DICENT SYMBOLS IN MIMICRY

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Introduction

Peirce proposed several typologies of signs, with different degrees of refinement and several relationships to one another (see Queiroz 2012a; Farias, Queiroz 2000, 2003; Freadman 2004). Here we are especially interested in how Peirce's extended theory of signs can contribute to the construction of models that serve as tools for the investigation of biological mimicry. As a corollary to our analysis of firefly signaling (see El-Hani et al. 2010), we analyze the capacity of producing dicent symbols (propositions) as a general requisite for a semiotic system to act as a mimic. As it is well known, the semiotic processes involved in biological mimicry most often do not result from learning processes taking place in the individual semiotic system, but from the fine-tuning of inherited capacities by natural selection among variants over hundreds to thousands or millions of generations. The concrete sign exchange that takes place within the lifetime of a single individual, indicating and describing at the same time, can be conceived of as dicent symbols or dicisigns. This calls for an investigation of the Peircean notion of the dicisign, which is a generalization of the notion of proposition. Peirce's formulation liberates our treatment of propositions from the confines of human language and points to their appearance also in pictures, gestures, etc., and, moreover, generalizes propositions from being

a human privilege so as to also embrace simpler dicisigns found in non-human animals.

Firefly propositions: An unexpected finding

Sign-mediated processes show a notable variety. According to Peirce, there are three fundamental kinds of signs underlying meaning processes – icons, indices, and symbols (CP 2.275). Respectively, a sign may be analogous to its object, spatiotemporally connected to it, or might represent it by means of a law, rule or habit. These classes correspond to relations of similarity, contiguity, and law between sign and object.

We developed a semiotic analysis of deception by firefly femmes fatales (El-Hani et al. 2010) specialized in mimicking the mating signals of other species of fireflies with the purpose of attracting responding males, which become their preys (Lloyd 1965, 1975, 1986). Typically, each firefly species has its own signal code or signature, including a male flash pattern and a female flash response. The species' patterns vary in several parameters, including flash duration, flash number and timing in a pattern, and flash form. In a typical sexual communication sequence, a flying male exchanges flashes with a perched female in a simple pattern. There is intense competition among the males for the females. Lloyd observed that *Photinus* males were answered by females of a different genus, *Photuris*, which he called the firefly femmes fatales. They were trying to attract the males to eat the latter by mimicking the mating signs of female *Photinus*. Given Lloyd's observations, it may be the case that a *Photinus* male is more than five times as likely to be answered by a femme fatale predator as by a female of its own species. An evolutionary "arms race" seems, in fact, to be taking place between *Photuris* females and the firefly *Photinus macdermotti,* which is greatly influenced by their aggressive mimicry.

When we try to interpret the firefly flashes involved in courtship or predation, we find that the three object-defined sign classes of icon, index and symbol are not sufficient to account for these

signs. They seem to combine different aspects of the basic categories. Consider, for instance, that on the one hand the flashes point out to the presence and location of the emitting firefly. In these terms, the firefly flashes can be said to be indexical in nature. However, they also refer to certain qualities of the emitter, related to its species and gender, and for this reason these can be said to be iconic signs. The flashes refer to a very specific and small part of the iconic qualities of the emitter. This is precisely what facilitates its being copied by other species (just like the black-and-yellow pattern of certain wasps, copied by non-dangerous species to signal danger). The process of the "arms race" between *Photuris* females and *Photinus macdermotti* males was made possible by the fact that the flashes became so conventionalized in their iconic aspect as to become a stable symbol of the species in question which is also readable by members of other species.

Thus, in order to account for the sign-mediated processes involved in firefly deception, we need to go beyond the basic classification of signs as icons, indices, and symbols. We should take in due account that icons, indices, and symbols are just sign aspects, not mutually exclusive classes of empirical, observable signs. According to Peirce's mature theory of signs (see Queiroz 2012a), fireflies are producing dicent symbols or propositions. The male and female signs are local signs, indicating the existence of something at specific locations in space and time: "Here and now is a *Photinus* male (responsive female)". Thus these signs possess a primitive propositional structure, composed of an index indicating the existence of the proposition subject (the "here and now is"), on the one hand, and a rhematic symbolic predicate describing the object, on the other (the "*Photinus* male (responsive female)").

