Chapter 11
The Communication of Form. Why Cybersemiotic Star Is Necessary for Information Studies?

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> *The problem of meaning in its most general form is the problem of how… we can get from the physics to the semantics.*
> John Searle (*1988, p. 27*)
> *I do not see why the inner world of cognition, emotions, and volition – including our cultural world of signs and meaning – should not be accepted as just as real as the physical world.*
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> *Søren Brier (2008, p. 404)*

Abstract The chapter first formulates the problems of information and analyzes why they are hard to solve. Then it critically reviews two classes of prevailing theories in information studies arguing that they cannot attain success because the assumptions behind them are too limited. In recent years, some semioticians have rediscovered the theory of information developed by Peirce. Deeply embodied in semiotics, the theory treats information as the communication of form in semiosis, which should be interpreted in terms of triadic relation in the semiotic relational process between representamen, object and interpretant. As a contemporary development of Peircean theory, cybersemiotics further constructs a conceptual framework through integrating it with Luhmann's social system theory. In particular, the

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transdisciplinary framework cybersemiotics shows a promising way to explain superficially incompatible aspects of information with the aid of the principle of complementarity.

Keywords Information · Cybersemiotics · Peirce · Transdisciplinarity and complementarity

11.1   Introduction

Many scholars who encounter the concept of information in their fields have been aware of the fact that the dominant information-processing paradigm is not enough for studying information. There has been a desire ever since the birth of Shannon-paradigm of objective information science in 1948 that to find a theory of information, which would be able to encompass all the aspect usually being present in human communication such as covering data, meaning, and usefulness of information. However, the state of contemporary information studies seems like Hobbes' state of nature, in which each scholar would have a right to everything about information, but everybody fights against each other for their way of making theoretical sense of the information paradigm. So, we have a Hobbes' war of all against all. While different from the social world, the social contract for information studies is still out of reach for now.

In this chapter, I first analyze why the problem of information is so hard to solve. Then I critically review two classes of prevailing theories in information studies arguing that they can't success because of the assumptions behind them. I therefore turn to Peirce's theory of information dug out of his oeuvre by semioticians in recent years (De Tienne 2005; Queiroz and El-Hani 2007; Nöth 2012; Liszka 2016). I believe that it brings new light to information studies because the theory treats information as the communication of form and meaning through a process of interpretation in a transdisciplinary framework including hermeneutical and phenomenological aspect. Cybersemiotics further enlarges the transdisciplinary framework by drawing on general system theory, second order cybernetics and autopoiesis theory as they are integrated in Niklas Luhmann's social system theory.

11.2   The Problems of Information

The question of "*what is information?*" is a difficult one. As Floridi says, "Information is notoriously a polymorphic phenomenon and a polysemantic concept so, as an *explicandum*, it can be associated with several explanations, depending on the level of abstraction adopted and the cluster of requirements and *desiderata* orientating a theory" (Floridi 2017). After almost 70 years, the claim made by

Shannon that, "It is hardly to be expected that a single concept of information would satisfactorily account for the numerous possible applications of this general field" (Shannon 1993, p. 180), is still true. No need to say developing a unified theory of information (UTI). However, no one would disagree with Wiener's well-known slogan that "Information is information, not matter or energy" (Wiener 1961, p. 132). The claim is raised at the end of chapter V, *Computing Machine and Nervous system*, of his masterpiece. He recognizes that any physical mechanism that processing information must cost certain energy, no matter if it is a computer or a brain. In both Shannon's and Wiener's way, information is defined as the possibility of a signal being sent out of a set of possible signals. No matter the signal being sent or the one being received, both are physical events. It means that the possibility of a signal being sent is measured by the possibility of physical events implementing the signal. Similarly, the record, analysis, replication, transmission of information are embodied in computer and related devices and implemented by the physical states of the devices. All the physical events implementing information processing cost energy.

The analysis clears two facts: first, without physical events, information cannot manifest; second, the fact that physical consequences of information cannot be measured by the energy cost implies that information cannot identify the physical events implementing it. This is what Wiener argued in the slogan. It is counter-intuitive in two aspects: Ontologically, information is not something physical but has physical consequences; epistemologically, information cannot be explained by physical processes. Here we then come to the problem of information in general: what is information? As it is not physical, what is the place of information in material reality? It seems information studies is in a similar situation to consciousness studies. However, if we follow the way discussing consciousness, information study would have fallen in endless metaphysical debates as the area of philosophy of mind. Therefore, I believe the problem of information, in general, is an empty problem without being further analyzed into subproblems that are susceptible to explore. It is fortunate that the state of information study is much better of than the consciousness study. First, compared with consciousness, people have more sympathy in the claim that information having its place in nature. The problem is how to understand it. Second, we already have several good formulations and mathematic theories of information, which can be our departure towards a complete theory of information if there is one to be found.

