Senders, Receivers, and Symbolic Artifacts

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A "sender-receiver" framework based on recent models developed in several fields can provide a general treatment of communicative and symbolic phenomena, replacing traditional "semiotic" theories that have failed to live up to the hopes of their advocates. Sender-receiver models have mostly been applied to linguistic behavior, gestures, and other ephemeral interactions between individuals. I look at the application of this framework to enduring artifacts, including pictures, using indigenous rock art in Australia as a case study.

1. Introduction

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1. Introduction

People have often been attracted by idea of a general "theory of signs" (symbols, representations...) that could be useful to people working in the human sciences, especially in fields like anthropology and archeology.[1] The best-known projects of this kind are known as *semiotics* or *semiology*. Those terms trace back to two traditions of

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[1] I am grateful to everyone who took part in the workshop *Symbols and Communicative Behaviour in Pleistocene Hominins ("Symbols 2")*, at the University of Sydney in 2016. Special thanks to Peter Hiscock and Kim Sterelny for organizing this event and for valuable discussion of all these topics.

work beginning in the late 19th and early 20th centuries, traditions initiated by Ferdinand de Saussure (semiology) and C. S. Peirce (semiotics). The Saussurian tradition was especially influential in the mid 20th century, when the "structuralist" framework was applied systematically to cases, in a quasi-scientific way (Barthes 1957/1984). In the late 20th century it degenerated into post-structuralist forms of no scientific value.[2]

One response to this history is to abandon the quest for a general theory, a call made explicitly by Sperber and Wilson (1986). They advocate a case-by-case approach. But in some fields, such as archeology and parts of anthropology, the idea of a general theory has remained appealing. There Peirce's framework has frequently been adopted, applied in a straightforward way without the theoretical excesses of other semiotics. Philosophers who see Peirce's theory of signs as a scrap of philosophical history with no ongoing importance would be surprised (as I was) to find workers in anthropology and archeology using it as a resource, guiding assessments of empirical phenomena.[3] People in fields like archeology do want a theory that would enable them to talk about – for example – how change in the form of a tool over a period of time reflected a transition from a non-symbolic to a symbolic role. Peirce's view is better than the Saussurian tradition, but it is primitive in many ways, and has a fair share of eccentricities (deriving from the monumental eccentricity of its founder). It's now possible to do better.

I think that a new framework does exist that does, or shows how to do, much of the work envisaged for a semiotic theory. I'm referring in the first instance to a family of models that have appeared largely independently in several disciplines (biology, economics, linguistics, philosophy), in forms that fit the concerns of those disciplines and often without much coordination between them. The models have in common the idea of approaching signs in terms of the dynamic shaping of the pairs of behaviors "on each side" of a sign – behaviors of making, producing, and sending signs, on one side, and behaviors of reading or interpreting signs, on the other.

A model due to David Lewis (1969) functions as a useful skeletal or minimal model of these phenomena. Lewis's model was not much noticed outside of a few parts of

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[2] Saussure's classic work is his (1974). In the case of Peirce, who wrote about the topic in a more scattered way, the summary by Atkin (2013) is particularly useful.

[3] For a range of examples, see the precursor to this paper, Godfrey-Smith (2014a).

philosophy for many decades, until Brian Skyrms (1996, 2010) revived and generalized it. In the meantime, a family of models had developed in other fields that addressed sender-receiver interaction in ways specific to those fields (in biology, see Maynard Smith and Harper 2003; in economics, Crawford and Sobel 1981). Ruth Millikan's account of language and representation (1984) developed a similar structure in informal terms. Some work in and around the semiotic tradition was set up with attention to the interlocking roles of sender and receiver (eg., Leach 1976), but the work I discuss here goes much further.

It is a natural project, and a natural task for philosophy, to put all this together and make the new approach explicit. I'll do that with an eye to fields like archeology that have an ongoing use for a theory of this kind. The development of the sender-receiver framework to so far as been very much model-driven; it has evolved in the form of models that yield definite results, but are highly idealized when considered in relation to empirical systems. One task of this paper is to make explicit the messages that are implicit in the modeling tradition, and that requires taking a step back from the idealizations usually made. I'll also extend the framework, in an informal way. Sender-receiver models have mostly been developed in application to spoken language, gestures, and so on, but the framework can also be applied to enduring artifacts and marks. The last part of the paper looks at a case study in this category: indigenous Australian rock art.

2. The Sender-Receiver Framework in Nine Principles

This section outlines the main ideas of the framework, organized with nine principles. These begin with basic issues, and move towards ideas more directly relevant to the applications discussed later.

Principle 1: Signs mediate interactions between two coadapted entities, sender and receiver.

I use *sign* in this paper as a broad and general term. Where the category begins and ends will become clear as we go, but the borders are not supposed to be sharp. Signs in this sense mediate interactions between two agent-like entities, which I usually call *sender* and *receiver*. These may be people, other organisms, or, in some cases, parts or

collections of organisms.[4] The same duality can be picked out by talking of "producers and consumers" (Millikan) or, in some cases, writers and readers, or speakers and hearers.

