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**Title:**

Where did information go? Reflections on the logical status of information in a cybernetic and semiotic perspective.

**Abstract**

This article explores the usefulness of interdisciplinarity as method of enquiry by proposing an investigation of the concept of information in the light of semiotics. This is because, as Kull, Deacon, Emmeche, Hoffmeyer and Stjernfelt state, information is an implicitly semiotic term (2009: 169), but the logical relation between semiosis and information has not been sufficiently clarified yet. Across the history of cybernetics, the concept of information undergoes an uneven development; that is, information is an ‘objective’ entity in first order cybernetics, and becomes a ‘subjective’ entity in second order cybernetics. This contradiction relegates the status of information to that of a ‘true’ or ‘false’ formal logic problem. The present study proposes that a solution to this contradiction can be found in Deely’s reconfiguration of Peirce’s ‘object’ (as found in his triadic model of semiosis) into ‘thing’ and ‘object’ (Deely 1981). This ontology allows one to argue that information is *neither* ‘true’ *nor* ‘false’, and to suggest that, when considered in light of its *workability*, information can be *both* true *and* false, and as such it constitutes an organism’s *purely objective reality* (Deely 2009b). It is stated that in the process of building such a reality, information is ‘motivated’ by environmental, physiological, emotional (including past feelings and expectations) constraints which are, in turn, framed by observership. Information is therefore found in the irreducible cybersemiotic process that links at once all these conditions and that is simultaneously constrained by them. The integration of cybernetics’ and semiotics’ understanding of information shows that history is the analytical principle that grants scientific rigour to interdisciplinary investigations. As such, in any attempt to clarify its epistemological stance (e.g. the semiotic aspect of information), it is argued that biosemiotics does not need only to acknowledge semiotics (as it does), but also cybernetics in its interdisciplinary heritage.

**Keywords**

interdisciplinarity, cybernetics, Deely, thing and object, constraints, history

**Introduction**

“Biosemiotics is the name of an interdisciplinary scientific project that is based on the recognition that life is fundamentally grounded in semiotic processes.” (2008: 3)

With this incipit, the biologist Jesper Hoffmeyer starts his pivotal book *Biosemiotics: an examination into the life of signs and the signs of life* (Hoffmeyer 2008). Hoffmeyer’s initial definition of biosemiotics hints at two things: firstly, that the scientist does not refer to biosemiotics as a ‘paradigm’ and prefers to use the term ‘project’ or ‘biosemiotic approach’ (as from the title of his book’s first chapter). He does so, as he states, in order to “avoid a premature hardening of the biosemiotics idea into an actual paradigm” (2008: 3, footnote); secondly his definition hints at the fact that, by force of its interdisciplinarity, biosemiotics is a candidate for cross criticism across all realms of knowledge, for example “those readers with a biological background who think that the biosemiotic approach may be a form of disguised *vitalism*. Empirical researchers may quickly spot a warning sign that suggests *metaphysics*. Humanists, on the other hand, may see a danger marker that points to *reductionism*.” (2008: 5) The lesson to learn from this reflection is that in general interdisciplinary projects may yet attract candidate scholars from a whole set of different fields but at the same time run the risk of being seriously criticised from every and each one of these perspective. Thus, the legitimate question that one may pose is “what is so good about interdisciplinary projects in such a way that makes people adhere to them?”, or, more generally, “what is the fundamental usefulness of interdisciplinarity as method of enquiry?”.

Since, it is quite difficult to ascertain the general usefulness of a method *a priori,* then one should at least attempt to ascertain the benefits of interdisciplinary, hybrid, or *integrative* methodologies at least at the level of the individual work alone. In fact, a typical problem of interdisciplinary studies is that, as argued by Thomas Benson, “the proponents of integrative studies have given surprisingly little attention to the important work of defining their goals and their methods clearly.”(1982: 40) The scope of the current essay is to address this issue by proposing an ‘interdisciplinary case study’. The study will consist of the *investigation of the concept of information in light of semiotics*. That is, I propose to bring together the product of the history of information science – the notion of information - and the ‘product’ of semiotics according to the view of the American semiotic philosopher John Deely - the notion of sign process in light of its relationship to logic. Issues of goals and methods as raised by Benson are addressed in that the analytical clarity of the concept of information is the main goal of this study, mainly because as Kull, Deacon, Emmeche, Hoffmeyer and Stjernfelt (2009: 169) note, information is an implicitly semiotic term but the logical relation between semiosis and information has not been sufficiently clarified yet. Also, this study makes its epistemological choices clear as it is 1) theoretical, starting with theory and ending with theory, thus proposing a demonstration, 2) historical, identifying differences in the conceptualisation of information as found across its history and 3)interdisciplinary, that is, *integrative* proper, as it proposes some steps towards a synoptic concept of information that draws from both semiotics and cybernetics. The corollary of this investigation is to bring forth the idea that an historical perspective may be beneficial for both biosemiotics’s analytical clarity and for interdisciplinary studies in general. Indeed it promises to be the key grounding principle bringing analytical rigour within any interdisciplinary study.

**Information – an *uneven* development**

To identify the main ‘problem’ with information, let us start with a brief account of its history. Information is a concept that finds its roots in the study of physics or physical systems and thus in the realm of the so called hard sciences as conceived towards the end of the Nineteenth Century and the beginning of the Twentieth Century. Up to the first half of the 1800s, science conceived of the world as made of matter and energy. This was the ordered world of classical mechanics and Newton’s laws. Then, in the second half of the Nineteenth Century, thanks to Rudolf Clausius (1865), the two laws of thermodynamics were formulated. This event brought about the discovery of entropy. Scientists realised that we lived not in a world of order, but in a disordered world of heat and entropy, where systems are destined to end in heat-death (a state in which a system is not capable of spontaneous reactions anymore and has lost all useful energy). However, in 1871 Maxwell proposed a ‘violation’ of the Second Law (the so called Maxwell’s demon) and demonstrated that there can be a case in which entropy does not increase in a system and no work is getting done. Subsequently, in 1894, Boltzmann’s work on atomic theory concerned itself with *ensembles* of elements (molecules) and *probable* behaviour of systems and established statistical thinking in physical systems. Thus, at the end of the Nineteenth Century, probability and not necessity became a new, formally describable scientific principle. Lastly, in 1925 Leo Szilard (see Brier 2008) proposed a solution to the contradiction identified in thermodynamics by Maxwell’s demon and described how the solution could operate. Szilard identified the notion of *information bit,* that is, the information value as obtained from the answer YES/NO question (or for SLOW/FAST in the case of gas molecules). In so doing he proposed the first explicit link between thermodynamic entropy and information, and thus introduced the concept of information, in its statistical conception as derived from its thermodynamic roots, in the hard sciences. From here, information became a ‘thing’, like a molecule or an atom, thus a commonly conceived physical *and* objective entity worth of scientific study.

