

Do orcas use symbols?

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Abstract: Recent theoretical studies of culture in whales and dolphins have reviewed experimental research on captive animals and patterns of behavioral variation found in wild populations. Captive studies of cognitive processes in dolphins, such as imitation, teaching, and use of gestures and other symbolic representations, have provided indications of the capacity for culture in dolphins. The ethnographic approach, based on evolutionary ecology, has found evidence that the vocal and behavioral traditions of killer whales (*Orcinus orca*) appear to have no parallel outside humans. To date, however, no published theory has provided a synthesis that accommodates both the experimental findings and the ethnographic evidence. The theory of symbolic interactionism, borrowed and adapted from sociology, provides a conceptual framework for integrating the experimental "process-oriented" and the ethnographic "product-oriented" perspectives. Symbolic interactionism may help account for the divergent and complex cultural traditions found in sympatric orca populations.

Keywords: Animal culture; cetaceans; cognition; convergence; culture; cultural identity; cultural transmission; dolphins; empathy; interpretation; orca; paradigm shift; sociology; symbolic interactionism.

1. Introduction

Rendell and Whitehead (2001) reviewed the evidence for cultural transmission in whales and dolphins from the perspectives of captive experimental studies, field studies based on evolutionary ecology and research on cultures in other animals. From the ethnographic perspective cultural transmission is deduced from spatial, temporal or social patterns of variation in behavior that are not consistent with genetic or environmental determination or individual learning. However, there is little consensus on what constitutes culture in non-human animals (Rendell and Whitehead 2001), although there is no empirical evidence supporting definitions of culture that make it a trait only humans show (Mundinger 1980). After a review of available definitions of culture R&W adopt Boyd and Richerson's (1985; 1996) definition:

Culture is information or behavior shared by a population or subpopulation that is acquired from conspecifics through some form of social learning. (Boyd and Richerson 1996).

According to R&W teaching and imitation are particularly important forms of social learning when considering cultural transmission. Their conundrum is that while experimental studies of imitation and learning in captive animals can be controlled and results may be unambiguous, they may simply measure what McGrew (1992) calls the "socio-ecological validity of the captive environment" rather than the animals' behavior in natural contexts. Ethnographic studies, on the other hand, describe what the animals actually do in the wild, but they cannot usually tell us much about the specific social learning processes involved in producing the observed behaviors.

1.1. Ethnographic evidence

R&W find growing evidence of culture in at least four species of cetaceans, and a compelling case for further study of cultural phenomena in this group. They also find that "the complex and stable

vocal and behavioural cultures of sympatric [overlapping] groups of killer whales (*Orcinus orca*) appear to have no parallel outside humans, and represent an independent evolution of cultural faculties."

There are at least two different forms of killer whale inhabiting the waters around Vancouver Island, BC. The two forms are sympatric but can be distinguished by diet, morphology, behavior, social structure and genetics (Baird 2000, Hoelzel, et al. 1998). They are known as 'residents' and 'transients' (Baird and Dill 1995). Best known is the fish-feeding, 'resident', form. 'Residents' live in highly stable matrilineal 'pods' averaging 12 animals (Bigg et al. 1990)-there is no known case of individuals changing pods in over 25 years of study (Baird 2000). In contrast 'transients' live in smaller pods, averaging 3 animals (Baird 2000). 'Transient' killer whales do occasionally leave their natal pods and travel with other 'transient' groups. The study of this species off Vancouver Island and in other areas has produced evidence for significant behavioral variation between social groups.

The strongest evidence for culture lies in the vocal dialects of 'resident' pods; each pod has a distinctive set of 7-17 'discrete' calls (Ford 1991a; Strager 1995). These dialects are maintained despite extensive associations between pods. Some pods share up to 10 calls (Ford 1991a) and pods which share calls can be grouped together in acoustic 'clans' (Ford 1991a), suggesting another level of population structure. Ford (1991) found four distinct clans within two 'resident' communities, and suggested that the observed pattern of call variation is a result of dialects being passed down through vocal learning, and being modified over time. Thus, given the lack of dispersal, acoustic clans may reflect common matrilineal ancestry, and the number of calls any two pods share may reflect their relatedness (Ford 1991a).

Deecke, et al. (2000) found that the detected pattern of call modification is most likely caused by cultural drift in the structure of the calls together with horizontal transmission of modifications between the two groups. Such vocal matching between members of different matrilineal groups would suggest that vocal learning is not limited to vertical transmission from mother to offspring, as required for some models of gene-culture coevolution. Cultural drift is described as the modification of behaviors in a population and subsequent fixation of the new variants by behavioral matching. Behavioral change is introduced by new behavioral patterns, and distributed within a group by behavioral matching between its members. Deecke, et al. found that dialect changes did not correlate with genetic markers, but did correlate with social structure. Thus "clan boundaries rather than boundaries between matrilineal groups are the barriers to vocal matching and horizontal transmission."

