

## Chapter 2

# The Transdisciplinary View of Information Theory from a Cybersemiotic Perspective

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At present, there is a general trend towards creating a transdisciplinary scientific theory of information, computing, semiotics, cognition, and communication<sup>1</sup> because these seem to be the most foundational disciplines in a knowledge society (Brier 2008, 2009a, b; Floridi 2004; Davies and Gregersen 2009; Dodig-Crnkovic and Burgin 2010; Hofkirchner 1999, 2010). But there are so many ways to define the concepts of information and information science (Floridi 2004; Qvortrup 1993). These include ways related to mathematics, physics, computer science, biology, communication science, information and system sciences, and human linguistic communication. Discussion of this issue is currently ongoing within the Foundation of Information Science (FIS)<sup>2</sup> as well as multiple conferences, journals and books still proliferating. When we look at the various information concepts available, we discover that they often have almost incommensurable theoretical foundations – some are rooted in the hard sciences, some in the life sciences, some in the

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<sup>1</sup>For lack of a better word, that is what I will call what we are aiming for. The concept of *transdisciplinary science* is supposed to cover the natural and life sciences, as well as the humanities and social sciences. In an anglophone context, this may seem like a contradiction in terms, since “science” most often is applied only to the natural sciences. However, in European contexts, the situation is different: concepts like the German word ‘*Wissenschaft*’ and the Danish word ‘*videnskab*’ include the natural, life, and social sciences as well as the humanities without assuming a positivistic unified science. For this reason, I will use the German concept of *Wissenschaft*.

<sup>2</sup>FIS is an international interdisciplinary group. It has been an attempt to rescue the *information* concept from its classical controversies and use it as a central scientific tool, so as to serve as a basis for a new, fundamental disciplinary development – *Information Science*. Home page <http://infoscience-fis.unizar.es/>. Journal *TripleC* <http://www.triple-c.at/index.php/tripleC>

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social sciences, and some in the humanities. How, then, can we help create some meta-order in this complex and fast developing research area? First I will try to sort out some major theories from this meta-view. One way of overcoming the incommensurability between paradigms and knowledge areas with different foundations is to produce transdisciplinary frameworks where interdisciplinary connections are made possible by a meta-reframing, which posits that signs, meaning, and interpretation are the foundational concepts within which information and associated concepts have to function. Thus I will argue for the necessity of going beyond the idea held by some current commentators (Chaitin 2010; Dodig-Crnkovic 2010) that the universe is a computer or even a quantum computer running on qubits.<sup>3</sup> I will argue that a pan-informational approach, based on a pan-computational ontology, precludes the development of a proper phenomenological theory of subjective consciousness and meaningful interpretation. Furthermore, I will argue that C.S. Peirce's semiosis creates a new paradigmatic transdisciplinary framework into which autopoietic-based cybernetic information can fit as an important aspect. I call this transdisciplinary frame Cybersemiotics. From a semiotic, linguistic, and language philosophy platform perspective, it makes sense to order information theories into syntactic, semantic, and pragmatic probability theories (Nöth 2012). So that is the way I will proceed.

## 2.1 The Syntactical Probabilistic Theory of Information

The syntactic theory calculates information according to the probabilities of the occurrence of signs in their respective contexts. This theory ultimately derives from Claude Shannon and Warren Weaver's theory of communication. Claude Shannon (1916–2001) was an AT&T researcher who was primarily interested in ascertaining the limitations of a channel in transferring signals and the cost of information transfer via a telephone line. He developed *The Mathematical Theory of Communication* (Shannon and Weaver 1963/1948). Shannon defines information as a

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<sup>3</sup>A qubit is a quantum bit. It is a unit of information or the counterpart thereof in quantum computing. It is the quantum analogue of the classical bit if you want. A qubit is the basic unit of information in a quantum computer. The Turing machine is a theoretical device that consists of tape of unlimited length that is divided into little squares. Each of these squares can either hold a symbol say 1 or 0 or be left blank. A read-write device reads these symbols and blanks, which gives the machine its instructions to perform a certain program. The difference between bits and qubits is that whereas a bit *must be* either 0 or 1, a qubit *can be* 0, 1, or a superposition of the two and so can be involved in entanglement. Quantum computers use superposition to run all the calculations of a normal computer simultaneously. Taken together, quantum superposition and entanglement create an enormously enhanced computing power. While a normal Turing machine can only perform one calculation at a time, a quantum Turing machine can perform many calculations in parallel at once.

purely quantitative measure of communicative exchange. His theory of information as entropy is based on pure probability and influenced psychologists such as George Miller, who made his information concept the foundation of a new science of mind (Miller 1951; Miller and Frick 1949). Shannon's information was also used in neuroscience (MacKay and McCulloch 1952). Recognized philosophical theories of information like that of Dretske (1981) have been inspired by Shannon's theory, which has also been used in attempts to naturalize mental content. Probabilistic entropy information is dimensionless and measured in bits. Weaver linked Shannon's mathematical theory to the second law of thermodynamics and stated that it is the entropy of the underlying stochastic process in the information source that determines the rate of information generation (Shannon and Weaver 1963/1948).

Shannon defined the amount of information as the negative of the logarithm of a sum of probabilities. The minus sign is there because, according to Shannon, the amount of information is equal to entropy. According to Weaver's interpretation and explanation of Shannon's theory, information is a measure of one's freedom of choice in selecting a message. The greater this freedom of choice, then the greater the uncertainty that the message actually selected is a particular one and the greater the amount of information. Greater freedom of choice, greater uncertainty, and greater information go hand in hand. One of the conclusions from Shannon's theory is that entropy contains more information than structure.<sup>4</sup> Information, according to Shannon, must not be confused with meaning. His information relates not so much to what you do say as to what you could say (or do not say). The problems of interpreting signals in a "message" are left outside the theoretical space within which Shannon's definition is formed. It is tempting to see Shannon's signals as "data" and the meaning of the signals as "information", but this would be wrong as it is not how he defined them.

Contrary to the assumptions of many system theorists, Shannon's information cannot be transmitted only by signals that "carry" it. The problem is that although the concepts of information theory cover only the technical level of communication, they were later applied to the sphere of human communication. Certain forms of early first-order cybernetic theory especially make claims regarding similarity to how the human brain works (McCulloch and Pitts 1943; Pickering 2010). But, humans do not communicate through electric signals from brain to brain. They communicate with meaningful signs between embodied minds. Qualia and meaning are unlikely to emerge from the Shannon information extracted from electrical signals between nervous cells *per se*. Thus, information has to be connected to embodied meaningful language in a culture or to the physical world of material objectivity.

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<sup>4</sup>Thus, whereas Norbert Wiener's later theory, which is the next one we will comment on below, sees information as negative entropy, i.e. a "structured piece of the world", information in Shannon's theory is the same as (positive) entropy. From this angle at least, Shannon's "information" is the opposite of Wiener's "information".

### 2.1.1 *The Thermodynamic-Cybernetic Type of Theory of Information*

This type of theory is most prominently associated with the work of Norbert Wiener (1948) and Erwin Schrödinger (1967). Here information is defined as neg-entropy in phase-space, an idea that contributed to the creation of cybernetics as a transdisciplinary paradigm of a technologically instrumentalist and utilitarian knowledge system. Wiener (1948) focused on the role of information in the control of both mechanical and biological systems. His first order cybernetics united thermodynamics in Boltzmann's probability interpretation with the ideas contained in Shannon's work. Thermodynamic entropy is measured in Joules/Kelvins. In contradistinction to Shannon's theory of information, Wiener reversed his definition of information from entropy to neg-entropy, from disorder to organization, which Schrödinger integrated into his theory of life. Wiener's concept of information relates both to man-made systems and to living subsystems like the liver or even the brain as a tissue of neurons. These systems use signals in a way that cybernetic theory seems to explain through control theory. Differences in perception or thinking became the food of the cybernetic mind, as this was defined by Wiener and later conceptually developed by Bateson (1973, 1980). Cybernetics sees mind as a circular system encompassing both the physical and the living as well as technological and organizational systems (Brier 2008). This information theory got its ecologically developed and proto-semiotic version through Gregory Bateson, who conceptualized information as a "difference that makes a difference".