Now, if thermodynamics was driven by the development of the steam engine, information theory at its roots was driven by the development of engineering communications systems. The concept of information is in fact subsequently found in Shannon and Weaver’s *Mathematical Theory of Communication* (1949). Shannon and Weaver were interested in how to transmit signals quickly and reliably over telegraph and telephone wires. In Shannon’s information theory, information was thus found in a linear communication system, the so called *transfer model*, and was defined as “the freedom of choice we have in constructing messages.” (Shannon and Weaver 1949: 7) Choice among a number of possibilities points at the fact that in communication engineering one deals with ensembles of elements (or of choices), “that information” – Weaver states - “be measured by entropy is, after all, natural” (Shannon and Weaver 1949: 7). Thus information was conceived, similarly to entropy, as the degree of randomness or of ‘shuffledness’ of a system (in the case of communication engineering, a system of possibilities of choices). Thus in Shannon and Weaver’s transfer model, *the selection of information reduces entropy in the source*. Around the same period, Norbert Wiener was performing his trans-disciplinary (or applied) studies on physiology and mathematics. Struck by Shannon’s newly formalised concept of information, he took it on board and linked it to his previous research on teleological systems (Rosenblueth et al. 1943). Thus he transposed Shannon and Weaver’s communication model onto a model with feedback, transforming their linear model into a circular model where information transfer reduces entropy within the system and as a consequence sustains the system’s organization or its life. Cybernetics in its first order conception was born (Wiener 1948). Information, the mathematical theory of communication and its implication for human language (despite Weaver’s pretty useless warning that his model does not deal with *meaning*) became thus a cornerstone of cybernetics, as also demonstrated by Shannon’s attendance at the Macy Conferences on cybernetics (1946-1953) from 1950 onwards. What one can deduce from this short history is that in its origins the concept of information was formal (in communication engineering-led information theory), and that it has been transposed as such in cybernetics, with an added purposefulness or functionalist overtone (since, as Wiener claimed, “to live effectively is to live with adequate information” [1951: 18]). Thus information in the sciences has come to be expressed both conceptually and formally by thermodynamic entropy[[1]](#footnote-1). In fact, information has been formulated by Shannon as the negative logarithm of entropy, by Szilard as a data unity called informational bit, and thus as an entity fully describable by two values such as 1 or 0, or True and False. In the end, because information is rooted in the statistical and mathematical notion of thermodynamic entropy and is fully and finitely describable in finite terms, one can clearly see how in both information theory and first order cybernetics, information has been characterised as an ‘objective’ entity.

However as one approaches the 1970s, the period in which *second order cybernetics* starts to establish itself, it is striking how the concept of information takes a less formal, nearly subjective turn. This happens first and foremost through the work of the anthropologist Gregory Bateson (1972 [1970]) who, in studying tribal rituals, defines information as “a difference that makes a difference.” (1972: 459) Citing Immanuel Kant’s statement that “in a piece of chalk there are an infinite number of potential facts”, Bateson argues that a potential fact becomes an actual fact only when this is perceived as relevant (or as making a difference) to a living organism. Thus, Bateson steps away from information theory’s and cybernetics’ view defining information through *formal correspondence* or *necessity* and, indeed, introduces the non-necessary (thus semiotic) notion of *relevance*. This conceptualisation implies that information does not exist in isolation, but only *in relation* to a perceiving organisation. A further step towards subjectivism comes through the work of the physicist Heinz von Foerster (1973), the Chilean biologists Maturana and Varela (1980) and the German sociologist Niklas Luhmann (2002). These figures yielded different contributions such as the notion of the blind spot and the theory of autopoiesis in biology and in social systems, but they have all been united by their interest in the theory of the *observer*. For example, von Foerster affirms that “the environment as we perceive it is our invention.” (1973: 1); Maturana and Varela state that autopoietic machines do not have inputs and outputs (1980: 80); Luhmann defines information as a “purely internal achievement”, an act of selection that does not exist in the external world, but is a construct (2002: 135). According to all these views, there is no information transfer as such in an observed system. Information is the *construction* of the system’s observer, that is, it is constructed by an observer while performing system observation. Like Bateson’s work, von Foerster, Maturana and Varela and Luhmann’s theories imply that information does not exist in itself. However, and unlike Bateson who does not specify for whom information is a difference (Brier 2008: 179), they specify that information only exists in the observer’s, or the scientist’s mind. As such, with second-order cybernetics the definition of information not only moved towards a less formally precise and descriptive definition of information but also took a constructivist turn and became a ‘subjective’ entity in its fastidiously relative and *arbitrary* overtones.

This account of the history of information leads us to realize a fundamental fact: that in cybernetics the concept of information undergoes profoundly different developments. If one intended cybernetics, for simplicity’s sake, as a single system developing along a timeline, these developments could be intended as contradictory. This expression can be defined along the line of Louis Althusser’s conception of history (2005 [1965]) as an event of sudden change, or a sudden leap forward or, in other words *an uneven development*. In cybernetics, in fact, information at first is ‘objective’ (first order), then it is ‘subjective’ (second order). Thus information is first *necessary*, then it is relative to an observer, or *arbitrary*. A consequence of this epistemological uneven development is that after second order cybernetics, information as a concept became harder to locate. One could say that information slipped out of scientists’ hands to the point that they found themselves asking: “where did information go?” This may not be a problem to the specialist thinker who intends that similar instances of reality can be described with different tools. Or, in other words, that concepts developed for different purposes (e.g. defining quantities or defining qualities but within the same thing) are not contradictory but simply different. However the uneven development of information becomes a problem to the integrative thinker who, in an opposite fashion to the specialist thinker, instead wishes to use *grosso modo* the same tools to understand different instances of reality, including those developed for different purposes. This paper takes its inspiration from the second approach - that of the integrative thinker - and argues that an interdisciplinary, rather than a specialist view on problem solving may be a feasible way to answer the questions “where is, then, information? Is it in the actual thing that we are observing? (as in first order, ‘objective’ cybernetic conception) Or is it in the observer? (as in second order, ‘subjective’ cybernetic conception).” As evident, this question embodies a subject/object dichotomy, a typical ‘true’ or ‘false’ formal logic problem that is constitutes an inconsistency for interdisciplinary enquiry. In light of this dichotomy, the present study asks whether instead it could be the case that information was both subjective and objective. The hypothetical answer is that yes, information can be both subjective and objective, but only if one applied a method of enquiry more flexible than logic in its strict, necessary or narrow sense.