1.2. Experimental evidence

Captive experiments (Herman 2001, Herman et al. 1993, 1994) suggest that at least some dolphins can use abstract representations of objects, actions and concepts to guide their behavior. These abstract representations correspond to standard definitions of symbol:

sym·bol n.

1. Something that represents something else by association, resemblance, or convention, especially a material object used to represent something invisible. (dictionary.com)

The symbols learned by dolphins are not merely simple representations of objects available in the dolphins' environment. Herman and Uneyama (1999) write:

We present evidence from our dolphin studies for the acquisition of the closed-class functionality of demonstratives, prepositions, conjunctions, and locatives. Sensitivity to argument structure is also evidenced by wholly untrained and consistent interpretations of the dolphin to probes of anomalous syntactic structures. These results are generated within our comprehension-based paradigm, which enables us to provide convincing objective evidence for the development and generalization of concepts by the dolphin subject.

A *demonstrative pronoun* is a symbol that points to an arbitrary comparison between objects; this and that are demonstratives.

A *preposition* is a word or phrase placed typically before a substantive word indicating the relation of that substantive to a verb, an adjective, or another substantive; at, by, with, from, and in regard to are prepositions.

A *conjunction* is the part of speech that serves to connect words, phrases, clauses, or sentences, such as and, but, as, and because.

A *locative* indicates place, or the place where, or wherein; as, a locative adjective; locative case of a noun.

Language is (dictionary.com):

- a. Communication of thoughts and feelings through a system of arbitrary signals, such as voice sounds, gestures, or written symbols;
- b. such a system including its rules for combining its components, such as words; or,
- c. a systematic means of communicating by the use of sounds or conventional symbols.

R&W "strongly believe that research on cultural processes is best served by an approach that integrates the sometimes opposing process- and product-oriented perspectives, as well as the laboratory and field approaches, taking good data from each." They attempt an integration of the two approaches, but conclude by de-emphasizing the role of laboratory findings in cetacean research (Bauer and Harley 2001). R&W go on to state "...we know virtually nothing about the actual learning mechanisms cetaceans employ," and:

Human culture is intimately linked to both language and symbolism, but there is currently no empirical basis for discussing the role or non-role of language and symbolism in cetacean culture - bottlenose dolphins have been taught artificial 'languages' (e.g. Herman et al. 1993), but such work tells us little about the role of communication in the natural situation (Tyack 1993). Cetacean cultures appear to possess other attributes that have otherwise been restricted to humans. In particular, we are aware of no phenomena outside humans comparable to the distinctive, stable and sympatric vocal and behavioural cultures which appear to exist at several levels of killer whale society.

1.3. The synthesis

If there is currently no empirical basis for discussing the role or non-role of language and symbolism in cetacean culture, perhaps it is because there is little theoretical basis for doing so. Heretofore that suggestion has seldom been raised in most literature (e.g., Tyack 1999).

The application of symbolic interactionism (a.k.a., interactionism) as a theoretical model to synthesize captive cetacean experimental findings and the results of field research draws from evolutionary ecology and cognitive ethology and adds an interactionist perspective to incorporate these approaches. Dolphins have been taught artificial 'languages,' and stable, sympatric, diverse and complex vocal and behavioral cultures appear to exist at several levels of killer whale society. Any overall theory of orca behavior must consider the proposition that orcas communicate with language, i.e., that they use symbols to share group-specific meanings and thereby develop cultures.

If the theory is found to fit the data, interactionism may help guide future studies of behavior, social dynamics and learning mechanisms in free-ranging cetaceans. In a review of interactionist literature from sociology, by substituting the word "orca" for the word "human," the foundations, though not all the elements, of interactionism can be transposed into a theoretical construct that unifies much of the data from across the spectrum of cetological research.

2. Interactionism vis-à-vis evolutionary ecology

Evolutionary ecology discusses reproductive strategies, sexual selection, life histories, genetics, adaptations, species diversity and ecological processes and communities. Genetic and ecological factors are seen as responsible for behavior, and all these factors combined are viewed as responsible for phenotypic variation among individuals within a population. Natural selection acts on this variation, which in turn determines the formation and survival of species and biotic communities. The effects of social structure and communication within and among groups are related to demographic processes across generations. An individual's foraging, mating and social behavior are generally viewed as influenced by its phenotype, by ecological circumstances, and by the actions of other individuals. General principles, or 'rules', underlie complex patterns of behavior, and these patterns underlie speciation, species diversity and behavioral ecology. Based on decades of field research on several species of cetaceans R&W have expanded the scope of evolutionary ecology to accommodate indications of culture-based behavior that parallels human cultures, albeit with a limited definition of the term and little comment on the processes that underlie culture in cetaceans. This reflects the empirical data, but one possible pitfall in this conceptualization, consistent with much modern sociological thought, is that culture theories assume that an individuals' actions (orca or human) simply consist of doing what the culture asserts as the right way to do things on the occasions when it is right to do them. Responses are seen as simply taken, readymade, from the "culture." Interactionism, however, places creative power in the individual in the context of collective action through interaction. Because interaction by definition is not a solitary activity, its vision of individual conduct focuses not on the capabilities, cognition or isolated acts of individuals but on the development of collective action, on how individuals act together to create an activity that is something they all have contributed to (Becker, H. S., pers. comm.).

