The Epigenesis of Symbolization

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Abstract

This paper outlines the epigenetic logic of the emergence and elaboration of symbolization. The account is based upon considerations arising from the study of the ontogenesis and phylogenesis of symbolic communication, abstraction from which yields generalizations regarding the necessary developmental pre-requisites for the capacity for symbolization and the processes of the elaboration of symbolic capacity into language.

1. Introduction

The topic of this paper is *the epigenetic emergence and elaboration of symbolization.* Each of the terms in this delineation of my topic is technical and all of them are disputed. Hence, this Introduction provides definitions of how I shall use the terms *epigenesis* (and epigenetic), *emergence*, *elaboration* and *symbolization*.

Epigenesis

By this I understand a particular conception of the interaction between genotype and somatic and extra-somatic environment in organismic development. The claim that such an interaction exists is trivial and undisputed, since everyone agrees that phenotype is co-determined by genes and environment. There are two important characteristics of epigenesis that I would like to highlight here.

The first is that the role of the environmental factors is *constructive* rather than, or in addition to, being *selective*. Many approaches to the developmental interaction between genotype and environment stress the role of specific input either in permitting a developmental process to unfold, or in parametrically selecting a particular variant of development. An example of the former would be phenomena such as "imprinting", where an essentially innate process of development is "triggered" by an environmental event during a critical developmental window. An example of the latter would be the role hypothesized by generative linguists to be played by typological characteristics of target languages in setting parameters and thereby permitting the child non-inductively to acquire the grammar of the target language. In neither of these cases does the environmental information add any higher *level of organisation* to the genetically coded information. That is to say, the pathway along which the behaviour develops, and its terminal structure, are assumed already to be directly encoded in genes.

By contrast, in epigenesis the developmental pathway and final structure of the behaviour that develops are a consequence as much of the environmental information as of the genetically encoded information. For example, the development of birdsong seems to involve reproduction by imitative learning rather than selection from amongst pre-established alternatives. Fledglings not exposed to a model do develop birdsong, but it is impoverished or unelaborated relative to that of those individuals developing in a normal environment in which models are available.

The second key characteristic of epigenesis is, accordingly, that a genetically specified developmental envelope or window specifies an initial behavioural (or perceptual) repertoire that is subsequently *elaborated* through experience of a relevant environment. This process of elaboration is directional (see below), and once it has taken place the initial plasticity of the embryonic, or unelaborated, repertoire is lost. A typical example is the development in human infancy of speech sound perception, in which the "universal" initial processor is transformed into a "language-specific" processor in a process that is probably analogous with that of the development of birdsong. We can note here that an epigenetic account of this process differs from a nativist, parameter-setting process inasmuch as no assumption is made that the infant brain is innately equipped with an inventory of all possible natural language phonemes (Characteristic 1, above). Equally, however, it differs from a classical learning account inasmuch as epigenesis depends upon the elaboration of an initial repertoire which itself is not learned, in a process which cannot be re-run—the initial, unelaborated capacity cannot be re-accessed after the epigenetic developmental process has taken place, as all second language learners come rapidly to realise. In other words, the process of developmental elaboration implies in epigenetic development a transition from relative plasticity and informational openness to relative rigidity and informational closure.

There is a third characteristic of epigenesis which I would hypothesize to be particularly relevant in human development, namely the role of ontogenesis itself in canalizing phylogenesis, through Baldwin effects and genetic assimilation. I will return to this process below, but I would not maintain that it is criterial for epigenesis in general terms.

Emergence

The "emergentist" hypothesis has received considerable attention recently as an alternative (closely allied with epigenetic theories) to nativism (MacWhinney, 1999). In the context of this workshop's focus on epigenesis, and to avoid terminological proliferation, I will use *emergence* to mean, quite widely, the development of new properties and/or levels of organization of behavioural and cognitive systems as a consequence of the operation or cooperation of simpler processes. Epigenesis is thus a special case of emergence. In this paper, I will focus on *symbolization* as a phylogenetically emergent property of communication , as well as upon its epigenetic development in infancy.

Elaboration

By *elaboration* I mean the process whereby development gives rise to increased complexity of organism, behaviour and cognition. Increase in complexity usually involves both form and function. A crucial distinction between Darwinian natural selection and epigenetic development is that the latter, but not the former, *implies* elaboration (see above). In ontogenesis, some instances of elaboration are under more or less direct genetic control, others may be epigenetically driven, and still others may be emergent consequences of the elaboration of subsystems. I will not make a strong distinction between emergence (new properties) and elaboration (greater complexity), which I see as two aspects of the underlying directionality of developmental change. Although it is appropriate to reject "teleological" explanations for Darwinian evolution, and teleology is not inherent in emergence, teleology *is* inherent in elaboration as a directional process whose "aim" is the increase in the spatio-temporal extent of the lived and cognized environment.

Symbolization

This is the central topic of this paper, and I shall restrict myself here to some brief remarks on which I shall elaborate below. The epigenetic development of symbolization involves the emergence of symbol usage from communicative signal usage. Whereas a communicative signal can be viewed as an instruction (perhaps coded) to *behave*, the use of symbols involves two emergent properties, *reference* and *construal.* Reference and construal are the basic functional components of the representational function of language, and the development of symbolization is essentially the process of the elaboration of the representational function.