"Coadapted" in my first principle is also used in a broad sense. A family of different selection processes that shape the behaviors on each side of a sign. These processes all give rise to a coevolution (again, broadly understood) of patterns of making and response. In a simple case, suppose signs of some sort are being made, and a receiver is making a choice of how to interpret and respond to them. The effects of those interpretations and uses may then affect the policies of the producer or sender. Thus there is coadaptation. The selection processes mediating this outcome operate at different timescales and with different degrees of intelligence. They include genetic evolution, learning by reinforcement, imitation of the successful behaviors of others, and deliberate choice – "selection" in its original sense. Whatever the mechanisms, the behaviors on one side are conditioned by what is happening, or what is envisaged to happen, on the other.

In a sender-receiver (SR) framework, this coevolution or co-shaping of behaviors is basic, and questions about syntax, semantics, and so on treated in a way filtered through the sender and receiver behaviors. The approach is based on "use" in a sense that recalls Wittgenstein, but the idea of use is made more specific, through attention to the complementary pairs of behaviors occuring on each side of a sign.[5]

The Lewis model (1969), developed in philosophy, is a minimal model of these interactions. Assume there are two agents, one who can see the state of the world but cannot act except to make signs, and another who can only see these products of the sender, but can act in a way that has consequences for both sides. Those consequences, which may be for good or ill, depend on the pairings of actions with the states of the world perceived by the sender. Lewis used the example of Paul Revere and the Sexton of the Old North Church in Boston, in the classic tale from the American revolution (as told, with much poetic license, by Henry Longfellow). The Sexton, the sender, hangs lanterns in the church tower in a way that maps states of the world to signs, ("one if by land, two

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[4] They might also be artifacts themselves, but in this paper I'll leave aside both artifactual and sub-personal "agents." See my (2014b) for the subpersonal case.

[5] For a note on the connection to Wittgenstein, see my (1988) review of Millikan's book.

if by sea") – this mapping is f_S in Figure 1. The receiver, Revere, maps those signs to acts (f_R). The result is a mapping from states to acts (F), and the payoffs that accrue to both agents depend on those pairings of states with acts. (Though the Sexton/sender mnemonic is helpful, Lewis did not say "sender" and "receiver" but "communicator" and "audience"). Lewis that assumed rational choice governed both sides; Sexton and Revere *decided* to follow their respective rules because this would lead to consequences they knew they wanted.[6]
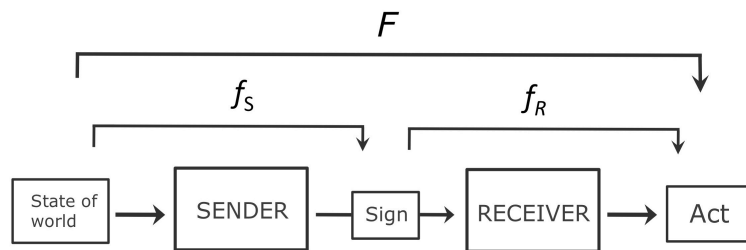
f_S : sender's rule, maps states of the world to signs.
f_R : receiver's rule, maps signs to acts.
F : the resulting mapping from states to acts.

Figure 1: Lewisian sender-receiver system

When this model is applied to almost any case, it will be a simplification. First, the model assumes that sign reception involves the production of definite behaviors. In real life, often all the receiver does, and all they are "supposed" to do, as far as the sender is concerned, is think some *thoughts*. They are supposed to remember something or realize something or think differently. This is far from the Lewis model in some ways, but it is still true that the *point* of the sender's behavior is to induce a *response* in the

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[6] The Lewis model, especially as I have pictured it in Figure 1, is reminiscent of Shannon's mathematical theory of information (1948), and his famous diagram of a "general communication system." Shannon has a "transmitter" on the left and a "receiver" on the right, where the transmitter is sensitive to an information "source" of some kind. Information is carried by a signal sent to the receiver whenever the signal reduces uncertainty about the source. The two models are complementary. Shannon took for granted the sender and receiver roles, and gave a theory of the channels that achieve coordination between them; Lewis took for granted the possibility of a channel, and gave a model of how agents could come to play the sender and receiver roles.

receiver, a response that has value for the sender. Otherwise, why would the sender bother? Some kinds of sign production, especially speaking, may be highly automatic in some situations, a facet of a general prosocial patterns of behavior that have deeper antecedents. Then it may seem not to matter what is being said (at least until something inappropriate is said). In starting out from the Lewis model I don't mean to suggest that all sign production is the product of a rigid calculus of cost and benefit, or that the only point in speaking is to get people to perform specific actions in response.

The Lewis model also assumes one-on-one interaction. In other cases there may be many receivers. Broadcast of this sort does not make much difference in principle. Unless the broadcast is inadvertent, the sender's choices will now be affected by the fact that there will be many receivers. Modeling such a case might be harder, but it's not a big theoretical difference. Models like that of Lewis, and more complex formal models that have followed in recent years, should be seen as providing a formal skeleton that enables us to understand general principles at work in complex systems. Actual-world cases almost always have more going on than the models recognize.