The kernel of truth in cultural explanations of behavior is that there is indeed such a thing as culture-shared understandings more or less known to all the participants in some collective action, to which they can all refer in anticipating what others are going to do. If we know what those shared understandings are, we can guess, pretty well though not perfectly, what others in a situation may do. What has to be added is that these shared understandings are only the beginning of the negotiation that constitutes interaction, the guidelines to which the participants can refer to as they develop the collective line of action they engage in. They may in fact do things just as they did them the last time, but that has to be recognized as a possibility, not as something guaranteed.

Evolutionary ecology, like its precursor behaviorism, in turn based on instinct theory, does not look for subjective or introspective factors to explain its observations. The truth in behaviorism is that behavior does have a biological base, which includes needs and basic capabilities for action. The explanation offered here is that, yes, we all experience hunger for food, the need for sexual activity, etc., but that for symbol-using animals (including humans and orcas), these needs must, first, be learned as desires that can be satisfied in a certain way, and this is learned in interaction with the environment, which includes other people (or orcas). These needs can be satisfied only by reaching some kind of agreement with others as to how that can be done, an agreement reached through the process of building up lines of conduct through interaction (Becker, H. S., pers. comm.).

For some writers, evolutionary ecology approaches interactionism by incorporating game theory (Bulmer 1994). The theory of games, first developed to analyze economic behavior, is modified so that it can be applied to evolving populations. Smith's (1982) concept of an evolutionarily stable strategy is relevant whenever the best thing for an animal or plant to do depends on what others are doing. Mathematical models are employed to understand how information is stored, passed on, and used by organisms as they live and reproduce (Smith 1982).

Evolutionary game theory searches for rules that govern evolutionary processes, for example, the coevolution of predator-prey interactions. It is generally assumed that a strategy or set of strategies is fixed as instinct for a given non-human creature, and that the offspring of that creature may, due to mutation, inherit a slightly different set of strategies (as instinctive

behaviors). Creatures with strategies that improve their reproductive success compared to their fellows contribute a greater share of genes - including the genes for strategies and other instinctive behaviors - to the next generation. Attributes such as cooperation, honesty and commitment are believed to derive from such strategies.

While game theory is interactional, and leads to testable predictions about the evolution of behavior, of sex and genetic systems, and of growth and life history patterns, it seeks only to describe behavior and outcomes of certain games, rather than the formation of cultures and collective behaviors in the broad sense.

2.1. Interactionism vis-à-vis cognitive ethology

The relatively recent field of cognitive ethology leaves open the possibilities for language use in natural settings, but...:

Although Griffin (1992) has included the results of many excellent studies of the possibility of language in nonhuman primates, cetaceans, and birds in his broad discussions of animal minds, they do not squarely fall within the primary domain of cognitive ethology as I envision it: the study of natural behaviors in natural settings from an evolutionary and ecological perspective. (Of course, this is not to discount the importance to cognitive ethology of research on captive animals.) Only future research will tell if the behavior of the few captive individuals who have been intensively studied in "language studies" (and those captive individuals observed in other endeavors) is related to the behavior of wild members of the same species, or if the data from captive animals are more an important demonstration of behavioral plasticity and behavioral potential (Bekoff 1998).

The field studies reviewed in R&W may provide the beginnings of the future research called for by Bekoff, but to date the theoretical perspective of cognitive ethology remains limited.

The focus of cognitive ethology includes the beliefs, desires and intentions of individuals, thus avoiding sweeping speciesist generalizations or comparisons (Bekoff 1998). The knowledge (beliefs, desires and intentions) possessed by the social group as a whole and the processes of teaching and learning that form that knowledge are thus beyond the primary domain of this approach. In part, this individualistic focus can be traced to one of the major influences on cognitive ethology: cognitive psychology (Yoerg and Kamil 1991), which also focuses on the capabilities and mental content of the individual human.

Symbolic Interactionism provides a definition of culture and a formulation of the processes that underlie it. Interactionism gives power to the individual to interpret and process stimuli, whether genetic, environmental or cultural, and decide not only how to respond, but whether to respond at all.

