level? Arguments about nonhuman consciousness range from claims of levels comparable to humans to refutation of any need to study such phenomena. We suggest that (a) species exhibit different levels attuned to their ecological niches, and (b) animals, within their maximum possible level, exhibit different extents of awareness appropriate to particular situations, much like humans (presumably conscious) who often act without conscious awareness of factors controlling their behavior. We propose that, to engage in *complex* information processing, animals likely exhibit perceptual consciousness *sensu* Natsoulas (1978), *i.e.*, are aware of what is being processed. We discuss these issues and provide examples suggesting perceptual consciousness.

INTRODUCTION

A little knowledge is a dangerous thing;
Drink deep or taste not the Pierian
spring:
There shallow draughts intoxicate the
brain,
And drinking largely sobers us again. . .
Alexander Pope, *Essay on Criticism*,
pt.ii.

The study of consciousness, particularly in nonhumans, is one of science's thorniest current problems. As relative naives to the field, sipping at the aforementioned spring, we find the topic intoxicating but are overwhelmed by its distinctions, disagreements, and controversies. Assertions about nonhuman consciousness range from claims for emergent levels in Cambrian organisms (Hameroff, 1998), to levels comparable to humans (*e.g.*, Griffin, 1992), to denial of the need to study such phenomena (Kennedy, 1992; Blumberg and Wasserman, 1995). Debate centers around two issues,

neither of which is easily resolved nor specific to nonhumans. The first involves defining conscious behavior. How *do* we define it? How is it related to awareness? To intentionality? To cognitive ability? The second issue is whether we gain anything by positing conscious, in addition to cognitive, behavior. Yet even if we deny consciousness a role in governing behavior or its existence entirely, we must account for its place in human beliefs. We contend that debate on these issues can advance research.

ASPECTS OF CONSCIOUSNESS

Lacking a consensus definition, we are left with ways people *use* the term "consciousness." It can be described by a contrast of levels or states, *e.g.*, access versus phenomenal consciousness (Block, 1996); state versus creature consciousness (Rosenthal, 1993); or reflective, primary and peripheral consciousness (Kihlstrom, 1987). Unconsciousness involves that which is outside of attention or awareness, not accessible to introspection. Comparative psychologists and cognitive ethologists who address consciousness in their subjects examine what is usually termed "perceptual consciousness" and "reflective consciousness" rather than "phenomenal conscious-

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ness” (Griffin, 1998). Perceptual consciousness encompasses awareness of one’s sensory perceptions, *e.g.*, how information provided by the senses is acknowledged, processed, and integrated such that it can be used for several purposes (Natsoulas, 1978). This definition requires an organism to be aware that it *is* processing information, possibly of how it is processing information, but not that it be aware that it *is* aware of how information is processed. Reflective consciousness encompasses central monitoring of sensory inputs and mental states, executive control of decision making and voluntary action, awareness of one’s own thoughts (being aware that one is aware; Carruthers, 1992) and attribution of mental states to others, and has been implicated in some types of deception. Phenomenal consciousness involves distinctive, unique, subjective aspects of mental states—or *qualia*, particular qualities of experience (Chalmers, 1996). What, for example, are qualia corresponding to “redness”? Do two beings seeing “red” have identical experiences? The origin and maintenance of perceptual and reflective consciousness can be tied to ecology, natural history, and evolutionary thought by their putative adaptive value. But “red” is not experienced with continuity across species if only because their physiologies of color perception differ.

To examine consciousness, scientists attempt to simplify, contrast, and isolate its aspects; for example, it has been studied as working memory, controlled (*vs.* automatic) behavior, and attention (*i.e.*, related to goal selection, vigilance, spatial orientation, or focus). When broken down into such components, consciousness becomes difficult to distinguish from cognitive traits or abilities that must underlie it. Arguments for human consciousness are often based on introspective report (Searle, 1998); in non-humans, for whom we lack such reports, we may question the distinction between cognition and consciousness. What do we gain by positing aspects of consciousness, *e.g.*, perceptual awareness or central monitoring/executive control, beyond saying that subjects have cognitive apparatuses sufficient to carry out the experimental task?