Maybe the most well-known taxonomy of information in full sense comes from Weaver's comments on Shannon's mathematical theory of communication, in which information is divided into the technical, semantic and effectiveness level (Weaver 1949). What the problem of information that he focused on is, is the accuracy of information at these levels in transmission. However, the problem of information is not merely the accuracy problem. Put it in another way, in order to solve the accuracy problem in full sense, we have to explain more. Thus, what a unified theory of information (UTI) aims to do is to go beyond the limitation of this classical framework. Nowadays, there are several taxonomies of information in general,

- Syntactics, the formal aspect of information; semantics, the meaning aspect of information; and pragmatics, and pragmatics, the functional aspect of information. (Nauta 1972, pp. 39–41),
- "… information as reality (e.g. as patterns of physical signals, which are neither true nor false), also known as environmental information; information about reality (semantic information, alethically qualifiable); and information for reality (instructions, like genetic information, algorithms, orders, or recipes)" (Floridi 2010, p. 30),
- "a) Physical information: Information as intrinsically measurable medium properties with respect to their capacity to support b) or c) irrespective of any specific instantiation of b) or c). b) Referential information: information as a non-intrinsic relation to something other than medium properties a) that a given medium can provide (i.e. reference or content) irrespective of any specific instantiation of c). c) Normative information: Information as the use value provided by a given referential relation (b) with respect to an end-directed dynamic that is susceptible to contextual factors that are not directly accessible (i.e. functional value or significance)" (Deacon 2016, personal communication),
- (a) Counting information: the mathematical concept of information defined by Shannon; (b) information about something: the information system refers to physical background conditions distinct from, and absent from, the informational system itself; (c) shaping information: it is the form or pattern of existing things (Gregersen 2010, pp. 330–332),
- or in common sense, quantity, content, and usefulness, of information.

Although the terms different authors employ are different and the relations between them are diverse with respect to different considerations, their meanings are similar. Hence, it is clear that there is little doubt that information has three aspects. It provides the ground on which we can stand to formulate the material problem of information. Following, I will adopt Deacon's glossary, aka physical, referential, and normative information, to discuss the problems of information with respect to his most recent works on information (Deacon 2007, 2008, 2010, 2012, 2015). As we have argued above, information processing is instantiated by the changes of physical states in which information embodies. Put it simply, information is conveyed by signals. More specifically, patterns, forms, or differences, which we think conveying information content, are constituted by the physical properties of the information medium. I call this aspect of information physical information. Of course, we have good mathematical theories for measuring the quantity of physical information. In terms of Chalmers (Charmers 1995), this is the easy problem of information. We can always find a way to measure the complexity of those patterns, differences, forms, etc., that embodying information. As we will see later, some scholar thinks that information is everywhere in the universe as every difference is potential physical information (Stonier 1997, for instance). However, we cannot distinguish information from other phenomenon in nature with respect to its physical embodiment. The hard problem of physical information is that these physical patterns, forms, or differences can convey something non-physical, namely

semantic content. How can it be possible? Why a painting of Winston Churchill occasionally drawn by traces of an ant is not a picture of him while a painting having wholly same pattern drawn by a painter is? (Putnam 1981, p. 1–2). The hard problem connects with the next aspect of information: referential information.

As Collier says, "The great tragedy of formal information theory is that its very expressive power is gained through abstraction away from the very thing that it has been designed to describe" (Collier 2003, p. 102). In other words, the formal theory misses the very thing that defines information. This very thing is referential information. Without saying anything about referential information, we can even say that those formal theories of information actually are not theories about information. Distinguishing from other phenomenon in nature, information, mind and language/sign have the ability to be about, to represent, or to stand for something else. It is a core theme in the philosophy of mind and language. Of course, we have the metaphysical problem of referential information that what it is. Then, we would come back to the problem of information, in general, we discuss at the beginning and fall in metaphysical debates again. However, I want to formulate the problem of referential information in a constructive way.

For information studies, what is counterintuitive is, that different from physical properties which are intrinsic to signals (physical information), information content is something extrinsic to its physical carriers. Then, the problem is that, how can physical information refer to something extrinsic to it? What is more mysterious, information content is not physical. How can physical information be about something not physical? Put it in another way, how can information content implement by physical signals? These are ontological problems of referential information. A piece of information always conveys the content about something other than itself. A bit of physical information, or a signal, always has a particular meaning, but that is the aspect that formal information theories do not deal with. As philosophy of language raises (for instance, Lycan 2008, p. 1), how a signal becomes meaningful? How a signal acquires its distinctive meaning? What is more, a signal conveys certain information content stably and reliably. The relation between a signal and its content/meaning is stable and reliable enough for signal employers in a community to identify the content from the signal. How does such relationship between emerges? These are problems of the genesis of referential information.