2. Signals and Symbols

Signals and signal sensitivity

Sensitivity to signals is as basic a property of life as the ability to reproduce. All organisms are able to detect signals indicating (indexing) the presence of conditions hospitable to survival (including metabolisation) and reproduction. The more complex the organism, the greater the range of signals to which it is sensitive, and the more complex its behaviours both in response to, and in the active search for, life-relevant signals. So basic is sensitivity to signals to our understanding of life, that we are hesitant to attribute life to self-reproducing biological systems that display this capacity in only a very limited degree, such as prions. In the most general terms life might be defined as the possession by self-organizing systems of the dynamic and mutually influencing emergent properties of reproduction and signal sensitivity, which together provide the basic conditions for the organismic "value system".

The functional characterization of simple, non-communicative signals is essentially identical to that of the S-R link of classical learning theory, although the responsivity of the organism may be either innately determined or learned. It is diagrammed in Fig. 1 below.

Signals, in social animals, may also be used to communicate (Fig. 2). Social, communicative signals may be *systematic,* that is, the same communicative modality may support a variety of coded instructions (as, we may hypothesize, in the vervet monkey alarm calls studied by Cheney and Sefarth), and it is even possible for them to support a simple "code-syntax". This does not, however, provide any criterion of symbolicity. In the familiar Peircian semiotic categorization, communicative signals, like all signals, are strictly *indexical*, even if they possess internal structure.

In the case of communicative signals, the only *necessary* attentional relationships are between the sender and the *stimulus* ($signal_1$), and the receiver and the *behaviour* ($signal_2$) of the sender. The social exchange of communicative signals does not require *intentionality*. The sender does not have to emit the communicative signal purposively, since the signal may simply be an innate or learned response to a stimulus. The receiver does not have to direct its attention either to the sender, or to the original stimulus ($signal_1$) that causes the sender to emit the communicative signal, but only to the communicative signal emitted by the sender. The sender is not signifying or representing a "referent" for the receiver, and no mutual awareness of the cognitive viewpoint of sender and receiver is implied in the exchange.

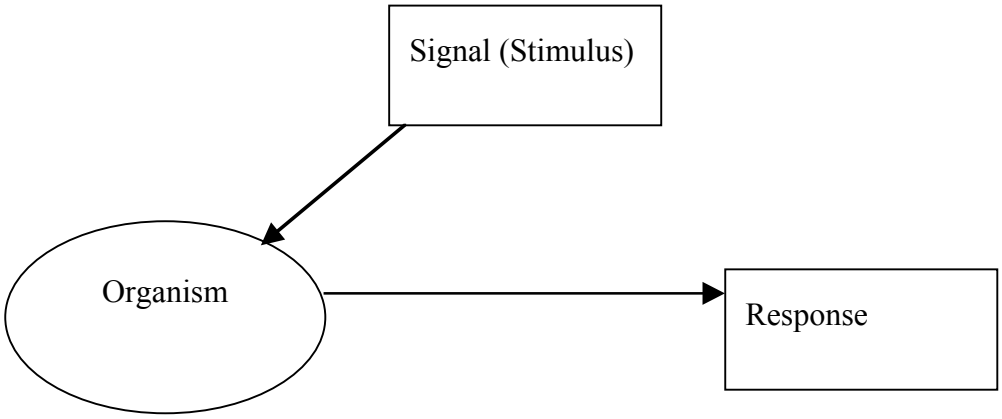

Figure 1. A non-communicative signal.

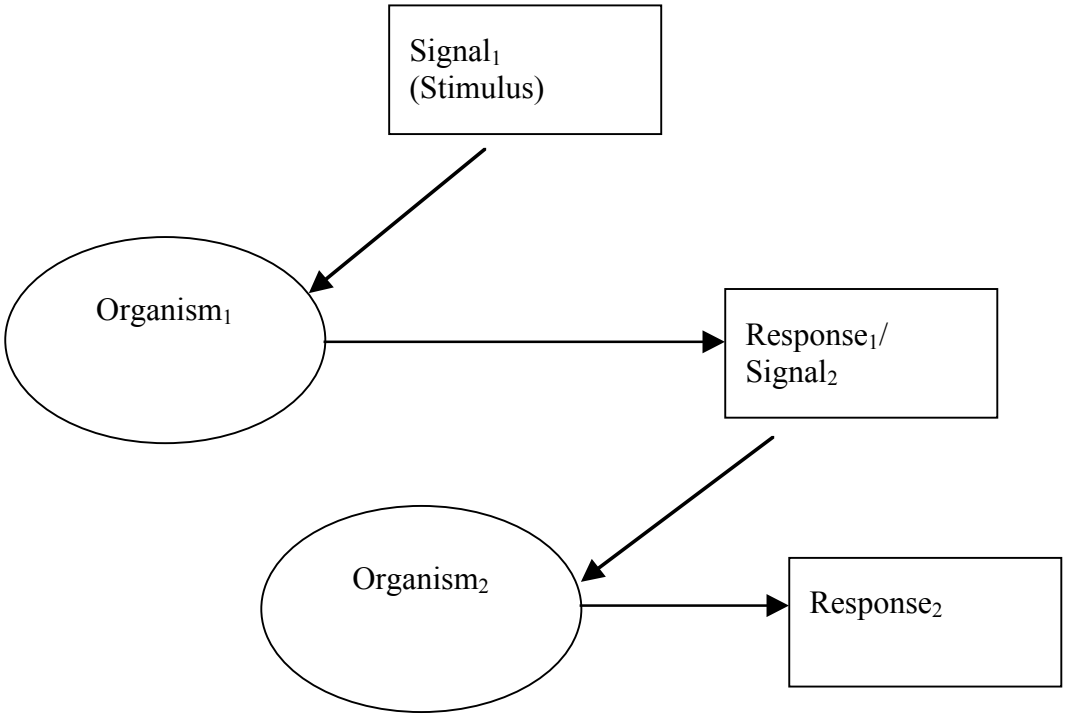

Figure 2. A communicative signal.