To get to meaning, Wiener's "information" must presume an observer with a meaning of his/her own outside the system, who determines the goal of the system. The observer in cybernetics unfortunately may be another machine, but in the end (or perhaps beginning) there must be a human being somewhere with an embodied and social intention or purpose. But the primacy of first-person experience *vis-à-vis* the whole concept of observer in cybernetics is never really contemplated in Wienerian first order cybernetics. It only starts in Gregory Bateson's theory of the informational mind and Heinz von Foerster's second order cybernetics (Brier 2008; Foerster 1984). It should be noted that both Bateson and von Foerster participated in the Macy Conferences that were so foundational for the cybernetic paradigm.

The observer's meaning in this view is interrelated with the system's meaning. But, in my view, Bateson, as well as von Foerster, merely delivered a cybernetic theory of mind, which provided no theoretical foundation for an account of the phenomenological and qualia<sup>5</sup>-based experimental aspects of mind

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<sup>5</sup> According to the *Stanford Encyclopedia of Philosophy*, "[p]hilosophers often use the term 'qualia' (singular 'quale') to refer to the introspectively accessible, phenomenal aspects of our mental lives. In this standard, broad sense of the term, it is difficult to deny that there are qualia. Disagreement typically centers on which mental states have qualia, whether qualia are intrinsic qualities of their bearers, and how qualia relate to the physical world both inside and outside the head. The status of qualia is hotly debated in philosophy largely because it is central to a proper understanding of

(Brier 1992a, b, 2008, 2009a, b, 2011; Brier and Joslyn 2013a, b). Before we address this issue, we will dig deeper into the physicalistic attempt to ground information and meaning on the quantum level.

### 2.1.2 *The Quantum Mechanical Physicalist Information Theory*

John Archibald Wheeler's "It from Bit" is the most prominent foundational theory of physical information. It is based on an interpretation of quantum physics and thus relies on the concept of qubits (Wheeler 1994, 1998; Barrow et al. 2004). Physical information is a concept that is well established within physics, and is basically just *a way to model material form and physical patterns*. Physicists can quantify material form with techniques deriving from Shannon or Wiener. This mathematical and physical foundation is the historically scientific background of *the non-semantic use of the word "information"*.

Quantum states are the key mathematical objects in quantum theory. It is therefore surprising that physicists have been unable to agree on what a quantum state truly represents. One possibility is that a pure quantum state corresponds directly to reality. Pusey et al. (2012) argue against the long history of suggestions that a quantum state (even a pure state) represents only knowledge or information about some probable aspect of reality. They show that any model in which a quantum state represents mere information about an underlying physical state of the system and in which systems are prepared independently as having independent physical states, must make predictions that contradict those of quantum theory. This means that physics and information science have to build on two different ontological assumptions, a difference that can only be solved through developing a pan-computational ontology, as we shall see. In his paper on the unavoidable cost of computation, Ball (2012) shows that forgetting is equal to the undoing of Maxwell's demon. The existence of pure informational states with no physical cost is not possible in nature.

Still a straight road from a theory based on physical states to a theory of meaningful conscious linguistic communication in a cultural setting seems almost impossible to conceive, as no convincing theories of qualitative emergence have been produced. The positivist 'unity of science' idea and its modern version in Wilson's (1999) *Consilience* theory are very idealistic and reductionist attempts to establish a subject-free 'objective' theory of universal scientific knowledge, which assumes that observation statements can be connected to experience unambiguously. This served as the foundation for the verificationist theory of logical positivism. However, this belief has been so thoroughly criticized that it has been abandoned

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the nature of consciousness. Qualia are at the very heart of the mind-body problem." <http://plato.stanford.edu/entries/qualia/>.

by scientists and philosophers of science and the physicalist unity of paradigm of unified science built on it has fallen into desuetude. But perhaps a new version thereof can be constructed on a pan-information or pan-computational paradigm. That is at least one way to explain the growth of this paradigm over the last 20 years.

## 2.2 The Pan-Computational and Pan-Information Science View

The basic notion that cognition essentially is *computation* and *information processing* has led to the idea of connecting human consciousness with the world through an enlarged vision of computation integrated with a computational information theory. On this view, all processes in the world are informational and computational—ideas that underpin the techno-science paradigms called pan-computationalism and pan-informationalism. The two views are often combined in various ways (e.g., Chaitin 2010; Dodig-Crnkovic 2010). Pan-computationalism is an attempt to answer the question of what the minimum ontological prerequisites are for us to simulate natural systems including our own mind and its intelligence in a convincing way. This is viewed as possible if the world's ontology – including our brains – is like a big computer.

But, such a machine would not be like the Turing computers we have made so far, as closed axiomatic systems are not able to learn. The Turing Machine is a machine that embodies a closed formal system. Thus, present-day computers represent only a restricted simulation of *natural computation*. The artificial languages controlling Turing and von Neumann machines are formal algorithms in which syntax determines meaning independently of context. These limits have to be breached in the further development of natural computation, as nature possesses more expressive means than those used by Turing Machines – for instance, those found in living systems.<sup>6</sup>

Thus a pan-computationalist sees whatever nature does as computational. All that remains to be learned is how those computations are really carried out in the organic world. The downside of this simple formula is that the phenomenological view of human consciousness seems incompatible with computationalism. Everything is

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<sup>6</sup>The formal languages that code machine programs are not compatible with that of the genetic code. Gene expression depends on environmental context and so genetic configurations cannot be treated in the same way as the formal languages humans have created. DNA is a product of the evolution of living systems with agency. Syntax in DNA may convey different and even contradictory meanings, depending on the cellular agents that exploit the genome for interpretations. Protein folding can be viewed as the first level of interpretation where information controls an energy- and rate-dependent physical activity that has a function for the cell as agent. This pragmatic aspect of semiosis is largely ignored by many researchers defining a “sign”, a “code”, or “information” as “pure relationship” in a dualistic ontology, which then makes the code function as a sort of pure objective “correspondence”. It is confusing because their concept fails to refer to those agents who developed these relationships.

fine if one proceeds with Dennett's (1991) functionalistic view regarding the inconsistency of the concept of qualia.<sup>7</sup> Dennett proposed replacing the Cartesian Theater model, with its privileged place in the brain where all the processes of the brain integrate and produce subjective experiences, with the idea that human consciousness is the mental software that reorganizes the functional architecture of the brain. But, as we mentioned above, Ball (2012) has shown that informational transactions cannot be separated from the entropy debt that, according to thermodynamics, is produced by all physical processes. On this view, informational processes, are also physical and may be viewed as the structuring of energy. Thus, it seems that we rather need to find theories that take their point of departure from real-life semantics instead.

### 2.3 A Semantic Probability Information Theory

A semantic probability information theory seeks to calculate the amount of content conveyed by a message. The most influential semantic theory of information is based on the work of Bar-Hillel and Carnap (1953). They imagine a formal language consisting of all sentences that might be true in a given possible universe (cf. Bar-Hillel 1964: 224). This is a problematic view, for, as Chomsky (1957) has pointed out, natural language has the intrinsic capacity to generate an infinite number of well-formed sentences and, thus, no natural language has a finite determinable number of sentences that could serve as a basis for determining all true sentences.