There is also the causal problem of referential information. Although referential information is not physical, it has physical consequences. Imagine the case that an American president who gives the order to launch nuclear missiles.

> The problem that lingers behind definitions of information boils down to a simple question: How can the content (aka meaning, reference, significant aboutness) of a sign or thought have any causal efficacy in the world if it is by definition not intrinsic to whatever physical object or process represents it? In other words, there is a paradox implicit in representational relationships. The content of a sign or signal is not an intrinsic property of whatever physically constitutes it. Rather, exactly the opposite is the case. The property of something that warrants calling something information, in the usual sense, is that it is something that the sign or signal conveying it is not (Deacon 2010, pp. 151).

Where does the causal power of referential information come from if we follow the principle of physical causal closure? As we can see, information studies share many common problems with the philosophy of language and of mind, it is easy to confuse information with language or signs in general. However, information is more subtle because it is intrinsically normative or end-directed. It is always for some end. It is not just meaningful but also individually significant. I call the useful aspect of information normative information. In Shannon's formal theory, information is defined with respect to the selection while the selection is always determined with respect to certain normative criterions (Weaver 1949). Information can be correct or incorrect, accurate or inaccurate, useful or useless for a specific receiver. What is unusual for information from language is that it has different significance for different individuals. The same signal may provide information about different things for different interpreters. Even for different interpreters, the same message may have different significance for each one. In other words, although physical and referential information is same, normative information may be different for different interpreters. Because the boundary conditions under which each interpreter employs the information are different. Then, the problem of normative information is that, why certain signal with physical and referential information has significance for its interpreters? Why are the significance of some information content different for different interpreters who are under different boundary conditions?

We do not lack good theories for each aspect of information.[1] For the measurement of the quantity of physical information, we have several good formal theories being sufficient for engineering purpose (Shannon 1948; Wiener 1961; Kolmogorov 1965, to name a few). For referential information, we have many theories of reference and meaning in the philosophy of language, such as Tarski-Davidson tradition, Austin-Searl tradition, Grice-Schiffer-Lewis tradition and Drestke-Millikan-Papineau tradition (Millikan 1984, p. 2). For normative information, it seems to correspond to pragmatics in linguistics. However, it is clear that these theories for different aspects of information distribute to different disciplines that range from engineering (communication engineering, for example) to natural science (for example, qua-bit and bioinformatics), to social science (library and information science, media and communication, for instance), and to humanities (philosophy, semiotics, linguistics, to name a few). Although there are some overlaps between these disciplines on information, the theories from the different areas are incoherent and full of conflicts. It is too bald to say that there exists a definition of information that is proper to all these theories and disciplines.

Nevertheless, there are still many endeavors trying to go beyond the limitation and to search for a UTI that can explain physical, referential and normative information coherently. Because many disciplines involving information are in need of a more developed transdisciplinary conception of information. Thus, the potential benefits of UTI are alluring. Although the road ahead is rough, many works aiming

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[1] There are several other ways to formulate problems of information with respect to other considerations, for example, Floridi (2004a) proposes a much more broad way. The formulation here focuses on "what is information?"

to explain information in full sense have been done. Next, I examine these works and argue why they are not enough or doomed to fail.

11.3 Methodologically Reductionist and Fundamentalist Theories

In general, there are three classes of theories in contemporary information studies trying to develop full theories of information examples: methodologically reductionist, fundamentalist and transdisciplinary theories. In this section, I review first two classes of the theories and argue that the assumptions behind them are not convincing. Although Shannon has explicitly noted at the very beginning of his paper that his theory aims to solve engineering problem and has nothing to do with semantic information, it was unavoidable that there was a tendency to confuse it with semantic information. A notable argument against the tendency is that it confuses what is conveyed and what provides conveyance, or, meaning and the signal conveying the meaning (Bar-Hillel 1955).

With the distinction in mind, Carnap and Bar-Hillel (1952) develop a formal theory of semantic information. The theory assumes an ideal language system including all semantic statements. The amount of the statements are finite. Semantic statements are not the symbols representing them. Despite of the distinction, the formula measuring the amount of a semantic statement is structurally homogenous to Shannon's theory. The quantity of a semantic statement is measured by the probability of the occurrence of the statement in the language system. Less likely a statement happens in the system, more information it contains. However, the theory implies a paradox called Bar-Hillel-Carnap paradox by Floridi (2004b). According to the theory, we cannot decide the quantity of the information contained in a contradiction as it is infinite or none. Therefore, Floridi developed a theory of strongly semantic information based on alethic and discrepancy value rather than probabilities (Floridi 2004b, 2011).