The social exchange of signals, therefore, does not involve *intersubjectivity*, since there is no shared world of joint attention and reference. Communicative signals are therefore not *conventional*. They do not depend upon a socially shared world of joint reference, and it cannot be said that there is a shared convention of a sign "standing for" a referent or class of referents, since the receiver does not refer the communicative signal to the stimulus causing the sender to emit it. The mechanism underpinning the social exchange of signals is neither intersubjectivity nor social convention, but simple *co-ordination* of individual organismic behaviour (which may, indeed, be complex, arising like many complex behaviours from natural selection).

Symbols and symbolization.

Symbols, on the other hand, are truly *conventional*, resting upon shared understanding that the symbol is a token *representing* some referential class, and that the *particular* token represents a *particular* (aspect of) a shared universe of reference and, ultimately, discourse.

Conventional symbol systems are *grounded* in an *intersubjective* meaning-field in which speakers *represent*, through symbolic action, some segment or aspect of reality for hearers. This representational function is unique to symbolization, and is precisely what distinguishes a symbol from a signal. A signal can be regarded as a (possibly coded) *instruction to behave* in a certain way. A symbol, on the other hand directs and guides, not the *behaviour* of the organism(s) receiving the signal, but their *understanding (construal)* or (minimally) their *attention*, with respect to a shared referential situation.

In this way, we can unpack and understand the concept of *intentionality*, widely understood to be intrinsic to symbol usage, but used in several different ways. For current purposes we can distinguish three meanings (or related aspects) of intentionality:

Intentionality$_1$. Purposiveness or goal-directedness.

Intentionality$_2$. Orientation to others as "minded" beings.

Intentionality$_3$. Directedness to the world, or reference.

I suggest that these different aspects of intentionality are inter-related in symbol usage, which involves the purposive use by a speaker of a symbolic sign to manipulate or direct the mental orientation (construal, or, minimally, attention) of a hearer with respect to an intersubjectively shared aspect of reality (*joint reference)*. N.B.—"speaker" and "hearer" should be understood as producer and interpreter of a symbolic sign in any modality, "reality" should be understood as any aspect of the shared universe of discourse.

It is important to emphasize here that symbolicity is here defined in terms of the semiotic and pragmatic *logic of communicative representation*, not on the specific typology, in the Peircian sense, of the relationship between sign and object (Sinha, 1988). Even an indexical sign, such as simple pointing, provided it is intentionally produced in an intersubjective field of joint reference, can be regarded as a kind of "proto-symbolic" communication, and the intentional and conventional production and comprehension of iconic representations such as maps clearly fall under this pragma-semiotic definition of symbolization.

My claim here is that the first criterion for symbolization, or the existence of a symbolic capacity in any organism or simulated organism, is *reference.* It is, however, important to specify that reference, in this definition, is not a property of signs or symbols "in themselves": symbols refer only by "inheriting" the referential function intended by their users—senders or receivers. The criteriality of reference to true symbolization has been pointed out by several authors, including by John Searle in his famous "Chinese room" thought experiment (Searle, 1980). However, Searle does not locate his argument in an analysis of the logic of communicative representation as grounded in an intersubjective field of *joint reference*, and his account can be criticized for locating referentiality (mysteriously) in the "mind/brain" of the individual speaker/hearer. The account I offer here and elsewhere (Sinha, 1999) is based instead upon a cognitive-functional or *usage-based* analysis of reference as communicative action.

Reference, however, is only the first of two criteria for fully developed, or "true", symbolization. I will claim that joint reference is the criterial basis for the *emergence* of symbolization, while the second criterion, which I shall call following (Langacker, 1987) *construal*, constitutes the set of cognitive operations which underpin the *elaboration* of proto-symbolic joint reference into true symbolization.

Simple, unadorned joint reference, such as implied by the production and comprehension of an indexical pointing gesture, serves to orient the attention of the receiver, but does not (in the general case) direct the receiver to any particular *understanding* or *conceptualization* of what is being referred to. The use of a truly symbolic sign, such as a word, however, at the very least implies a categorization of the referent, and may involve complex manipulations of perspective and Figure-Ground relations.

This cognitive-functional analysis of symbol usage is essentially the same as that advanced by Karl Bühler (Bühler, 1990 [1934])in his "Organon theory" of language (Fig. 3).