**Semiotics – flexible enquiry**

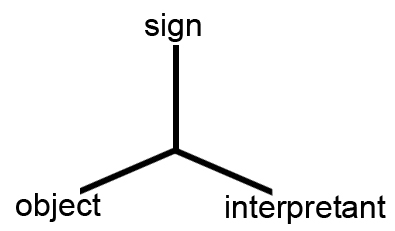
The method that I propose to use in order to mediate the dichotomy found in the concept of information comes from *semiotics*. Semiotics can be considered as a general doctrine of signs originating from the philosophy of Charles S. Peirce (1839 -1914) and that has as its precursors the ancient physicians Hippocrates of Cos and Galen of Pergamon, the seventeenth-century Latin scholastic John Poinsot (1589-1644) and the English philosopher and physician John Locke (Deely 2006). This tradition of semiotics, or ‘semiotics proper’, conceives of the sign as a *general model* that can be identified across all the universe and not just across human cultures. In this sense the philosophy underlying ‘semiotics proper’ is more comprehensive and thus more workable than the linguistic perspective underwriting semiology that, as embodied in the work of the linguist Saussure and linguistically-fixate thinkers like Barthes, focuses purely on the linguistic sign and verbal communication. For example, communication in semiotics is not conceived merely as human language as semiology entails, but as a biological and thus fundamentally organizational phenomena that is found at the roots of organic life. Hence the name *bio*semiotics (Sebeok 1991) or *global semiotics* (Sebeok 2001). This view characterised by a renewed, non-linguistic generality is what I propose to use to put forth an interdisciplinary view on information in cybernetics.

To be more precise, I am going to utilise the perspective proposed by Thomas Sebeok’s former student and scholar, the philosopher John Deely (1942- ) who focuses on the relation between logic and semiotics. In a masterpiece named “The relation of logic to semiotics”(2009 [1981]), Deely in fact explores the conceptual overlap that one finds when reading the history of logic in light of semiotics. Deely (2009a: 143) points especially to the following quote from Fisch (1977: 36):

(…) Peirce from the beginning conceived of logic as coming in its entirety within the scope of the general theory of signs (…) for a time in his fifties he distinguished a narrow and a broad sense of logic, in the latter of which it was coextensive with the general theory of signs (…) eventually he abandoned the narrow sense.

With reference to this quote Deely strengthens the view that logic is but a narrow part of semiotics or, as Peirce originally put it, a subclass that worries specifically about “conditions of the truth of representation.” (Peirce 1955b: 99) Unlike logic in the narrow sense, Peirce’s pragmatic conception of semiotics is underwritten by the *quasi-necessary* (Peirce 1955b: 98) logic of *abduction* (Peirce 1955a: 304). Abductive logic, or semiotics, does not just worry about the truth conditions of a reasoning process (as in semantics) nor even just about its formal coherency (as in formal logic or syntactics) but worries also about its function, or its place in a context (the pragmatic side of reasoning). Thus, following this broader line of enquiry, Deely operates a reconfiguration of the notion of ‘objectivity’. Deely’s contribution in this sense has been chosen because objectivity is a key concept that allows one to find a middle path between the formal-reductionist or constructionist views that first order and second order cybernetics hold for information. Let us therefore see how Deely reconfigures objectivity in light of semiotics.

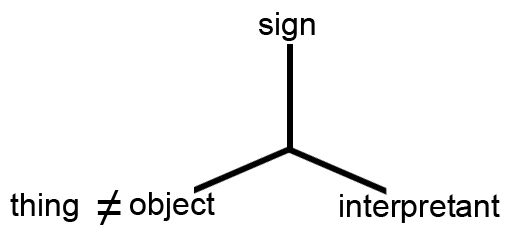
For the sake of simplicity, let us conceive of a ‘traditional’ notion of objectivity within the context of semantics, the field that studies the correspondence of the content of a proposition with reality. Following this simplistic view, an objective or *true* statement would be something whose content is coincident with reality, whereas a non-objective or *false* statement would be a statement whose content does not match reality. Deely reconfigures this simplistic notion through Peirce’s triadic model of the sign, conceived as a unity emerging from the irreducible relations among *representamen (*or sign-vehicle*), object,* and *interpretant (*or meaningful reation*)*.



**Fig. 1** Peirce’s triadic sign model

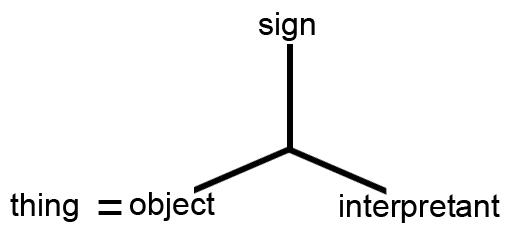
In other words, Peirce’s definition of the signs, as illustrated in Fig. 1, holds that “a sign, or *representamen*, is something which stands to somebody for something in some respect of capacity”. (1955b: 99) To introduce ‘objectivity’ in this model, Deely brings in Peirce’ s example of the thermometer whose mercury line reacts to an increase in warmth in a room and rises (2006: 31). When considered by itself, the rise of mercury brought about by the increase of ambient warmth is a cause-effect dyadic interaction. However when somebody is there to perceive the rise of mercury, there is a triadic (or semiotic) interaction of sign, object and interpretant. Thus, when semiosis takes place, or, when a dyadic interaction enters someone’s field of experience, the warmth of the environment from being a *physical* thing, becomes the *known*thing, or a personal element of experience or *object;* the *rise of mercury in the thermometer* becomes a *sign* of the warmth of the environment; the *increase of ambient temperature* becomes the *interpretant* of the rise of mercury interacting with the environment-object. What is really important here is the distinction that Deely makes between *thing* and *object*. According to this distinction, a thing is that which exists beside being known; it constitutes ‘mind-independent reality’ and reflects a physical situation. When one comes across a thing, an informed ‘object*’* is generated. This amounts to ‘mind-dependent reality’. An object therefore is defined as that which is *known/seen*. Thus *experience is what distinguishes an object from a thing*, in other words ‘objective’ means ‘experienced’.

Why is Deely’s thing/object distinction important? The fact that an interpretative judgement –that is, the process of forming an interpretant - may be based on a ‘thing’ or merely on an ‘object’ helps one to characterize the interesting quasi-necessary nature of the interpretant (and of information). This is because the rise of mercury in the thermometer (the sign) signifies a rise in ambient temperature (interpretant) in any case, whether the thermometer gives a correct reading (or points to a thing, an actual or physical state of a situation) or is instead malfunctioning and gives an incorrect reading (or points to an object, an element of experience that however does not correspond to physical reality). In this case the interpretant is based on error. Therefore, as Fig. 2 shows, there can be two cases that describe an interpretant:



**Figure 2**. The interpretant is objective but *not* physical

A situation in which a generated judgement or an interpretant is objective *but not* physical, the reason being that the object upon which it is based does not correspond to a thing or the actual state of affairs of the environment; Or,



**Fig 3.** The interpretant is objective *and* physical

A case (Fig. 3) in which an interpretant is objective *and* physical, that is, when the object upon which it is based does correspond to a physical thing. Thus the interpretation of a dyadic interaction or an event is relatively accurate,workable and relates to what has actually taken place.

