

Signaling without Cooperation

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Abstract

Ethological theories usually attribute semantic content to animal signals. To account for this fact, many biologists and philosophers appeal to some version of Teleosemantics. However, this picture has recently come under attack: while mainstream teleosemantics assumes that representational systems must cooperate, some biologists and philosophers argue that in certain cases signaling can evolve within systems lacking common interest. In this paper I defend the standard view from this objection.

1. Introduction

Many living beings have evolved mechanisms that allow them to inform others. Illustrative examples are the bright red color of the granular poison frog (*Oophaga granulifera*), which warns predators of its noxious taste, or the alarm calls of the meerkat (*Suricata suricata*) (Hollen and Radford, 2009). Ethological studies are pervaded with attributions of semantic content to animal signals (Maynard-Smith and Harper, 2003; Seyfarth et al. 2010). The challenge is to account for the nature and meaning of these signals.

In that respect, teleosemantics is one of the most promising naturalistic theories of representation. Its main goal is to explain in virtue of what process certain states qualify as representations and how their content is determined. Mainstream versions of teleosemantics (most prominently Millikan's, 1984, 1993, 2004) assume that (at least, in simple signaling systems) representations originate within cooperating systems. This view is also popular in ethology (Maynard-Smith and Harper, 2003; Searcy and Nowicki, 2005). However, this thesis has been challenged by some biologists (Dawkins and Krebs, 1978; Rendall et al, 2009) and philosophers (Sterelny, 1995; Stegmann, 2005, 2009; Cao, 2012), who have presented several examples that suggest that signaling can take place within uncooperative systems. In addition, this objection has motivated a different sort of naturalistic approach, which departs from the standard teleosemantic framework. In this paper I would like to argue that these cases of signaling between uncooperating organisms can be accounted for within the standard teleosemantic framework, which assumes a cooperation requirement.

The paper is organized in the following way. In the first section, I outline the main tenets of the standard teleosemantic framework. In the second section I present the main objection based on some alleged cases of uncooperative signaling systems in relatively unsophisticated biological mechanisms. In the final part, I defend teleosemantics from this objection.

2. Teleosemantics

Like any other philosophical theory, teleosemantics comes in different versions. For simplicity, here I will mainly rely on Millikan's view, which is the most influential and

¹ The final publication is available at <http://www.springerlink.com>

popular version. Nonetheless, the framework I am going to put forward could be accepted (with slight modifications) by many teleosemanticists such as Papineau (2003), Shea (2007) and Godfrey-Smith (1996; 2006).

There are two key notions that need to be explained in order to describe the teleosemantic framework: *function* and *sender-receiver*.

First, teleosemantic theories have traditionally adopted an etiological notion of function, according to which functions are selected effects (Neander, 1991). On this view, a trait's function is the effect that explains why past traits of the same kind have been selected for by natural selection (Wright, 1973; Millikan, 1984). For instance, the function of kidneys is to filter wastes from blood because this is the effect that explains why kidneys were selected for by natural selection. The appeal to functions is usually regarded as the distinctive feature of teleosemantic theories (Neander, 2012; Millikan, 2004, p. 63).

The second important notion is that of a sender-receiver structure. In short, a sender-receiver structure is constituted by two systems: a sender, which takes some input and produces a state, and the receiver, which takes this state as input and produces an effect as output. This sender-receiver structure is widely used in abstract models of signaling in some fields, such as communication theory and signal detection theory.

The key move of teleosemantics is to add the notion of etiological function to the sender-receiver framework in order to provide a naturalistic account of representations in the biological world. In a nutshell, the idea is that a representational system is composed of two different kinds of mechanisms (sender and receiver), which are endowed with certain etiological functions. The function of the sender (or 'producer system') is to produce a representation R when certain state of affairs obtains. The function of the receiver (or 'consumer system') is to act in a certain way (e.g. produce some behavior) when representation R is produced. Crucially, representations are states that stand between a sender and the receiver that possess these functions (Millikan, 1984, 1993; Godfrey-Smith, 1996, 2006; Shea, 2007).

What determines the meaning of state R? In order to ascertain this, we need to look at those historical cases that explain why the consumer system has been selected for. That is what the teleosemantic literature calls a 'Normal explanation' (with a capital 'N', to mark that it is a technical notion—Millikan, 1984, ch. 2). A Normal explanation is an explanation of how a particular trait has historically performed its function (Millikan, 1984, p. 34). For instance, the Normal explanation of how a heart performed its function must mention the fact that it was supplied with blood, it was connected to the rest of the body through the right vessels, and so on. Now, according to teleosemantics, the content of a representation is the state that must be mentioned in the Normal explanation of how the consumer system performed its function. That is, in order to know R's content, we need to consider those occasions in which R was tokened and the action of the consumer system was successful. If we focus on those occasions, we will usually find a state of affairs that causally explains why the activity of the consumer was successful. Teleosemantics claims that this is the state represented by R.

Let me illustrate this theory with an example. Like many other birds, the white-browed scrubwren (*Sericornis frontalis*) produces a trill call when a predator is approaching, which helps other scrubwrens escape from danger (Leavesley and Magrath, 2004).² Here the sender is the white-browed scrubwren sending the trill call (or, rather, some mechanism within the scrubwren that is responsible for trill call); the receivers are the rest of

² It is important to notice that a sender-receiver structure can be instantiated within a single organism or in different organisms.

scrubwrens (or, rather, some mechanism within scrubwrens that is responsible for the interpretation of the trill call); finally, the representation is the call itself. In this case, the function of the sender is to produce a trill call (that is, the representation R) in certain circumstances and the function of the receiver is to help the scrubwrens escape from danger.³ According to teleosemantics, the trill call represents (something like) *predator approaching*, because if we look at historical situations that account for the selection of the consumer system, the Normal explanation of how the call-consuming-mechanism was favored by natural selection surely mentions the fact that there was a predator approaching. When there was no predator, escaping was a waste of time and energy.

It is important so stress that something like this picture seems to be assumed by many biologists. For instance, Maynard Smith and Harper (2003, p, 15) define a signal as “an act or structure that alters the behavior of another organism, which evolved because of that effect, and which is effective because the receiver’s response has also evolved”. This definition seems to be in accordance with the sender-receiver model assumed by a teleosemantic approach to animal signaling: signals are structures that stand between a sender and a receiver, in which the evolutionary function of the sender is to affect the receiver by means of the signal and the receiver’s function is to respond in certain ways to its presence.