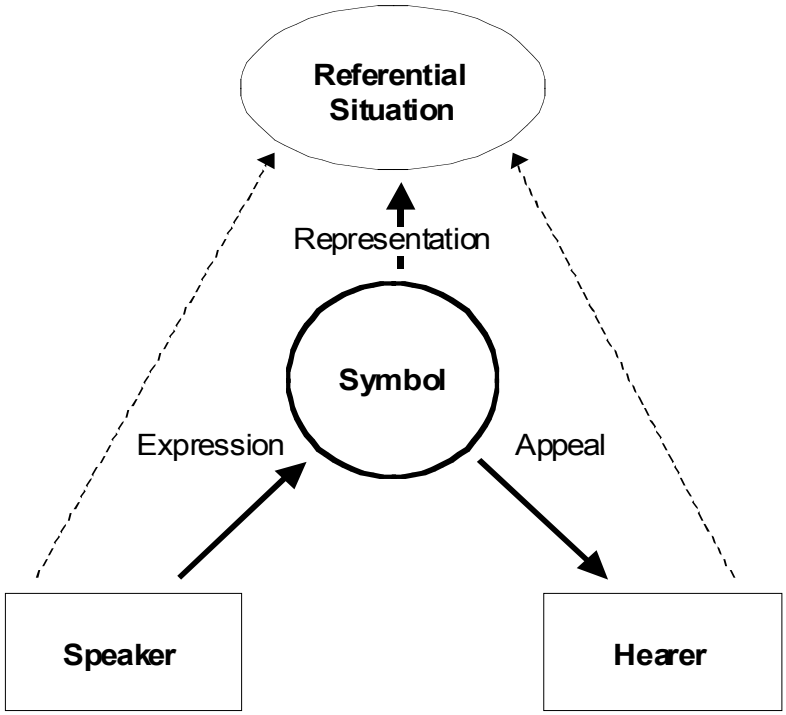

Figure 3. Symbolic communication. A modified version of Bühler's Organon model. Broken lines represent joint attention.

3. The emergence of symbolization.

It is possible to envisage an evolutionary scenario for the phylogenetic emergence of symbolic communication from signal communication. We may hypothesize the following steps:

1. The receiver comes to pay attention to the sender *as* the source of communicative signals.

2. The sender comes to pay attention to the receiver *as* a recipient of communicative signals.

3. The receiver comes to pay attention to the evidential reliability of the sender's communicative signals as a source of information, by checking what the sender is paying attention to, or doing.

4. The sender comes to pay attention to the receiver's readiness to reliably act upon the information communicated, by paying attention to what the receiver is paying attention to, or doing.

The first two steps of this sequence do not involve intersubjective "sharing" by the communicating organisms of a referential world, but they do require orientation towards, or social referencing, of a communication partner either as a source of information or as an actor whose behaviour can be influenced. This level of communicative competence is probably widespread amongst mammals, underpinning complex signal-mediated social behaviours. Not only communication between conspecifics, but also communication between humans and domesticated or working animals such as dogs, horses and elephants often seems to involve an understanding on the part of the domesticated animal that the human can both send and receive signals. My young border collie, for example, brings a ball and nuzzles me with it, while looking at me, when she wants to play (an instance of Step 2 above). This can be considered an elementary instance of Communicative Intentionality, in the sense that the dog is able to treat communication as a means to indirectly achieve goal directed action (Intentionality_1).

A communicative signal indexing a non-communicative intention (such as a wish to engage in play, grooming, or any other social behaviour) often has its origins in an initiatory segment of the behaviour, which may be abbreviated or stylized in shifting its status from "just behaviour" to signal. It is the understanding by each of the communication partners that the other can both send and receive such signals that constitutes the mastery of Steps 1 and 2 above. Communication, with the achievement of Steps 1 and 2, remains strictly signal-based, but it implies the establishment of a first or primary level of intersubjectivity, consisting of a recognition by each communication partner of the other *as* a communication partner, and the recognition by each partner of the other as an agent capable of acting as initiator or mediator of goal directed action.

In phylogenesis, then, the basis of intersubjectivity is (I hypothesize) constructed through the mediation of goal directed social behaviours by signals, and the understanding of the communicative partner as a potential agent. The ontogenesis of intersubjectivity in humans follows a different route: primary intersubjectivity appears to be innate (Fig. 4).

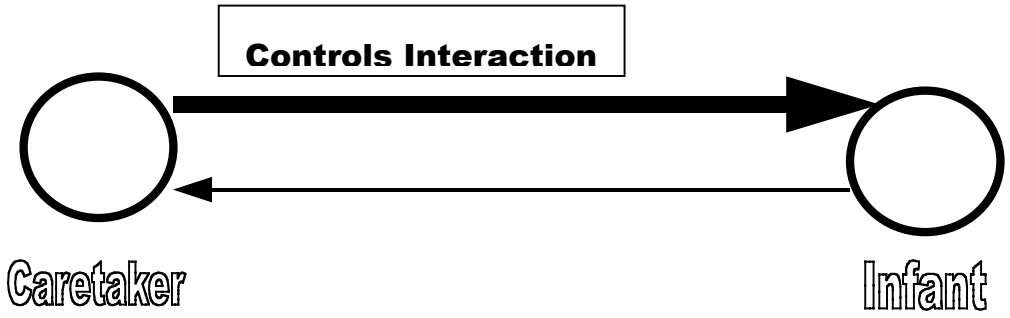

Figure 4. Primary Intersubjectivity. Caretaker-neonate interaction from 3 weeks.