Does *any* interaction between two agents that mediated by the production of something used by the other agent count as sign use? No, sign use does shades off into other phenomena, but not any chain-like relationship between three things has the pattern of sender, sign, receiver. Almost anything could function as a sign, but the behaviors on each side are more constrained. The Lewis model is very restricted with respect to the relations between the agents on each side. Other cases won't follow exactly that pattern, but a characteristic of sign use is the irrelevance of the *intrinsic* properties of the sign; what matters are its relations to other things, especially its effects on the pairing of behaviors with other acts and states (see Principle 3 below). This is roughly the same phenomenon referred to in classical semiotics as the "arbitrariness" of signs – the Sexton and Revere could have chosen flags or radio signals and achieved the same ends. In contrast, an exchange of food between a "sender" and "receiver" is not a piece of signing behavior if the point of the interaction depends on the intrinsic properties of the food. A gift of food might have a communicative role as well, though, and sign use shades off into other kinds of behavior.

Sign use is a two-sided phenomenon. There is a perennial temptation, especially when developing theories of the meaning or content of signs, to make one side or the other primary – to say that a sign is what it is, and has the meaning it has, because of *how it is made*, or because of *how it is interpreted*. The SR framework as I understand it regards both one-sided moves as errors; the theory is essentially two-sided. Lewis made this point (in a deft, minimal way) in his 1969 discussion: once we know the facts about how signs are being sent and received in some system, and also know why those policies or habits are in place, we know all there is to know about the content of the signs; there is no motivation to say that the content of the signs comes from *this* side, or from the other.

Principle 2: Common interest sustains informative communication.
The most tractable cases of sign use, both in models and in everday life, feature a close alignment of interests between sender and receiver. Lewis's 1969 model made this assumption, and much other work has treated cooperation as the natural or necessary setting for communication.[7] Intuitively, it seems that in a Lewis-like situation, in the absence of common interest communication should collapse. The receiver has no reason to listen to a sender who is motivated to mislead, and if the receiver ignores the sender, there is no reason for to keep talking.

In the biological literature this issue has become central. Often there seems to be *some* common interest between animals in a communicative setting, but plenty of potential for conflict as well. Recent biological models have often looked at signal *cost* as means to penalize dishonesty in senders (an idea first developed in economics by Spence 1973). Manolo Martínez and I have used computerized search techniques to work out how much *how much* overlap of interest is needed to maintain communication in a Lewis model, in the absence of special assumptions about signal costs.[8] We quantify common interest between sender and receiver by measuring the similarity between their preference orderings over behaviors in each possible state of the world. If for every state of the world that the sender might detect, the two agents agree which receiver action would be best, which would be second-best, and so on, then $C=1$ (complete common interest). If in

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[7] See, for example, Millikan (1984), Tomasello (2008), Sterelny (2012).
[8] See Godfrey-Smith and Martínez (2013), Martínez and Godfrey-Smith (2016).

each state of the world their preference orderings over actions are reversed, then *C*=0 (complete conflict of interest). Intermediate values of *C* reflect partial agreement about these orderings. We find that common interest as measured by *C* is very predictive of communcation being maintained or lost in an evolutionary process, but also find that communication can in a few cases be maintained in what look like very antagnostic circumstances: cases where *C*=0. Those cases are very rare. We are presently extending the analysis to cover cases further from the Lewis model (see Principle 3). We conclude that if you know about the degree of common interest in a social situation, you can make some predictions about likelihood of communication being sustained, and some predictions also about the amount of information that signals will carry. However, a surprisingly low degree of common interest may suffice to keep two agents talking.

Principle 3: Sign use can function to coordinate acts with states of the world, or with other acts.

Compare the Sexton and Revere, as in the Lewis model, with "calling the stroke" in a boat being rowed by more than one person. It does not matter when the rowers row, as long as they row together, and this coordination can be enabled by calling the stroke. Here sign production is not responsive to some exogenous state of the world, a state "chosen by nature" as game theorists put it. Instead the point of communication is to coordinate one act with another, where the distinction between "acts" and "states" is a distinction between what is under the control of some agent who is a party to the communicative interaction, and what is not under any agent's control. Communication, then, may function to enable *act-state* coordination or *act-act* coordination (Godfrey-Smith 2014). In game theory, the "Battle of the Sexes" and the "Stag Hunt" are games that may feature signaling, where the outcome is act-act coordination.

Much ordinary communication plays both roles, perhaps with one more in the foreground than the other. More accurately, we are all continually acting in ways that adapt us to both unchosen states that are *known* by some agents and not others, and to actions that may be *chosen* by some agent and not others. Communicative acts help us with both. (States of the world that now must be perceived, and are part of the external furniture, may also be the results of earlier acts by oneself or others.)

Principle 4: Sign use can bridge both space and time; memory is communication.
In the simplest cases, those along the lines of the Sexton and Revere, the gap being bridged by communication is, in a broad sense, spatial. The activities of a sender and receiver will usually be temporally separated as well, but that may be incidental. In contrast, there are cases of sign use where bridging time is the point of the activity; sender and receiver are temporally separated in a significant way and not, or only incidentally, spatially separated.

Sender-receiver interaction over time is a form of *memory*. I think this idea has general importance, and applies both to psychological forms of memory and social activity. Specifically, *mnemonic artifacts* are signs that exist within sender-receiver systems. A mark is made at one time to enable a later reader to act or respond in ways that suit both. Durability of the sign is hence important; spoken words or gestures won't suffice.