No one would disagree that those theories are elegant in their form and ingenuity. However, scholars who want to find a theory explaining what information is dissatisfy with those formal theories. Some scholar, Dretske (1981), for instance, argues that semantic information is unmeasurable. Given the receiver already knows about the possibility of source, only when the conditional possibility of s being F is 1, can we say that a signal carries the information s is F. Some may argue against that the requirement is too strong to accept (Collier 2015). Dretske argues that if the conditional possibility is not 1, then the sent and the received message are two different message qualitatively even with a little bit of difference. We can of course always find a way to measure semantic information, but it is with respect to certain standards affording a particular purpose. In other words, whether semantic information is measurable depends on the purpose they aim to afford. That is to say, the formal theories take semantic information for granted, and then proceeds to bracket

it from consideration to deal with measurable features of information (Deacon 2010, p. 150).

Some researcher may argue that the ideal formal language system many logical and probability based theories presume do not exist. Chomsky has shown that all natural languages have the intrinsic capacity to generate an infinite number of well-formed sentences. (Brier 2015b), Thus, there is no such language can serve as the basis for those formal theories of semantic information. In addition, the language-centric framing in those theories is misleading that obscuring information's naturalistic and nondigital features. For example, "Does a sneeze have a meaning? Not in any standard sense, but it provides information "about" the state of a person who sneezed" (Deacon, 2016, personal communication).

Actually, the assumption behind those formal theories of semantic information is methodologically reductionism. All the theorists are aware of the fact that semantic information is different from the one handled by the mathematical theories. However, semantic content or meaning is not physical and thus has neither spatial nor temporal extension. While only things having extension are measurable. This is the reason why Descartes proposed mind-body dualism (Husserl 1936/1970) Therefore, in order to measure semantic information, it has to be transformed to something measurable methodologically, namely something has extension. As Descartes has already argued, only physical things have extension. Although semantic information cannot be reduced to physical properties, we can construct something having extension like physical ones but not physical with respect to particular criterions, aka some logical system. With the transformation, semantic content is reduced to something having extension methodologically. Then, the theories of semantic information cannot be generalized unconditionally unless come to embrace objective idealism like Hegel's. To put it differently, they are no help for those who want to explain information in full sense.

Opposite to the methodologically reductionist theories of information, the fundamentalist theories "treats it (information) as an unanalyzed primitive, and brackets its necessary physicality and efficacy from consideration in order to focus on intrinsic attributes" (Deacon 2010, p. 150). Generally, there are four kinds of theories. The mystical theory, Chalmers for instance, treats information as a basic property of the universe essentially different from other physical properties (Chalmers 1996). Information is not an *explanandum* but an *explanans*. This way is too counterintuitive for me. Some may argue that it does not solve but avoid the problem. The pan-informationalist or digitalist theories (Zuse 1967, 1969; Wheeler 1989; Schmidhuber 1997; Wolframe 2002; Dodig-Crnkovic 2011, to name a few) argue that the universe is fundamentally computable. As Floridi (2011) argues, the problem of the theories is that they lack specific boundary conditions under which they are workable and are thus empty. Another problem is that what we want is a theory being able to solve the problem "what is information?" While the answer those theories give is that "information is computable." Stonier (1997) identified information as organization being a basic property of the Cosmos. Then the term "information" is redundant as it is a synonymy of terms like organization, difference, structure, etc. Wu (2005) names a new subfield of the field of being the field of information and based on that new

ontology develops a philosophy of information in Chinese style. However, what we want to explain is information in the common sense practical and meaningful universe rather than to name something metaphysical as information (Zhou and Brier 2015).

There is a common and stubborn assumption hiding behind the superficial conflicts between methodologically reductionist and fundamentalist classes of theories. Both classes implicitly treat information as something substantial like physical entities, or singularly present (Deacon 2010). Like water flow and air flow in which molecular as substantial entities flow from one place to another, it seems we talk about the flow of information in a similar sense. Of course, some may argue that information is not something physically substantial but difference, pattern, form, or data, etc. However, as we see above, the assumption is misleading. Many have been aware that we should not see information as something substantial and singular.

