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Information is the enclosure of meaning: Cybernetics, semiotics, and alternative theories of information



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ABSTRACT

This essay carefully reviews and further develops some overlooked theories of information, grounding them in a more general theory of meaning. And it argues that information is best understood as the enclosure of meaning: an attempt to render a highly messy and stereotypically human process relatively formal, quantifiable, and context-independent. It highlights the ideas of Donald MacKay in relation to those of Claude Shannon, and it foregrounds the semiotic framework of Charles Sanders Peirce in relation to cybernetics (and the then-incipient discipline of computer science). It shows how Katherine Hayles and Mark Hansen, two influential theorists of new media, misread MacKay in their attempt to put the 'human' (as well as affect, meaning, the body, and so forth) back into a theory of information. And it thereby shows that the framework these theorists seek was, in some sense, already well developed before cybernetics even entered the scene. It offers two alternative definitions of information, one focusing on interaction (individuals and practices) and the other focusing on institutions (collectivities and structures), that effectively mediate between relatively quantitative theories of information and relatively qualitative theories of meaning.

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1. Introduction

At the most abstract level, this essay argues that *information is the enclosure of meaning*. In part, this means that information is a species of meaning that is relatively regimented as to its use-value, truth-value, and exchange-value. In part, this means that it is a species of meaning that has been relatively mediated by technology, science, and economy. And in part, this means that the values in question (be they signs, objects, or interpretants) become relatively portable: not so much independent of context, as dependent on contexts which have been engineered so as to be relatively ubiquitous, and hence seemingly context-free.¹

While the focus in what follows will be on the relation between information and meaning (and thus, relatively speaking, the relation between signs and objects), we could also focus on the signer–interpreter (or sender–receiver) relation, and argue that infrastructure is the enclosure of interaction (Kockelman, 2011). And we could focus on the sign–interpretant (or input–output) relation, and argue that computation is the enclosure of interpretation (Kockelman, 2013). In this way, we could focus on a *set of concomitant processes whereby semiosis gets not only automated, but also formatted and networked*. This essay should thus be understood as just one part of a much larger project.

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¹ Kockelman (2007a, 2013; and see Bernstein and Kockelman 2013) takes up the notion of enclosure in a more general and developed sense. In particular, the other modes of enclosure discussed there should be understood as applicable to information (meaning), computation (interpretation), and infrastructure (interaction) as well. Reasons of space prohibit the pursuit of this more general framing here.

Such a relatively abstract claim is necessarily grounded in many concrete details. And so, in making such a claim, several alternative approaches—or *counter-frameworks*—for understanding information will be carefully described. Section 2 reviews the ideas of Donald MacKay, in relation to those of Claude Shannon, foregrounding the relation between three relatively technical and quantitative kinds of information-content: selectional (Shannon's original definition, which turns on the relative improbability of a message given an ensemble of messages), structural (which turns on the frame of relevance that is used to construct a mapping between messages and referents), and metrical (which turns on the degree of resolution such a mapping is capable of capturing). It also discusses the relation between information per se and meaning, which MacKay understood as the effect a message has on an interpreting agent.

Section 3 then shows how two influential theorists of new media, Katherine Hayles and Mark Hansen, misread MacKay (jumbling and eliding his various distinctions), and discusses some of the consequences of their misreading for humanist critiques of cybernetic theory, with their attempts to use MacKay and similar theorists to recover 'the body', 'affect', and so forth. Section 4 introduces the most relevant categories from Peirce's theory of meaning, showing their relation to MacKay's ideas, as well as to key concerns in the history of cybernetics and computer science more generally. Together, these two sections show how much of what Hayles and Hansen want from a theory of meaning (in relation to information), and a theory of interpretation (in relation to embodiment and affect), may be found in Peirce's work (and much more besides).

Section 5 then goes on to carefully develop two other ways of understanding information that are particularly important for understanding the relation between information as it is localized in an utterance (topic, focus, argument) and information as it is shared by a collectivity (denotation, connotation, information). In this way, it foregrounds two ways of framing information that are relatively human-specific, interaction-centered, and institution-based. Such frames are particularly important in that they function as a kind of stepping stone between information-content in the relatively specific and quantitative sense and meaning in the relatively general and qualitative sense.

2. Information and meaning as theorized by MacKay

MacKay (1922–1987) was a British physicist, and a participant in both the London Symposia on Information Theory and the American Conferences on Cybernetics (sponsored by the Josiah Macy Jr. Foundation). His essays spanned some 20 years, and ranged from popular radio broadcasts, through technical papers, to RAND memos. With the encouragement of his friend, the linguist and literary theorist Roman Jakobson (himself heavily indebted to the ideas of Peirce), many of these were collected into a book, entitled *Information, Mechanism and Meaning* (1969a).

Throughout these essays, MacKay consistently distinguished between the everyday sense of information (i.e. when one learns something one didn't know before) and *information-content*: or the amount of information a message contains when measured through some technical means (1969b, p. 18). In a broad sense, then, MacKay's theory of information is concerned with the "processes by which representations come into being, together with the theory of those abstract features which are common to a representation and that which it represents" (1969f, p. 80). Whereas in a narrow, more technical sense, his theory is concerned with the "problem of measuring changes in knowledge" (1969h, p. 156).