We are now in position to define in more detail what is the minimal structure required for a representational system to originate:

TELEOSEMANTICS: R is a representation of S iff there are two systems P (for producer) and C (for consumer) such that:

- 1) P and C have etiological functions:
 - (a) P has the function of producing R when a state S obtains.
 - (b) C has the function of producing an effect E. The Normal explanation⁴ of how C performs the effect E involves the state S.
- 2) P and C have coevolved in such a way that a Normal condition for the proper performance of each system is the presence and proper functioning of the other.

I have already justified conditions 1a and 1b of TELEOSEMANTICS, but 2 remains unexplained. This is the condition that appeals to the cooperation of the systems. Let consider it in some detail.

2.1 Cooperation

Condition 2 claims that a Normal condition for the performance of P’s and C’s function is the presence and proper functioning of the other mechanism. That means that the fact that the producer P has performed its function helps to explain why the consumer C historically complied with its function, and the fact that C performed its function helps to explain why P historically complied with its function. That is the relevant sense in which P and C must be cooperating devices.

³ Of course, this sender-receiver model is supposed to apply at the level of types. Teleosemantics does not require that every representation (token) is consumed by another system. A particular alarm call can be a representation even if it is not heard by any fellow. It suffices if these activities are performed often enough in consumer systems of that type. We will come back to that issue later.

⁴ Strictly speaking, Millikanian teleosemantics claims we should focus on the *least detailed* Normal explanation of how C has historically performed its function. Since these details are irrelevant for the discussion at hand, I will leave them aside.

Why should we think producer and consumer systems have been cooperating? The intuitive idea behind this claim (which is also supported by abstract models of signaling systems such as Lewis, 1969; Skyrms, 2010, p.77-82) is that, on the one hand, senders acquire the capacity of producing signals only if they benefit from the receiver's activity; otherwise, they would stop producing signs (Maynard Smith and Harper, 2003, p. 3). If the sender did not profit from the action of the consumer system, it seems it would not evolve a mechanism for informing the receiver about the presence of some state of affairs (Millikan, 2004, 2005). Similarly, receivers must benefit from the senders performing their functions; otherwise, they would ignore the sign (Maynard Smith and Harper, 2003, p. 3). That shows that a Normal condition for the proper performance of each system (producer and consumer) is the presence and proper functioning of the other. In other words, sender and receiver must have coevolved as cooperating systems.

The idea that sender and receivers should cooperate is entrenched in scientific reasoning as well:

If there is, on average, no information of benefit to the receiver of a signal, then receiver should evolve to ignore that signal. If receivers ignore the signal, then signaling no longer has any benefit to the signaler, and the whole communication systems should disappear. (Searcy and Nowicki, 2005)

An analysis that allows the signaler's behavior to evolve but does not permit any evolution in the receiver's response does not make sense (...). In fact, receivers should evolve responses to signals only when it is advantageous to do so. And if it does not benefit receivers to respond in a particular way to a specific acoustic feature then selection will favor receivers that attend to some other cue. (Seyfarth et al., 2010)

Indeed, the way content is determined according to TELEOSEMANTICS (specified in condition 1) seems to assume that sender and receiver are, to some extent, cooperating systems. The theory claims that the content of sign produced by a sender is determined by the historical needs of the consumer. So, if P is a sender and produces a state R that represents S, then by definition there must be some consumer that has performed its function often enough thanks to the presence of S. Consequently, if P is a sender that produces meaningful signs, there must be a consumer that often enough benefits from perceiving the sign. This way of determining content seems to entail that representations originate between systems that have some common interest.

In that respect, it is important to stress that the requirement of cooperation does not demand *complete* common interest; it suffices if the sender and the receiver have *partial* common interest. Each one must somehow benefit from the activity of the other, and that benefit must partially explain the selection of the mechanism.⁵ As condition 2 in TELEOSEMANTICS claims, the Normal condition for the proper performance of each system must be the presence and proper functioning of the other. The contribution of each, however, might be suboptimal (some models of partial interest can be found, for instance, in Skyrms, 1996, 2010).

⁵ One can easily be misled here by the different uses of the expression 'common interest' that can be found in the literature. For instance, Maynard Smith and Harper (2003, p. 27) define cases of 'common interest' as involving two organisms that 'place the possible outcomes of the interaction in the same rank order of preference'. This is a stronger notion from the one I am using here (and the one that is required for teleosemantics). In the sense intended here, there can be common interest between two organisms even if there is partial competition or even if signaling involves some partial cost that could be avoided by the organisms involved. This is why, prima facie, phenomena like the 'handicap principle' (Zahavi and Zahavi, 1997) do not threaten teleosemantics.

Despite the intuitive plausibility of the cooperation requirement, some people have recently argued that it should be dropped from the theory. Their criticism is motivated by some cases that apparently illustrate the existence of signaling without cooperation. If this objection succeeded, then obviously condition 2 of TELEOSEMANTICS would be in jeopardy. That would be in itself a significant result, given the lively debate on cooperation. In addition, once the cooperation requirement is dropped from the theory, one might wonder whether the sender-receiver model is the right framework for thinking about animal signaling (see Skyrms, 2010, p. 77). Indeed, those who reject or ignore the cooperation requirement tend to refuse the sender-receiver model. Finally, as I will argue in the next section, if one abandons this framework, condition 1a of TELEOSEMANTICS will probably be inadequate.⁶ These are some of the reasons that motivate a careful look at the alleged existence of signaling between organisms that lack partial or complete common interest.

2.2 Uncooperative systems

The assumption that cooperation between signaling systems is required has been attacked in various ways by some biologists and philosophers. From the scientific domain, the idea that signaling presupposes a certain degree of cooperation among participants has been seriously challenged from a general perspective on evolution (Dawkins and Krebs, 1976) as well as alternative ethological approaches (e.g. Rendall et al., 2009). Here I will leave aside the general problem of selfishness and manipulation (which, I think, has already been sensibly replied to from an evolutionary perspective by Godfrey-Smith, 1996, 2009 and from an ethological point of view by Sefarth et al. 2010) and I will focus on a set of counterexamples that philosophers have raised against the teleosemantics framework that is supposed to account for the nature and meaning of animal signaling.

In this context, the objection was originally raised by Sterelny (1995) and developed by Stegmann (2009) and it is based on the phenomenon of mimicking. Mimicry (or mimetism) is the similarity of one species to another which benefits one or (less frequently) both. More precisely, the argument is based on what ethologists call ‘aggressive mimicry’ (Wickler, 1965). In aggressive mimicry, a predator or parasite imitates some feature of another species in order to exploit other members. A species of Australian katydid (*Chlorobalium leucoviridis*), for example, imitates the mating sound of female cicadas in order to attract male cicadas and devour them (Marshall and Hill, 2009). Similarly, the bolas spider (*Mastophora* species) attracts male moths by imitating the sex pheromones of female moths (Eberhard, 1977). The key intuition motivating the objection to teleosemantics is that all these cases seem to involve signaling without cooperation.