If one considers an interpretant as the conclusion of an abductive argument, one can see that an interpretant can rest on a true premise (when the object corresponds to a thing) or on a false premise (when the object deviates from a physical situation). This means that in a ‘semiotic argument’, or in abduction (Peirce 1955a: 304), a truth condition may not be satisfied but the interpretant – arising as a relation between sign and thing-that-becomes-object - will exist anyway and will always constitute an element of experience. That is, whatever the values of the premises, in semiotics *an interpretant is always objective,* or experienced, and thus, in a sense, real. This ‘experienced’ reality Deely calls *purely objective reality.”* (Deely 2009b: 342–344) Thus it does not matter whether an interpretant is true or false (and in fact, it can be both at the same time, see Cannizzaro 2009). Deely argues that “Fully actual objectivity arises only when and in the physical interaction of two or more physical substances one at least of the interactants is an animal (…)”(2009b: 343), in other words he stresses the central role of embodiment in constituting ‘purely objective reality’. Therefore because of its embodiment within experience, an interpretant always ‘makes sense’ and always provides a workable picture of reality. For example, it does not matter that zombies do not exist. One can still ‘experience’ them through a movie, establish a meaningful relation between this ‘objective’ experience and one’s own semiotic self, and then be afraid of zombies as if they were a real thing. Similarly, one can still have feelings for a deceased beloved person and physically react to the thought of it. Put brutally, one can still make sense and react to something that does not longer exist. The reaction caused in one’s body shows that the ‘object’ upon which this abduction is based is ‘more real’ than anything else, precisely in light of its basis in experience. Thus semiotically, and as opposed to common sense based on strict logic, it is not non-sense to love someone who is no longer there. Deely in fact explains that “a fictious relation is not real but is still a relation” (2009b: 336), the reason being that “relations depend upon a fundament, and this fundament is a modification of subjectivity” (Deely 2009b: 339). In short any form of physio-psychological reaction is the legitimate result of the formation of a relation and thus of an interpretant.

However Deely also reminds that in light of the embodiment of semiotic experience, “the interaction partially specifies and determines the awareness of the animal (*species impressa*) semiosically to form and construct a further awareness of its own (*species expressa*) transforming the bare physical into an objective world with which the animal can and must deal according to its biological type.” (Deely 2009b: 343) Thus the animal’s biological type is fundamental to conceive of an interpretant. This is particularly evident (although not limited to) in the case of animals possessing malfunctioning sensorial organs. These in fact allow the formation of an interpretant which is based on an object that diverging only partially from a thing, thus of an interpretant that yet makes sense but is not entirely accurate. For example, people with mild to moderate hearing impairment hear distorted sounds, not sounds as ‘they really are’. However, when someone wears hearing aids for the first time and experiences the ‘sounds as they really are’, these will instead sound distorted. This happens to the point that music as sensed through hearing aids sounds less aesthetically pleasant and thus less musical than music as usually sensed through defective but natural hearing organs. Thus for those used to make sense of sounds in their own way, music can as a result be more ‘musical’ in its distorted form, rather than its ‘true’ form with hearing aids on. Indeed one may have come to prefer, for example, bass-based music in life precisely because one’s anatomical availability has never allowed one to hear high-pitched sounds (e.g. guitars) correctly. The same is valid for common sensorial distortion that can occur within sight. Wearing a new pair of glasses in fact can often give the feeling of a distorted perception, for example the floor may look much higher or curvier than it ‘really’ is. What is striking about natural sensorial distortion is that, when corrected with artificial devices, the ‘real’ thing – i.e. the floor as correctly seen through new lenses - appears false. That is, an accurate view of the environment makes less sense than the habitual, distorted and merely objective view (where the object of experience does not fully correspond to a thing) that one can normally have of it.

Thus what matters for an interpretant to form is not whether this is true or false, natural or constructed. By means of being based on experience, any view of the physical world can always be considered as natural, or real. What matters is that this world view *works*, and that it provides a workable picture of the environment, or a model, for living beings to live within. This means that in semiosis, or in an abductive judgement, a truth condition may not be satisfied for a number of reasons - the partial or total loss of accuracy of the symmetry between thing-object - but an interpretant will still exist, will still be legitimate or *functiona*l. This is to say that an interpretant always embodies within itself the *causes* that generated it and the *purpose* that it serves, whether these are environmental – caused by the thing - or sensorial – caused by the framing devices. Causes and purposes are the conditions of existence, and of experience, of an interpretant.

From here one can start delineating the benefits that Deely’s re-working of the notion of objectivity through the distinction between ‘thing’ – the physical situation - and ‘object’ – the known situation - can bring to a reconfiguration of information. Deely’s work, in fact, allows theorisation to move away from reflecting on information from the point of view of ‘truth conditions’. This is because information could make sense (create an intepretant) even if the thing to which it relates does not exist (zombie), does no longer exist (a dead beloved person), or is sensed through a ‘defective’ device (hearing or sight impairment) and produces therefore only a partially accurate world view.

**Where is information?**

From the above discussion one may re-formulate our initial question from “where is, then, information?” to “ In the process of forming an interpretant, where can one find information?” In other words, what does Deely’s re-working of objectivity imply for the notion of information as contradictorily found in cybernetics?

By impinging upon the relation between logic and semiotics, and thus upon the distinction between ‘thing’ and ‘object’, Deely’s *purely objective reality* implies that information is neither in the ‘thing’, as first order cybernetics contends, nor exists only in the mind of the observer - or is a mere ‘object’ - as second order cybernetics contends. Thus information is neither entirely necessary nor entirely arbitrary but, along the line of Peirce’s interpretant, *it is both* or it is quasi-necessary. In fact, similarly to the interpretant that “mediates the difference between thing and object” (Deely 2006: 34), information is in the *relationship between thing and object*. More specifically, and to distinguish information from the interpretant, information is what ‘makes’ a human-independent thing into a human-dependent and known object. As the cybersemiotician Søren Brier puts it

Information seen as both protosemiosis (in evolution) or quasi-semiosis (when embedded in machine computational processes) falls between the two. It is connected to formal causation and works through signals and dualities of patterns; it is not yet a fully triadic semiosis, but it is still above the brute force of efficient causation (Brier 2008: 380).