Actually, we should formulate information under the consideration of the whole situation of information transmission, as Weaver has shown long ago (Weaver 1949). Since the whole situation of information, namely communication, comes across almost all levels of the world, from physical, to biological, to cognitive, to social, as well as the disciplines of natural science can be arranged as a hierarchy, many scholars think that we should understand information in a transdisciplinary approach (Collier 1990, 1999; Deacon 2007, 2008; Hofkirchner 2013, to name a few). One of the most promising ways in the approach is a conceptual framework developed by a Danish scholar Søren Brier. Through combining Peircean semiotics and Luhmann's social system theory, Brier calls his transdisciplinary framework cybersemiotics. In the rest of the chapter, I first try to show how the theory of information developed by Peirce based on semiotics brings new light to the problems of information. Then, I will argue that the shape of a theory of information, covering the explanations of physical, referential, and normative information, is visible with the new development contributed by cybersemiotics. At last, I will explain why cybersemiotics makes a difference.

11.4 Information in Formation: Peirce's Theory of Information

In recent years, some semioticians rediscovered an exciting fact that Peirce developed a theory of information based on his theory of sign or rather his semiotics. Peirce not only developed a theory of the measurement of information (see Nöth 2012) but also a theory explaining how signs convey information embodying their semiotic process (De Tienne 2005; Queiroz and El-Hani 2007; Liszka 2016). In this section, I focus on the latter part of the theory as the former roots in the latter (De Tienne 2005). I argue that the theory brings new light to the telic nature of information. While, as many (Weaver 1949; Deacon 2007; Hofkirchner 2013, for instance)

has recognized, the telic nature is the source of the hard problem. In his theory, Peirce shows that how meaning emerges in semiosis.

According to Peirce, semiosis can be defined as a triadic relation between a sign, its object and its interpretant. That is, sign, object and interpretant are the most basic constitutive elements of a semiosis. No one is reducible to another. Any description of semiosis involves a relation constituted by those three elementary terms. But the statuses of those three are not equal. In a semiosis, a sign is determined by its object and determines its interpretant. Put it differently, an object has an effect on one's mind, creating an interpretant, through a sign in semiosis. Obviously, the effect upon a mind is not a causal one. What is conveyed from the object to the mind by the sign in semiosis? Peirce says,

> … 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 (Peirce 1992, 1998, p. 22).

It is the form in an object being conveyed to create an interpretant in one's mind by a sign in semiosis. Integrating both definitions of sign, we can define semiosis as a triadic process of communication of a form from the Object to the Interpretant through Sign mediation (Queiroz and El-Hani 2007, p. 291). The account of sign as a medium of the communication of a form explains the order of determination in semiosis, too. Peirce clarifies,

> As a medium, the Sign is essentially in a triadic relation, to its Object which it is determined, and to its interpretant which it determines. In its relation to the Object, the Sign is passive; that is to say, its correspondence to the Object is brought about by an effect upon the Sign, the Object remaining unaffected. On the other hand, in its relation to the Interpretant the sign is active, determining the Interpretant without being itself thereby affected (Peirce 1967, p. 2).

As Liszka argues, the communication of form in semiosis have three phases: First, the object determines the sigh by its form. Second, the sign determines the interpretant in a similar way in which the sign is determined by the object's form. Third, the interpretant effects something in the sign agent in a way similar to how the sign relates to the object. (Liszka 2016). Queiroz and El-hani (2007) argues that the communication of a form is information. Some may still not immediately be satisfied with the theory. First, it does not provide an account of form. If the term form is in the sense of difference, pattern, or data, it just provides an account of physical information. The formulation of the communication of form from an object to an interpretant through the mediation also reminds us the formulation of "the flow of information" in which information is seen as something substantial and singular. It falls in methodological reductionism. While this is a trap we want to avoid. Or if it is in the sense of Stonier's concept of organization as a basic property of the universe, then it leads to fundamentalism. In short, without an explanation of form, Peirce's theory cannot be successful. Second, as I have argued, the theory seems does not solve the problem that how the telic nature of information emerges in

semiosis. Without the solution, we cannot distinguish the communication of form from data processing. It falls in methodological reductionism.

Actually, Peirce has solved both problems in his theory. Peirce begins his investigation of form with a Medieval debate: Do universals exist, or only individuals do and the universals are only nominal names for categories of individuals? (Liszka 2016, p. 53). Those who suggest universals exist are realists and those not are nominalists. Peirce stands with realists. He frames the question as that how a universal can present in an individual and answers it according to his semiotics. First, form is not a singular thing for Peirce. Although it is substantially embodied in the matter of an object, it can be conveyed to an interpretant by a sign which is outside the object (Peirce 1967, p. 3). It is something expressed as a regularity of its organization, or a habit. It is "…a representation of that state of things as represents only the sameness and diversities involved in that state of things, without definitely qualifying the subjects of the samenesses and diversities" (Peirce 1992, 1998, p. 378). In his most recent book, Deacon negatively frames the concept of form, regularity, or habit as the concept constraint. (Deacon 2012: chapter 6). He argues that a representation of sameness and diversities is realized through reducing those states, which would have possible implement, by a constraint. Through such formulation, the concept of form can get off from the trap of treating it as mental products. In short, a form is neither something substantial and singular nor some basic property of the universe.