Now, in order to develop the problem in some detail, let me focus on the case of aggressive mimicry in fireflies discussed at length by Stegmann (2005, 2009):

Among the fireflies are some species that prey on other fireflies. Females of the species *Photuris versicolor*, for example, prey on the males of several *Photinus* species. Predation involves the deceptive use of mating signals (Lloyd, 1975). The aptly named ‘femmes fatales’ lure the males by sending the sort of mating signals that the males’ conspecific females would send. So, for instance, if a predator perceives the flashes of a male *P. macdermotti*, and if she’s hungry, then she will emit the sort of flash that a female *P.*

⁶ Nonetheless, a rejection of the cooperation requirement, the sender-receiver model and condition 1a of TELEOSEMANTICS is still compatible with some versions of teleosemantics. Indeed, as I will argue later, one could keep condition 1b in order to develop a consumer-based teleosemantic account very similar to Millikans’ own approach. I want to thank an anonymous referee for pressing on this issue.

macdermotti would emit if she were willing to mate. (...) From an ethological point of view, the predator's female-*macdermotti*-type flash carries the information that there is a female *P. macdermotti* willing to mate.(...) But the co-occurrence of a female *macdermotti* type flash with the presence of a hungry predator is clearly not the normal condition for the male's consuming device to achieve its function. (Stegmann, 2009, p. 868)

Let us try to describe more carefully the case having in mind the sender-receiver structure sketched earlier (for simplicity, let us call members of the *Photinus* species 'F-females' and 'F-males' and members of the *Photuris versicolor* species 'Predator'). First, if we set aside for a moment the parasiting behavior and focus on the usual behavior of the F-species, the schema described in TELEOSEMANTICS happily applies. F-females (producer) Normally send a signal (light) to F-males (consumer). Since the behavior of the F-males (i.e. mating) was historically successful only in those occasions where there was a F-female ready to mate and because there was such a female, then TELEOSEMANTICS predicts that the light emitted means something like *F-female willing to mate*. So far so good.

The problem arises when we focus on the parasiting behavior. The light emitted by the 'femmes fatales' of the Predator species (*Photuris versicolor*) seems to be a representation. Indeed, it intuitively means the same as the light emitted by the parasited bug, namely something like *F-female willing to mate*. This is the reason F-males are attracted to Predators, which do not hesitate in devouring them. In fact, it seems that only if we assume that the light emitted by Predator has the same content as the light emitted by F-females (the parasited bug) can we explain the behavior of F-males. Hence, the following claim seems to be true:

MIMICRY: The light emitted by Predator is a signal, which means something like *F-female willing to mate*.⁷

The key problem Sterelny and others point out is that it seems TELEOSEMANTICS cannot accommodate MIMICRY. First of all, notice that the receivers of the light emitted by Predator are the F-males, so in this case the sender and the receiver are predator and prey. Since we can reasonably assume that in this case predator and prey have no common interest,⁸ it seems MIMICRY entails that a state can be a representation even if the sender and the receiver are not cooperating devices. That clashes with condition 2 of TELEOSEMANTICS.

The second reason why TELEOSEMANTICS does not yield that result is that condition 1a does not seem to be satisfied. That is (assuming an etiological understanding of function) the function of the light-emitting mechanism in Predators (which, in this case, qualifies as the sender) is not to produce a light when there is an F-female willing to mate. Here is the reason: according to the etiological understanding of function, a trait T has a function F iff T has been selected for F. Functions are selected effects. However, producing a light when

⁷ MIMICRY is defined in terms of the *Photuris versicolor* and *Photinus* species, but notice that the problem pointed out here concerns (at least) any case of aggressive mimicry. This example is supposed to highlight a broad and significant set of cases that teleosemantics cannot account for.

⁸ This qualification is required because it has been argued that, in some cases, predator and prey may have some common interest. For instance, according to the Perception Advertisement Hypothesis, some organisms inform their predators that they have been perceived, so that hunting per surprise becomes futile (Radner, 1999, p. 129-130). Gazelles, for example, perform a set of controlled jumps (called 'stotting') so as to communicate to the predator that it has been detected (Sterelny and Griffiths, 1999) or that it is a healthy exemplar (Maynard-Smith and Harper, 2003, p. 61; Ruxton et al 2004, ch. 6). Apparently, this sort of signs benefit both predator and prey; the former does not attempt an attack that will probably fail and the latter avoids a possible threat (Millikan, 2004; Ruxton et al. 2004, ch. 6).

Even if these examples exist, aggressive mimicry seems to be a different sort of case. It is extremely plausible that the light emitted by Predator in order to lure F-males only benefits the former.

there was an F-female willing to mate does not seem to be the selected effect of the light-emitting mechanism of Predator. Flashing when there is an F-female is not the historical effect of the light-emitting mechanism that accounts for its existence. In the historical situations that account for the selection of the Predator's mechanism, there probably was a hungry Predator and an F-male, but not an F-female willing to mate. Consequently, condition 1 of TELEOSEMANTICS is not satisfied.⁹

Let me put the idea under a different light. If we accept MIMICRY (i.e., if the Predator's flashes mean *F-female willing to mate*), then (by condition 1a) the function of the producer system must be to send a flash when there is an F-female willing to mate. However, if we assume an etiological understanding of function, it is extremely implausible that the Predator's mechanism has been selected for producing flashes when there are F-females. Therefore, MIMICRY seems to be incompatible with 1a of TELEOSEMANTICS.

Consequently, the following claim seems to be true:

INCOMPATIBILITY: TELEOSEMANTICS is incompatible with MIMICRY.

We have, then, three plausible theses that are mutually inconsistent: TELEOSEMANTICS, MIMICRY and INCOMPATIBILITY. At least one of them should be given up.

One first option is to hold that this counterexample suggests that the whole framework set up in TELEOSEMANTICS must be entirely rejected. That is probably an extreme position to take, since TELEOSEMANTICS seems to yield the right results in a wide range of cases and has independent support.

A more refined and popular version of the first option consists in modifying TELEOSEMANTICS in order to make it compatible with MIMICRY. For instance, one could argue that TELEOSEMANTICS specifies a set of sufficient but not necessary conditions for representational systems to arise (along the lines of Sterelny, 1995; Sterelny and Griffiths, 1999). Defenders of this proposal are probably committed to a 'splitting account' of the phenomenon of representation, according to which different sorts of representations require different analysis.