Ethology: Stimulus > Response

Cognitive ethology: Stimulus/knowledge, desires, beliefs and intentions > Response

Evolutionary ecology: Phenotype/environment/behavior/culture > Response/speciation/ecological community

Symbolic interactionism: Phenotype/environment/behavior/culture > Interpretation > Response/speciation/ecology

Symbolic Interactionism gives much more power to the individual because it assumes an active thinker interpreting objects and events prior to acting, rather than a passive animal acting in accordance with external variables. For the interactionist, society consists of organized and patterned interactions among autonomous individuals acting on the basis of meanings. Thus, research by interactionists focuses on easily observable interactions rather than on macro-level structural relationships involving social institutions.

The difficulty of observing interactions between orcas is not underestimated here, though the

value of attempting to do so is emphasized. This focus on interaction and on the meaning of events to the participants in those events (their definition of the situation) shifts the attention of interactionists away from stable norms and values, external influences or environmental or genetic determinants toward more changeable, continually readjusting social processes. For interactionists, symbolic communication among members of society creates socially constructed relations, which remain in constant flux despite general stability in the basic accepted framework governing those relations. The on-going improvisational process is what maintains the appearance of stability.

From the standpoint of this paper, evolutionary ecology is necessary for an understanding of the evolutionary principles and ecological interactions that form the backdrop in which orcas act out their cultural lifestyles, but it is inadequate to explain or describe the learning processes and normal interplay of orca cultural behavior. Cognitive ethology looks at the knowledge, beliefs, desires, emotions and intentions of individuals, but does not investigate how those mental elements are built up through interaction between individuals, and does not consider that arbitrary symbols may be endowed with subjective meaning through interactions, resulting in the construction of cultures to which individual members are affiliated. The viewpoint expressed here is that orcas and humans have independently evolved (converged) into symbol-using animals. Behavior based largely on symbolic interaction fosters the creation of complex cultures that allow action based on meaningful interpretation and choice, that is not reflexively subject to genetic, environmental, or even cultural, stimuli.

2.2. Shifting emphasis

This paper suggests a shift in emphasis from the prevailing ethological or evolutionary ecology perspective of the orca as behaving according to instinctual or genetic predispositions, or environmental conditions or cultural systems, and toward an understanding that orcas behave largely according to conscious decisions arrived at through symbolic interaction. Rather than act in lock-step with external or innate factors, orcas can pause to reflect and interpret their situation, and think about how others (orcas, humans, seals, salmon) will respond to what they are thinking of doing, and adjust what they may do to take account of that imagined response. Responses are thus never isolated acts, but are part of developing lines of activity, long arcs of action in a process of noting things happening in the environment, envisioning responses to them, and adapting those responses in the light of anticipated possible responses. (H.S. Becker, pers. comm.)

Partially bridging the gap between interactionism and evolutionary ecology is Hinde (1976, 1983), in which interactions are also the basis of social structure. Additionally, Tschudin et al. review the neuroanatomy and experimental evidence for social evolution in dolphins and notes that "dolphins have higher relative neocortex volumes than have all non-human primates, including chimpanzees, as well as all other mammalian species," and that "preliminary analysis indicated that in dolphins the neocortex ratio was related to sociality" (Tschudin et al. 1996). Tschudin maintains that "it is possible to obtain experimental evidence for culture in dolphins," and cites studies of Theory of Mind (ToM) showing that "dolphins can interpret the referential nature of untrained human signs such as pointing and directed gaze, as well as being able to use a replica of an object to discriminate between different objects" (Tschudin et al. 2001). Theory of Mind refers to the capacity of an individual to attribute mental states such as beliefs, desires and intentions to others (Premack and Woodruff 1978). Tschudin concludes that that "all of the dolphins pass attribution-of-belief tasks. If their performance cannot be explained by learning or cueing, we suggest that dolphins have the capacity to attribute mental states to others" (Tschudin et al. in prep.) in a display of second-order intentionality (see Leslie 1987).

Thus we have both sides of the bridge, but not the span itself. Cognitive ethology ascribes mental, subjective content to non-human animals; Theory of Mind asserts that dolphins have the capacity to attribute mental states to others, and R&W conclude that orcas exhibit cultures that appear to have no parallel outside humans. Lacking is a theory that provides the means by which the mental contents construct the cultures. To complete the bridge we need to look at the processes of symbolic interaction, especially language.

2.3. The question of language

Language in humans is all-pervasive. It largely forms our perceptions, our sense of self and identity, our interpersonal relations and our social and private behavior. Any discussion of culture must consider the role of language. The premise of Palmer's *Toward a Theory of Cultural Linguistics* (1996) is:

The relationship between language and culture is an especially rich area of inquiry; as language both reflects the culture of its speakers and helps to construct their culture.