The category of mnemonic artifacts is a functional one, in a sense derived from the role of coevolutionary processes. Lots of marks and signs *do* happen to endure, without being made as mnemonic devices – without being made as a way of achieving coordination over time. They might have a short-term role and then persist, being seen later by observers like us who are not part of the SR system. But some marks and artifacts exist *as* time-bridging devices. This creates unusual features in the feedback or feedback-like processes that shape sender and receiver behaviors. A sender might make a sign and not be around to benefit when the intended receivers act in response to it. Still, a sender can guide their behaviors with the desire that a much later receiver interpret the sign and react in a particular way, and this can be the reason for the sign-making. Recognition of such a long-ago intention can also be part what shapes the response of a later receiver.

Principle 5: The SR framework accommodates Gricean inferential communication as well as "code-based" communication.
An important body of recent work in linguistics and philosophy has developed the ideas of Paul Grice (1957) about the unusual psychological underpinnings of human communication, especially the role played by the recognition of communicative

intentions. Sperber and Wilson (1986) opposed two models of communication, the "code model," based on socially established mappings between signs and contentsm and the "inferential model," which holds that human communication typically works by speakers providing *evidence* for inferences made by their hearers. Scott-Philips (2014) holds that the sorts of models I emphasize here are alligned with a "code" approach that is not appropriate for the special case of human communication. My response is that the distinctive phenomena seen in Gricean or inference-based communication can be accommodated within the SR framework.[9]

 The special features of inferential communication, and much of the cash value of the distinction between the two modes, concern the role of novelty, improvisation, and dealing with incomplete signs. Anomalous sentences or peculiar gestures can often be efficacious because a receiver realizes that the producer of the sounds or movements is *trying to get something across.* In human contexts, senders will use whatever resources they have available to get a smart receiver to make the inferences they want them to make. This interplay between an opportunistic producer and an attuned interpreter is a kind of sender-receiver coadaptation.

 There are risks in extending any theoretical framework too far to cover cases that others see as antithetical to it; the risk is one of trivialization. A framework that covers every possible phenomenon is empty. But in this case the compatibility is real. Asserting the primacy of sender-receiver coadaptation does not require asserting the primacy of conventionally established codes over opportunistic, inference-based communication. The idea of an antagonism between the inferential approach and the SR framework might arise from assuming too literal an application for idealized models. Creative sign use relying on the recognition of communicative intentions is a kind of sender-receiver interaction made possible when the agents on each side are smart and reflective enough.

Principle 6: Syntax is a special case of a broader notion of <u>organization</u> in sign systems. Syntactic or combinatorial structure in signs was not included in the simplest SR models, but subsequent work looked at the evolution of simple syntactic structure in signs

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[9] See Planer (forthcoming) for further discussion of the relation between Gricean communication, the SR framework, and Scott-Philips' arguments.

embedded within systems of this kind (Barrett 2009). Syntactic structure is approached *via* its role in sender-receiver coadaptation. A sign, considered as a physical object, might have parts, but this structure may or may not be significant in use of the sign.

I'll sketch my preferred way of handling these features, acknowledging that others are possible. The most basic distinction in this area is not between syntactically structured and unstructured signs, but between sign systems with and without *organization*.[10] The latter I will call *nominal* sign systems. The signs in those systems are unstructured in a very strong sense. Paul Revere can once again provide an illustration. The sexton used a lantern code – *one if by land, two if by sea*. This code features a mapping between signs and states of the world, but the difference in magnitude between one and two lanterns does not play any role. One lantern and two lanterns are just distinguishable signals. Suppose the sexton had represented the size, not the route, of the British forces, and arranged with Revere to put out one lantern for one brigade, two lanterns for two, and so on.... Now the internal stucture of the signs does play a role. But this role could be played without the signs themselves having parts: perhaps the lantern is to be dimmer if the forces are small, brighter if the forces are larger. Now there is a relation between different signs – the *brighter-than* relation – that maps to a relation between armies – *larger-than*. That is *organization* without *syntax*; the signs have no internal parts that can be rearranged. Often, though, the way an organized sign system is achieved is by means of internal structure; signs in the system are related to each other by the sharing of constituents. "Britain won" and "Britain lost" are related by a shared constituent, "Britain."

In other cases, such as pictures and maps, relations between one sign and another in the system are less important than relations between parts of a single interpretable object: spatial (and/or temporal) relations between parts of a sign can map to relations between parts of a represented domain. This part of the SR framework might be developed in several different ways, and my aim here is to motivate the more general idea that organization and syntax can and should be viewed through the lens of sender-receiver interaction.

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[10] For a more filled-out version of these ideas, see Godfrey-Smith (forthcoming).

I said "should" just above, and this is a salient point of contrast with semiotics, especially the Saussurian tradition. This kind of semiotics was centrally concerned with structure, and in a way that led to trouble. Behaviors and artifacts can often have part-whole structure without this figuring in the *use* of signs – in the interlocking patterns of production and interpretation. Consider clothes, for example. Outfits have a combinatorial character, almost always. But this can be entirely incidental to any semiotic role they might have (see also Johnson, forthcoming). Classical semiotics was too keen to see structure everywhere, as structure was their main explanatory principle, rather than use and sender-receiver coadaptation.[11]

Principle 7: Not all signs function by referring to objects.
Not all signs have "objects." In some cases this may be due to referential failure, but more strongly, looking for an "object" for a sign is not always the right way to understand its role. In particular, sign use that functions in act-act coordination (Principle 3) is resistant to a referential interpretation of this kind. The aim in those cases is not to describe anything, but to achieve coordination of acts. Signs of this kind might often be seen as having an imperative content – as commands – but even this may be too specific in some cases; signs may have a vaguer coordinative role.