Caretakers (usually mothers) and infants engage from a very early age in episodes of "communication" in which the bodily movements, facial expressions and vocalizations of the two participants provide the signals necessary for the maintenance of the communicative channel or intersubjective "we" formed by the dyad. The real time temporal meshing by the mother of her actions with those of the baby is of fundamental importance to the maintenance of intersubjectivity (Trevarthen and Hubley, 1978), indicating the emergence of a psychologically real "ontology of the social".

In taking Steps 3 and 4, the sender and/or receiver develop the capacity to understand that a signal indexes an intention, rather than the action intended. With this, the possibility is opened for deception and suspicion regarding intentions. The most basic level of understanding of the communicative partner not just as a potential agent, but as an experiential subject within the intersubjective field, is the ability to follow gaze, as evidenced by human infants form about 6 mo. of age (Butterworth and Jarrett, 1991) and by a number of other species (Fig. 5).

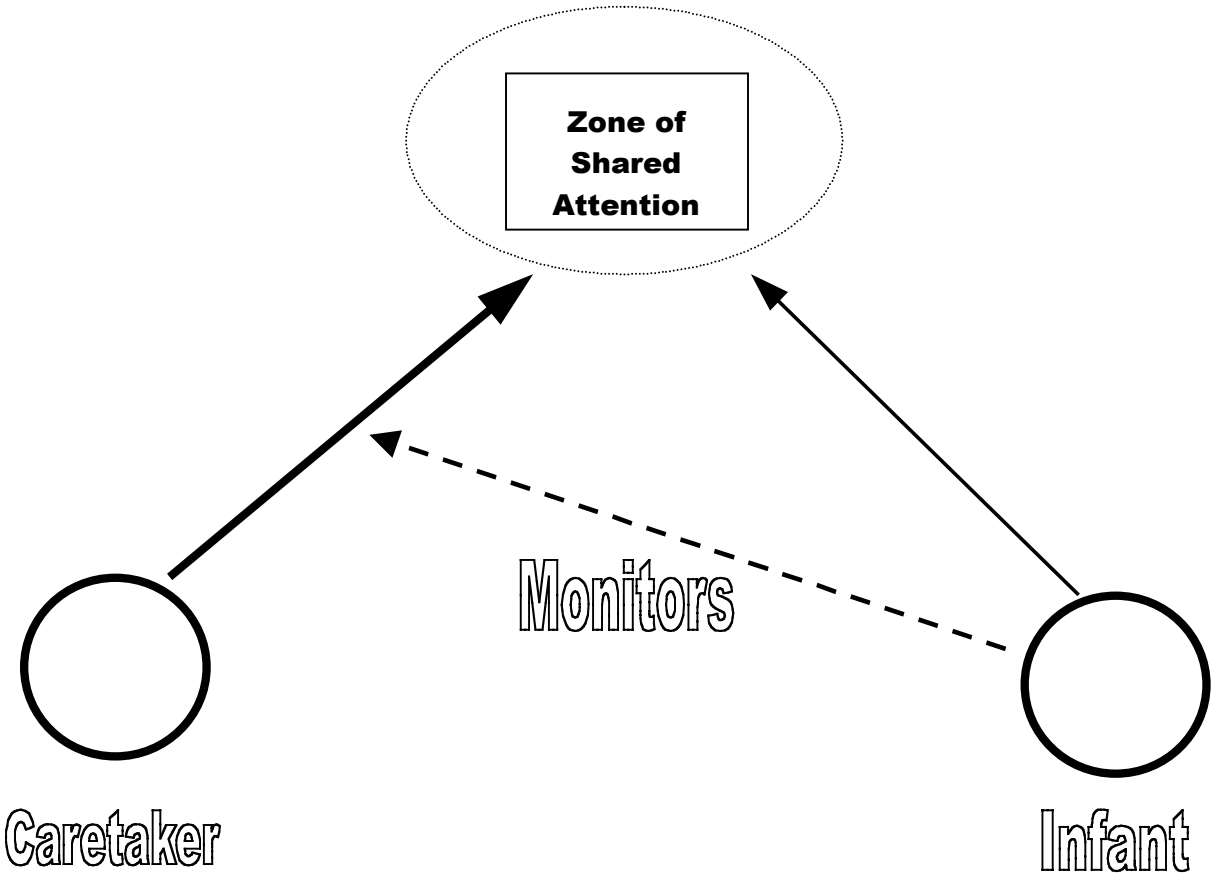

Figure 5. Gaze following. Human infants 6 mo., chimps, dolphins, sheepdogs.

Gaze following allows the receiver to monitor the activity and attention of the communicative partner, but not to manipulate as sender the attention of the receiver to a specific object or referent. The existence of spontaneous productive pointing even in our closest primate relatives is disputed, and probably occurs in the wild only intermittently, unsystematically and unreliably.

The ontogenetic development of this capacity has been well researched in the past couple of decades. From around nine or ten months of age human infants "begin to engage with adults in relatively extended bouts of joint attention to objects ... In these triadic interactions infants actively co-ordinate their visual attention to person and object, for example by looking to an adult periodically as the two of them play together with a toy, or by following the adults gaze. Infants also become capable at this age of intentionally communicating to adults their desire to obtain an object or to share attention to an object, usually through non-linguistic gestures such as pointing or showing, often accompanied by gaze alternation between object and person." (Tomasello, 1996: 310). The achievement of joint reference in human infancy establishes the "referential triangle" (Fig. 6) also referred to as "secondary intersubjectivity" (Trevarthen and Hubley, 1978).