GOALS OF THIS PAPER

We approach these questions by positing simple stances on brain function, evolutionary continuity, and relationships between some cognitive abilities and awareness in the hope of provoking debate and improving contrast on the issues. We propose that:

(1) Perceptual and reflective consciousness are functions of a brain’s combined associative and representational capacities; the richer those capacities, the greater the scope of an animal’s perceptual and reflective consciousness. We argue, however, not that brain homologies, analogs, and evolutionary convergences afford evidence for all aspects of consciousness but, as for cognitive abilities, only for the possibility of various levels of nonhuman consciousness: We suggest that various species exhibit different levels of awareness attuned to their ecological niches (see below). Given that humans, presumably conscious, often act without conscious awareness of factors controlling their behavior (*e.g.*, see Berns *et al.*, 1997; Weiskrantz *et al.*, 1974; Nisbett and Wilson, 1977; Siegler and Stern, 1998), we argue that species, within their maximum possible level, exhibit different extents of awareness appropriate to particular situations (see Chalmers, 1996; Allen and Bekoff, 1997; Delacour, 1997).

(2) Some cognitive abilities may be isomorphic with aspects of consciousness: Levels of cognitive transfer, association, and cross-modal integration required in some experimental tasks correspond to levels of perceptual and/or reflective consciousness. We also contend that perceptual consciousness can be termed “awareness,” and that what Pepperberg (1992) has defined as complex, higher-order cognition is equivalent to awareness, as an aspect of consciousness. Isolating awareness from other aspects of consciousness is not without precedent. For Chalmers (1996, p. 28), awareness is “. . . a state wherein we have access to some information, and can use that information in the control of behavior,” but the state need not include phenomenal consciousness because it can exist “. . . without any particular associated phe-

nominal experience.” Chalmers later redefines awareness as coherent with consciousness (p.219ff), but we believe much can be gained by focusing on awareness. We document (below) specific behavior patterns that suggest rudiments of perceptual consciousness (awareness) in Grey parrots (*Psittacus erithacus*), without claiming such consciousness matches that of humans.

PERCEPTUAL AND REPRESENTATIONAL
CONSCIOUSNESS AND BRAIN FUNCTION:
ANALOGIES TO NAMING AND COUNTING

We find parallels between studies of consciousness/awareness and those in other cognitive areas that engender similar levels of controversy, and argue that cautions needed—and often ignored—in those areas be applied to the current problem. Specifically, animal consciousness debates recall those on animal “language” and animal “counting.” In all cases, some researchers define the trait as whatever animals cannot be shown to do (Fouts, 1973). Such a definition has both negative and positive aspects. Negative aspects are clear: Whatever level of competence animals demonstrate, detractors simply “up the ante,” redefining the concept so as to exclude nonhumans. Positive aspects are less clear but related and extremely important: Studies on nonhumans have forced researchers to examine in detail just what does constitute language, counting, and now, we hope, awareness and possibly consciousness.

We summarize these parallels without giving detailed reviews of either language or counting studies. To call behavior “naming” or “counting” (or “conscious”) when it represents a simpler category not only causes confusion and miscommunication, but also may prevent us from determining the full extent of nonhuman abilities: Researchers, for example, call a budgerigar’s (*Melopsittacus undulatus*) ability to associate a symbol and one specific object “naming,” without even demonstrating transfer to related items (Manabe *et al.*, 1995). Might the bird be able to label not only a training light as “green,” but also transfer that label to all shapes, objects, and instances of that color? By giving the most complex of labels to a low-level action, re-