Nevertheless, Bar-Hillel proposes to determine the information values of actual sentences according to the probability of occurrence in reference to this formal knowledge base, measured from the number of sentences *excluded*. Of course, as in Shannon's theory, one has to determine actual real probability (in the given situation and language); clearly, this is not really possible in the sphere of natural language. Thus, meaning and probability measures seem very difficult to synthesize or combine.

It becomes even more difficult if one implements a pragmatic theory that seeks to study how the sender's message influences and increases the receiver's knowledge, as Dretske (1981) does in *Knowledge and the Flow of Information*. Dretske defines information as the content of new, true, meaningful, and understandable knowledge. Gibberish, by contrast, is both meaningless and uninformative, and sentences uttered or written in a foreign language that we have not mastered fail to convey information; furthermore, telling a person something s/he knows already does not count either as real information in this theory, nor do false statements. An informative message for Dretske must convey *new* and comprehensive knowledge.

Thus, information in this theory is not 'objective', but relativized in relation to the receiver's knowledge. This makes the theory more acceptable, perhaps, but

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<sup>7</sup>Qualia are first person subjective experiences that each one of us is immediately aware of, such as the taste of sweetness or the smell of roses or feeling hot. For further discussion, see note 5 above.

it also makes it difficult to operationalize the idea of probability in reality. It is difficult to produce a quantitative statement that is more reliable than a qualitative analysis based on some sort of relation to the human condition such as, for example, ethics, aesthetics, truth, and rationality. One alternative, then, is to build information theories from the basic context of human meaningful communication.

## 2.4 Information Theory Founded in Intersubjective Linguistic Communication Among Humans in a Culture

This is what Machlup's (1983) famous analysis of information promotes (Brier 2008). Beginning from a traditional humanistic viewpoint, Machlup suggests that only people can send and receive information, which is a very different perspective from that of information science and its further development into pan-informationalism. In his analysis of the concept of information, Machlup (1983: 657) posits that the creation of a concept and a theory of information should take its starting point from the human communicative situation. He thereby develops a critique, from a position within the humanities, of the objective concept of information on which cognitive science is based. This critique takes its point of departure from exactly that aspect of information most weakly represented in the information-processing paradigm, namely the socio-phenomenological and hermeneutical aspect of signification in human communication. Machlup points out that, lexically, the word "information" means to inform: *to give form* to something, especially mind, consciousness or character, through learning or instruction, and to pass on knowledge about facts or events. The essential historical meanings of the concept of information are: (1) To tell something to someone. (2) That which one is told.

Note that this is a definition with a starting point in natural language communication between embodied and conscious persons living within a social and cultural context. Machlup (1983) concludes, in contradistinction to Dretske, that, in his paradigm, the correct conceptions of information and knowledge are based on the following tenets:

- Neither knowledge nor information needs to be correct or universally true.
- New knowledge can be achieved without the addition of new data through thought/insight/sense making.
- Empirically-based cognition is not the reception of information.<sup>8</sup>
- Data are that which is given to the receiver or the researcher for the extraction of information.

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<sup>8</sup>On this subject Popper and Kuhn, as well as Peirce, hold that there is no direct semantic or logical-syntactic connection between observation and knowledge. Thus there seems to be no easy way for science to avoid the gatekeeping of interpretation. We can measure how many bits the senses "take in", but unless you believe in a primitive form of pan-computationalism, the world is not constructed out of bits that are then "channeled" into the mind through the senses. This critical view opposes pan-informationalism.



Data are not necessarily numbers. In most contexts, data are not different from information, except in computer languages, where they are the information (input) that is to be treated in the system. Used generally in this way, the concept of data is a relative one. What are data for one person may be information for another.<sup>9</sup> From Machlup's point of view, the use of the information concept in neurophysiology, brain research, and genetics must therefore be considered an analogy or a metaphor. But Machlup wants not only to delimit the concept of information against "downward" reductionism through the natural and technical sciences; he also wants to delimit it against "upwards" expansion to social entities in the social sciences. Thus he considers it to be a metaphoric use if one claims that institutions or societies as such receive or give information. It is always individual human subjects who exchange, induce, and produce meaning among themselves. According to Machlup, to speak of information within the framework of Shannon and Weaver's technical and statistically grounded theory of communication is to push the analogy too far, for that theory concerns itself with impulses and the transmission of signals, but is not about any form of meaning. In this view, one should always attach a prefix to such theories of information such as 'technical', 'statistical', etc. if one uses the concept in these contexts.

All of these negatives point toward the conclusion that the creation and communication of information demands some basic characteristics associated with individual, embodied, conscious minds. But the well-established fact – which Gadamer's (2004) hermeneutics always underlines – that all understanding and interpretation happen within a social-historical background seems not to be an essential part of Machlup's theory of information. Thus we must conclude that it seems that neither the information-processing paradigm nor a pure phenomenological paradigm based solely on the lifeworld of human persons is able to establish a transdisciplinary unifying principle that ties together the qualitative differences in communication that arise in a setting that involves humans, documents, institutions, societies, and computers. A generalized system theory view may then be a way to find a common denominator between these different kinds of entities.

## 2.5 Information as Part of General System Theory

This view is mostly inspired by Ludwig von Bertalanffy. Today many researchers seem to adhere to an organicist philosophy based on complexity science or the theory of complex adaptive systems (CAS). Hofkirchner (1999, 2010) has been one of the main developers of these kinds of theories. One can here seemingly still adhere to a kind of physicalist basic ontology, by assuming that the increase of complexity drives the emergence of new levels of being with new qualities such

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<sup>9</sup>This is contrary to a physicalist empiricist position that believes in quantitative data as the origin of all true knowledge.

as life, as well as cognition and consciousness, qualia and feelings. But, I do not find that the present theories of emergence and downward causation offer us any accepted mechanism for understanding the emergence of life—not to mention the mind as a locus of experience—from matter. This is especially true if our basic understanding of matter is that it is something dead and inert. As Emmeche (1991) shows, none of the accepted forms of emergence deal with how experiences arise from matter through self-organization, if one believes in the reality of qualia and subjective experience. Emmeche (2004) realizes that a broader idea of ontology is necessary and describes qualitative organicism as one way of breaking out of physicalism and making a broader ontological stipulation that experience is a part of objective reality. He writes:

**Qualitative organicism.** This is a more radical position differing from mainstream organicism in its appraisal of teleology and phenomenal qualities. It emphasizes not only the ontological reality of biological higher level entities (such as self-reproducing organisms being parts of historical lineages) but also the existence of qualitative experiential aspects of cognitive behavior. When sensing light or colors, an organism is not merely performing a detection of external signals which then get processed internally (described in terms of neurochemistry or information processing); something more is to be told if we want the full story, namely about the organism's own experience of the light. This experience is seen as real. It may be said to have a subjective mode of existence, yet it is an objectively real phenomenon (Emmeche 2004: 117).

Thus there is a real problem in making ontological assumptions that can support a transdisciplinary framework, especially if such a framework is primarily based in the natural and technical sciences or, alternatively, in traditional humanities. A third possibility, therefore, is a systems theory rooted, not only in biological but also in psychic and communicative autopoietic systems.