I take this point to be important in understanding the origins of human symbolic behavior, when signs may have been social tools that helped coordinate new forms of group living. Referential interpretations of signs – those that require an object – are often assumed or made into a theoretical default, though, perhaps as a result both of familiar features of latter-day high-tech sign-*use* (maps, books, databases, newspapers) of the influence of historically important theories. Peirce's theory, for example, holds that any sign has an object. That insistence might be understood in weak and inclusive way, perhaps to say no more than signs always have *significance*, something they mean, but talk of objects in the context often encourages a tendency to see all signs as descriptive, as saying something about how things *are*. This is a real feature of some cases, but should not be seen as basic or inevitable.

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[11] There are exceptions; above I noted that Leach (1976) set up a semiotic theory within a sender-receiver framework.

Principle 8: Art is an SR phenomenon.

Art objects have a mediating position between producers and audience; art production and reception are special kind of SR behaviors. I will flesh this idea out a little, but against the background of a very anti-essentialist view about art as a category. I think what "counts as art" is highly indefinite, in part because *art* is something like what A.C. Gallie (1956) called an "essentially contested concept," a concept reliably resistent to the drawing of boundaries, for good social reasons. Still, a communicative orientation to art seems reasonable in many cases, and the SR framework has a role to play.

Art-making is a communicative behavior in a broad sense, and it coevolves with a particular kind of reception. For Prum (2010), that kind of reception involves *evaluation*, as opposed to other receiver behaviors. Art is "a form of communication that has coevolved with its evaluation." I'll discuss "evaluation," in this sense, in more detail below, but as Prum notes, art in this sense is not a subset of human behaviors, but something that spans human and non-human behavior. Compare birdsongs directed at potential mates with alarm calls. Both are produced to be received; both are products of coevolved sender and receiver behaviors. But in the case of the song, the response goes *via* an evaluation of quality, in some sense, not just via recognition or comprehension. In the alarm case, the evaluation of quality is not relevant (even if questions of honesty or sincerity might arise). A sunset might be evaluated, but it was not produced to be evaluated. The alarm call was produced to be heard and responded to, but not produced to be evaluated. A mating call was produced to be seen *and* evaluated.

Boardman (2016) also develops a communicative view of art, but with a more Gricean character. An art object is supposed to be appreciated by an audience, but the audience is also supposed to recognize the fact *that* the object was produced with that intention. The producer must have intentions of a certain kind, and must intend that the receiver recognize them.[12] Nonhuman cases then become at least uncertain, perhaps excluded in every case.

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[12] Here is Boardman's formulation: "x is a work of art iff: (a) x is presented to a public audience for the purpose of their appreciation or contemplation of x and (b) a proper understanding of x requires recognition of (a)" (2016, Abstract). I am not sure about the importance of some minor

Boardman's category is then a subset of Prum's. I think both have problems when seen as analyses of an intuitive category, *art*. Some athletic displays pass both tests, pornography passes Prum's but probably not Boardman's.[13] "Art," as I said, resists if-and-only-if analyses, and does so in for comprehensible cultural reasons. But the Prum and Boardman categories do capture significant kinds, organized as subsets of a broader category of SR systems, with the narrower kind capturing a lot of paradigm cases of art. The communicative character of art persists through a lot of disruptive and novel artistic behaviors.[14]
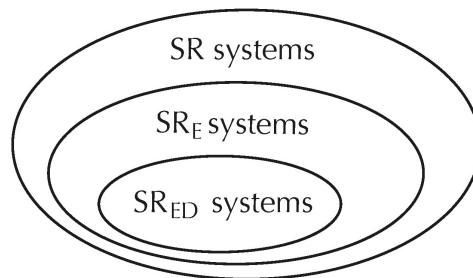

Figure 2: Nested categories that bear on the nature of art, as understood within communicative theories. SR systems in which the intended or biologically appropriate receiver's action is one of *evaluation* of what has been produced are a subset of SR systems, labeled "SR_E," where "E" stands for *evaluate*. A further subset is comprised of systems in which the producer of an artifact or behavior intends the receiver or audience to *recognize* the intention to produce an object or behavior to be evaluated in these ways: "SR_{ED}," where "D" stands for *display*.

Principle 9: The icon/index/symbol distinction embodies misconceptions.
This last subsection makes comparisons to Peirce's view. I expressed the principle above in a way that focuses on the part of Peirce's view that remains most influential, but will discuss the whole package.

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differences with my version in the main text – for example, the role of "contemplation." Note that this test is disjunctive.

[13] Discussion at the CUNY Graduate Center Science Studies seminar in 2016 helped with this treatment. For further discussion of the evolution of evaluative behaviors and art, see Wilson (2016).

[14] I have in mind the fact that artistic traditions, especially recent Western traditions, embrace many deliberately disruptive moves.