The telic nature of information, or semiosis, originates from the personal purpose and "all general purposes flow down from it" (De Tienne 2005, p. 158). However, with the elaboration in semiosis, a form goes beyond the limitation of a personal purpose and acquires an objectively teleological nature in Peircean kind rather than Aristotelian. In Aristotelian teleology, the final purpose is the end expected state of an object. While in Peirce's semiotic philosophy that has affinities to Aristotelian view but now in an evolutionary objective idealist process philosophy, with the symbol as its central dynamic form. "Put briefly, … for Peirce every symbol is teleological in the sense that, being preoccupied with its own development into new interpretants" (De Tienne 2005, p. 157).

De Tienne (2005) owes the acquirement of the telic nature to two distinct functions of interpretant. First, an interpretant is being determined by the sign determining it to determine other interpretant relative to the object in a same triadic way the sign representing the object. Second, the interpretant also represents the very relation that the sign representing its object rather than the object merely, and thus provides another interpretant. The two functions help an interpretant anticipates other signs in two ways. The first function makes an interpretant anticipate the formation of other signs in mind, aka other interpretant. In cognitive semiotics, the anticipation helps a person form correct memory (Deacon 1997). The anticipation of an interpretant with the second function ensures the formation of signs embodying in the same triadic relation as the interpretant under similar circumstantial conditions in the future. Therefore, sign as the medium acquires the agency of replication in one's minds and in the future. "… there is a continuum or continuous history of anticipation that traverses any sign process from its origin within the dynamic object

to its end in (teleologically) final interpretant" (De Tienne 2005, p. 158).That is, sign as a medium of communication of form acquires objectively telic nature in semiosis.

Information as the communication of form is processual. Using De Tienne's term, information is a process constituted by three dimensions: exformation, transformation and metaformation. Thus the object emanates form for the proximate purpose of attracting attention to it, and for the remote purpose of fueling the semiotic telic engine. This is exformation. Transformation is the process of transmitting the form emanating from the object. "Signing is the art of conveying forms through other forms." (De Tienne 2005, p. 163). Metaformation is the effect made by the proactive interpretant when influenced by transformation. As we can see, Peirce's theory of information is neither reductionist nor fundamentalist. The next question is how information manifests at the different levels of the living world and grow into knowledge adapting to different dimensions of the world but is incompatible with each other. This is what cybersemiotics tries to answer.

11.5   At the Center of Cybersemiotic Star

A riddle cybersemiotics tries to answer is that how to bridge the gaps between natural, social and human science (Brier 2014b, 2015a, 2016). Through integrating Luhmann's system theory and Peircean semiotics, especially its contemporary development, biosemiotics, Brier develops a transdisciplinary conceptual framework called cybersemiotics. He believes that gaps between the logical space of nature and of reason can be bridged and thus provides a comprehensive account of information with the framework (Brier 2014a). In this section, I will argue that the framework provides a convincible account of how information grows to knowledge in different fields and thus answers the riddle of information.

Following Luhmann, Brier argues that the living world can be modelled as a triple autopoiesis model consisting of three systems: the biological, psychic and socio-communicative system. "Autopoiesis" is a term created by Maturana and Varela to refer to organizationally closed, self-reproduced and self-identified system (Maturana and Varela 1979, 1987). A biological autopoietic system refers to a living system individual which we normally name it as a physiological system. However, the description of autopoietic system is qualitatively different from the description of physiological systems in the standard biological science. The former has an agency that is experiential and meaningful while the latter is a subject of mechanistic natural science from a third-person perspective. A psychic autopoietic system is a description of the living system from the first-person perspective.

Socio-communicative autopoiesis builds on biological and psychic autopoiesis but is qualitatively different from them. Both biological and psychic autopiesis are silent in the sense that they are still in biological sphere. First, socio-communicative autopoiesis has no extension. It is a pure semiosis consisting of symbolic connections. Second, it has an intrinsic form of organization that transcends the biological

sphere. Through symbolic semiosis, it breaks through the limitation of individual autopoiesis and builds an inter-subjective sphere. "As psycho-biological beings, we live in symbiosis with the closed socio-communicative system that creates a culture and the intersubjective knowledge systems" (Brier 2008, p. 330). Brier thinks that Luhmann's system theory is not enough unless combining with Peircean biosemiotics. What distinguishes those three dimensions of autopoiesis are the ways of communication of form, namely semiosis or information, rather than their organizations or components. With the contribution of biosemiotics, Brier classifies four types of semiosis works in a socio-communicative system: endosemiosis, phenosemiosis, intrasemiosis and thought semiosis.