Another strategy is to alter the sender-receiver structure described in TELEOSEMANTICS. Neander (2006, 2013), Stegmann (2009) or Cao (2012), for instance, dispense with the sender-receiver framework. According to the former, content is exclusively determined by the producer system (she rejects condition 1b and probably also condition 2 of TELEOSEMANTICS). On the contrary, according to Cao and Stegmann representational content is fully determined by the consumer system (they reject 1a and 2). Since the differences between Millikan's and Neander's models have already been discussed in the literature (e.g. Schulte, forthcoming), I will not develop them in detail. In contrast, the differences between the mainstream model and Stegmann's and Cao's framework are less obvious, because both are very heavily consumer-based. So let me briefly describe them.

There are (at least) three crucial points of disagreement between these purely consumer-based theories and TELEOSEMANTICS. On the one hand, Stegmann and Cao reject the cooperation requirement and the sender-receiver model. As I said, this is a significant thesis, not only because it changes the framework for thinking about signals, but also

⁹ Here I think Stegmann (2009, p. 868) misdescribes what the mainstream teleosemanticists would say. He claims that, on this view, 'the function of the predator's producing device is to token [F-female-type] flashes that map the presence of the hungry predator'. If that were the case (and assuming mainstream teleosemantics) the flash would mean *there is a hungry predator*, and not *there is an F-female willing to mate*. However, that would constitute a denial of MIMICRY (see also 3.3).

because it compels us to reconsider the use of abstract models of signaling in analyzing the phenomenon of representation (Godfrey-Smith, 1996; Skyrms, 2010).

The second important difference (closely related to the previous one) concerns the status question (Schulte, forthcoming). According to Millikanian teleosemantics, a state qualifies as a representation iff there is a sender-receiver system with the right etiological functions. In contrast, according to Stegmann's approach, a state (token) is a representation iff '[an item (token)] is consumed by a mechanism whose normal condition to perform its function is that items of this type correspond to something other than themselves according to a mapping' (Stegmann, 2009, p. 871). Tree rings or smoke can readily qualify as genuine representations on Stegmann's account if there is some organism that consumes them and has been designed to do so, but would not count as representations on mainstream teleosemantics unless they are produced by a sender with the right functions. There are other examples that highlight the importance of this disagreement. Consider the courtship signaling of wolf spiders (*Schizocosa ocreata*), which involves active behaviors (waving and tapping of the forelegs, seismic communication by stridulation and percussion) and morphological traits (tufts in the forelegs) (Roberts et al. 2007). If a wolf spider performs this set of behaviors, but they are not perceived by any female, there is no particular consumer system for this state (token), so it would not count as a representation according to Stegmann's (2009, p. 871) view, but would qualify as a representation according to mainstream teleosemantics.

Thirdly, there is also a difference in content determination. As we saw in detail, in mainstream teleosemantics representational content is determined by the state that consumers have historically required in order to act successfully. According to TELEOSEMANTICS, the sender has the function of producing R when S obtains (rather than, say, the function of producing R when S* obtains) because S (and not S*) is the state that consumers have historically needed in order to act in a fitness-enhancing way. However, once a sender-receiver system is in place and has been selected for, the presence of a receiver in a particular occasion is not required for a state to be a representation and to have certain content (see footnote 2). In a particular occasion, the content of a state (token) is S if the producer system has the function of producing this state when S obtains; the needs or even the presence of a consumer is irrelevant. In contrast, according to Stegmann's approach, the representational content of a state depends on the historical needs of the consumer system that is present at that particular occasion. To illustrate this difference, consider the jumping spider (*Phidippus clarus*), which preys on wolf spiders and uses its exaggerated courtship behavior as a sign that there is a potential prey around (Roberts et al. 2007). If in a given occasion a wolf spider performs this mating behavior and it is only perceived by a predator, Stegmann's account predicts that the behavior is a representation of food being around for jumping spiders. In contrast, TELEOSEMANTICS entails that its content is still something like *male willing to mate*.

There is an alternative interpretation of Stegmann's view. He might be assuming that, for a state R to mean S, it suffices if there is *some* consumer that *at some point* would take R to mean S. This view would still differ from mainstream teleosemantics in content attribution, because it would imply that any representation (token) has always as many contents as potential consumers. According to this version of Stegmann's account, the wolf spider's mating signal would always mean *male willing to mate* (for wolf spiders), *food being around* (for jumping spiders), and so on, while according to mainstream teleosemantics it only means *male willing to mate*.

Finally, it is worth pointing out that there are also close similarities between both accounts. In particular, both accept condition 1b of TELEOSEMANTICS and they probably attribute

the same contents in a wide range of central cases. Nonetheless, the differences are still significant.

In what follows, I will try to defend TELEOSEMANTICS. Given the tension between TELEOSEMANTICS, MIMICRY and INCOMPATIBILITY, I will argue that both MIMICRY and INCOMPATIBILITY can be rejected. Of course, in order for standard teleosemantics to overcome the difficulty, it suffices if one of these theses is abandoned, but I would like to show that there are many options available to the teleosemanticist. More precisely, I will argue that cases of aggressive mimicry can be perfectly accommodated within TELEOSEMANTICS, either by denying that Predators really emit signals, or by holding that the fact that they send signals is compatible with the theory. I will not try to argue which of these options is more plausible, although I will highlight the costs and benefits of taking each alternative.

3 Accounting for Uncooperative Mechanisms

3.1 Rejecting MIMICRY

Let me start by considering the more straightforward way of solving the puzzle. The first strategy is to reject MIMICRY and maintain that, strictly speaking, Predators do not produce representations, but meaningless states. This option assumes that the flashings emitted by Predators are not really signals, even if they look exactly like the signals emitted by F-females. More generally, the first suggestion is that in cases of aggressive mimicry in which a sign is copied, no real signal is produced by the mimicker.

There is of course an obvious problem with this proposal. The teleosemanticist could be accused of offering an ad hoc solution to a serious objection. Is there any reason (besides rescuing teleosemantics) for thinking that the Predator's flashings are not really representations? After all (the objection runs) they resemble very much the original signals and have the same effects, i.e. attracting F-males. Furthermore, it seems that ethologists usually explain the behavior of F-males by assuming that the light emitted by Predator are representations that mean something like *F-female willing to mate*.

In response, there are at least two important considerations besides teleosemantics for rejecting MIMICRY. The first one concerns the explanation of behavior and the second one has to do with general explanations of mimicry and cryptic strategies.