If the social systems of orcas indeed represent an independent evolution of cultural faculties, it follows that we must entertain the notion that orcas communicate using something analogous to language. To date there is little consideration of this possibility in scientific literature. Resounding intellectual opposition to this notion is to be expected. Chomsky (2000), for instance, says:

The human faculty of language seems to be a true "species property," varying little among humans and without significant analogue elsewhere. There is no serious reason today to challenge the Cartesian view that the ability to use linguistic signs to express freely-formed thoughts marks "the true distinction between man and animal."

Furthermore, the faculty of language enters crucially into every aspect of human life, thought, and interaction. It is largely responsible for the fact that alone in the biological world, humans have a history, cultural evolution and diversity of any complexity and richness, even biological success in the technical sense that their numbers are huge.

We further assume that the language organ is like others in that its basic character is an expression of the genes. How that happens remains a distant prospect for inquiry, but we can investigate the genetically-determined "initial state" of the language faculty in other ways.

Chomsky states that language enters into every aspect of life, but his insistence that only humans are capable of language seems premature. A "language gene" has recently been announced (Lai, 2001) that may affect the human ability to make fine movements of the mouth and larynx, and thus to develop spoken language. However, the "initial state" of the language faculty surely lies deeper than these muscle movements. Cetaceans produce sound in a variety of ways, none involving facial movements or larynx, and while studies have yet to identify genetic precursors for those abilities, there is no basis to assume that they lack the cognitive foundations for language or the mechanisms to produce speech.

Rather, it appears that language and culture emerge from a constellation of factors including, but not limited to, a high degree of encephalization and cognitive ability, and the ability to make many subtle and sophisticated sounds or gestures. A perceived need or desire to form language systems and complex cultures may also be a factor. Though they may possess the requisite abilities, some whale species, for instance, may not find a need to develop intricate cultures or communication systems in order to solve essential problems of survival. The apparently small number of discrete calls made by orcas (relative to human languages) may reflect this lack of need or desire to introduce greater variety or complexity into their communications. Then too, it may reflect our inability to distinguish the complexity of the whales' communication systems.

3. Symbolic interactionism

Interactionism provides a structured and established framework to account for the extensive and sometimes baffling findings about orca behavior from a variety of contexts.

The basic outline of interactionism is a set of internally consistent and empirically validated conceptual perspectives. The three basic premises of symbolic interactionism are (Blumer 1969):

- * We act toward things on the basis of the meanings the things have for us;
- * The meanings of such things derive from the social interactions one has with others;
- * These meanings are modified through an interpretive process.

Symbolic interactionism has a long intellectual history and is one of the major theoretical perspectives in sociology. This interpretation of human identity and social life began with the German sociologist and economist, Max Weber (1864-1920) and the American philosopher, George Herbert Mead (1863-1931) both of whom emphasized a pragmatic methodology as well as subjective meaning as a major factor in human behavior and social process. Mead was inspired by Darwin, arguing that we should regard the human being in natural, rather than supernatural, terms. Cognitive ethology began when Darwin argued that animal minds must be similar to human minds since animal bodies are similar to human bodies (Jamieson and Bekoff 1993). Mead tried to understand difficult and abstract concepts like self, mind, symbols and truth as qualities developed by the human being as part of nature, part of our heritage in the animal kingdom (Charon 1992). Mead believed that human uniqueness relates to the ability to reason and to communicate symbolically with ourselves and with others, made possible by a highly developed brain, heavy reliance on society and socialization, and the ability to make many subtle and sophisticated sounds. Darwin was also influential on Mead in his emphasis on an evolutionary, dynamic universe rather than a static one. The individual and society are likewise always in process through interaction, with patterns and meanings always emerging and being changed or reaffirmed over time.

Although there are a number of versions of interactionist thought, the following description offers a simplified version of these ideas, concentrating on points of convergence. Herbert Blumer, who studied with Mead at the University of Chicago, coined the term, "symbolic interactionism," and formulated the most prominent version of the theory (Blumer 1969).

Interactionists focus on the subjective aspects of social life, rather than on objective, macro-structural aspects of social systems (or genetic or environmental variables). One reason for this focus is that interactionists base their theoretical perspective on their image of humans, rather than on their image of society (as the functionalists do). For interactionists, humans are pragmatic actors who continually adjust their behavior to the actions of other actors. We can adjust to these actions only because we are able to interpret them, i.e., to denote them symbolically and treat the actions and those who perform them as symbolic objects. This adjustment to symbolic objects and events is aided by our ability to imaginatively rehearse alternative lines of action before we act. The process is further aided by our ability to think about and to react to our own actions and even our selves as symbolic objects. Thus, the interactionist theorist sees humans as active, creative participants who construct their social world, not as passive, conforming objects of socialization.

In the context of this paper, orcas are also seen as self-aware creative actors who interpret their circumstances and act accordingly, rather than passive, conforming objects of their environments or their societies.