Thus information, as suggested by Brier, is *protosemiotic*. Indeed, information can be identified as protosemiotic also within Peirce’s ‘formula’ of perceptual judgments, defined by him as “the extremist case of Abductive Judgements.” (Peirce 1955a: 305) This formula reads as follows: “A well-recognised kind of object, M, has for its ordinary predicates P1, P2, P3, etc., indistinctly recognized. The suggesting object, S, has the same predicates, P1, P2, P3, etc. Hence, S is of the kind M.” (Peirce 1955a: 305)

With this set of statements, or with this abduction, Peirce describes the process through which, upon noticing the overlap of predicates (P1, P2, P3, etc.), or a resemblance between different classes of objects (M and S), one concludes that S and M belong to the same class of objects or, in other words, one forms an interpretant, or an *informed guess* like Sherlock Holmes’s ‘deductions’ (Sebeok and Umiker- Sebeok 1988) or Guglielmo da Baskerville’s medieval investigations (Eco 1980). Information in this formula could be identified at the level of the predicates P1, P2, P3, etc., thus as ‘indistinctly’ recognised features. Peirce succinctly explains the indistinctiveness that characterises information by saying that “The first premiss is not actually thought, though it is in the mind habitually. This, of itself, would not make the inference unconscious. But it is so because it is not recognized as an inference.” (Peirce 1955a: 305) Thus, by constituting the predicate of an abductive judgement or the proto-semiotic basis of hypothetical reasoning, information aids the simultaneous formation of an interpretant but it is not until this is formed, and successive deductions and inductions confirm it, that information becomes known, recognised or distinct.

In fact, although information is not fully triadic semiosis, thus suggesting the idea that it may exist before semiosis, or world experience, it is still something that is inseparable from the process of acquiring knowledge, and thus inseparable from the process of mediating the difference between an independent thing and a known object. This means that information yet bears a degree of symmetry or reflection to a physical situation that exists independently of the human being – thus in this sense it embeds ‘a grain of truth’ - but at the same time is also inseparable from the experience of a situation. Thus, when considering information, one needs to bear in mind that ‘informed’ fundamentally means ‘known’. Therefore information is yet proto-semiotic but does not come before the experience of semiosis or during an ideal first stage of semiosis. The literary theorist Stanley Fish (1980) put this point well when counter-arguing the idea that the interpretation of a literary text consists in conferring meaning to *something* – an idealistically conceived set of information - that is already unproblematically *there*:

(…) ‘confer’ is exactly the wrong word because it implies a two-stage procedure in which a reader or hearer first scrutinizes an utterance and *then* gives it a meaning. (…) There is no such first stage, that one hears an utterance within, and not as preliminary to determining, a knowledge of its purposes and concerns, and that to so hear it is already to have assigned it a shape and given it a meaning (Fish 1980: 310).

Thus, in short, according to Fish, there is no ideation, or ‘neutral information’ before interpretation. When one comes across a text, or when one experiences a physical thing, in Fish’s terms this has already been ‘interpreted’ or, to use Sebeok’s terminology, ‘modelled’. As Sebeok and Danesi (2000) wrote, “Modelling is the innate the ability to produce *forms* to stand for objects, events, feelings, actions, situations or ideas perceived to have some meaning, purpose or useful function.”(2000: 1) Similarly, the second-order cybernetician von Foerster defined biological cognition through the notion of computing. Along the line of ‘modelling’, the term ‘computing’ indicates “any operation, not necessarily numerical, that transforms, modifies, re-arranges or orders observed physical entities” (1973: 5) Because Von Foerster (1973: 1) argues that the environment that we live in is the result of a computation constrained by a physiological blind spot, and thus it is our invention, and Sebeok similarly claims that “the world-as-perceived depends crucially on each organism’s total sensorium (1991: 54)”, one can contend that knowledge is indistinguishable from the way it is represented. Thus, to support Fish’s claim, there is no first stage in modelling, or a real, neutral thing upon which cognitive forms are modelled. Models, subject to their sensorial framing and to their root in experience, in light of their informed ‘status’, are already the ‘real’ thing. What precedes semiosis instead, or the act of forming an interpretant (a model of reality), is simply the need for semiosis. As the Estonian semiotician Juri Lotman put it, “the semiotic situation precedes the instruments of semiosis.” (Lotman 2001: 143-144)

Thus information needs to be conceived of as being a constitutive part – i.e the predicate part - of modelling conceived holistically as an irreducible system of signification that emerges at once. Information, as has been seen following Brier’s characterisation, is *protosemiotic* (2008: 380) - but not in terms of time. That is, information does not actually come before semiosis, but as one of its constitutive, relational elements. Information originates simultaneously and irreducibly with signification, as they recursively trigger each other. In short, there is no information prior to the experience of knowing, although, as Deely’s *purely objective reality* teaches, there can well be ‘things’ before experience.

**information as motivated**

“The unit of survival is a flexible organism in its environment” (Bateson 1972: 457). With this statement the anthropologist Gregory Bateson envisaged the need to study biological organisms in relation to their environments. In other words, he prescribed the need for a *contextual* understanding of living systems. The biosemioticians Kull, Deacon, Emmeche, Hoffmeyer and Stjernfelt more recently also acknowledged the need for an understanding of context within biology, affirming that “in biology empirical facts are always contextually constrained.” (2009: 169) At the same time they rightly offer a reminder that “contextuality should not be conceived as a free ticket to determinations from outside domains – rather, contextuality is constrained by function”. (2009: 169) Thus, the above biosemioticians conceive of context broadly along the line of the semiotician Gunther Kress, who conceives of context not in terms of arbitrariness but in terms of functionality, or, *motivation*. In his argument against arbitrariness (1993) Kress brings the example of a drawing by a three and a half year old child who drew seven uneven, ugly circles of different sizes on a piece of paper and said “this is a car”. For Kress, due to the child’s physical size and to his physical position and psychological disposition in respect to the car the day he observed it, the wheels were its most prominent features, and thus they ended up being the main source of inspiration for the child’s drawing. “From the point of view of the producer, it [the sign] represents his [the child’s] particular ‘interest’ in the object, an interest which is itself a reflection of his place in the world, physically, cognitively, socially, culturally, conceptually.” However “at the same time, the sign is also motivated by the features of the object to be represented.” (1993: 72) In other words Kress contends that the kid’s drawing has been motivated by the object he observed and by his context of observation. Thus motivation, and not arbitrariness nor necessity alone, constrain an organism’s world of experience, and make up his objective world, in Deely’s sense, or its *informed* world*.*

Kress’ notion of motivation proves fundamental for information theory, semiotics and biosemiotics, especially if further spelt out within the semiotic and logical framework opened up by Deely’s reflections on objectivity. It allows one, in fact, to identify three conditions that motivate information: *environmental framing, sensorial framing,* and *emotions.* Thus, firstly, to use Deely’s terminology, a personal world view would be motivated by ‘thing-availability’ or environmental framing. Simply put, one cannot form a model of something if there is not a something. A biosemiotic, integrative conception of information should therefore take into account both Deely’s ontological notion of ‘thing’ as well as the cybernetic notion of structural coupling (Maturana and Varela 1980, Varela 1991).