First of all, I think that a careful look at these cases shows that a satisfactory explanation does not require accepting that the light emitted by Predator is really a signal. What scientists seem to assume in order to accommodate this situation is that F-males *wrongly think* (or, to use a less cognitively loaded term, *represent*) that the Predator's light is a signal. We can fully explain the phenomena by saying that F-males are simply wrong; the light produced by Predator is not a signal and does not mean anything, but F-males are misled by the strong resemblance of the light emitted by Predators and F-females (see El-Hani et al., 2010, p. 11). In that particular case, it seems that the additional claim that this state is indeed a real signal sheds no additional light onto this explanation.¹⁰

Considering other cases of aggressive mimicking might help to clarify this point. Think about the astonishing example of the blister beetles (*Meloe franciscanus*). Just after hatching, larvae of the blister beetle climb to the top of stems where they form an aggregation that

¹⁰ Of course, assuming that the Predator's flashings are real signals can also explain why F-males are mistaken. Nonetheless, that does not affect my main point, because what I argue is that accepting that they are signals is not required in explanations of behavior and that rejecting MIMICRY has interesting advantages from a scientific point of view.

resembles a bee. These aggregations attract (through visual and chemical cues) male bees, which try to copulate with them. During the pseudo-copulation, larvae attach to the male bee and are eventually transported to the bee's colony that they will parasitize (Hafernik and Saul-Gershenz, 2000). This is usually classified as an example of aggressive mimicry (Ruxton et al, 2004, ch. 6). However, in this case the hypothesis that male bees are misled because an aggregation of blister beetles' larvae *really* constitutes a female bee is preposterous. In general, we do not expect mimicking and mimicked entities to be of the same kind. Male bees are misled into thinking that there is a female bee ready to mate because an aggregation of larvae look and smell like them, but they are simply wrong. Similarly, F-males are misled into thinking that the Predator's light is a signal, but they are wrong. Consequently, Predators do not emit real signals, but only flashings that resemble signals. As a result, MIMICRY turns out to be false.

A second reason for rejecting MIMICRY is that taking this perspective has interesting advantages from a scientific point of view. There are many strategies organisms employ in order to confuse others. For instance, in the phenomenon known as 'masquerade', organisms tend to resemble inanimate things in order to be avoided by predators. In contrast to the strategy of background matching (that is, standard cases of camouflaging), in masquerade the organism is usually detected but confused for another thing. A remarkable example includes the sea dragon (*Phyllopteryx eques*), an Australian sea-horse with numerous outgrowths that resembles a sea weed (Ruxton et al. 2004, p. 23). Likewise, some Amazonian fish species avoid predators by resembling dead leaves (Sazima et al., 2006). A similar phenomenon is the so called 'disruptive coloration', in which the organism's coloration tends to obscure the true form of the animal and conceal certain parts. For instance, it has been suggested that the white spots on the morph of the isopod *Idotea baltica* serve to obscure its real form rather than to match spots in the background (Merilaita, 1998). Another strategy is deflection which works by increasing the predator's probability of striking at a highly defended or expendable part. Some lizards, for example, have brightly colored tails, which contrast with the cryptic coloration of the rest of the body. This conspicuous color increases the likelihood of an attack being directed at the tail, which lizards can shed and regrow (Ruxton et al. 2004, p. 183). We could also add to this list the well-known cases of Batesian and Müllerian mimicry.

Now, intuitively, there is something important that all these strategies have in common: their function is to lead predators to *misidentify* the prey. That is, what explains the evolution of all these strategies is that often enough they manage to produce false representations in predators. Predators think (or represent) that there is a sea weed, that there is a leaf, or that there is a blurry entity with unclear contours. This is the central function that explains why all these different forms of camouflaging and mimicking have evolved. Classifying them together has obvious advantages from a scientific point of view. Despite the significant differences among these strategies, some models and generalizations are applicable to all of them, so highlighting this common background has fruitful consequences for some research programs (Ruxton et al. 2004).

Aggressive mimicry is usually understood within the same paradigm. For instance, many of the models and theories that are useful for explaining cases of Batesian mimicry or masquerade can also be employed in explaining aggressive mimicry (Maynard-Smith and Harper, 2003). Therefore, from a scientific point of view, it makes a lot of sense to focus on the fact that the function of all these strategies is to mislead predators. This claim lends support to the idea that the central explanatory notion is that of misidentification.

Consequently, an interesting scientific perspective classifies most cases of camouflaging and mimicry by appealing to the fact that they lead other organisms to misrepresent. What unifies all these strategies is that they cause misidentifications, not that they are signals. I

also argued that the claim that the light emitted by Predators is a signal is not doing any substantive explanatory work and that, in general, we do not expect mimicking and mimicked entities to literally be members of the same kind. As a result, I think there are good reasons for rejecting MIMICRY.

3.2. Rejecting INCOMPATIBILITY

I just argued that one option is to reject MIMICRY and maintain that, strictly speaking, the mimicking system does not produce representations, but meaningless states. A second strategy I would like to discuss is that of endorsing TELEOSEMANTICS and MIMICRY and rejecting INCOMPATIBILITY. The goal is to argue that one can coherently hold that the Predator's light is a representation that means something like *F-female willing to mate* and, at the same time, that cooperation between producer and consumer is a requirement for a state to qualify as a representation.

In what follows, I would like to show that, if one assumes TELEOSEMANTICS and MIMICRY, there are two different ways in which teleosemantics can accommodate cases of aggressive mimicry: copying signals and copying mechanisms.

3.2.1 Copying Signals

The first strategy for showing that TELEOSEMANTICS and MIMICRY are compatible is to argue that the flashes emitted by Predators carry representational content because they ride piggyback on the flashes emitted by F-females. In other words, the Predators' flashes are contentful signs in virtue of belonging to the same kind as the F-females'. However, for this strategy to go through, we need a principled criterion of individuation. Here I will develop an approach which I think is particularly promising and which is very popular in both teleosemantics and biology. Nonetheless, I will show later on that other ways of individuating traits and states are also compatible with this solution.

To begin with, let us grant MIMICRY for the sake of the argument. That is, let us assume that the signals emitted by Predator are indeed representations. If one accepts that much, it should be obvious that the signals emitted by Predator have the same content as the flashings emitted by the mimicked females (F-females): *F-female willing to mate*. Indeed, not only the content of the representation, but many non-intentional properties (light intensity, frequency, brightness, etc.) are shared by the mimicking and the mimicked signals. Even some of their functions are shared; after all, both signals have the function to attract F-males (Stegmann, 2009, p. 871-2). This is a piece of significant evidence that needs to be accounted for.

Obviously, what explains this resemblance is the existence of a strong tendency for the parasiting system to reproduce any feature of the parasited sign. The Predator's signal is supposed to be a copy of F-females' signals. If the intensity of the light emitted by F-females were to change, there would probably be an evolutionary trend towards a change of the Predator's light intensity in the same direction. The fact that there is this counterfactual dependence relation between the two suggests that there is a causal relation between them (Sober, 1984). The properties of the parasiting representational system are (historically) caused by the properties of the parasited system. This causal relation to a great extent explains the commonalities between the mimicking and the mimicked system. Consequently, there is a strong tendency for the Predator's and the F-female's signals to share many properties in virtue of an underlying causal process of copy.