searchers settle for describing only the simplest behavior, and risk dissuading further research or missing what might be an animal’s highest competence level (Pepperberg, 1998, 1999). Various hierarchical behavior levels exist that are related to “naming” in its richest sense; the level actually demonstrated must be specified carefully (Savage-Rumbaugh, 1986; Pepperberg, 1998, 1999). The same argument holds for other aspects of language (*e.g.*, Bickerton, 1990), counting (*e.g.*, Davis and Pérusse, 1988; Pepperberg, 1988) and, we contend, consciousness in any of its senses. We argue that consciousness and awareness, like language and counting, are not unitary phenomena, but rather multilevel (Goodyear *et al.*, 2000). Linguistic and counting abilities are present at some level in taxa as diverse as birds and primates; all can exhibit certain, but not necessarily all, aspects in a particular situation (Delacour, 1997). Those abilities must be due to homologous or convergent brain evolution, perceptual structures, and learning mechanisms. We propose that a continuity of *perceptual consciousness*—higher order cognition, or “awareness”—can exist across taxa for the same reasons. To wit, animals may exhibit rudiments of awareness as they exhibit rudiments of language and counting. To ignore the presence of such rudiments because their fullest expressions have not been uncovered would not only be as serious an error as using the evidence to claim behavior equivalent to that of humans, but may also miss important intermediate levels.

We thus argue for extreme care when claiming conscious or nonconscious, aware or unaware behavior in nonhumans (and, for that matter, in humans). A specific example may explain our position. “Insight” is usually considered a fully unconscious process in which an organism is unaware how current information is processed, what earlier information is accessed, and how multiple sets of information are integrated to arrive at a solution. We, however, suggest how insight can involve some *rudimentary* awareness: The organism (whether human or nonhuman) is clearly aware of the need to solve a problem and likely has some

awareness of relevant incoming information.

COGNITIVE ABILITIES: WHY POSIT LEVELS OF AWARENESS?

Most researchers study cognitive behavior by assuming their subjects form representations about perceived data and then process such information; why then is consciousness or awareness required, and, if required, at what level? Delacour (1997, p. 259), for example, posits consciousness as simply a "... certain style of cognition, characterized by a particular integration of different processes..." Two possibilities exist for arguing for awareness, at least, as distinct from both general task-solving abilities and other aspects of consciousness. First, we propose that, when engaging in some forms of *complex* information processing, animals exhibit "perceptual consciousness": are aware of what is being processed, *sensu* Natsoulas (1978) and consistent with Delacour. Complex comparative psychology tasks (*e.g.*, transfer, category formation) require integrating perception, centralized monitoring, and behavioral control; in contrast, simpler associative processes probably require only perception. We thus argue that awareness (higher order cognition defined, *e.g.*, in Pepperberg, 1992) is required for complex tasks; we provide examples involving the existence of such awareness. Second, although we have yet to find that positing conscious behavior has led us to any fruitful experiments that would not otherwise have been done, we suggest that, for a select few tasks, a purely information-processing account is insufficient to explain the observations completely. Our data do not provide evidence for consciousness equivalent to that of humans, but present limited evidence for some of its elements.

Levels of awareness: Examples from laboratory and field studies

Some examples may clarify our definitions of levels of awareness. Let us posit a task hierarchy roughly paralleling Thomas' (1980, 1996) hierarchy of cognitive behavior to determine what level of awareness appears necessary for accomplishing each

task. By itself, positing lower awareness levels neither provides explanatory information nor defines awareness; rather the *contrast* it provides with higher levels may assist our behavioral analyses. Lower levels of information processing may involve, but do not require, high awareness levels.

An organism is startled by a very loud tone. After several exposures, the startle response begins to wane. We believe that an organism that simply *habituates* does not require any level of awareness. Such behavior is exhibited by almost every living creature with a nervous system.

A white rat consistently presses a lever at the appearance of a *specific* green block to obtain a food reward. No other objects are ever introduced and no other responses are ever required. Such behavior can be considered the simplest form of *associative learning*, and may, but need not, require any level of awareness. The organism most likely responds based on a "habit system" (*e.g.*, Mishkin and Petri, 1984; Squire *et al.*, 1993), which uses a particular neural pathway that stores response tendencies but not neural representations (see Kintsch, 1996 for a detailed summary). The organism needs no representation with which to compare the object or indicator, nor any concept of "greenness," "blockness," etc. Such behavior patterns are not unlike the simplest fixed-action patterns found in certain organisms. (Levels of awareness present in more complex forms of associative learning can be inferred from examples given below.)