## 2.6 Information as Part of a System-Theoretical Autopoietic View of Communication

It is primarily Niklas Luhmann's unique and complex system theory that attempts to achieve this three-leveled transdisciplinarity. In his systemic theory of communication, information is viewed as an intrinsic part of a message, which consists of *utterance, information, and interpretation*. Thus, for Luhmann, information is *explicitly always a part of a message* in an autopoietic communication system. In his words:

If one conceptualizes communication as the synthesis of three selections, as the unity of information, utterance, and understanding, then communication is realized if and to the extent that understanding comes about. Everything else happens "outside" the unity of an elemental communication and presupposes it. This is especially true for a fourth type of selection: for the acceptance or rejection of the specific meaning that was communicated (Luhmann 1995: 47).

Luhmann (1995) explicitly states that his whole epistemology derives from the fact that all kinds of rational knowing are based on making a difference between the observing system and the environment. This epistemological foundation is derived in turn from Spencer-Brown's (1979) *Laws of Form* as well as the work of Gregory Bateson and Heinz von Foerster.<sup>10</sup> There is a biological system in Luhmann's systems theory that seems to be equivalent to Maturana and Varela's biological autopoiesis (Maturana and Varela 1980, 1986).<sup>11</sup> Luhmann's revolutionary idea is to generalize the concept of autopoiesis in a sort of meta-biology and then distinguish between biological, psychological, and social autopoiesis. Biological autopoiesis works in the medium of life; but psychological and communicational autopoiesis' operational closure creates a 'meaningful world' of its own that, while it does not exclude external influences, nevertheless selects them in such a way as to have influence according to the system's own inner world of meaning and survival. According to Luhmann, the deep meanings of an individual's psychic world should re-emerge in the ontological basis of communication as an independent system:

...communication is a completely independent, autonomous, self-referentially closed selection, a mode of constantly changing the forms of meaning material, of reshaping freedom into freedom under changing conditions, whereby (given the premise that the environment is complex enough and not ordered as pure randomness) experiences of reliability gradually accrue and are then re-included in the process. Thus a meaning world emerges through epigenetic evolution that makes possible communication that is less probable (Luhmann 1995: 149).

Luhmann essentially identifies two autonomous worlds of meaning based on the psychic and the socio-communicative autopoietic operations. He defines them as both operating in the medium of meaning, which is not culture because he also has a view of this term that differs from the received sociological version. Thus, psychic systems – which, as also Habermas argues, are not the same as classical subjects of the humanities – face competition from the social system, which has the ability to cognize through communication. In Habermas's view:

... the "self" of the system is distinguished from that of the subject because it does not consolidate the "I" of the apperceptive "I think" that, according to Kant's formulation, has to be able to accompany all my representations (Habermas 1987: 369).

This latter ability is not available to the psychic system in Luhmann's theory. The psyche does not communicate *per se*, but is limited to its own closed world of meaning, thoughts, and feelings. Thus it is not the source of communication as in Machlup's humanistic conception of information communication. Teubner writes:

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<sup>10</sup>It is not clear if an observer needs to have feelings, free will, and qualia as minimum requirements in Spencer-Brown's theory. Spencer-Brown works in a logical framework and does not systematically discuss the ontology necessary to support the epistemology of differences and form that he promotes in *that* work. But he discusses it in another of his less scientific works, written under the name James Keys, *It takes Two to Play This Game*; there, he promotes a Buddhist inspired "living emptiness" philosophy (Brier 2007, 2009a).

<sup>11</sup>Which, as with all other cybernetic theories, does not have an explicit theoretical position for quale consciousness and its subject-derived agency.

Social autopoiesis argues for the modern contract to be seen as being primarily about inter-discursivity, not the inter-personal relations between two actors with their own goals and resources. This means giving up the idea of the dominance of the psychic inner worlds of the actors and their subjective meanings and individual resources. ... The interests that people think they are realizing or exchanging through a contract are therefore not their personal interests, but are social or discursive products (Teubner 1997).<sup>12</sup>

Habermas is well aware of the significance of the shift in the concept of information and in socio-communicative meaning wrought by the Luhmanian paradigm. He writes:

In this way, subject-centered reason is replaced by systems rationality. As a result, the critique of reason carried out as a critique of metaphysics and a critique of power, which we have considered in these lectures, is deprived of its object. To the degree that systems theory does not merely make its specific disciplinary contribution with the system of the sciences but also penetrates the lifeworld with its claim to universality, it replaces metaphysical background convictions with metabiological ones. Hence, the conflict between objectivists and subjectivists loses its point (Habermas 1987: 385).

I agree with Habermas' very precise philosophical diagnosis. Luhmann (1990, 1995) accepts the psyche as an autopoietic system, but makes no attempt to explain its creation or ontological status. He seems to find some compatibility between Husserl's phenomenology and system theory. Whereas many biologists take the spontaneous development of life as a given, Luhmann tends to treat the development of meaning as a culturally given phenomenon. The processing of meaning precedes and controls communication as an independent variable in Luhmann's theory. This metabiological perspective posits that meaning is processed without intentionality (Leydesdorff 2007). Luhmann apparently wanted to dispense with an ontology of the subject grounded in phenomenological intentionality in favor of systems theory, which did not really have a phenomenological foundation. He thus understood information in Bateson's terms as a difference that makes a difference and integrated Bateson's cybernetic theory with some aspects of Husserl's phenomenology. The epistemology in Luhmann's paradigm is partly based on an interpretation of Spencer Brown's *Laws of Form*, without, however, adopting the latter's ontology of mystical unity where the observer is basic in making the first distinction (Brier 2007, 2013). Consciousness is accepted in an open ontology,<sup>13</sup> but the unification of the various frameworks of Wiener, Bateson, Maturana, Spencer Brown, Bertalanffy's general system theory, and Husserl's phenomenology do not seem to be carried through in a manner that is philosophically consistent. I do not think Luhmann manages to produce an ontology for, and a definition of, experientially-based meaning. He is a systemic sociologist, not a philosopher (Brier 2007; Thyssen 2006).

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<sup>12</sup>Electronic document without page numbers.

<sup>13</sup>Meaning that this ontology is not specified or even delimited.

Thus, this communicational foundation of information has produced a novelty in the form of a quantitative probabilistic view of information integrated within an autopoietic systems framework, combined with a semantic and pragmatic framework. But I find the claimed integration with the Husserlian phenomenology questionable and see a better possibility of integrating it into the evolutionary triadic phaneroscopic foundation of Peirce's semiotics. This would bring us closer to a transdisciplinary foundation for a universal theory of information, cognition, and communication.

There are only two non-reductionistic attempts to transdisciplinary approaches that stand out. One is Luhmann's, with his three levels of autopoiesis: the biological, the psychological, and the socio-communicative. But it does not really include a first person perspective and quale consciousness and is weakly connected to a realistic natural scientific worldview.<sup>14</sup>

Another non-reductionist transdisciplinarity framework that does not have the shortcomings of Luhmann's is the semiotic-logical paradigm of C.S. Peirce's transdisciplinary triadic pragmatism which, through the semiotics of logic, attempted to connect logic, empirical research, and meaningful cognition. Peirce defines the word "interpretation" generally as the action of symbols (as information vehicles) on physical, living, and other systems (such as matter and energy). This brings us back to the idea of how to combine the understandings of information we have described so far into a common framework. My suggestion is Cybersemiotics (Brier 2008), which is an attempt to combine the best aspects of Peirce's and Luhmann's work.

### 2.6.1 *Cybersemiotics as a New Way of Combining the Natural, Technical, Life and Social Sciences with Humanities*

A transdisciplinary paradigm of information, cognition, and communication encompassing the natural, life, technical, and social sciences, as well as the humanities, within its theory needs to engage the role of first-person conscious embodied perception as well as intersubjective social awareness in producing signification from all sorts of verbal communication combined with pictorial, cinematic, and bodily types of non-verbal communications.