The emergence of the "referential triangle" marks the emergence of the first criterion for symbol usage, namely reference in intersubjective field. From this point until about 14 mo. of age, infants increasingly mediate the manipulation of the field of joint attention by manipulating objects in give-and-take routines, and early in the second year of life they begin to demonstrate active mastery of the conventional or canonical usage of objects in play situations, their usage of such objects being dominated by objects' canonical functions until well into the third year of life (Sinha, 1988). It seems to be a well-founded conclusion that by early in the first year of life, the basic foundations of symbolization in intersubjectivity and in an understanding of conventionality have been laid.

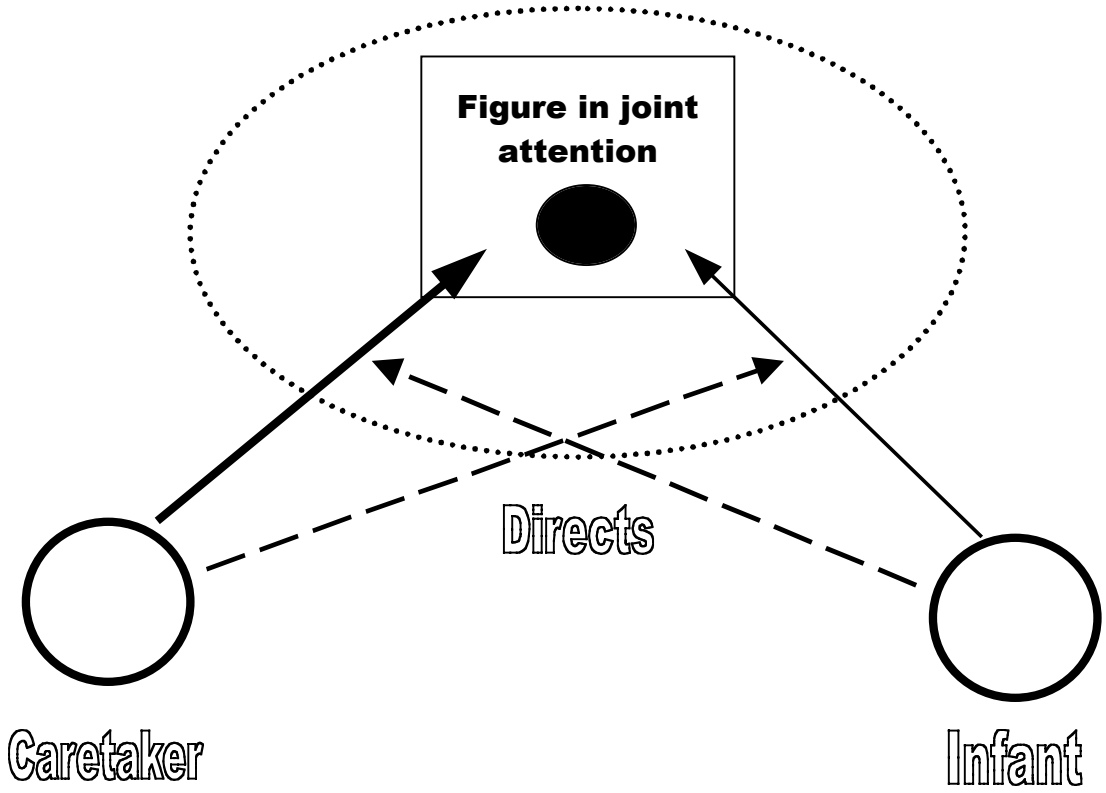

Figure 6. The referential triangle. Joint reference at 9-10 mo. in human infancy, chimps (?), bonobos.

4. The elaboration of symbolic representation.

The classical definition of the sign—*aliquid stat pro aliquo*—specifies very clearly that fully developed symbol usage depends upon the mastery of symbolic material, and in the case of natural languages, a symbolic system. Formalist theories in cognitive science, heavily influenced by generative linguistics, identify the criterion of fully-developed symbolization with the productive and combinatorial properties of language-like symbol systems, and it is often claimed that the structural and systemic properties of such conventional systems are *arbitrary* with respect to their functional and cognitive properties.

Such approaches overlook the fundamental *motivation* of the elaboration of conventionalized symbol usage by cognitive and functional factors, and the basis of this motivation in the communicative

requirement for *flexible construal* of referential situations.

The notion of construal (Langacker, 1987) can be simply illustrated by example. Any referential situation which requires characterization in terms of the *relationships* obtaining between more than one entity may so be characterized in more than one way. I can say, for example, that the cup is on the saucer, or that the saucer is under the cup. In the first case, the cup is the Figure (or Trajector), and the saucer the Ground (or Landmark) in relation to which the location of the cup is specified. In the second case, these cognitive roles are reversed. Similarly, the lexicalization "father of" represents the same relationship as the lexicalization "child of", but the two lexicalizations are perspectivized or profiled from different points of view.

Without going into details, we can say that the *elaboration* of symbolization into grammar involves the mastery of natural language subsystems that functionally permit flexible construal, and that this is the essential cognitive-functional motivation underlying the evolution and acquisition of language by humans.