On the other hand, it is well known that a common way of individuating kinds in biology is precisely by appealing to this kind of causal process of copy. In particular, according to a very popular theory defended by Boyd (1999a, 1999b), Griffiths (1999), Wilson (1999) and Millikan (2000) among others, many biological kinds are groups of entities that share stable similarities due to an underlying causal process. In a nutshell, the idea is that two entities belong to the same kind if they tend to have common or overlapping properties, these similarities are explained by a causal mechanism and this clustering of properties is scientifically or practically important.¹¹ For instance, all members of the species *Canis lupus* belong to the same kind because they tend to have many properties in common in virtue of being reproduced from each other and they form a significant cluster. Similarly, some people argue that many other biological categories are constituted by a set of entities that tend to resemble each other because they are copied from past members of the same kind and are subject to certain causal mechanisms that support this connection.¹² (Neander, 2002; Millikan, 1984, ch. 1). This approach has also been extended to many other types of entities, like social kinds, moral properties, or artifacts (Boyd, 1991, 1988; Millikan, 2005).

There are different ways of specifying in more detail the idea of *reproduction* employed here. In what follows, I will rely on Boyd's definition of Homeostatic Property Cluster Kinds (HPC):

The natural definition of one of these homeostatic property cluster kinds is determined by the members of a cluster of often co-occurring properties and by the ("homeostatic") mechanisms that bring about their co-occurrence. (...). The paradigmatic cases of natural kinds -biological species- are homeostatic cluster kinds (Boyd, 1991, p. 141)

More precisely, according to Boyd (1999a, p. 143), there is an HPC when the following conditions hold:

1. There is a family (F) of properties that are contingently clustered in nature in the sense that they co-occur in an important number of cases
2. Their co-occurrence is, at least typically, the result of homeostasis: either the presence of some of the properties of F tends (under appropriate conditions) to favor the presence of the others, or there are underlying mechanisms or processes that tend to maintain the presence of the properties in F, or both.
3. The homeostatic clustering of the properties in F is causally important (theoretically and practically).

Two caveats are important. First, the details of Boyd's account need not concern us here. Similar approaches to natural kinds based on reproduction could play the same role in the argument. Secondly, we do not need to assume that *all* or even *most* biological kinds are Homeostatic Property Cluster Kinds. The key assumption required by my argument is that something like this account captures a real and scientifically interesting way of typing entities, which relies on the fact that they tend to share a set of properties in virtue of some underlying process of copy.

¹¹ Notice that, for our purposes, we only need to assume that this process of copy is a sufficient condition for a set of entities to constitute a biological kind. The idea is, I think, extremely plausible and it is a claim that many teleosemanticists have explicitly argued for (Millikan, 1984, 2000; Neander, 2002).

¹² Let me mention that kinds like *heart* or *eye*, which are sometimes suggested in the literature, are probably not reproductive kinds in the sense intended here. Eyes, for instance, have probably evolved independently several times (Nilsson, 1996), so convergence rather than homology explains why they share many properties in common. Perhaps *vertebrate eye* or *mammalian heart* are more plausible examples of reproductive kinds. I want to thank an anonymous referee for this suggestion.

Now, once we have in place a definition of HPC the key premise for solving the incompatibility of MIMICRY and TELEOSEMANTICS is not hard to come by: the flashings emitted by Predators and F-females form a (scientifically relevant) HPC. That is, the Predator's flashes and the signals emitted by F-females belong to the same kind in virtue of the fact that they tend to have many properties in common due to an underlying robust causal mechanism. Furthermore, this homeostatic clustering is important from a scientific point of view (e.g. ethology). Thus, since they are both signals of the same type, they both represent *female willing to mate*.

Let me stress the key step in the argument. We saw that there is a strong evolutionary tendency for the Predator's signal to reproduce any properties of the signal of F-females. Many features like the intensity of the light, its brightness, its frequency and so on are copied through a robust causal process. Thus, given the definition of HPC and its relevance for ethology, this process of copy is enough for justifying the claim that the signal emitted by Predator and the signal emitted by F-females belong to the same type of signals. At some point, this process of reproduction justifies the claim that the Predator's light is indeed a signal which also copied the meaning from the original.

The proposal, then, is that a popular perspective on the nature of biological kinds has the consequence that the Predator's flashings and the F-female's flashings are both signals of the same relevant kind. Crucially, this proposal shows that MIMICRY is compatible with TELEOSEMANTICS: the only sender-receiver system is that of F-females and F-males and, nonetheless, the Predator's flashings are contentful signals in virtue of being copied from the original signals of F-females. That is, since we already saw that TELEOSEMANTICS can easily explain the fact that signals of F-females directed at F-males are representations, to account for the Predator's flashings we just need to realize that they ride piggyback on the signals of F-females. Furthermore, this approach can explain why the content of the Predator's signal is exactly the same as the content of the F-female's signal.

Before presenting some objections to this proposal, let me develop a slightly different way in which MIMICRY and TELEOSEMANTICS can be said to be compatible.

3.2.2 Copying Mechanisms

There is a second way of showing that TELEOSEMANTICS is fully compatible with MIMICRY. A more ambitious hypothesis is that, in order for TELEOSEMANTICS to account for cases of parasitism, we must realize that, in some sense, the parasitic representational *system* belongs to the same biological kind as their parasited *system*. In other words, both the producer system of F-females and the producer system of Predator belong to the same biological kind. The proposal, then, is that the parasiting mechanism system is a mere copy of the parasited one. This initially surprising idea is supported by two plausible claims: on the one hand, the thesis that two entities belong to the same kind if they tend to have important properties in common in virtue of some homeostatic (causal) process. On the other hand, the observation that this strong causal process of copy is taking place in the case of the signaling system of F-females and Predators. Since we might think this is a robust and non-accidental link that has been active during the evolution of the whole representational system, the producer systems of F-females and Predator could satisfy the criteria for qualifying as members of the same biological kind.

Let me try to motivate the idea from a different perspective. Traits can be typed in many different ways. Probably, the mechanism within Predators that emits flashes differs in many respects from the mechanism within F-females (although some studies suggest that this mechanism is extremely similar across fireflies luciferases; Lewis and Cratsley, 2008, p.

298). However, both mechanisms also have many properties in common; in particular, they generate lights with many properties in common (the same intensity, the same frequency, etc.) which attract F-males. Moreover, this mechanism has been designed to attract F-males and all these similarities are not a mere coincidence, but the result of robust evolutionary forces. Now, if we think that the kind *being an F-light-emitting mechanism* is a functional category, it could be argued that, according to some particular way of individuating traits, the Predator's and the F-females light-emitting mechanisms belong to the same kind.