Endosemiosis refers to the semiosis that occurs within organisms, particularly those semiotic interactions at a purely biological level among cells, tissues, and organs. Phenosemiosis denotes to our inner feelings, perceptions, and volitions in their non-conceptual or prelinguistic forms that are not recognized by conceptual consciousness. There are also internal semiotic interactions between the psyche and the body different from endosemiosis. Brier calls it intrasemiosis. Thought semiosis describes semiotic interactions between the psyche and the language system. It not only makes some inner psychic states verbally expressible but also intersubjective communication possible. As we can see, these types of semiosis bridge the gaps between different levels of autopoiesis and different forms of autopoiesis at the same level. Endosemiosis happens between biological autopoietic systems. They make up a whole organism with the biological autopoiesis. As Brier says, we are still not clear about the relation between the biological and psychic autopoietic system (Brier 2008, p. 397). Intrasemiosis bridges the biological and psychic autopoiesis. Thought semiosis bridges psychic autopoiesis with socio-communicative autopoiesis. Every semiosis discussed here can be analyzed as exformation-transformation-metaformation process, aka information. However, sign games displayed at different levels of semiosis are different.

Endosemiosis consists of chemical signals among hormonal systems, signals in nervous systems, including the brain, transmitters in the immune system, etc. We should not confuse chemical signs conveyed in a living system with physical signals in an engineering communication system, like telecommunication system. The former help establish a second-order autopoietic system within a multicellular organism. The second-order autopoiesis means that every cellular in a multicellular organism is itself autopoietic and the endosemiosis happen between them constitute an autopoietic system again at a new level. It is an autopoiesis builds on autopoiesis. Actually, the emergence of autopoiesis at new levels is a distinctive feature of the living world. Based on the stipulation made above, it is convincible that similar sign games happen at the level of intrasemiosis.

Intrasemiosis is more about instinctual movements. Cognitive coupling, namely an instinctual movement ritualized and acquiring a value for a living system, happens at the level through coordination of behavior. He calls it languaging which termed by Maturana and Varela, but now in a Peircean semiotic context. Within evolution and life experience in which a human infant grows, sign games at the preliminary levels develop into language games. Our psyche is perfused with

language at this level. Semiosis at each level creates a distinctive significantion. Endosemiosis creates structural couplings, intrasemiosis creates instinctual signification, together with phenosemiosis, thought semiosis creates conceptual signification. Together, they create individual signification sphere.[2] Within language games, the communication between individuals creates cultural signification sphere. It constitutes the cybersemiotic model of information, signification, cognition and communication and thus provides a unified framework of them.

The model is at the heart of the cybersemiotic star. Four branches of knowledge grow from that heart. Each branch explains a dimension of the world: matter/energy, life/living systems, inner life/consciousness and sense/meaning. Respectively, we divide the knowledge in different disciplines classified as natural, social and human science.

11.6   Pragmaticism and Complementarity

Brier (2016) argues that the spirit behind cybersemiotics, namely Peirce's pragmaticism, can answer Emerson's riddle of the Sphinx. Peirce defines pragmaticism as a maxim, "Consider what effects, that might *conceivably* have practical bearings, you *conceive* the objects of your *conception* to have. Then, your *conception* of those effects is the whole of your *conception* of the object" (Peirce 1931–1958, 438). In other words, the knowledge of an object is not only about the object but also the effects someone conceives the object to have. Put it differently, the knowledge of an object is a combination between the object and the effects the knower conceives of. We have no knowledge about pure objects. I find that pragmaticism implies the complementarity principle Bohr used to solve the conceptual dilemmas in quantum physics (Bohr 1937). Bohr proposed the principle of complementarity to overcome certain conceptual difficulties in physics (Bohr 1937). The difficulties come from the inconsistency between the fundamental principles of macrophysics and of microphysics. There are two paradigmatic inconsistences. First, according to physical theory, the precise position and the precise momentum of a macroobject studied by macrophysics can be determined simultaneously. While such determination is not possible for microobjects, which are subjects of microphysics, according to Heisenberg's Uncertainty Principle. Second, according to macrophysical theory, any macroobjects that are corpuscular (C) and not wavelike (W) will always be C and not W, irrespective of the experimental arrangement by which it is investigated, and vice versa. While, according to microphysics, the same microobject can be both C but not W, and, W but not C at different times investigated by different experimental arrangements.

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[2] "Signification sphere" is a glossary created by Brier to denote the experiential, meaningful and significant world for an organism. It has analogue meaning with von Uexküll's "Umwelt", Maturana and Varela's "cognitive domain", and Hoffmeyer's "semiotic niche" but now in a cybersemiotic philosophical framework that draws on Peirce's semiotic view of evolution.