Secondly, as anticipated with the examples of short-sightedness or hearing impairment, an informed world view is subject to sensorial-physiological framing. Through his concept of ‘object’ Deely reminds us that our world view may be objective (known) but deviant from a physical situation rather than coincident with it (2006: 42). Thus he hints at error in signification that “may help to make the third factor [the interpretant] evident, but removal of error does not at all take the third factor away”(2006: 45). Thus while we can only perceive what we can afford to perceive – as von Foerster’s theory of the blind spot reminds us - our living organization is still capable of building a picture of reality, or an objective world, that ‘makes sense’ to the point that we can still live within it decently even in the case of it not being entirely accurate. This explains why people often do not realise the loss in sensorial efficiency that occurs naturally with age, or do not make a problem out of it, and can live for years without wearing glasses or hearing aids. When Sebeok (1991) brought to the forefront Jakob von Uexküll’s concept of *Umwelt* or sensorial world, he wanted to underline the fundamental role that sensorial framing, or the inner anatomical structure of the species itself plus the kind of innate modelling capability it possesses, has in shaping the organism’s personal world view. Indeed, Sebeok was also aware that sensorial framing does not just happen within the observed system, but also at the level of the observing system (1978) a typically second-order cybernetic issue. Thus any attempt to further delineate a biosemiotic concept of information needs to take into account general theories of error (Wilden 1980, Serres 1982, Sebeok 1991b) and specific theories of error, especially within the context of sensorial malfunctioning. It has to be remembered here that ‘error’ does not necessarily have, although it does not exclude, a negative connotation, as it constitutes the basis for learning. In fact, as coursework marking experience may commonly show, some dyslexic or foreign students aware of their own difficulty with language are likely to put three times the effort into their coursework than their fellow native speaker or non-dyslexic classmates, and thus end up performing much better than the class average. Thus ‘error’ needs to be considered on the basis of both its destructive capability and its creative capability, which, to a large extent, may as well be two sides of the same coin. Additionally, a biosemiotic concept for information cannot ignore second order cybernetics’ explicit efforts in inserting a theory of the observer (von Foerster 1973, Maturana and Varela 1980) within any theory of observation, thus within science in general. As Cobley notes in fact, “the future of research in the sphere of biosemiotics will be enhanced by a greater understanding of ‘observership’. (2010: 2045) It follows that if biosemiotics wants to conceive of itself as a science, thus claiming a degree of ‘rightness’ in what it does, it certainly cannot conceive as itself of observer-free. ‘Accuracy’ cannot exclude the observer.

Thirdly, any dissertation on the nature of information needs to take into account the emotional aspect that this entails, an issue already anticipated by Bateson’s through his notion of ‘difference that makes a difference’ or relevance. However, as Brier underlines, while Bateson realized the survival value of emotions, he never theorized the non-mechanical qualia aspects of it (2008: 327-328). Thus, implicitly following the line of argument opened by Eco, who wrote about iconicity (1976), and Sebeok who identified iconic ‘natural’ language as primary modeling system (1991), Brier underlines the importance of Peirce’s category of firstness by saying “To Peirce, a feeling is a quality of immediate consciousness having its own quality, one that is independent of any other state of mind and that is perfectly simple in itself.” (2008: 347) As Brier underlines in *cybersemiotics*, an understanding of information needs to include a theorisation of Peirce’s notion of qualia, an approach that has only recently been taken up and applied by Cobley (2009) in relation to a theory of feelings within narrative, and by Wheeler (2010) in reference to the necessity of knowledge gaps as embodied in humans’ need for religion or spirituality. These applicative efforts show that feelings or qualia need to be further delineated in relation to their functional aspects, that is, in relation to their cause and purpose. Thus on one side, information becomes relevant to a living being when one has already had *previous experience* (or previous informed emotions) arising from objects. This ‘collection of previous emotions’ that aids the recognition of something as relevant, or as a piece of information, can be better explained in reference to Juri Lotman’s amusing illustration of *common memory* (2001 [1990]):

There is a story about the celebrated mathematician P. L. Chebyshev. An unexpected audience consisting of tailors, modistes and fashionable young ladies turned up to one of his lectures on the subject of the mathematical problem of cutting the cloth. But the lecturer’s opening words: ‘Let’s suppose for simplicity’s sake that the human body is spherical’ put them to flight. Only the mathematician who found nothing strange in the remark stayed. The text ‘selected’ its own audience creating it in its own image and likeness. Communication with another person is only possible if there is some degree of common memory. (2001: 63)

Thus, similarly, one may argue that information becomes relevant to a living system only when the system itself has already a model of that information stored in the form of emotion – that is, informed emotion - within a web of other emotions, called by Lotman ‘common memory’. In this way, common memory becomes the antecedent cause or the antecedent constraining factor of information.

On the other side, it is also *future experiences*, or future emotions that potentially frame information. In relation to semiosis intended as biological communication, Kull, Deacon, Emmeche, Hoffmeyer and Stjernfelt affirm that “teleological processes that are specially organised with respect to specific ends or referents are unique to living systems.” (2009: 168) Thus teleology is a defining feature of semiosis, which in turn is the defining feature of life. One may argue that if teleology describes semiosis, or an irreducible sign-object-interpretant relation, then at the same it also characterises information, which, as Deely’s reconfiguration of objectivity allowed us to affirm, is in the relationship between thing and object. Hence future interpretants in the form of future emotions are what allow the recognition and thus the framing of information in the present. This view is supported by the fact that Sebeok himself declared that “the ideal of semiotic analysis is to combine causal with functional [teleological] explanation - to show how sign form interrelates dynamically with sign function.”(1979: 13) Emotions, understood as the most fundamental semiotic events that can occur within living beings, obviously may need to be theorized in light of theory of the observer, and thus as being present in both the observed system and the observing system.

The challenges posed by the constraining or *motivating* conditions of information that, as shown, consist of environmental framing, sensorial framing, and emotional framing in their cause and purpose declination, show that there is no information as such or information as conceived in isolation. Nor is information simply in ‘the thing’ or in ‘the object’ (arbitrarily created by the observer’s mind). *Information is found in the irreducible, bio-semiotic process that links at once all these conditions, and that is simultaneously constrained by them.* Information thus emerges at once with the emergence of an interpretant that, in turn, recursively linking to other interpretants, constitutes at once the organism’s objective world, or, to use Jakob von Uexküll’s term, its Umwelt (1982 [1940]). Information is ultimately also constrained by the person who willingly perturbs the spontaneous functionality of abduction and turns it into the less spontaneous, conscious process of deduction and induction. That is, information is ultimately shaped, and its abductive overtone interrupted, by its conscious observer.