Human society is seen as consisting of acting people, and the life of the society is seen as consisting of their actions. The acting units may be separate individuals, collectivities whose members are acting together on a common quest, or organizations acting on behalf of a constituency. There is no empirically observable activity in a human society that does not spring from some acting unit (Blumer 1969).

Interactionism emphasizes self-consciousness: "conscious life...is a continual flow of self-indications" (Blumer 1969). The question is always: "What does it mean to me?" Humans "make indications," meaning we single out objects (including other people and ourselves) and attach meaning to them; we constantly judge the object's applicability to the situation we are in, making active judgments about how to use (or refuse) the object. Our world is a flow of interacting meaningful objects, i.e., symbols. Actors do not "build up" meanings on their own, but do so by "taking the role" of others; that is, by seeing situations from others' perspectives. Meaning is

derived socially, as a question of mutual alignment, not an individual construction. In this alignment actors seek not self-interest but community affiliation.

3.1. Taking the role of the other

The capacity for taking the role of the other, or empathy, is central to the development of selfhood. It is probably the most important mind activity, and it is necessary for both the acquisition and the use of symbols. It is how children play when they try to act like firefighters or teachers, what people do on a date when they try to figure out what their date is thinking, what teachers do to know what to teach, what students do to know what to learn, and what salespeople, politicians and charismatic leaders do when they try to imagine how to appeal to those they are trying to influence. Role-taking is imagining the world from the perspective of another, and it is the perspectives of others that allow us to view ourselves. The emergence of self is dependent on, and preceded by, this process. Taking the role of the other is important for learning our perspectives, for working through social situations, for knowing how to manipulate, direct, or control others, for loving, for cooperation, and for symbolic communication (Charon 1992). The ability to take the role of the other amounts to what we might term "social intelligence." Interactionists emphasize the improvisational quality of roles. Role-making is also a key mechanism of interaction, for all situations and roles are inherently ambiguous, thus requiring us to create those situations and roles to some extent before we can act.

An example of role-taking for cetology would be the presumed role of the post-reproductive female orca as matriarch. Dr. Paul Spong's well-recounted story of his 1968 experiments with a captive orca at Vancouver Public Aquarium provides another example of role-playing by an orca. The orca, called Skana, had performed almost perfectly on visual acuity experiments, when suddenly she began giving 100% wrong answers to the same tests. Skana had earlier demonstrated that she knew what Spong was asking, but then suddenly reinterpreted the situation, changed her role and refused to accept Spong's interpretation of their relationship (Weyler 1986; Hand 1994).

3.2. The importance of self

Self-awareness is an essential component of symbolic interaction. Selfhood means that the individual is able to see self in situation. We assess how others affect us, and how we affect them (Charon 1992). As we can talk to others, we can talk to our self. Because of the self, humans are able to think, to point things out to themselves, to interpret a situation, to communicate with themselves in the ways they are able to communicate with other humans. Without self-communication, the human would not be able to communicate symbolically with others, for it is only because we can simultaneously give off meaning to others and understand how it is interpreted that effective symbolic communication can take place.

3.3. Cetacean self-recognition

The ability to recognize oneself in a mirror is a rare capacity in the animal kingdom. Until recently, only humans and great apes had shown convincing evidence of mirror self-recognition (MSR). Now bottlenose dolphins must be added to that short list. MSR tests have shown that dolphins use mirrors to investigate parts of their bodies that are marked (Reiss and Marino 2001). According to the authors, "These findings imply that the emergence of MSR is not a byproduct of factors specific to great apes and humans but instead may be due to more general characteristics such as a high degree of encephalization and cognitive ability. The results represent a striking case of cognitive convergence in the face of profound differences in neuroanatomical characteristics and evolutionary history."

Thus, dolphins meet an essential requirement of symbolic interaction: self-identification. The experimental and ethnographic evidence indicates that orcas, the most highly encephalized delphinid, have continued this convergence to include the ability to use symbols as part of normal everyday interaction.

3.4. The question of consciousness

Cetaceans are voluntary breathers. They consciously determine the precise timing of each breath to coincide with reaching the water's surface with their blowholes. Respiration often takes place in a social context; it is highly correlated with group behavior. Dolphins also rest one hemisphere of their brains while guiding swimming and breathing with the other half. This activity appears to also be under voluntary, conscious control among orcas—resting behavior is usually synchronous within family groups. Anecdotal evidence from marine parks recounts that the onset of the ovulation cycle in orcas is unpredictable, and that it may not occur for many months, then suddenly start without correlation with seasonality, male presence or behavior, or dietary parameters (van Ginneken, A.M., pers. comm.)

According to Urian, et al. (1996):

Bottlenose dolphins showed diffuse peaks and considerable flexibility in their seasonality of reproduction. There was no relationship between latitude and seasonality of reproduction or synchrony of births. However, there was a correlation between origin of population and seasonality of reproduction in both wild and captive dolphins. We suggest that adaptations to local environmental conditions have the strongest influence on seasonality of reproduction in these populations of bottlenose dolphins.