In Peirce's theory, any sign has an *interpretant*, by which the sign has a relation to its *object*. I noted above that signs need not have objects (unless "object" is understood extremely broadly). More importantly, Peirce's view is focused entirely on the receiver side. The "interpretant" is basically the interpeter of the sign, though Peirce specifically emphasises the mental aspect of this interpretation. To be a sign is to be interpreted as one.

There's no mistake in identifying a receiver-side category of this sort, just as it would not be a mistake to single out a sender-side category ("to be a sign is to be produced as one"). I've argued here that a two-sided perspective should be taken – if a slogan were to be given, it would be: "to be a sign is to be produced and interpreted as one." Identifying *that* kind makes it natural to also note the presence of the other categories, and in some fields they have names. In behavioral biology, the distinction between *signals* and *cues* is of a distinction along these lines. A signal is produced with the function of affecting a coadapted interpreter; a cue is an informative indicator of something that was not produced with that role.[15] Dark clouds are a *cue* indicating rain, not a *signal* of rain, in this sense. The biological sense of *signal* is roughly equivalent to my sense of *sign*. In a purely receiver-sided treatment, cues are included as *bona fide* signs along with signs that were produced *to be* interpreted by a coevolved producer. There is no error in carving up categories differently, but in this case, unwanted downstream consequences arise.

Peirce used the categories of *index*, *icon*, and *symbol* to distinguish the ways by which a sign can refer to its object. An index refers by physical correlation, an icon by resemblance, and a symbol by "convention." Users of Peirce's theory in archeology sometimes postulate a sequence, where symbols and "rest on a foundation" of icons and indices (Hovers et al. 2003, p. 492). Icons and indices some first, symbols later.

The Peircean distinction is intuitive, but a close look reveals problems, and the problems are clear when one has a close eye on the distinction between cases with and without a coadapted sender or producer of a sign. If we are in the domain of cues, purely indexical phenomena are possible. One can use clouds as a sign of rain. Whenever there

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[15] See Maynard Smith and Harper (2003) and Godfrey-Smith (2013) for more detailed discussions of the relations between cues and signals in biological contexts.

has been coadaptation of sender and receiver behaviors, by some selection process, there is a "conventional" aspect to the signs used. In simple cases of signals that inform a receiver about transient phenomena (alarm calls, for example), the formation of a signaling system *creates* indexicality. It creates a physical correlation between the presence of the sign and the type of event it is aimed at dealing with. That is, in these cases indexicality is the *product* of "convention."[16] So physical correlation can be a pre-existing resource in cue-like, senderless cases, but is a product of convention on other occasions.

Turning to iconicity, it is possible for cue-like phenomena to display this feature, but I take it this is uncommon and present in only rudimentary forms.[17] Most picture-like signs are the products of design, or coadapted SR action – they are made to be seen. Iconicity in these cases is one kind of *organization* in a sign system (Principle 6); the relations between parts of the sign map to relations within the represented domain. In these cases there is an essential role for iconicity *and* an essential role for conventionality. This will be especially common in cases like rock carvings, discussed below. When rock carvings are figurative, they are usually highly stylized. The determination of what is retained from the form of an object, and how it should be represented, is conventional. But these objects are *also* iconic. The convention determines *which* relations between parts are semantically significant and hence candidates for playing an iconic role.

I don't that say this convention+icon combination is inevitable; in cases like snapshot photographs, a symbolic artifact has an iconic role with rather little role for convention. But the idea that conventionality and iconicity are alternative routes to reference is generally erroneous.

So: picturing is often convention-based, and indexical relations can be products of conventions. Both picturing and indexicality can exist outside coadapted SR systems, with no role for "convention," but only in simple cases.

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[16] Skyrms (2010) made essentially this point, not about Peirce but about Grice and "natural meaning."

[17] I am going to use "reference" very loosely in this passage, in comformity with the framework I am discussing.

What then becomes of the idea that a *symbol* is a more complex, sophisticated kind of sign? That is how the idea is often handled by archeologists, and there does seem to be a category here that deserves a name. I think there are several overlapping phenomena. One is organization (Principle 6); organized sign systems have more resources, especially through combinatorial operations. Another is a contrast between signs with an enduring role as compared with what Millikan calls "signals." For Millikan, the term "signal" applies to cases where the time of production of a sign is a semantically relevant feature of it, and momentary or time-sensitive events are being represented (predator coming now! etc.). Perhaps a symbol has some sort of enduring role, not so time-specific, that contrasts with this category? Perhaps, though such time-sensitive cases can be complex in ways that might motivate talk of "symbols" (this is a symbol of the imminent arrival of the Antichrist). I am not convinced there's a single category here – a category *symbol* within the broader category of signs. There is sheer complexity of SR behavior; there is organization; there is representation of persisting or non-transitory affairs; there is abstraction, and reference to hidden things.... The term "symbol" might be used to mark any of those, and I'll use it broadly below.