**Conclusion**

The specific goal of this essay was to contribute towards bringing analytical clarity within biosemiotics by tackling the definition of one of its most fundamental, and possibly most controversial terms: information. As shown, the history of the concept of information from its thermodynamic roots, through information theory to cybernetics, displays an uneven development. Information was in fact firmly found in the observed system in first order cybernetics, then in the observing system in second order cybernetics. Information was first true (necessarily existing), then it was conceived of as false (arbitrarily constructed). Seen from an interdisciplinary perspective that seeks to cast a unitary view on the reality which it observes, functionally different views on information in cybernetics end up in a subject/object dichotomy that could be bypassed only by utilizing a method of enquiry more flexible than logic. This more flexible approach is ‘semiotics proper’, as conceived in the tradition of Charles Peirce. Semiotics proper, then, is broader than semantic or syntactic-driven logic because it includes pragmatics. Peirce, in fact, defines semiotics as ‘quasi-necessary’, hinting at the fact that semiotics is yet more flexible than logic, but nevertheless it does not exclude it (as embodied in his triadic model of the sign). Within Peircean semiotics, the work of John Deely and particularly his distinction between ‘thing’ and ‘object’ have been identified as pivotal contributions that cannot be bypassed if one wants to embrace biosemiotics from a ‘semiotics proper’ perspective. Deely’s reconfiguration of the ‘object’ within Peirce’s triadic model, into ‘thing’ and ‘object’ in fact allows one to locate information in the *relationship* between thing and object, between what is mind-*independent* and what is mind-*dependent*. According to Deely then, the objective world views of organisms can be physical and objective (known and accurate) or merely objective (known but inaccurate). Thus the broadly defining factors of information are not ‘either/or’ as found in logic (i.e. information is *either* true *or* false), but are ‘both/and’ as found in hypothetical reasoning, abduction and semiotics (i.e. information is *both* true *and* false). This is evident in that organisms can successfully live in Umwelten that are not entirely accurate, but find them nevertheless functional. Therefore Deely’s *purely objective reality* mitigates the naïve objectivism superseding first order cybernetics and the radical constructivism of second order cybernetics by allowing one, in turn, to reconfigure information as neither necessary nor arbitrary, but as *both*. At the same time, Lotman’s and Sebeok’s recursive views of semiosis (both informed by cybernetics) reinforce a systemic understanding of information in terms of circularity and holism. Information, in fact, is proto-semiotic in the sense that it is a fundamental element of semiosis but it does not come before it: it emerges concomitantly within and with it, thus it is an irreducible part of semiosis. Finally, in light of information being both necessary and arbitrary one can conclude that information is *motivated*. The motivating or constraining conditions of information are *environmental framing, sensorial framing*, and *emotional framing*. These need to be considered 1)within the context of cause-and-purpose, thus recursive processes of interpretant-formation, or *learning* and 2)within the context of observation; thus any account of these conditions must in turn account for the ‘bias’ of the *observer,* that is, how the observer is in turn affected by its environment, its physiological possibilities, and its emotions.

This integrative definition of information in light of both semiotics and cybernetics is a proposal towards an interdisciplinary biosemiotic model of information. Here the contributions of both semiotics and cybernetics are equally fundamental, even better in their functionally different form. It is only through the richness of positions brought about by conceptual ruptures or *uneven development*s characterising concepts, that one can propose a temporary synthesis. This synthesis has been clearly aided by interdisciplinarity, whose grounding principles need at this point be clearly spelt out. According to Miller (1982), interdisciplinarity includes principles from Marxism, General Systems Theory and structuralism. The present investigation of information in the light of semiotics and cybernetics has been rooted in all these grand-theories in that 1)the Marxist configuration of history in terms of ‘contradiction and overdetermination’ by the French philosopher Althusser (2005 [1965]) allowed the identification of information as a historical contradiction that, far from being a negative event, is crucial for the advancement of knowledge, 2) Bertalanffy’s notion of *isomorphic model*s as embodied in General Systems Theory (1968) has allowed the identification of *information* and *interpretant* as isomorphic models and the distinction of the former as a component of the latter, and 3) Lotman’s work on translation and rhetoric (2001: 62) has informed the process of “transfer into one semiotic sphere the structural principles of another”, thus translating semiotics into cybernetics (and to an extent, the other way round) without narrowly reducing one to the other. These perspectives have been openly identified as the principles guiding the integration of semiotics and cybernetics in the attempt to address the typical issues of the lack of methodological consideration within integrative studies as raised by Thomas Benson (1982).

Also this study demonstrates that grounding an investigation in its historicity helps in precisely identifying the gap in research to be addressed. The rigour that one gains in historically framing a problem is that of retaining its complexity and richness and avoiding oversimplification and disciplinary stereotypes. The historical process of integration of this study has thus brought to light explicitly the contiguity of interests between cybernetics and semiotics and has allowed steps towards a biosemiotic synthesis of the concept of information. However, reading this statement the other way around, one could claim that the emphasis put on the assiduous clarification of the notion of information in biosemiotics (as embodied in this current issue of *Biosemiotics*) is a posteriori proof of both a semiotic and a cybernetic heritage of biosemiotics. Thus one can clearly start to see the next gap that biosemiotics may need to address: what if, in fact, this contiguity of interests between cybernetics and semiotics was in effect  *continuity*? In which case, one could admit the possibility that biosemiotics itself, taking its impetus from semiotics, is a continuous, though uneven, development of modern cybernetics and systems theory. Ignoring the cybernetic heritage of biosemiotics would therefore constitute a historically and epistemologically unjustified omission on the side of biosemioticians. That ignoring the cybernetic past of biosemiotics is a mistake is evident also in the following statement by the modern founder of biosemiotics, Thomas Sebeok. Following his and his wife’s unexpected participation to the Fourth Biennial Estonian summer school in semiotics, heavily informed by cybernetics, in summer 1970, Sebeok commented

Bogatyrev presided while Lotman was introduced as the secretary of the school. A freewheeling and never less than rousing debate continued over lunch, through the course of a leisurely, intimate amble outdoors, and finally during a farewell tea. Jean and I, exhilarated but exhausted, were driven back to our hotel at dusk, thus ending one of the most fascinating days of our lives. (Sebeok 1977: vii)

Given Sebeok’s admiration for Soviet Semiotics and what has been gained in terms of analytical clarity through the historically-framed study of information, the following corollaries can be formulated: 1)that one should explore the interdisciplinary history of biosemiotics in order to avoid unjustified theoretical omissions, and 2) that one should challenge the idea that “the concept of information and information science have their own history apart from the concept of sign and semiosis” (Brier and Joslyn 2010: 1). In fact, given the presence in biosemiotics of the hybrid figures of Thomas Sebeok and Juri Lotman, both equally informed by cybernetics and semiotics in the 1970s, a separation between the history of information and the history of meaning is arguably not the case. These histories have in fact converged together in the 1970s, the era of educational reforms reconfiguring not just traditional educational programs in terms of interdisciplinarity, but also, as clearly embodied in both Sebeok and Lotman’s work, framing research in terms of interdisciplinarity.