The way Bohr proposed to overcome the epistemological dilemma is the principle of complementarity. In order to solve the difficulties, Bohr first distinguished the phenomena that are explained by microphysics from the phenomena that are explained by macrophysics. The observed phenomena of a macroobject are independent of the experimental arrangements by which it is investigated. While the situation is different in the case of microobjects. We cannot explain the observed phenomena of a microobject irrespective of the experimental arrangements by which it is investigated. Then, Bohr redefined the phenomena of microobjects in a way different from the way define the phenomena of macroobjects. Instead of defining the phenomena by assigning properties to an object irrespective of the experimental arrangements with which it is explored, he argued that the assignment of the properties to microobjects is relative to the experimental arrangement used to investigate it. For Bohr, it is meaningless to assign a property to a microobject without combining with the related experimental arrangement. Therefore, different from macrophysics, the same microobject under two different experimental arrangements used by which to investigate it are two different phenomena, and thus two different things. For Bohr (1937), these two pairwise phenomena stand in a relation of complementarity for an observer. Thus, the principle of complementarity helps get out of the epistemological dilemma.

Bohr (1937) believed that the principle can be generalized and extended to fields other than physics but did not argue it in detail. Lindenberg and Oppenheim (1974) fulfil Bohr's wish. They reformulate the epistemological dilemma in physics as assignment paradoxes. A person P encounters an assignment paradox relative to a character Ch if and only if (a) according to P, Ch is intentionally permanent; (b) there are entities$_1$ (in domain$_1$) with respect to which the assignment of Ch by P are *de facto* permanent; (c) there are entities$_2$ (in domain$_2$) with respect to which the assignment of Ch by P are not *de facto* permanent. The assignment paradox can be removed by redefining the object investigated. In the situation of encountering an assignment paradox, we should not separate the object and the context in which it is investigated. That is, the same object investigated in a different context are different things. Then the assignment paradox is removed. Formally, we can define complementarity as: Given characters Ch' and Ch'', and given mutually exclusive contexts C' and C', then two phenomenon Ph' and Ph'' is complementarity for a person P if and only if: (a) P is confronted with an assignment paradox relative to Ch' and Ch'' if he assigns them to entities *per se* in domain$_2$; (b) assignments of Ch' and Ch'' by P to the entities depend on C' and C'; (c) the assignment paradox is removed by assigning Ch' and Ch'' to Ph' and Ph'' respectively rather than the entities *per se*.

Isomorphically, given physical information as Phy, referential information as Ref, and normative information as Nor, we can construct the assignment paradox of information as: (a) A person P intentionally assign characteristics Phy, Ref and Nor to information at the same time; (b) there are entities in domain$_1$ with respect to which the assignment of Phy, Ref and Nor by P at the same time are *de facto* permanent; (c) there are entities in domain$_2$ with respect to which the assignment of Phy, Ref and Nor by P at the same time are not *de facto* permanent.

Similarly, the assignment paradox can be removed by complementarity in information studies: Given Phy, Ref and Nor, and given mutually exclusive scientific theories of information, then phenomena Ph(Phy), Ph(Ref) and Ph(Nor) are complementarity for a person P if and only if: (a) P is confronted with an assignment paradox relative to Phy, Ref and Nor if he assigns them to information *per se* in domain$_2$; (b) assignments of Phy, Ref and Nor by P to the entities depend on relative particular discourses;[3] (c) the assignment paradox is removed by assigning Phy, Ref and Nor to Ph(Phy), Ph(Ref) and Ph(Nor) respectively rather than the entities *per se*.

According to the formulation, physical, referential, and normative information are actually different phenomena. It is elliptical and meaningless to talk about information *per se* in information studies. We cannot separate information from the context in which it is investigated. Physical, referential and normative information stand in a relation of complementarity for researchers. This is why Brier argues that there are four branches of knowledge in cybersemiotics star rather than constructs a reductionist hierarchical or fundamentalist model of semiosis and knowledge. In a nutshell, with Peirce's theory of information, cybersemiotics and the complementarity principle in pragmaticist sense, the conflicts and inconsistencies in information studies can be understood as perspective conversions. When we converse our perspectives, the theoretical contexts in which we investigate information changes. It is meaningless to talk about information without combining with the related theoretical context in which it is investigated. Therefore, this is why methodologically reductionist theories are too limited to give a complete account of information, and fundamentalist theories are doomed to fail. This is also why cybersemiotics star is necessary for information studies.

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[3] I assume there would be a discourse by means of which Nor is investigated.

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