We thus have to embrace what C.S. Peirce (1931–1958) called *cenoscopic science* or, to use Cantwell Smith's (1998) modern phrase, *intentional sciences* (further discussed in Brier 2010a, b). This means that we need to integratively reflect our phenomenological point of departure for knowledge creation in the

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<sup>14</sup>Luhmann's operational constructivism lacks, in my opinion, a clear view of the type of deep ontological work towards uncovering deep intransitive structures in reality, which is also the aim of the natural, life, social, and human sciences to which Roy Bhaskar (1997/75, 1998/1979) and C.S. Peirce (1931–1958) are devoted.

sciences. If our transdisciplinary efforts do not do so, but base themselves on physicalism or informationalism, it is going to be difficult to make any real progress in the understanding of the relation between human consciousness, nature, computation, and cultural meaning simply because no theory of consciousness of qualities and meaning can be built from that foundation (Brier 2013).<sup>15</sup> In the famous book *Chance and Necessity* (1971), Jacques Monod highlighted the apparent epistemological contradiction between the teleonomy of living organisms and the principle of objectivity in science based on the ontological assumption of the natural sciences that there are no intentions or meaning in inanimate nature. Consciousness is not only a product of culture but also a product of the natural evolution of living bodies. Furthermore, we should not view culture as part of a reality outside nature (dualism), but as a special developed part of nature in a broadened naturalism (Brier 2013; Fink 2006). I agree with Bateson (1973) and Maturana (1988a, b) that we must commence our understanding of information with the process of knowing. Bateson's definition of information as a difference that makes a difference is very fruitful. His theoretical problem is that he makes nearly every cybernetic system a communicator and a knower, be it a homeostatic machine, an organism, or an ecosystem or organisation. But the big difference between computers and humans is this embodied field of meaning in which human communication operates. Computers can only provide pragmatic meaning within a system like chess, for instance, if that meaning is modelled in the computer's own memory.<sup>16</sup> This is why the type of unpersonalized, unembodied logical and mathematical reasoning that has been the foundation of the mechanical paradigm of classical science cannot be the sole support of a transdisciplinary foundation for rationality. The paradox is that the sciences think this domain of conscious sense experiences, meaning, and rationality emerges later in evolution than energy, matter, and information, but we have also shown that it is the prerequisite for the intersubjective knowing process from which the whole idea of science springs.

Like Fink (2006), I object to the use of the term "nature" to mean only what the physico-chemical sciences can describe. What we can measure intersubjectively is a part of the reality we call nature. Thus the meaning of a sign, a word, or a sentence has some kind of existence more or less independent of the individual human being. The natural sciences see humans primarily as connected to all other entities and processes in the world by being made of the same "stuff".<sup>17</sup> However

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<sup>15</sup>This is where Dennett and I part ways. I do not believe that the road he takes leads to a transdisciplinary solution.

<sup>16</sup>I think of the meaning of taking a pawn measured in points and in strategic probabilities of winning, but not personal anger at having overlooked the possibility. I think of the meaning of arriving at checkmate within the frame of the game, but not the personal feeling of humiliation and loss of social position.

<sup>17</sup>Few realize how much debate and development preceded the construction of the conceptions of basic "matter" underlining the realism of physicalism.

I see no reason to assume that physics has a special privilege to explain what this universal “stuff” is. Rather I agree with biosemiotics (Kull et al. 2009) that signs are real relational processes, which connect all living beings with each other and with the environment. With Peirce, I prefer the concept of *hylé* to characterize the basic “stuff” the world is made of as it – in contrast to the modern physical concept of matter – does not carry the indication of matter being completely inert and dead. This concept was fundamental to Aristotle’s philosophy but has been moved, in Peirce’s semiotic philosophy, into an evolutionary process-oriented paradigm and further developed along semiotic lines.

As a consequence of the widely shared perspective that human beings are embodied, feeling, knowing, and enculturated beings participating in semiosis and language processes, our analysis so far points to the fact that they can be seen as living simultaneously in four different worlds. One way to describe and classify these worlds – as much as possible in accordance with the currently received view of the many sciences mentioned – is:

1. The physico-chemical part of the natural world that also constitutes the pure material-energetic aspect of our body.
2. Our embodiedness as the source of life, which we share with other living species. It is a product of ecology and evolution; but also formed by cultural practices.
3. Our inner world of feeling, will, drives, affects, and thoughts, manifested as mind, consciousness, and self-consciousness. We think it is partly produced by our embodied nervous system and formed by culture most strongly through our childhood.
4. The cultural world of language, meaning, power, and technology, such as the informational machines we call computers. Language, pragmatically viewed, connects our perception with our thinking, communication, and acting in the social world.

Each of the four worlds has historically developed its own type of narrative, with its own fundamentalist and reductionist versions vitiating the project of transdisciplinarity. Physicists and chemists tend to view the universe as consisting of matter, forces, and energy. Mechanistically oriented biologists extend this view into their subject area. But non-mechanistically oriented biologists tend to perceive living systems as the basic organizers of reality, possessing self-organizing, self-protecting, self-promoting, and reflective properties as well as perception, instincts, and communication that physics and chemistry cannot (yet?) explain. This view of life as a foundational quality is why I insist that the natural and the life sciences are not the same.

The social and cultural sciences, especially dialectical and historic materialistic perspectives, as well as the radical social constructivist ones, tend to see the world as constructed from social, human, and linguistic interpretations, unless they are dualistic, accepting that nature is just as science describes it (Brier 2008). Thus, energy-matter-information, life, consciousness, and meaning become separated in

different domains or worlds. But this is in conflict with our everyday lifeworld experience. Here they are not in any way absolutely separated. Thus we lack a transdisciplinary *wissenschaftlich* explanation of how they are integrated.

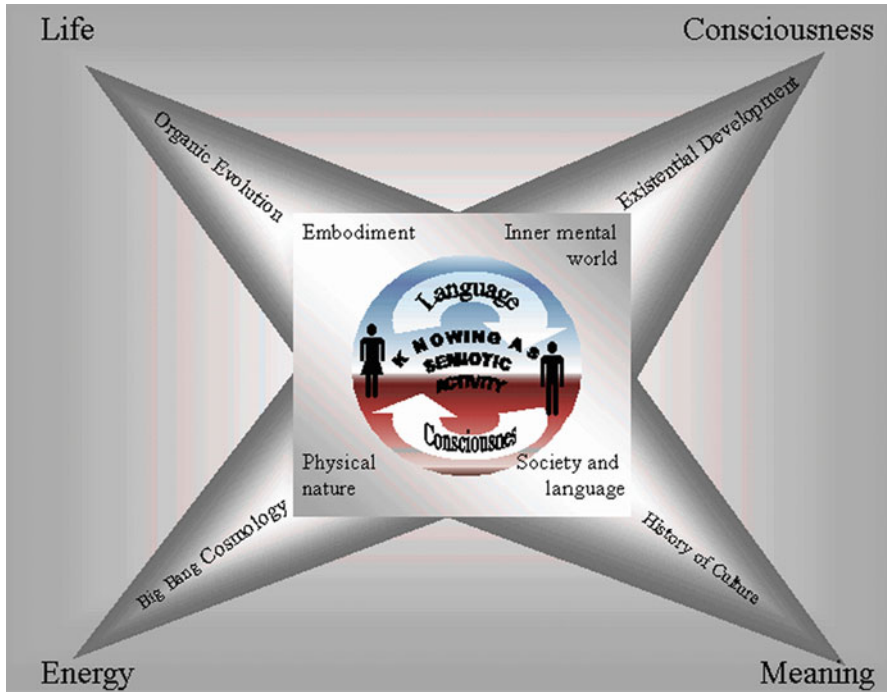
One of the reasons for the separatist tendencies of the received views of natural and social science as well as the humanities may be that the traditions of science and the humanities were established before the theory of evolution became broadly recognized. Thus, the incompatibility of these four dominant views in the Western world's systematization of knowledge is a deep paradox in the modern worldview's attempt to build a "unified narrative" of the world. This is especially the case since it has been broadly accepted in all four worlds that the 'unity of science' idea of the logical positivists failed because it was predicated on the excessively narrow epistemological foundation of verificationism. Karl Popper's (1960, 1976) critical analysis and argumentation for a falsificationist view of scientific knowledge has been accepted as a turning point in the break with the positivist unity of science, but not as providing any final solution to the problem. Thomas Kuhn's (1970) work on paradigms and their incommensurability has been generally accepted by philosophers of science and many scientists, changing the revolutionary mono-paradigmatic view based on the history of the natural sciences into an acceptance of parallel co-existing paradigms especially in the realm of the social sciences and humanities. I have extended this view to include the social and the life sciences here in order to put all forms of *Wissenschaft* on an equal standing, because I find it true in an absolute naturalism and a necessary prerequisite for establishing a non-reductionist transdisciplinary view.