That concludes my nine-part outline. The framework above generalizes what I take to be the message of a range of specific models developed in different fields – philosophy, biology, economics, linguistics. A framework of this kind can be defended independently of formal work, but real support for this approach comes from the fact of a theoretical convergence across several fields, and the development of rigorous models with a coherent overall message. Another kind of support is as follows. A distinctive feature of this approach is the fact that it is organized round models that answer the following question: *why* should someone talk (write, draw...), and why should anyone pay attention to what is being sent or produced? Under which circumstances does communication arise and spread, and when does it collapse? This orientation to questions of function and stability is an important strength of the models that the framework draw

on.[18] It takes additional work, though, to distill the essential features of the framework as it bears on real systems, from the idealizations and regimentations seen in the models.[19]

Putting the principles above together: sign-using behavior, which involves coadapted or coevolving behaviors of production and interpretation of signs, is seen in both human and non-human agents. Stably maintained sign use generally depends on some degree of common interest (though it can survive in principle with very little), and it may coordinate the actions of agents with the state of the world, or the actions of one agent with others. Signs can be broadcast to many receivers rather than directed at one, and in either case the actual or perceived net effects of these receptive behaviors are what keeps the sender doing what they're doing. Organization and syntax are aspects of much, though not all, communicative behavior. Through the complex psychology of humans, Gricean phenomena arise – the flexible, opportunistic use of signs aimed at getting messages across through the recognition of intentions. SR systems enable memory, using signs to bridge time rather than space. Durability of the sign itself then becomes a factor. The production and reception of art is one kind of SR behavior, though art-making practices are so unruly and reactive that it would be a mistake to use this fact as the basis for a reductive theory.

3. Australian Petroglyphs

This last section will work through a case study: rock carvings and markings made in Australia by indigenous people prior to the time of European settlement. These artifacts are usually called "petroglyphs." They are also referred to as "rock art," but in a broad sense of "art," as their function is often not known. My aim in developing this case study is mostly illustrative. I do not have expertise in this area, and rely on the writings of specialists, especially the work of Jo McDonald and Peter Veth, who are central figures in this field.[20] I choose the example of Australian rock art firstly because of its great

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[18] As well as the work on common interest cited earlier, see Huttegger et al. (2010) for a detailed exploration of conditions under which communication prevails in a Lewis model.

[19] My attempt to do this distillation here is partly a response to challenges in Sterelny (forthcoming), who sees the SR framework as limited in its application.

[20] See McDonald and Veth (2012a, 2012b, 2013), Veth et al. (2012).

intrinsic interest, and secondly because these are phenomena that investigators do tend to look at through the lens of semiotic theories, especially the framework of Peirce. A number of the papers I cite in this section make use of a Peircian famework. My aim is to discuss how these phenomena and the debates appear from the viewpoint of the framework outlined above. I'll describe some hypotheses and possibilities, but my aim is not to defend new claims about the history and function of petroglyphs; instead it is to show the resources of the SR framework.

Beginning with some basics, the literature distinguishes two or three main forms of rock art, which may have a chronological organization (see Figure 3). Leslie Maynard (1979) argued that the record shows an "evolution" that begins with a non-figurative, abstract style, seen over the whole content, that was "replaced" by several more figurative styles containing recognizable images of people and animals.[21] The allegedly older, non-figurative form is known as the *Pararamitee* style, named after a particular location. It is thought to include examples well over 10,000 years old. Also in the story are the enigmatic *cupules*, which are arrays of small, shallow hemispherical depressions, hammered into rock. These are found in all continents except Antarctica, and can be very old – hundreds of thousands of years old.

One possible chronology, then, is: cupules, with or preceding the geometric Panaramitee form, then figurative forms. It is possible that the appearance of a historical sequence here is misleading; in particular, cupules are so durable that they would probably *appear* to be the first forms even if other styles had been present when they were made. McDonald and Veth, however, do think that the sequence from geometric to figurative forms reflects a historical shift.[22]

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[21] "Maynard's model saw an evolution from a pan-continental stylistically-homogenous (i.e. non-figurative).. style assemblage of engravings/petroglyphs replaced by a set of regional Simple Figurative styles and regional Complex Figurative styles" (McDonald and Veth, 2012a, p. 991).

[22] "What is clear is that there is an older – predominantly geometric – art form present across Australia, which is replaced in some areas by one or more figurative art vocabularies; while in other areas this iconography appears to endure." (McDonald and Veth 2012a, p. 992).
Peter Hiscock (via discussion at *Symbols 2*) suggests that the appearance of a temporal sequence here may be entirely an artifact of preservation; he suspects that all three forms of rock art were present in Australia from very early times, but some are preserved much better than others.

Figure 3 [to come]

What are the functions of petroglyphs of these kinds? What significance lies in the differences in style? There is some consensus on the general roles played by rock art, but not much, as far as I can tell, about the different forms. McDonald and Veth, drawing partly on contemporary ethnographical work on indigenous Australians, list functions such as marking place and affiliation, storytelling, use in initiation ceremonies, providing physical form for ancestral beings and events, and "maintaining association with Dreamings and a homeland" (2012, p. 96).

If we think about these artifacts from the point of view of the SR framework, a series of questions arises. First, of each object, was it *made to be seen*? The answer might seem an obvious yes, but for some Pleistocene rock art, a case can be presented that it was *not* made to be seen (Clottes and Lewis Williams 1998). Some rock art is placed in locations that make it very hard to see, and it may be that the *making* of the carving or painting was the important element, not any later viewing. When this is so, we will encounter durable remnants of activities that were never embedded in sender-receiver interactions at all. If a piece of rock art *was* made to be seen, then further questions arise. Was its durability a consequence of an attempt to bridge time, and perform a memory function? What sort of audience – narrow or broad – figured in the coevolution of the practices of production? What role might the object have played in act-act coordination, as opposed to representing some domain?