Now, if we accept that the Predators' producer system and the F-females' producer system belong to the same biological kind, then MIMICRY can be perfectly accommodated within TELEOSEMANTICS. On this approach, what explains the apparent incompatibility is that we were previously misapplying the sender-receiver framework to the case of fireflies. Given that producer and consumer systems must constitute biological kinds (after all, they must be *selected for*) and given that the light-emitting mechanism of F-female and Predators belong to the same kind, in order to properly apply the sender-receiver framework we should be assessing whether the light emitting mechanism of F-females *and* Predators has some common interest with the consumer system of F-males. And, once the question is cashed out in these terms, the answer seems to be clearly affirmative. There is partial common interest between the F-light emitting mechanism (which can be found in F-females and Predators) and the F-light consuming mechanism of F-males.

One consideration in favor of this view is that ethologists usually assume that deception presupposes partial common interest between sender and receiver (Maynard-Smith and Harper, 200, p. 87). The idea that deceptive senders ride piggyback on honest senders is also widespread: 'In all kinds of signaling systems in nature there is information transmission *which is sufficient to maintain signaling*, but we also find misinformation and even deception' (Skyrms, 2010, p. 80, emphasis added).

But one might raise the following question: If the relevant producer P includes the signaling systems of Predators and F-females, is still the function of P to produce a state R when there is an *F-female ready to mate*? If the producer includes the light-emitting mechanism of Predator, it might seem that the function of the producer (and the content of the signal) has to change. However, this worry is unfounded. On the etiological understanding of functions, the function of a trait is the effect that explains why past tokens of this trait were selected for. But, crucially, only the light emitted by F-females (and *not* the flashes emitted by Predator) helps to explain the existence of the representation system; the producer system in Predator rides piggyback on the success of the system in F-females. In other words, the producer P in firefly signaling exists *despite the fact* that this kind includes Predators, which reduces the overall reliability of the whole representational system. And, since Predators do not positively contribute to the selection of the whole mechanism, their activity does not alter the function (or content) of the representational system. Consequently, even if the Predators' producer system and F-females' producer system belong to the same biological kind, its function and content is exclusively determined by the effects of F-females and F-males.

Consequently, if the Producer system of Predators and F-females belong to the same kind, both MIMICRY and TELEOSEMANTICS are compatible. Members of Predator produce a representation that is consumed by F-males and, at the same time, cooperation is required for a state to qualify as a representation. The key suggestion that dissolves the perplexity is that the sender-receiver model (and the cooperation requirement) applies at the level of kinds of mechanisms, and at this level the mechanism of F-females and Predators belong to the same biological kind.

I admit that this is probably the most revisionary proposal and, given the previous alternatives, not the one most people would favor. Even if traits can be typed in many different ways, classifying the producer of Predators and the producer of F-females as belonging to the same biological kind would have significant consequences in some areas of biology. This is an important issue that deserves to be seriously taken into account before this last proposal is finally adopted or rejected. Nonetheless, I think this is an option available to the teleosemanticist in order to accommodate cases of mimicry that should not be discarded without serious consideration. Much more should be done in order to show that cases of aggressive mimicry pose a significant problem for teleosemantics.

Summing up, I have considered three ways in which mainstream teleosemantics can account for cases of aggressive mimicry. The first one is to reject MIMICRY and hold that the light emitted by predators is not really a signal. The second strategy is to accept TELEOSEMANTICS and MIMICRY, but deny INCOMPATIBILITY. I have shown there are two ways of carrying out this suggestion. According to the first proposal, TELEOSEMANTICS applies at the level of F-females and F-males and the Predator's flashings simply ride piggyback on these signals. The second solution assumes a different way of typing systems: the producer systems in Predator and F-females form a single kind, so that common interest between producers and consumer is justified. To complete this discussion, let me now turn to three objections.

4. Objections

4.1 Stegmann's reply

Stegmann (2009) seems to shortly consider the reply based on the rejection of INCOMPATIBILITY. In particular, he writes:

Might the predator's flashes have content because they inherit it from the cooperative flashes they mimic? The notion of copy of 'reproduction' plays an significant role in Millikan's (1984) account. The predators' flashes, however, do not qualify as 'reproductions' in her technical sense. 'Reproductions' share properties with the model due to the fact that the model is *directly* causally responsible for the reproductions' properties (Millikan, 1984, p.20). Imitations like the parrot's 'hello' are reproductions in this sense. But there is no such direct causal link from cooperative to mimicking flashes. Nor do the predators's flashes form a 'higher-order reproductively established family' together with the females' flashes. For this would require that either all flashes are produced by the same device or, if produced by distinct devices, the devices are reproductions of one another (Millikan, 1984, 24-5). Neither is the case. (Stegmann, 2009, p. 869, emphasis in the original)

I will provide two responses to this reply. First, I will argue that there is indeed a notion of reproduction that can play that role in the argument. Secondly, I will defend that even Stegmann (and, more generally, anyone willing to solve the puzzle of uncooperative signaling) has to assume that the Predator's flashes and the mimicking flashes belong to the same kind and that, somehow, the former inherits the content of the later.

First, without getting into the details of Millikan's own notion of *reproductively established family*, I do think there are certain ways of understanding *reproduction* that show that the argument goes through. I tried to capture this notion of reproduction by appealing to Boyd's HPC kinds: members of *Drosophila melanogaster*, for instance, belong to the same kind because they tend to have many properties in common in virtue of some sort of homeostatic mechanism. Of course, in that particular case, the homeostatic mechanism involves genetic material, but as Godfrey-Smith (2009) has extensively shown, the sense in

which members of the same species reproduce does not require the existence of a set of genes with high-fidelity reproduction. I argued at length that this notion of reproduction can be employed in the argument. Nonetheless, let me present a more compelling example for our discussion.

One of the advantages of shoaling is that fish have the opportunity to learn from experienced members of the group. For example, there is some evidence that naive fathead minnows (*Pimephales promelas*) give fright responses to chemical stimuli from predatory northern pike (*Esox lucius*) when paired with pike-experienced conspecifics but not when paired with pike-naive conspecifics. Pike-conditioned minnows seem to transmit this behavior to pike-naive fellows. Similarly, it has been found that Brook sticklebacks (*Culaea inconstans*), which are also preyed by the northern pike and usually form mixed aggregations with fathead minnows, can learn this fright response from pike-experienced minnows. Indeed, they even transmit this behavior to pike-naive minnows. (Mathis et al. 1996; see also Krause, 1993; Mathis and Smith 1993).