Linguistic complexity is, on this view, the structural consequence of the operation of cognitive-functional principles for motivating construction which have been extensively studied in recent years by cognitive and functional linguists.

The main principles of motivation are:

Iconicity and Analogy (including specific motivations by: *embodiment, image schematization, force dynamics, cultural schematization*).

Figure-Ground articulation.

Topic-Comment articulation.

Perspective and Profiling.

Fig. 7 diagrams the semiotic structure resulting from the elaboration of joint reference into linguistic (symbolic) conceptualization *via* the mastery of symbolic vehicles enabling flexible construal. Fig. 7 is also to be understood as an elaboration, based upon cognitive-functional linguistic principles, of the Organon-model diagrammed in Fig. 3. In Fig. 7, the broken lines no longer represent joint attention but the mutual construal of a referential situation by speaker and hearer within an intersubjectively shared universe of discourse.

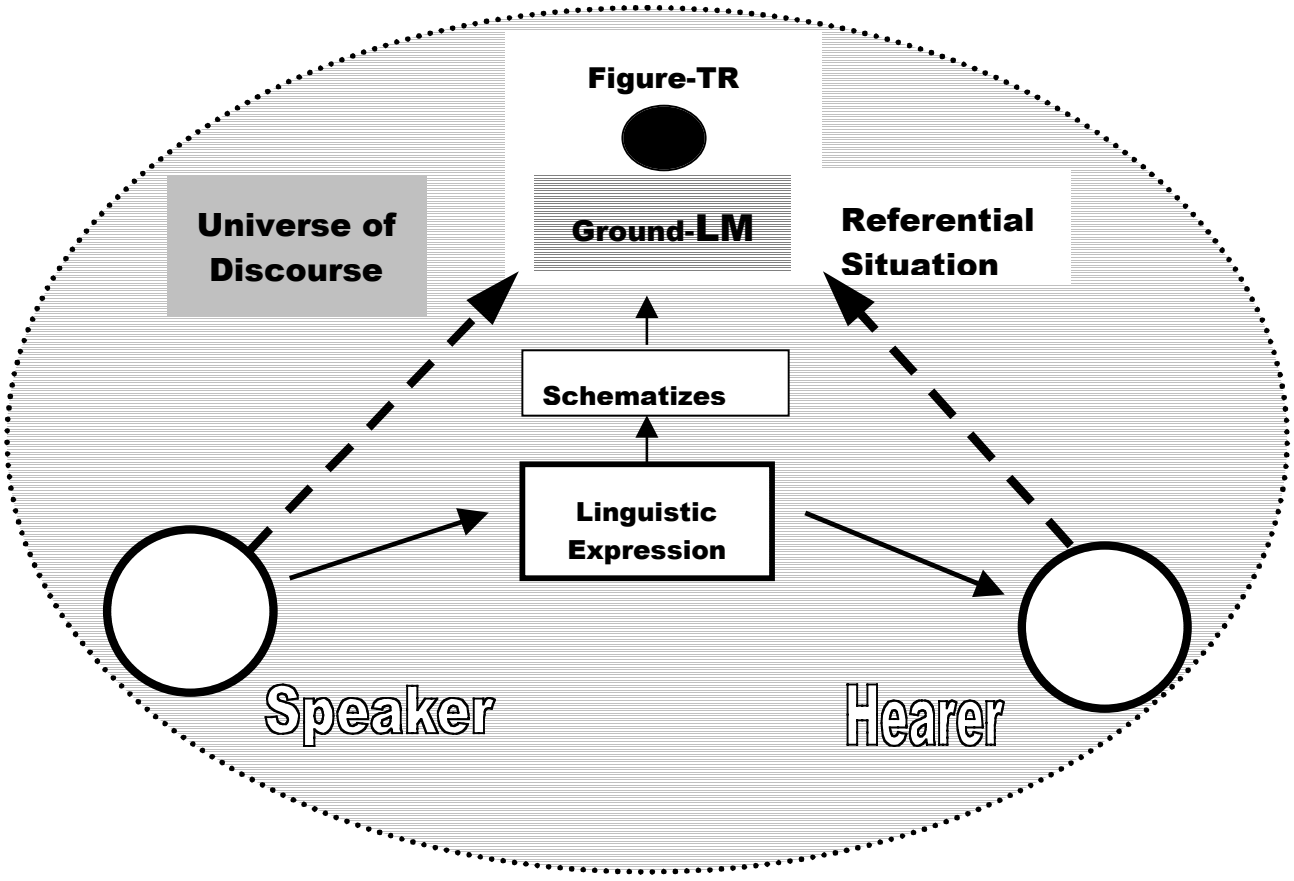

Figure 7. Semiotic mediation. Linguistic conceptualization as symbolic construal.

5. Infancy, evolution and culture.

There is a common epigenetic logic to the phylogenetic and ontogenetic development of symbolization. The logic is one of process, from signals to the emergence and elaboration of symbols. This logic involves the following sub-processes, which significantly temporally overlap but which emerge in the order of mention below:

Intentionality and intersubjectivity.

Conventionalizaton based in intersubjectivity.

Structural elaboration yielding flexible construal.