My suggestion for finding a transdisciplinary commensurable framework for all *Wissenschaften* is to start in the middle, with our daily lived semiotic, social, and linguistic practice. I view the communicative and semiotic mind, in combination with a concept of information, as that which binds all four worlds together. The view that all thought uses signs as vehicles and all objects of experience are comprised of signs constitutes the foundation of a unified theory of signs and sciences among the foundations of which we include phenomenology. Like Luhmann and Peirce, I cannot see how we can avoid it when we ask from what or where comes the ability of the observer to produce knowledge and furthermore to reflect consciously on how knowledge is produced in language.

This semiotic view integrates the sciences' view of reality as well as the cybernetic, informational, and systems views of reality into a single model in an attempt to avoid the inner inconsistencies described earlier. I have combined some of the core aspects of this framework into a visual and simplified model called the Cybersemiotic star for those readers who – like me – get a special kind of insight by looking at such visual representations. Those I encourage to consult Fig. 2.1, the rest to stay with the text.

Peirce simply viewed man as a growing, living symbol summarizing all his experience. I want to use this daring interdisciplinary way of understanding the relation between man, language, and reality as a point of departure. Therefore





**Fig. 2.1** The Cybersemiotic star: A model of how the communicative social system of the embodied mind produces four main areas of knowledge that can also understood to be prerequisites for interpersonal observation and knowing. Physical nature is usually explained as originating in energy and matter, living systems as emerging from the development of semiotic life processes (for the production of special proteins from DNA in the first cell). Social culture is explained as founded on the development of meaning in language and practical habits, and, finally, our inner mental world is explained as deriving from the development of our individual life world and self-consciousness. All these types of knowledge are seen as having their origin in our primary semiotic intersubjective lifeworld of observing as well as social communication and action (Brier 2008).

Cybersemiotics is built on the idea of Peircean evolutionary, pragmaticist semiotics as well as his phaneroscopy, his three basic categories,<sup>18</sup> his sign typology, and his synechism, tychism, and agapism.<sup>19</sup>

<sup>18</sup>These categories are “Firstness”, “Secondness”, and “Thirdness”. Firstness stands for the aspects of reality that include possibility, the may-bes, the vague, spontaneity, pure feeling, the present. Secondness stands for actuality, the determinate/singular, fact, and the past. Thirdness stands for mediating between Firstness and Secondness, conditional necessity, the would-be, the tendency to take habits, the general, law, and the future. Through Thirdness, the meaning of signs emerges as a movement from may-bes to would-bes. (CP 5.469, 1907).

<sup>19</sup>Peirce writes that *tychism* is “... absolute chance – pure tychism ...” (CP 6.322, c. 1909). So Tychism is connected to Firstness as real objective chance in the universe. But it has to be integrated with the Secondness of resistance, facts, and individuality to create Thirdness to mediate connections between the two categories. It is connected to his pragmatism: “It is that

The other important problem is that ontologies and epistemologies usually follow the various conceptions of the four cardinal aspects of the world and the paradigms developed within them. Thus, if we – for instance, for the sake of medicine – want to create a transdisciplinary theory of information, cognition, consciousness, and meaningful communication (see Cowley et al. 2010, for the initiation of such an attempt), then it is necessary to adjust the ontologies of the different subject areas that we wish to integrate into our transdisciplinary<sup>20</sup> paradigm so as to make them compatible in a larger context.

### 2.6.2 *Peirce's Transdisciplinary Semiotically-Based Information Theory*

Similarly to Luhmann's view, Peirce holds that signs grow in information through the development of their interpretants<sup>21</sup> (CP 3.608, 1908).<sup>22</sup> This binds up information with the interpretations of signs, which is an ongoing personal and social process. Human communication – which occupies the central position in our model – involves a very complex interpretation by the “receiver”. The meaning of a text or a sign does not exist independently of the receiver as a fixed state. It enters as a percept through our senses and clashes with our mind. A percept is the result of our interaction with what seems exterior to consciousness. Regarding percepts, Peirce writes:

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synthesis of tychism and of pragmatism for which I long ago proposed the name, *Synechism*” (CP 4.584, 1906). *Synechism* is “... that tendency of philosophical thought which insists upon the idea of continuity as of prime importance in philosophy and, in particular, upon the necessity of hypotheses involving true continuity” (CP 6.169, 1902). It thus constitutes the deep continuity between everything, including mind and matter as well as the three categories: “... I chiefly insist upon continuity, or Thirdness, ...” (CP 6.202, 1898). As for *agapism*, Peirce writes in his famous article ‘Evolutionary Love’ that “The *agapastic* development of thought should ... be distinguished by its purposive character, this purpose being the development of an idea. We should have a direct *agapic* or sympathetic comprehension and recognition of it by virtue of the continuity of thought” (CP 6.315, 1893).

<sup>20</sup>Not much has been written about the ontological conditions necessary for transdisciplinarity. But Basarah Nicolescu's (2002) *Manifesto of Transdisciplinarity* is a profound work on the meaning and consequences of transdisciplinarity.

<sup>21</sup>Peirce explains the concept of interpretant thus: “The Sign creates something in the Mind of the Interpreter, which something, in that it has been so created by the sign, has been, in a mediate and relative way, also created by the Object of the Sign, although the Object is essentially other than the Sign. And this creature of the sign is called the Interpretant” (EP 2: 493–94, 1909). In Peirce scholarship, the siglum “EP” stands for the two-volume University of Indiana edition of *The Essential Peirce* (Peirce 1992, 1998).

<sup>22</sup>Note that, in Peirce scholarship, “CP” is the customary way of referring to the Harvard edition of Peirce's *Collected Papers* (= Peirce 1931–1958). Citations give volume and paragraph number, separated by a period (e.g., Peirce CP 5.89 refers to volume 5, paragraph 89), and can be followed by the date of the manuscript or publication in question.

The direct percept [...] has no generality; [...] it appears under a physical guise [...] it does not appear as psychical. The psychical, then, is not contained in the percept (Peirce CP 1.253, 1902).