This situation is no rare case, however. It may be that, in all cases of deception, we need to turn to Peirce's account of dicent symbols, since propositions are the (composite) signs which may be true or false, and deception is obviously a case of a false proposition.

Robert W. Mitchell (1986: 21) formalizes the concept of deception as follows:

(i) An organism R registers (or believes) something Y from some organism S, where S can be described as benefiting when (or desiring that)
(iia) R acts appropriately toward Y, because
(iib) Y means X; and
(iii) it is untrue that X is the case.

In order to be explicit about the role of signs in the mediation of deception, El-Hani et al. (2010: 36) proposed the following modified version of Mitchell's definition:

(i) An organism R registers a sign Y emitted by organism E, and E can be described as benefiting when
(iia) R behaves toward Y, as if
(iib) Y means that X is the case; but
(iii) it is untrue that X is the case.

It is clear, then, that deception demands a situation in which a sign emitted by a given organism and registered by another organism conveys false information. And, as argued above, since only propositions can be true or false, composite signs used in animal deception should be treated as propositions. Is this too far-fetched? To answer this worry, let us examine what a proposition is in terms of Peirce's theory. Usually, a proposition is taken to mean linguistically represented signs claiming something about an object (e.g., "S is P"), but Peirce generalized the notion of proposition in his theory of dicisigns (i.e., signs-which-say-something) to encompass also non-linguistic cases. The proposition forms part of the concept triad rheme–proposition–argument, another of Peirce's classifications of signs. The rheme is the skeleton of a proposition – but with one or more of its subject slots left blank. Thus "_is blue" is a rheme just like "_ gives _ to _". When one or more slots in a rheme are filled by an index (a pointing finger, a demonstrative pronoun, a proper name, etc.), it becomes a proposition. When a proposition is inferred from one or more further propositions, it is an argument. (CP 5.139)

The crucial structure uniting all propositions, linguistic or not, is that they refer twice to the same object, by means of indices and icons, respectively. In the proposition, the object dealt with must be indicated by means of an index (in the linguistic case: a proper name, a class name, a pronoun, etc.), constituting the subject of the proposition, while the predicate of the proposition is presented by means of an icon (in the linguistic case: an adjective, a class name, or verb describing aspects of the object indicated by the index). Notice that it is not the indexical part of these signs that is responsible for the deception: in our firefly example, the signs correctly indicate the firefly femme fatale at a specified point in space and time. It is the symbolic-iconic code indicating the character of the animal emitting the sign that does the lying.

We agree with Lloyd (1986) that deception can act as a triggering factor in the evolution of communication complexity. Lies are only possible at the level of propositions claiming that something is the case when it is not. Simple propositions can lie and, by lying, they can trigger increasingly more complex sign processes. This complexity scale should not, however, be mapped onto the distinction icon–index–symbol. It should rather be conceived of by other means, e.g., the number of nested levels of communication, the complexity of the sign vehicles, the complexity of the perceptive and cognitive processes necessary to interpret signs, etc.

We consider these findings to be an important part of a proper semiotic modelling of deception in animal communication. It is worth summarizing the basic ideas:

1) Our semiotic analysis of firefly communication shows the necessity of considering even simple sign uses in deceptive strategies in biology as dicent symbols, i.e. propositions displaying the duplicity of referring indexically and signifying iconically. These signs can only be used to deceive because they propositionally claim that something is the case, when it is untrue that it is indeed the case.

2) This analysis casts doubt upon the widespread assumption that the distinction between icons, indices, and symbols can be mapped directly onto biological macro-evolution so as to

form three distinct, consecutive phases (cf. Deacon's 1997 and otherwise important *The Symbolic Species*; see also Queiroz 2012b). Rather, all three aspects of object reference are present in different combinations already in relatively simple biological sign uses. Firefly signal patterns are a case in point, hinting at a continuous scale with simple icons at one end and symbolical stylizations of icons at the other end.

3) Our analysis also shows the need for considering two time-scales to understand the evolution of deception (in the case of fireflies, and certainly in the case of many other deceptive mimicry phenomena): one for individual sign exchanges involving particular specimens with relatively low interpretation plasticity, and one for the "arms race" between species which leads to the evolution of nested deception strategies.

The study of firefly signal patterns seems very promising for further investigation, both empirical and theoretical, on the role of biological deception in the evolution of animal communication.

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