What about an organism that supposedly has learned to "choose nonmatch," *i.e.*, peck a green button when given a red sample and red and green choices? Interestingly, pigeons do not learn to choose green, but slowly learn to match and then avoid pecking the match (Zentall *et al.*, 1981). A pigeon need not be aware of anything specific about the green sample, nor that it is being trained with respect to oddity, nor of any concept of redness. We suggest that the pigeon has the **first level** of awareness: the ability to follow a simple rule involving perception of a specific item and its avoidance. The pigeon need not necessarily be *aware* of devising or following the rule. If it were indeed aware of the rule, it could

transfer immediately to a task using vertical and horizontal samples; if aware of “redness” it would easily transfer to a task where red was now correct . . . but such is not the case in this instance. Possibly a pigeon’s difficulty in learning this behavior stems from its unnaturalness: To avoid pebbles mixed with grain, a pigeon would not learn to recognize pebbles but would preferentially learn to recognize grain. In contrast, a response to Batesian mimicry, which usually involves one-trial learning, would suggest a higher-order awareness (see below).

What about an animal that has developed a “learning set”? The organism, having been given a series of discrimination problems, each using a new object pair, acquires a win-stay/lose-shift response (at 80–90% accuracy) after ~200 problems (Macphail, 1982). We suggest the organism has a **second level** of awareness: knows not only that a rule exists with respect to “likeness/familiarity” (first level), but is aware enough of the rule to transfer it across situations. If, however, the organism were truly aware of using the rule, it would, when transferred to a win-shift/lose-stay paradigm, readjust after only a very few trials; most organisms do exhibit a savings in trials from the initial acquisition, but do not transfer quickly (Rumbaugh and Pate, 1984). In nature, many foragers likely have such awareness (e.g., hummingbirds that fully empty a flower’s nectar in nature—*i.e.*, win-shift—transfer across inflorescences but do not transfer quickly to win-stay in an operant setting; Cole *et al.*, 1982).

What about a chimpanzee that has acquired a concept of category? The subject, after learning to sort samples into “food” and “not food” without eating samples during the sort, can sort a new pile appropriately (Savage-Rumbaugh *et al.*, 1980). It must sort items not only with respect to the category rule, but also respond to a new set based on prior data: Which of these items have been previously found edible? The subject must *integrate* two different sets of stored information, which we suggest requires **third level** awareness. Whether the actual integration is performed consciously or not, the animal likely has some represen-

tation or memory of what was edible in the past, and has learned to sort based on this representation, not on any specific physical quality (e.g., color). Animals that engage in *a wide variety of* foraging strategies likely exhibit this awareness level. An animal that can respond on the basis of relative class concepts (e.g., bigger/smaller) has this awareness level: must sort based on a rule that involves no intrinsic properties of a specific object, and must compare items to determine which fits the concept and thus, again, integrate two different sets of information.

What about a parrot that examines a tray of blue and green blocks and balls and in response to a specific query labels the number of blue blocks (Trick and Pylyshyn, 1989; Pepperberg, 1994)? Some representations of blueness and blockness must be formed and integrated to enable a search, and this representation must be *maintained* during the enumeration process, which itself draws on some representation of number. The bird, however, may not consciously be engaged in the enumeration process (e.g., may use an alternative perceptual mechanism; Davis and Pérusse, 1988). We suggest a **fourth level** awareness. Possibly wild birds that determine their course of action by recognizing which neighbor is singing, which song is being sung (*i.e.*, integrate representations of specific bird and specific song, like blockness and blueness versus other combinations), and the number of repetitions of the song (e.g., Beecher *et al.*, 1996; Smith and Smith, 1996), exhibit such an awareness.