According to Peirce's three categories—Firstness, Secondness, and Thirdness<sup>23</sup> —, the process of the percept is a pure 'Second': a clash between two different phenomena. Thus, it includes Firstness, but not Thirdness, as there is no interpretation of any kind of regularity or meaning yet. Thus, to Peirce, Thirdness in perception emerges with the construction of an perceptual fact or a cognition, which is the intellect's fallible generation of meaning through a generalization operated upon a series of percepts and concepts, i.e., what he calls abduction. The perceptual judgment constitutes an irresistible hypothesis for consciousness with regards to making sense through interpretation. According to Peirce, then, percepts are not, strictly speaking, objects of experience. Though the percept makes knowledge possible, it offers no information, as it does not contain any Thirdness in its immediateness. Experience, understood as the knowing process imposed upon us in the course of living, is "perfused" with Thirdness. Thirdness takes the form of generality and continuity within a fallible account of percepts. "Meaning" must somehow be constructed by the receiver from the information gathered by the interpretation of signs, within certain frames that reality imposes on us for survival. Peirce writes:

At any moment, we are in possession of certain information, that is, of cognitions which have been logically derived by induction and hypothesis<sup>24</sup> from previous cognitions which are less general, less distinct, and of which we have a less lively consciousness (Peirce CP 5.311, 1868).

Peirce develops an information theory that starts with a physical event hitting the perceptual organs – i.e., Secondness – but he does not construct a probability-based theory of information as do Shannon or Wiener. Instead, Peirce develops a theory based on the logical quantities of extension and intension associated with the concept of symbol that is so vital for his semiotics.<sup>25</sup> Peirce defines his concept of information directly from his semiotics and its most important species of sign, namely, the symbol. From this basis, he introduces a new way of calculating the value of information conveyed by new propositions. He explains this in a passage worth quoting *in extenso*:

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<sup>23</sup>Peirce writes about the categories: "Careful analysis shows that to the three grades of valency of indecomposable concepts correspond three classes of characters or predicates. Firstly come "firstnesses," or positive internal characters of the subject in itself; secondly come "secondnesses," or brute actions of one subject or substance on another, regardless of law or of any third subject; thirdly comes "thirdnesses," or the mental or quasi-mental influence of one subject on another relatively to a third." (CP 5.469, 1907)

<sup>24</sup>An early concept of what he came to call abduction.

<sup>25</sup>The seminal paper by Nöth (2012) is my main source on Peirce's theory of information.

In a paper . . . I endeavored to show that the three conceptions of reference to a ground,<sup>26</sup> reference to a correlate, and references to an interpretant, are those of which logic must principally make use. I there also introduced the term “symbol,” to include both concept and word. Logic treats of the reference of symbols in general to their objects. A symbol, in its reference to its object, has a triple reference:

- First, Its direct reference to its object, or the real things which it represents;
- Second, Its reference to its ground through its object, or the common characters of those objects;
- Third, Its reference to its interpretant through its object, or all the facts known about its object.

What are thus referred to, so far as they are known, are:

- First, The informed *breadth* of the symbol<sup>27</sup>;
- Second, The informed *depth* of the symbol;
- Third, The sum of synthetical propositions in which the symbol is subject or predicate, or the *information* concerning the symbol.

By breadth and depth, without an adjective, I shall hereafter mean the informed breadth and depth.

It is plain that the breadth and depth of a symbol, so far as they are not essential, measure the *information* concerning it, that is, the synthetical propositions of which it is subject or predicate. This follows directly from the definitions of breadth, depth, and information. Hence it follows:

- First, That, as long as the information remains constant, the greater the breadth, the less the depth;
- Second, That every increase of information is accompanied by an increase in depth or breadth, independent of the other quantity;
- Third, That, when there is no information, there is either no depth or no breadth, and conversely.

These are the true and obvious relations of breadth and depth. They will be naturally suggested if we term the information the area, and write – Breadth X Depth = *Area* (CP 2.418–419, 1868).

Here Peirce suggests measuring the amount of information that symbols acquire through their individual and cultural history of use; or what Peirce calls the “growth of symbols”. This is also augmented by the combination of terms in propositions as they then interact and change each other’s meaning. “No proposition is supposed to leave its terms as it finds them. . . .; and there are three objects of symbols the connotative, denotative, informative; it follows that there will be three kinds of propositions, . . .” says Peirce (W1: 277).<sup>28</sup> Thus, propositions are a further source of the growth of symbols and, in the sciences, synthetic propositions are a

<sup>26</sup>Peirce writes in (CP 2.228): “[A sign] stands for [its] object, not in all respects, but in reference to a sort of idea, which I have sometimes called the ground of the [sign]”. Peirce defined the sign’s ground as the pure abstraction of the quality in respect of which the sign refers to its object.

<sup>27</sup>“Informed breadth” is equivalent to extension under a certain state of information.

<sup>28</sup>In Peirce scholarship, W customarily stands for the *Writings of C.S. Peirce*, the chronological edition of his entire corpus of writings published by the Indiana University Press. It can be found in the reference list under Peirce (1982–).

source of the acquisition of new knowledge. When an adjective precedes a noun, the logical content of the noun is modified by the adjective. If the noun, “information” is modified by the adjective “physical”, then the logical content of the abstract concept of information is modified by what the author understands the term “physical” to mean. Nöth (2012: 139) writes further on this subject:

Symbols have both extension, since they denote classes of objects, and they have intension, since the objects they denote must have certain characters in common. There are even reasons to argue that all signs, that is, symbols, indices, and icons, have both extension and intension, . . . With this assumption, Peirce differs from logicians who argue that proper names (*indices* for Peirce) have only extension (reference) and no intension (sense), whereas fictional names, such as *unicorn*, and signs of mere qualities (icons) have no extension but only intension.

Although Peirce’s information theory is built not only on denotative formal signs but also on a vast array of meaningful signs, it is still a realistic information theory. One needs to have empirical reference<sup>29</sup> in order to produce real information. Peirce writes:

If there be anything that conveys information and yet has absolutely no relation nor reference to anything with which the person to whom it conveys the information has, when he comprehends that information, the slightest acquaintance, direct or indirect—and a very strange sort of information that would be—the vehicle of that sort of information is not, in this volume, called a Sign (CP 2.231, 1910).

In other words, analytical statements lack informativity. The more synthetic a proposition is (i.e., the greater the empirical reference that it has), the more informative it is. *Quantity* is a measure of the extension of a symbol. It refers to the fact that different symbols “may denote more or fewer possible things; in this regard they are said to have extension.” (W1: 187). Thus, the extension of the symbol *fish* is larger than the one of *sharks* since *fish* is applicable to more animals than *Sharks*. *Quality*, on the other hand, is dependent on the intension of a symbol, which is the number of characters attributed to a term. That is a *logical quantity*. This is a quantity very different from the probability theory underlying Shannon’s and Wiener’s objective information theories. Nöth (2012: 144) explains:

*Information* is thus a third logical quantity between depth and breadth. Peirce calls it the “implication” of a symbol (W1: 465). The word *man* has no more than one meaning, but it has many biological, religious, political and other implications which go beyond the mere lexical definition of the word (W1: 465–466). In this sense, informational implication takes into account all available knowledge and not only the defining characters from which lexical definitions are made up.

This view is also our transdisciplinary key interlinking the various arms of the Cybersemiotic star. Peirce is aware of the fact that the amount of information transferred in communication is dependent on the knowledge horizon of the receiver or, rather, interpreter. He writes “If you inform me of any truth, and I know it

<sup>29</sup>Empirical reference would also be to social-cultural phenomena like “Unicorn”.

already, there is no information” (MS 463: 13, 1903).<sup>30</sup> Thus information has to be able to combine with what you already know. “Actual information extends the knowledge horizon of the interpreter. Information is the measure of how much a symbol involves more or less real knowledge” (W1: 187). Thus ‘objective’ does not mean ‘interpreter-independent’! Peirce writes,

I do not call the knowledge that a person known to be a woman is an adult, nor the knowledge that a corpse is not a woman, by the name ‘information,’ because the word ‘woman’ *means* a living adult human being having female sexuality. Knowledge that is not informational may be termed ‘verbal’ (MS 664: 20, 1910).