It should be emphasized that there is no claim here that ontogenesis necessarily involves, within any one of these processes, the recapitulation in ontogenesis of stages passed through in phylogenesis. Although we can observe analogous phenomena in (for example) the symbolic communication of human children and non-human primates, there are also many differences. We have seen, for example, that primary intersubjectivity appears to be innate in humans, while it is hypothesized to be emergent in phylogenesis from the mediation by communicative signals of non-communicative social behaviours. Similarly, although it is plausible to draw very general analogies in terms of principles of motivation between grammaticalization processes in historical language change, and the acquisition by the child of the constructional resources of grammar, the stages and strategies characterizing each of these processes are very different (Slobin, 1997).

Commonalities in developmental logic do not, therefore, imply that ontogenesis recapitulates phylogenesis. Instead, I would like to suggest that ontogenesis—and in particular the ecological niche of infancy—played a crucial role in the evolutionary development of the human symbolic capacity. Human infants, as has often been pointed out, are extraordinarily well adapted to the demands of enculturation and the acquisition of symbolic communication. I would suggest that this is because, once established, the emergent social ontology of intersubjectivity and conventionalization sets up new parameters for the selection of context-sensitive and socially situated learning processes, rather than "content-dedicated" cognitive mechanisms. In such an evolutionary process, a major role might have been played by "Baldwin effects" (genetic assimilation) which lend a teleological directionality to natural selection through the developmental mimesis of the inherent teleology of the elaboration of symbolic communication (see Section 1).

Such an account is quite different from—indeed diametrically opposed to—not only modularity theories of language, but the entire logic of currently popular "evolutionary psychology" narratives of origin. The traditional and dominant view of evolution and development is one in which the development of "higher" levels of organization is dependent upon prior developments in "lower" levels of organization. In particular, the priority of individual organismic properties is assumed to carry over from the level at which natural selection occurs to the level of psychological processes. Even if the existence of emergent, higher level (socio-cultural) properties is conceded, the autonomy of these levels is continually undermined by theories reducing them to the causal properties of supposedly "more basic" levels.

An alternative view, consistent with recent findings in primatology ("apes have culture"), stresses the emergence of the first foundation of symbolization and language not in individual organismic modules, but in the quintessentially social realm of intersubjectivity and normativity (including conventionalization).

According to such an alternative account, the emergence of what we can designate, in general terms, of an emergent socio-cultural level of organization set the stage for subsequent genetic selection (and epigenetic development)—rather than the other way round. The difference between the traditional and the alternative views is diagrammed in Fig. 8.

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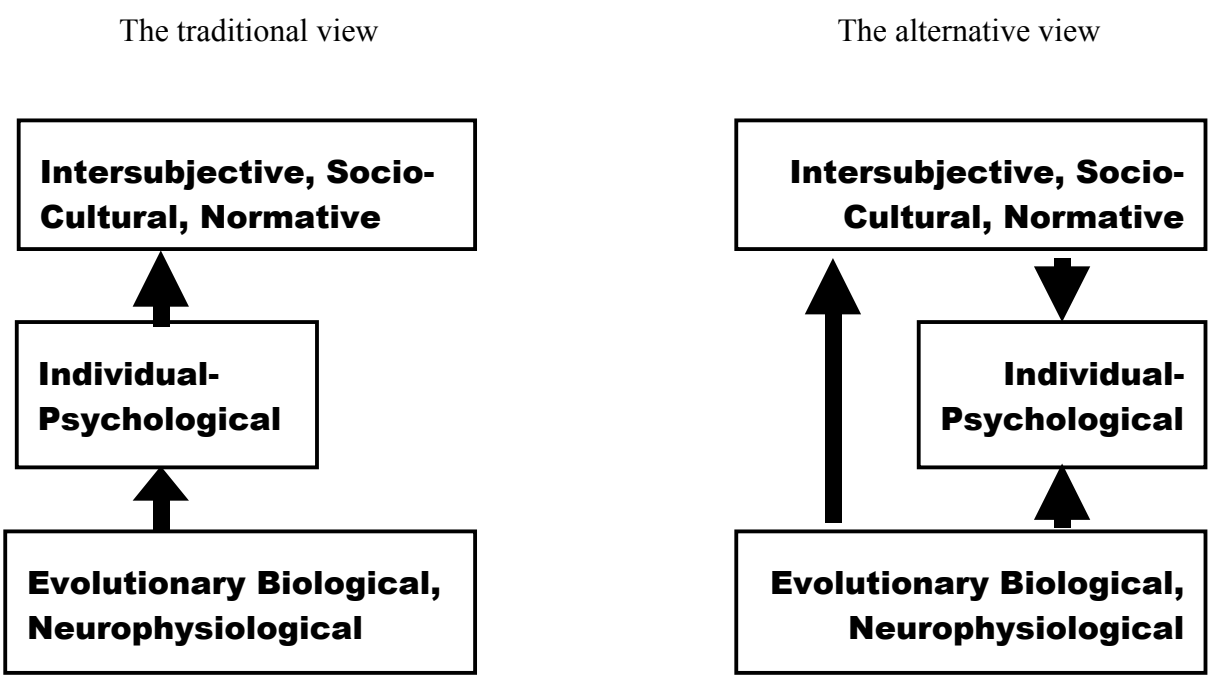

Figure 8. Two views of evolution and development.