Conscious control over behaviors such as respiration, brain activity and ovulation may bring those activities under the influence of cultural learning. An alternative explanation to Urian, et al.'s, in keeping with R&W's findings suggesting cultural learning in some species of cetaceans, could be that different populations constitute different cultures which maintain different rules and traditions concerning seasonality of reproduction.

3.5. Culture

Over time, interaction creates culture. The culture of a society becomes the overall guide for the individual's definition and action. Mead used the term "generalized other" to describe the shared culture of the group. The "generalized other" is the generally understood set of perceptions, values and rules. A generalized other develops in interaction and is used by individuals to control themselves in that interaction. A generalized other is the guide for normal, civilized behavior; it is the law that must be obeyed; it is the system; it is the conscience of the group that individuals are expected to follow in interaction. Individuals act together because they trade interpretations through interaction and, taking what the others are doing into account, try to get it together and most of the time, succeed to some extent. It's an ongoing thing—the "together" has to be continually modified to take account of all that happens. So it's adaptive, which is to say interaction plays a role in the evolutionary process (Becker, H. S., pers. comm.).

3.6. Symbolic Interactionists' perspective on animals

Symbolic Interactionist theorists have seldom considered that interactionism may apply to non-human animals, nor is there any evidence that interactionists today are aware of the results of either experimental or field research on cetaceans from the past few decades. Mead, the primary early American interactionist theorist, said:

Animals respond reflexively. Humans respond reflectively." Infrahumans, (the term Mead used to label presymbolic infants and nonhuman animals) are not symbolic, do not define social objects in interaction, do not use symbols or language as we defined it above, and do not use perspectives to define the reality they respond to. Infrahumans - at least the vast majority of them - seem to have a passive relationship with their environments. Behavior is usually instinctive (biologically programmed) or learned through imitation and experience. There is communication among many infrahumans, but it is what might be called a conversation of nonmeaningful gestures, where the act of one organism becomes a cue for the response of the other (Mead 1934).

More recently, however, Charon (1992) has discussed the possibility that nonhumans may use symbols:

Evidence is still being sought to determine if symbol use exists in nonhuman animals. The symbolic interactionist, by and large, sees the human as unique in nature, and unique precisely because of symbol use. If, however it is established that other animals use symbols too, then this fact will in no way detract from the perspective; indeed, our understanding of both the human and other symbol-using animals will be greatly increased. However, if other animals do indeed use symbols in the sense defined here, it must be established that (1) the symbols are developed socially, through interaction, (2) the symbols are not universally agreed on within the species but are arbitrarily established by and changed through interaction of users, and (3) a language of sounds or gestures exists that is meaningful and that includes rules allowing for combining the sounds or gestures into meaningful statements.

3.6.1. Do orcas qualify as symbol-users?

The first requirement, that symbols are developed socially, through interaction, has been satisfied by captive orcas who have demonstrated that they learned the calls of their tankmates from other orca communities (Bain 1986) and by evidence for interpod call mimicry in the wild (Ford 1991a). Captive experiments in the acquisition of meaningful gestures and other symbols support this finding.

The second requirement, that the symbols are not universally agreed on within the species, has been abundantly demonstrated by the dialects used by each orca pod and the completely distinct call repertoires used by each orca community (Ford 1991a).

The third requirement, that a language of sounds or gestures exists that is meaningful and that includes rules for combining them into meaningful statements, has been demonstrated for captive dolphins. Though similar experiments have not been done on orcas, it is parsimonious to presume that orcas, as the largest-brained delphinids, would also pass this test. Demonstrations of meaningful communication among orcas in the wild may be more difficult to establish empirically, but perhaps with hypotheses guided by the paradigm of interactionism future studies may be designed to ask this question.

4. Methodology

Allen and Bekoff (1997) argue that the main distinction between cognitive ethology and classical ethology lies not in the types of data collected, but in the understanding of the conceptual resources that are appropriate for explaining those data. The same applies to the study of symbolic interaction among cetaceans.

R&W say: "The logistical difficulties of studying wild cetaceans make the study of culture difficult, and often give rise to information that is incomplete and poor in detail." This paper suggests not merely studying the behavioral manifestations of culture in orcas, but the inner mental states, or meanings, conveyed symbolically through interaction. The challenge is daunting. And yet the weight of the evidence, interpreted through interactionist theory, tells us that orcas interact symbolically. The obstacles do not negate the evidence. We know the dark side of the moon exists even if we can't see it.