Precisely here is where “analyticity” comes in. Peirce is saying that the concept of *adult* is contained in *Woman*: thus, to say “A woman is an adult” is to make an analytic statement. Thus information is a process in which the symbol of *shark*, for instance, as a concept with a content that I know, is constantly undergoing development. When I see a documentary showing me many different species of sharks, that I did not know before, like *hammerheads*, then my symbol of sharks grows, because I have added information to my conception of the species *shark* by increasing the quantities of extension or intension of the symbol connected to it, which now include *hammerheads* within their scope. Peirce writes:

An ordinary proposition ingeniously contrives to convey novel information through signs whose significance depends entirely on the interpreter’s familiarity with them; and this it does by means of a ‘predicate,’ i.e., a term explicitly indefinite in breadth, and defining its breadth by means of ‘Subjects,’ or terms whose breadths are somewhat definite, but whose informative depth (i.e., all the depth except an essential superficialities) is indefinite, while conversely the depth of the Subjects is in a measure defined by the Predicate (CP 4.543, 1905).

So it is not the lexical definition of “shark” that carries the information, but all the other things I know about sharks’ behavior, size, colors, way of movement, prey, and how many of them we catch each day and eat in shark fin soup. Peirce underlines that “the information of a term is the measure of its superfluous comprehension” (W1: 467), which is all the extraneous world knowledge I have about sharks, including if I have been bitten by one. In other words, information is all the knowledge “outside” the lexical definitions! Indeed, Johansen (1993: 148) has suggested that “One way to define *information* is this: the set of characters which can be predicated of a symbol minus the characters contained in its verbal definition.”

But, what if one of my students includes something undetermined living underwater looking like a fish and which might possibly be a whale in her symbol or conceptualization of fish – is there then no information? Peirce would conclude that, in this case, we are dealing with the possible, which he considers to be real but having to do with propensities rather than certainties: “that is possible which, in a certain state of information, is not known to be false” (CP 3.442, 1896). Moreover,

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<sup>30</sup>MS customarily stands for manuscripts written by Peirce not found in the CP. Many of them can be found on *Arisbe: the Peirce Gateway* home page (<http://www.cspeirce.com>), but also other places on the Internet. Sooner or later they will appear in the *Writings*.

“the Possible, in its primary meaning, is that which may be true for aught we know, that whose falsity we do not know” (CP 3.374, 1885). As Peirce holds a fallibilist view of science combined with a pragmatist and realistic view of knowledge, he must conclude:

The cognitions which ... reach us ... are of two kinds, the true and the untrue, or cognitions whose objects are real and those whose objects are unreal. And what do we mean by the real? ... The real, then, is that which, sooner or later, information and reasoning would finally result in, and which is therefore independent of the vagaries of me and you (CP 5.311, 1868).

Thus Peirce produces a new transdisciplinary theory of information connected to his semiotic theory of cognition and communication, which differs substantially from the usual conceptions. Nöth (2012: 139) explains:

In modern linguistics, the intensions of words are described in the form of semantic features, whereas their extension is studied in a reference semantic framework. For Peirce, however, extension and intension cannot be separated from each other since the extension or denotation of a symbol “is created by its connotation” (W1: 287), that is, through the predicates attributed to a subject term. We can only determine the referent (denotatum or extension) of a word if we know its meaning (intension or connotation) and vice versa: we must know the referent if we want to specify its semantic features ...

Thus, Peirce’s theory combines the concepts of meaning and information within a framework of pragmatic realism established on a semiotic understanding of cognition and communication. In this way, he builds bridges between the four different and often incommensurable worlds we mapped in Fig. 2.1. Peirce’s theory can be modernized by combining it with Luhmann’s communicative systems theory, which introduces autopoiesis at the level of biology, psychology, and social communication (Brier 2008, 2011). Luhmann and Peirce both share the idea of form as the essential component in communication. Peirce (MS 793:1–3) writes:

[...] a Sign may be defined as a Medium for the communication of a Form. [...]. As a medium, the Sign is essentially in a triadic relation, to its Object which determines it, and to its Interpretant which it determines. [...]. That which is communicated from the Object through the Sign to the Interpretant is a Form; that is to say, it is nothing like an existent, but is a power, is the fact that something would happen under certain conditions.

In Peirce’s dynamic process semiotics, a form is something that is embodied in an object as a habit. Thus, form acts as a constraining factor on interpretative behavior or what he calls a real possibility in the form of a ‘would-be’. Thus *the form is embodied in the object as a sort of disposition to act* (Nöth 2012).

## 2.7 Conclusion

When scientific methods are applied to information, cognition, and communication, we are only left with codes, grammar, phonetics, programs, formal language, copy machines, adaptors, and the analysis of meaningful relations is lost amidst all the

formal technicalities. Contrary to reductionist loss of meaning, Cybersemiotics follows in the footsteps of Peirce, whose semiotics allows us theoretically to distinguish between the information the sender intended to be in the sign, the (possible) information in the sign itself and the information the interpreter gets out of the sign. The knowledge in the sign must be interpreted for a full semiosis<sup>31</sup> to happen and for the receiver – for example, a party in a conversation – to acquire the information imparted by his or her interlocutor.

Thus, in this transdisciplinary frame for interdisciplinarity the sign process is viewed as transcending the division between nature and culture, between the natural sciences, the life sciences, the social sciences, and the humanities and between phenomena that are exterior and those that are interior to human consciousness. As such, it is central to any conception of knowledge and information. Through the development of Peirce's semiotics into a biosemiotics combined with Luhmann's three levels of autopoiesis, the subjective, the natural, and the social are integrated into one framework because signs are relations and not objects (Brier 2008). As such, they are able to bring all the things of the world into a contextual and historical web of culture, a family, a lineage, a species, and the experiential embodied lifeworlds, be they the sedimentation of the experience of an individual or of a group of people. Signs have the "active power to establish connections between different objects, especially between objects in different Universes" (CP 6.455, 1908).

We must accept that experience and meaning are just as real as matter. This does not mean that what physicists call the "world" or "reality" as such is imbued with meaning. It means that their concept of "world" and "reality" is unable to reflexively encompass the embodied psychological and social foundation of knowledge. Thus their idea of reality does not take our full measure as conscious, linguistic, and social creatures. It lacks an embodied phenomenological foundation in the understanding of *Wissenschaft*. From a semiotic viewpoint, we can see man as a parasite of symbols (Nöth 2012), because we use them to create our perceived selves as self-conscious, cultural communicative beings. Peirce points out that self-reproduction and self-replication are not only characteristics of organisms and chromosomes, but also of symbols. Signs replicate through and in their tokens. Replicas of symbols in their acoustic or written form are indeed dead things (phenomena of Secondness), but symbols as genuine Thirdness live on as self-replicative beings. It is within that wider reality of life connecting subjects in language and social actions to nature and technology that information is created.

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<sup>31</sup>Peirce defines semiosis the following way: "It is important to understand what I mean by semiosis. All dynamical action, or action of brute force, physical or psychical, either takes place between two subjects (whether they react equally upon each other, or one is agent and the other patient, entirely or partially) or at any rate is a resultant of such actions between pairs. But by "semiosis" I mean, on the contrary, an action, or influence, which is, or involves, a coöperation of three subjects, such as a sign, its object, and its interpretant, this tri-relative influence not being in any way resolvable into actions between pairs." (EP 2:411, 1907)



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