What about organisms that not only solve a complex Piagetian object permanence task, but also demonstrate knowledge of the specific item that was hidden (Funk, 1996; Pepperberg *et al.*, 1997)? Here an object is placed in a small container; the container is then passed under successive screens until the item is hidden in the designated site, whereupon the researcher shows the empty initial cover, then passes it under another screen, and finally leaves the initial cover in an accessible site that varies in each trial. An additional, untouched screen is present to see if the subject examines only screens handled by the researcher. A subject shows

it is not using a “go to last place item was seen” or “go to last place researcher touched” rule by ignoring the initial cover. The order of movement varies among trials. On occasion, a researcher tricks the subject by showing that a particularly desirable item is being hidden, but hides something else. Here the subject must have some level of awareness of and memory for the identity of the hidden item to respond with “surprise” (see below) when a less desirable one is found; the subject must also be actively tracking the item’s movement to infer when and where it was hidden, and remember the site and how to extract the item from the site, because simple rules will not provide the answer. An organism may not be aware of its *use* of these multiple representations, but must be aware *of* these representations and the cognitive dissonance arising when its representation is not matched. We thus argue for **fifth level** awareness: Natsoulas’ (1978) perceptual consciousness. Birds in nature that remember not just where they cached an item, but when and the specific nature of the item (Clayton and Dickinson, 1998) presumably need to demonstrate such awareness.

What about a parrot who, given 7 items of various colors, shapes, and materials and asked to label the color of the one that, for example, is wood and square, on occasion successively provides each of 6 possible wrong answers, then repeats the wrong answers, thus avoiding the correct answer on 12/12 trials (Pepperberg, 1992)? A chance explanation is not supported by statistics. And, unlike the pigeon that used identity to respond to what researchers assumed was oddity, the parrot is not performing a familiarity match: It sees 7 items, and must use a recursive mechanism to decode a symbolic query to remember and provide the designated attribute (which must in turn be symbolically encoded) of the one item defined by conjunction of two other attributes: provide the color label of the one item symbolically labeled wood *and* square from an array of other items that are wood *or* square, but not both. The bird must have a representation of the labels of all attributes, integrate that information with a search for the appropriate item (which re-

quires combining representations of two attributes), encode the correct attribute label, then specifically avoid uttering that label to produce all other relevant labels for 12 trials. We suggest some awareness drives this behavior. The level may not go beyond that of perceptual, and we hesitate to argue for one comparable to that of humans, but do argue for at least level five.

Possible advantages of positing awareness and other aspects of consciousness

To return to our earlier question, what are the benefits of positing consciousness or awareness rather than cognitive behavior? Two possibilities exist. First is that testing for consciousness or awareness leads to experiments that would not otherwise be performed. Such is the case for positing complex information processing in animals (see Balda *et al.*, 1998). In no instance, however, were the studies described above designed to test for consciousness or awareness. Second is that an information-processing explanation cannot completely account for the behavioral data. We hesitantly suggest such may be the case for results of the last two experiments.

In the object permanence study, parrots react with surprise and anger (*e.g.*, odd yips, beak-banging) when the hidden item is other than the expected one (Pepperberg *et al.*, 1997). The standard argument is that the subject has a representation of what is hidden, and reacts to the difference (the cognitive dissonance) between the observed item and its representation. The birds’ reactions also suggest they do not expect that item A can routinely “turn into” B. But why is the observed reaction one of surprise and anger, not continued search or immobility? Their behavior differs strikingly from that of a very young child who predictably looks longer at a situation that violates its expectations (*e.g.*, Baillargeon *et al.*, 1985), or the standard, expected dishabituation response (Mishkin and Petri, 1984). As far as we know, a computer, the ultimate information processor, assuming it can be programmed to perform the inferential searching task, would (unless programmed for this specific eventuality) react with an “error message,” and freeze. We

can, of course, argue that anger and surprise are the “error messages” emitted by a non-human. We do not suggest that dissonance in cognitive processing requires or must be indicated by emotions; a glance at any daily newspaper would be enough to argue that “gut-level” emotional responses often short-circuit cognitive processes in humans; might the anger of a parrot be a short-circuiting of the logical response to continue searching? Is it logical or illogical to continue searching when all logic points to the item being “there”? What *is* the logical response? All we can suggest is that the animal must be aware of this cognitive dissonance and the immutability of items, at the level described by Natsoulas, or it would not exhibit such emotion-driven surprise at the outcome. Nevertheless, lack of a specific surprise reaction might not be telling. Allen (1997) would argue that our birds’ reactions indeed indicate awareness because they differ, for example, from the slow extinguishing of lever pressing in an unaware animal whose expectations are violated. We would like to accept Allen’s argument, but cannot: Given operant experimental design, researchers would not observe any initial surprise reaction in the supposedly unaware animal, and its slow extinguishing is not so different from human reactions when food does not come, as expected, from a vending machine: We have all watched humans repeat their button presses numerous times. Can we argue for awareness based on positive reactions when absent reactions need not denote unawareness?