**References**

Althusser, L. (2005 [1965]). ‘For my English readers’ and ‘Contradiction and overdetermination’, In: For Marx (pp. 9–15, pp.89–116). London: Verso.

Bateson, G. (1972 [1970]). Form, substance, and difference, In: Steps to an ecology of mind (Pp. 448–65). New York: Ballantine.

Benson, T. C. (1982). Five arguments against interdisciplinary studies. Issues in Integrative Studies, 1, 38–48.

von Bertalanffy, L. (1968). General system theory. foundations, development, applications. Harmondsworth: Penguin.

Brier, S. (2008). Cybersemiotics: why information is not enough! Toronto: University of Toronto Press.

Brier, S., & Joslyn, C. (2010). Introduction to information in biosemiotics. A special issue of the Journal of Biosemiotics (Call for papers guidelines).

Hoffmeyer, J. (2008). Biosemiotics. An examination into the signs of life and the life of signs. Scranton: University of Scranton Press.

Cannizzaro, S. (2009). The line of beauty: on natural forms and abduction. In K. Haworth et al. (Eds.), Semiotics 2008. Ottawa: Legas.

Cobley, P. (2009). Time, feeling and abduction: towards a new theory of narrative. In J. Deely & L. Sbrocchi (Eds.), Semiotics 2008 (pp. 858–868). Ottawa: Legas.

Cobley, P. (2010). Cybersemiotic and human modelling. Entropy, 12: 2045-2066.

Deely, J. (2006). Basics of semiotics. Fifth Edition. Tartu: Tartu University Press.

Deely, J. (2009 [1981]). The Relation of logic to semiotics. In P. Cobley (Ed.) Realism for the 21st Century (Pp. 140–210). Scranton and London: Scranton University Press.

Deely, J. (2009b). Afterword: on purely objective Reality. In P. Cobley (Ed.), Realism for the 21st Century (pp. 327–344). Scranton and London: Scranton University Press.

Eco, U. (1976). A theory of semiotics. Bloomington: Indiana University Press.

Eco, U. (1980). Il Nome della Rosa. Milano: Bompiani.

Fisch, M. H. (1977). Peirce’s place in American thought. Ars Semeiotica 1(2): 21-37.

Fish, S. E. (1980). Is there a text in this class? In: Is there a text in this class: the authority of interpretive communities (pp. 303–321). Baltimore and London: Johns Hopkins University Press

von Foerster, H. (2003 [1973]). On constructing a reality. In: Understanding understanding: essays on cybernetics and cognition (pp. 211–27). New York: Springer.

Kress, G. R. (1993). Against arbitrariness: the social production of the sign as a foundational issue in critical discourse analysis. In: Discourse and Society, 4(2), 169–191.

Kull, K., Deacon, T., Emmeche, C., Hoffmeyer, J., Stjernfelt, F. (2009). Theses on Biosemiotics: prolegomena to a theoretical biology. Biological theory 4(2): 167–173.

Lotman, Y. M. (2001). Universe of the mind: a semiotic theory of culture. London: I.B. Tauris.

Maturana, H., & Varela, F. (1980). Autopoiesis and cognition: the realization of the living (pp. 73–95). Boston: Riedel.

Miller, R. C. (1982). Varieties of interdisciplinary approaches in the social sciences: a 1981 overview. Issues of Integrative Studies, 1, 1–37.

Niklas Luhmann, N. (2002 [1990]). The cognitive program of constructivism and the reality that remains unknown. In: W. Rasch (Ed.) Theories of distinction: redescribing the descriptions of modernity (Pp.128–52). Stanford: Stanford University Press.

Peirce, C. S. (1955 [1891–1902]). Perceptual Judgments. In Buchler J. (ed.), Philosophical writings of Peirce (pp. 302–305). New York: Dover.

Peirce, C. S. (1955b [1897–1903]). Logic as semiotic: The theory of signs. In: Buchler J. (Ed.), Philosophical writings of Peirce. New York: Dover, Pp. 98–119.

Rosenbleuth, A., Wiener, N., Bigelow, J. (1943). Behavior, purpose and teleology. Philosophy of science 10: 18–24.

Sebeok, T. A. (1977). Foreword to the Paperback Edition. In D. P. Lucid (Ed.), Soviet Semiotics. An Anthology (pp. v–vii). Baltimore and London: the John Hopkins University Press.

Sebeok. T. A. (1979). Looking in the destination for what should have been sought in the source.In: The sign and its masters. Austin, London: University of Texas Press.

Sebeok, T. A. (1979). Prefigurements of art. Semiotica, 27, 3–73.

Sebeok, T. A. & Umiker- Sebeok, J. (1988). ‘You know my method’: a juxtaposition of Charles S. Peirce and Sherlock Holmes’, In: U. Eco & T. Sebeok, (ed.) The Sign of Three (pp. 11–47). Bloomington : Indiana University Press.

Sebeok, T. A. (1991). In what sense is language a ‘primary modeling system’? In: A sign is just a sign, Bloomington and London: Indiana University Press.

Sebeok T. A. (1991b). Communication. In: A sign is just a sign. Advances in semiotics. Indiana University press.

Sebeok, T. A., & Danesi,M. (2000). The forms of meaning: Modeling systems theory and semiotic analysis. New York: Mouton de Gruyter.

Sebeok, T. (2001). Global semiotics. Bloomington: Indiana University Press.

Serres, M. (1982 [1980]). The origin of language: Biology, information theory, and thermodynamics. In: Hermes: Literature, science, philosophy (Pp. 71–83). Baltimore: Johns Hopkins University Press.

Shannon, C., & Weaver, W. (1949). Recent contributions to the mathematical theory of communication. In: The mathematical theory of communication (pp. 3–28). Urbana: University of Illinois Press.

von Uexküll, J. (1982 [1940]). The theory of meaning. Semiotica. 42(1): 25–44.

Varela, F. (1991) Autopoiesis and a biology of intentionality. Available at <ftp://ftp.eeng.dcu.ie/pub/alife/bmcm9401/varela.pdf> . Accessed on 26th April 2012.

Wheeler, W. (2010). Gregory Bateson and biosemiotics: transcendence and animism in the 21st century. Green letters: studies in ecocriticism, No. 13.

Wiener, N. (1948). Cybernetics : or control and communication in the animal and the machine. Cambridge: MIT Press.

Wiener, N. (1951). What is cybernetics? In: The human use of human beings (Pp. 1–20). London: Free Association.

Wilden, A. (1980). Epistemology and ecology. In: System and structure: essays in communication and exchange (pp. 202–229). London: Tavistock Publications.

1. And with interesting incongruencies. Entropy in information theory has the positive, discursive connotation of availability of choice, whereas in cybernetics it possesses the thermodynamic, negative discursive meaning of chaos and disorganization. [↑](#footnote-ref-1)