Were cupules, for example, made to be seen? They are often placed in conspicuous locations, suggesting that they were. They were often made in very hard rock, and would have taken considerable work, but are generally too small as depressions, and often on surfaces with too much slope, to have a plausible utilitarian purpose as receptacles (Bednarik 2008, Wright et al., 2014). This all suggests that they were made to be seen. But they are also found in similar form all over the world. What

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Figurative designs are more fragile. Scraps of ochre that could plausibly have been used in painting have been found on the floors of very old sites. No paintings are left visible, but what may be remnants of this activity are present.

might be a plausible communicative or symbolic role? One possibility is that their very unnaturalness was supposed to function as mark of human activity. If you come across cupules, and are not in your own territory, then you know someone else has been here, and has been here often enough and/or in sufficient numbers to make marks on a particular scale. This possibility has a Gricean or quasi-Gricean aspect to it; cupules are made in order that later observers recognize a communicative intention. This role is not one that depends on an established code within a local community, but works through habits of inference that a maker can expect to be present in later viewers who are not from the same culture but do share the same basic psychology.[23]

Might they have had a more ceremonial role? Yes, but we are looking for an explanation that applies to many cultures in many parts of the world. So they may have functioned primarily as deliberate, recognizable marks of human agency. If so, they may be *early* symbolic artifacts that have a Gricean, intention-based role.[24]

The geometical or Panaramitee style appears different in role. As far as I know, the evidence from their location suggests, or is at no tension with, the idea that they were made to be seen. The geometical forms suggest a role more specific than mere indication of presence and labor. They seem good candidates for having a ceremonial role. If so, then given the culture-specific character of rituals and ceremonies, it seems likely that they had a "code"-like nature; they had an intended interpretation that was to be learned within a particular culture.

The third category comprises the figurative style, with easily recognized pictures of animals and people. I'll discuss this further in a moment. First, though, it is worth noting that *if* there were to be a chronological sequence from geometrical styles to figurative ones, this would amount to a reversal of some patterns that tend to be asserted on general theoretical grounds. I noted earlier that those influenced by Peirce often see "symbols" as arriving after indexical and iconic signs. Here the transition from

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[23] Making cupules is hard work and takes time. The number of cupules at a site will at least be a *cue* (a natural indicator) of the number of people and/or hours involved in their production, and might also be a communicative signal of such facts.

[24] Steven Kuhn (in discussion at *Symbols 2*) tells me that cupules in some American Indian cultures have a more culturally specific role in fertility rituals, involving placement of the afterbirth.

geometical to figurative is the other way round; if the geometric designs have specific significance, then this was established by convention and was arbitrary. Figurative art has highly conventional elements, as I noted above, but it also has iconic features. Here, if the chronology is to be trusted (see footnote 19) icons arose late.

Finally, a few words about the figurative stage or mode. Here we are very plausibly in the realm of culturally established practices, and what McDonald and Veth describe as "the provisioning of the next generation with the 'capital' of social geography and its metaphysical basis." To a modern eye, many of these objects also seem more suggestive of *art* in a rich sense. That may be an anachronistic imposition of contemporary habits of response, but the discussion in the previous section of art as a special kind of communication (Principle 8) is relevant here. There are all sorts of communicative practices that involve the coevolution of production and interpretation, but only some of these involve *evaluation* on the receiver side (Prum), and only a subset of those work by the recognition of a producer's intentions (Boardman). Many petroglyphs were made to be seen, but perhaps only a subset were made to be evaluated. Some may have had symbolic roles in which evaluation was not relevant (as in a map or call to action), while others may have been produced to induce an evaluative response, either as well or instead.

The idea of evaluative responses as a subset of receiver behaviors is a good one. What *is* evaluation, though? Prum adopts a rather hedonic approach. He regards *beauty* as the fundamental positive aesthetic attribute, and understands the experience of beauty in terms of psychological responses that produce a "desire for continued association" with the stimulus that produced the experience. Other kinds of (positive) aesthetic response certainly exist – we can see something as elegant or noble, and so on, but the response to beauty (and its contraries) has a kind of psychological primacy in his story. This last part of Prum's view seems less well motivated than the rest. Especially in the case of earlier forms of human culture, it may well be that evaluation is indeed a crucially important subset of receiver-side behaviors, but evaluation has a great deal to do with a sense of propriety, awe, and other culturally specific modes of response, and less to do with the hedonic side of human psychology. Again, though, what does seem an important part of the story is the difference between receiver-side behaviors that are evaluative and those

that are not. At some stage in the evolution of petroglyphs, an early stage or a late one, we reach objects that are supposed to be evaluated as well as interpreted.

In sum: the sender-receiver framework, in some form, is the right one to use in this area. It is superior to the Peirce framework, superior to structuralism and its relatives, and does not abandon the goal of generality. It can be applied to enduring artifacts as well as to ephemeral behaviors like speech and gesture. When applied to durable objects that are produced in the way they are *because* they are durable, this is a treatment of memory as communication. Rock art lends itself to a treatment of this kind; the distinctions that are important in this case are ones the SR framework addresses. Even a briefly sketched application of the framework uncovers new possibilities, and reasons to question narratives developed within other frameworks.

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