Now, it seems hard to deny that the behavior performed by minnows and sticklebacks are copied from each other. For one thing, the same behavior is passed from pike-experienced to pike-naive minnows and sticklebacks. Furthermore, experienced sticklebacks can also transmit this behavior to pike-naive minnows. So the claim that these behaviors are reproductions and that they are essentially the same type of behavior is extremely plausible.

Of course, one can insist that the stickleback's behavior is neither copied from fathead minnows in the direct way parrots copy 'hello', nor are they produced by the same device or by devices that are reproductions from one another, as Stegmann suggests. But there is surely a relevant sense in which the minnows' and the sticklebacks' fright reaction is a copy of each other. My contention is that, whatever notion of reproduction one employs in order to account for these cases, it can also be used to solve the puzzles of signaling between uncooperative systems.

Consider the particular flashes of F-females. There must also be a sense in which the flashes emitted by current F-females are reproductions of the flashes of their ancestors. This notion of reproduction probably involves the existence of causally grounded similarities. My claim is that this sense of reproduction also explains why the Predator's flashes and the F-females' flashes are reproductions. Both flashes share many intentional and non-intentional properties (intensity, frequency, etc.), there is a strong evolutionary tendency for the Predator's flashes to copy any property of F-females flashes and this way of classifying entities is scientifically important. That much seems to be pretty uncontroversial. The question, then, is the following: Why are these similarities and causal relations between signals and producer systems insufficient for establishing the relevant 'reproductive relation' between signals or even between systems?

There is a different reason for thinking Stegmann's reply is unfounded. If one endorses MIMICRY, the content of the mimicking and mimicked states are the same. But, once we accept that much, the idea that the Predators' and the F-females' flashes belong to the same kind is an assumption that probably any plausible account of aggressive mimicking should make. How else could one explain that the content of the signal of Predators is *F-female willing to mate*? And, if one accepts that both signals are of the same type, we are naturally led to one of the two solutions I gave.

Interestingly enough, Stegmann (2009, p. 871) himself claims that the mimicked and the mimicking signal belong to the same type (see also Skeyrms, 2010, p. 75). That seems to be in tension with the previous objection to teleosemantics:

The first condition [of Stegmann's account] endows female-*macdermotti*-type flashes with representational content irrespective of whether they were generated by females or predators.

And he provides two different criteria of individuation: one can either individuate flashes in virtue of their (etiologically) biological functions or in virtue of their causal properties. I myself favored the notion of reproduction and 'homeostatic property cluster' because I think they provide the most powerful explanation of the wide range of properties shared and have already been defended by teleosemanticists. Nonetheless, Stegmann's own individuation conditions could also be used in the defense of mainstream teleosemantics, since I already showed that the signals of Predators and F-females share certain functions and causal properties. The challenge, then, is to provide a plausible alternative explanation.

Therefore, I think Stegmann's objection against the proposal I just offered can be resisted.

4.2 Different Functions

The last solution I suggested claims that the producer systems in Predator and F-females belong to the same biological kind and hence have the same function (*to produce an R when state S obtains*). However, one might worry that there is a sense in which the function of the signaling system in Predator is to *prey* on F-males, while the function of F-females is to *mate* with F-males. Is it coherent to accept that the producer systems of Predator and F-females belong to the same kind and, at the same time, claim that the organisms pursue radically different goals with them?

Yes, it is. There are many ways this fact can be accommodated. First, the same trait can have many functions at the same time (see Millikan, 2004, Ch. 1). The fact that two systems share a certain function does not entail that they share all functions. For one thing, any trait belongs to many different kinds. For another, it is possible to accept that the function of the particular mechanism that produces light signals in Predator is to do one thing, and at the same hold that this mechanism is included within a larger system (perhaps a 'prey detecting system', which includes other subsystems) that has a different function. Consequently, the solution I am offering to the problem of uncooperative systems is fully compatible with Predators having different goals from F-females.

4.3 Counterintuitive Functions

A final problem concerns the attribution of counterintuitive functions. If the strategy based on copying mechanisms is right (and, certainly, I admitted it is the most revisionary one), when the Predator produces a flash and it lures an F-male, the Predator's light-emitting mechanism has failed to fulfill one of its functions, namely producing a light when there is an F-female willing to mate. However, that result is clearly counterintuitive: when the activity of the Predator's light-emitting mechanism causes the ingestion of a tasty meal, it seems that everything went well for Predator. There seems to be no room for malfunctioning.

I think there is a satisfactory reply to this worry. First, remember that I suggested the strategy based on copying mechanisms as a possible way of showing that TELEOSEMANTICS and MIMICRY are compatible. If one denies MIMICRY, then the problem for TELEOSEMANTICS disappears. If, on the contrary, one accepts MIMICRY (i.e. if the Predator's flashings mean *F-female willing to mate*), one is committed to accept that when there is no F-female willing to mate, then the Predator's representation is *false*. That is, even if Predators manage to get some food, the representation that they use in order to attract F-

males is *false*. This is a kind of wrongness that everyone should grant and the only one that TELEOSEMANTICS is forced to accept. Let me explain.

If TELEOSEMANTICS adopts the third strategy, it is committed to the idea that the mechanism in Predators fails to fulfill one of its functions when it lures a male; however, producing a false representation is already failing to fulfill one of its functions (specified in condition 1a of TELEOSEMANTICS). Indeed, it intuitively seems that when a mechanism produces a false representation, there is something that has gone wrong. So it is true that a teleosemanticist has to accept that when Predators manage to attract an F-male one of the functions of their mechanism is unsatisfied, but this is just another way of saying that the mechanism produces a false representation. And, since everyone is committed to the idea that Predators achieve their goals by producing false representations, the claim that there is something that goes wrong in these cases (even when Predators successfully lure a male) should not be troubling.¹³

5. Conclusion

In this paper I have argued that cases of parasitic representational systems do not constitute a counterexample to the idea that signaling systems require certain amount of cooperation between sender and receivers. I have shown that there are three different ways of accommodating cases of aggressive mimicry within the theory. If the arguments I presented are on the right track, teleosemantics can explain cases of aggressive mimicry with the same framework that it uses in order to explain the rest of representational systems. That shows that a set of cases that most people thought were problematic for teleosemantics are fully compatible with standard version of the theory which assumes that sender and receiver must be cooperating systems.

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¹³ Note that this argument is only supposed to defend TELEOSEMANTICS from a sensible objection. In particular, it does not provide a reason for favoring TELEOSEMANTICS over Stegmann's view, because the latter can avoid the problem by simply denying that there is any sense in which the Predator's mechanism is malfunctioning. I want to thank an anonymous referee for pressing me on this issue.

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