What about arguments that suggest reactions of anger and surprise in such cases require a level of awareness implying proto-consciousness, similar to levels of proto-language and proto-counting? Is it because the bird lacks or because it has full awareness that it does not immediately respond with, for example, prolonged search? One bird did continue to search, but only after displaying anger. Is that behavior smart, aware, or stupid? Positing higher-order *information* processing or even awareness leads us only to expect a reaction indicating cognitive dissonance, not the nature of the reaction or any explanation of the reaction

that occurs. Interestingly, positing the addition of *conscious processing* leads to an unexpected end.

For some researchers, a specific feature of consciousness is the existence of “. . . noncomputable, seemingly random, conscious choices with an element of unpredictability. . .” (Hameroff, 1998; also Barinaga, 1996; Allen and Bekoff, 1997). Our birds’ behavior in the above example appears to fit this mode. Thus we are led to the somewhat surprising conclusion that a subject is most conscious when normal cognitive processes fail and it must access something else to decide how to proceed (Allen and Bekoff, 1997). This “something else” is not necessarily logical and can be an emotional state. Have we circled back to Mishkin and Petri’s “habit state”?

Let us look at the second level-five example, the successive wrong responses, for information. Might an organism be conscious if it knows why it should respond in a given way yet opts to respond differently? A human who recognizes that excessive anger at authority figures is not a logical response to being stopped for speeding but stems instead from rebellion against overcontrolling parents can inhibit inappropriate levels of anger at a policeman writing a ticket. Is the process similar, if reversed, for a bird who gives the wrong answers? It recognizes that a correct response yields a specific reward, but chooses to inhibit that response to elicit some other caretaker reaction. The correct answer is logical; the bird chooses to respond in an intentionally illogical manner. We argue, again hesitantly, that the bird is aware not only of what it needs to answer *incorrectly*, but also of how to use its knowledge to affect its trainers’ behavior for its own ends, and is thus above level five. We again seem to see “. . . noncomputable, seemingly random, conscious choices with an element of unpredictability. . .” But what do we gain by positing consciousness beyond awareness?

CONCLUSIONS

We find ourselves in an interesting quandary. We began by looking at information processing, argued that the higher orders (previously defined as cognitive processing,

Pepperberg, 1992, 1998) appeared to require some awareness about what is being processed *sensu* Natsoulas (1978), but found a need to acknowledge noncognitive (or not necessarily logical) processes when we attempted to interpret our data to incorporate consciousness. Thus we suggest that researchers studying higher order processing—objective aspects of animal behavior—may arrive at more detailed explanations by invoking perceptual consciousness (awareness) but will likely gain little by positing other aspects of consciousness; we also suggest that awareness can be defined as higher-order cognitive processing and vice versa, because both are defined with respect to accessing information that is then used in the control of behavior. In contrast, we find that, in agreement with Dawkins (1993), consciousness (or proto-consciousness) may assist in examining *subjective*, *i.e.*, emotional, aspects of animal behavior and the *boundary* between the subjective and objective. We suggest that consciousness depends on certain cognitive abilities, but has some existence apart from them. Although the internal, subjective nature of consciousness means that little evidence exists for its presence other than, for humans, as individual reports about integrative processes involving awareness, we posit that the evolutionary homologies/convergences across taxa in brain function that lead to continuity (but not necessarily isomorphism) in cognitive processing also allow for (but do not necessarily lead to) convergence (but not necessarily isomorphism) with respect to consciousness. We end by cautioning and admonishing fellow scientists to avoid superficial forays into the realm of consciousness and to recognize both limitations and advantages of positing consciousness, depending upon the focus of their research.

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