Research methods may include staged social encounters (where legal, ethical and/or opportunistically encountered), playback of recorded vocalizations, the presentation of stimuli in different modalities, neurobiological techniques, observation of predator-prey interactions, observation of foraging behavior, and studies of social behavior in general. There are no large differences between methods used to study animal interaction and those used to study other aspects of animal behavior. Differences lie not so much in what is done and how it is done, but rather how data are explained.

Interactionists tend to study human social interaction through *participant observation*, rather

than surveys and interviews. Direct observation permits the researcher to meet all of the basic requirements of an empirical science (Blumer 1969). Close contact and immersion in the everyday lives of the participants is necessary for understanding the meanings of their actions, their definitions of the situation itself, and the processes by which actors construct the situation through their interaction.

Field researchers who spend long hours observing orcas in communities and listening to their communications are only beginning to arrive at some general observations to describe how the calls may relate to behavior. Some recent field studies involve correlating video/acoustic recording devices to discern individual orcas making particular discrete calls to determine the location of vocalizing orca whales (Viers 2001). Other researchers observe and record behavior from the surface while simultaneously recording calls. Morton (2002) says: "The traditional approach attempted to correlate the occurrence of a sound with a specific behavior. In this study we looked at the percentage emission rather than the absolute occurrence of sounds." Morton concluded: "Whales didn't match a single sound with a specific behavior," but "what mattered wasn't the sound itself but rather the frequency of its use."

There are few, if any, roadmaps for empirical research into orca communications, so openness to diverse observations and unexpected correlations or events will probably yield the most instructive outlines to use as guides for further investigations. For example, Ford writes (1991b): "Whenever a pod is routinely foraging or traveling, calls tend to be stereotyped, varying only slightly in duration or pitch. Some situations create excitement among the whales, however, such as when two pods meet after an extended period of separation. Then vocal activity is often intense, and the calls produced tend to be higher in pitch, shorter in duration, and repeated more rapidly than the same calls given by relaxed or resting whales. And when whales are interacting physically—chasing, pushing, and nipping each other—or when juveniles play together, they incorporate many aberrations into their normal calls and emit an array of squeaks, squawks, and whistles that are seldom, if ever, repeated in the same form."

A major methodological obstacle in the analysis of vocal interactions is figuring out which whale is making which call. Miller and Bain (2000) towed an array of hydrophones behind a boat and suspended a video camera from a balloon to identify individuals and achieve real-time video/audio correlation, resulting in the suggestion that: "pod-specific calling behaviour in resident killer whales arises primarily as a consequence of accumulated drift or divergence between highly cohesive matrilineal units as they gradually separate into different pods."

If the evolutionary arcs of *Orcinus orca* and *Homo sapiens* have converged in the capacity for symbolic thought and communication, the expression of that ability is likely to be vastly different in the two species. A methodology founded on the assumption that both species are capable of symbol use might address the differences as well as the similarities in how symbols are conveyed between individuals and how they are used. The contrasting findings could help clarify the abilities and normal usage of both species.

5. Conclusion - orcas use symbols

Although R&W "...hope to stimulate discussion and research on culture in these animals (cetaceans)" there is little information or even speculation about the processes underlying culture in orcas. R&W review the literature and find that there are "suggestions of gene-culture coevolution in cetaceans, that culture may be implicated in some unusual behavioral and life-history traits of whales and dolphins," and that "there is a clear case for studying the cultural transmission of information directly as parts of the research agendas of the long-term field studies of whales and dolphins."

R&W state that: "...understanding process (cultural transmission) is crucial to our understanding of the product (culture)," and that social learning is integral to their definition of culture and is referred to throughout their article, but there is little description or inquiry about what form of social learning or transmission process may be involved. In fact "...no attempt is made to deduce what particular form of social learning underlies the observed patterns." They observe that "Clearly, according to accepted definitions, killer whales teach." And yet, "...there is much

conceptual confusion surrounding imitative and nonimitative social learning: it is not clear how the bewildering taxonomy of terms for various social learning mechanisms relate to each other, nor that the underlying conceptual approach is really satisfactory - many of the mechanisms are based on unobservable and ill-defined mechanisms, are not mutually exclusive, and give little or no information regarding conditions for occurrence or functional significance."

What is clear is that prevailing theoretical paradigms (behaviorism, evolutionary ecology, cognitive ethology) do not discuss the possibility that any non-human animal uses symbols extensively in normal everyday communication, or that the use of symbols substantially affects behavior.

The theory of symbolic interactionism simplifies and clarifies the form of social learning that underlies both the experimental and the ethnographic observations that indicate that there is good evidence for cultural transmission in several cetacean species. This established body of theory encompasses present theories to explain how teaching, imitative and nonimitative learning may occur as well as vertical, horizontal and oblique cultural transmission. Interactionism provides a comprehensive theory that economically incorporates these approaches. Interactionism ratchets the argument for cetacean culture to a new synthesis that accounts for a variety of diverse data.

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