As for information-content, MacKay thought there were three basic types: selectional, structural and metrical (1969b). *Selectional information-content* was just *Shannon's original measure* (1948), and turned on the relative improbability, or surprise-value, of an actual message (given an ensemble of possible messages). Loosely speaking, the less likely a message, the more informative it is. Such a measure could be used to understand the replication of representations (which MacKay took to be the central function of communication, following Shannon). Structural and metrical information-content, in contrast, were used to understand the production of representations (which MacKay took to be the central function of science). In particular, *structural information-content* turned on the degrees of freedom, or number of independently specifiable dimensions, underlying a system of representations (so far as such representations have these in common with the states of affairs they represent). And *metrical information-content* turned on the precision, or reliability, of a given measurement along any such dimension. MacKay sometimes grouped structural and metrical information-content together as information "by construction" (1969h, p. 160) or as "descriptive information-content" (1969b, p. 12).

One example should suffice to give the reader a sense of how these three kinds of information-content relate to each other, as well as the details of their actual measurement. Suppose we are trying to design a representational system for describing the location of an object. The structural information-content of such a system turns on the number of dimensions we are trying to locate the object in: say, along a line (one dimension), in a plane (two dimensions), or within a volume (three dimensions). The metrical information-content of such a system turns on the precision with which we can locate the object along any of its dimensions: say, to within a millimeter (along a line), to within a square centimeter (in a plane), or to within a cubic meter (within a volume). All things being equal, if we increase the number of dimensions in which we measure (say, from two dimensions to three dimensions), or the precision of measurement along a dimension (say, from centimeters to millimeters), we increase the structural and metrical information-content, respectively.

Suppose we have constructed a system of representations in this way, such that we can now specify where an object is located in a square meter of space to within a square centimeter. This means our system has the ability to represent 10,000 possible positions (or one message for each square centimeter in the square meter). If we now want to communicate the position of an object to another (using this system of representation), we can send one of 10,000 possible messages to them. Assuming each message is equally likely (because the object is equally likely to be located at any position), the selectional

information-content of any actual message is $-\log_2(1/10,000)$, or about 13 bits.² That is, the selectional information-content of a given message is $-\log_2(p)$, where p is the probability of that message given an ensemble of possible messages. This is just Shannon's original measure. (The information-content of a single message is the same as the average information-content of an ensemble of messages when all messages are equally probable.)

Notice how this selectional information-content is directly related to the structural and metrical information-content: together structural and metrical information-content determine the number of possible messages, and hence the 'size' of the ensemble of messages. In this example, increasing the precision (say, to a square millimeter), or adding a dimension (say, height) would increase the number of possible messages that could be communicated, thereby decreasing the probability that any one of them is sent, thereby increasing the 'surprise-value', or selectional information-content, of the actual message that is sent. Even though he was at pains to distinguish the three kinds of information-content, MacKay also stressed their interrelatedness. In one metaphor, for example, he likened them to volume (selectional), area (structural), and width (metrical). This suggests that he understood structural and metrical information-content to be presupposed by selectional information-content (1969b). Indeed, Brillouin (1962 [1956], p. 291) would later argue that MacKay's usage of structural and metrical information-content was already built into selective information-content, and so that only a single theory of information was needed—in particular, Shannon's original measure. And while this is true, in some sense, MacKay's ideas were important because they stressed the highly motivated, or relatively iconic and indexical, relation between the system of representations per se (qua signs) and the states of affairs it could represent (qua objects).³

In some sense, then, structural information-content is a *frame of relevance*, and metrical information-content is a *degree of resolution* (Kockelman, 2009). The exact same entity or event may be represented using different frames of relevance with different degrees of resolution, depending on the semiotic system (language, construction, theory, instrument, picture, world-views, *episteme*, etc.) of those doing the representing. *And as a function of which frame of relevance is used, with what degree of resolution, the ensemble of possible representations may vary (as well as the probability of any representation within this ensemble), and with this the selectional information-content (or Shannon measure) of any particular representation (qua message).* Thus, while many physical systems have a 'natural' frame of relevance (e.g. phase space, or the positions and momenta of all the particles in the system) and a 'natural' degree of resolution (e.g. Planck's constant, or 6.62×10^{-34} m² kg/s), most other systems have their frame of relevance and degree of resolution, or structural and metrical information-content, projected onto them by the observer—and hence their selectional information-content as well. Note, then, that the ideas of structural and metrical information-content were not invented by MacKay; but were rather well-known (even if called something else) to physicists such as Boltzmann and Gibbs (1960 [1902]), as well as communication engineers like Gabor (1946).

A key issue for critical theory is to understand the conditions for, and consequences of, the frame of relevance and degree of resolution that is projected onto a particular domain (experience, individual, event, etc.), such that its information-content can be reckoned in such ways—for instance, the way different degrees of resolution and frames of reference presume and produce different kinds of social relations, conceptual categories, and moral values. This is one way to refigure what McLuhan meant when he spoke about 'the new *scale* that is introduced into our affairs by each extension of ourselves, or by any new technology [qua medium]' (1994 [1964], p. 7), italics added). Different forms of media, and not just different kinds of digital media per se, presume and produce different frames of relevance and degrees of resolution, and hence different kinds of selves who can sense and instigate, as well as communicate and cogitate, through such media on such scales.

In addition to his account of information, MacKay also offered an account of meaning—by which he meant the effect a representation has on a receiver (1969c, 1969f, 1969g). In particular, MacKay understood the meaning of a representation in terms of its selective function on the ensemble of possible states of conditional readiness of the receiver. His metaphor for this process involved keys, switch boxes, and railroad tracks. In particular, just as a key, when placed in a switch box, changes the possible configuration of railway tracks (such that any train that subsequently arrives will have its movement channeled in a particular way); a representation, when interpreted by a mind, affects the interpreter's subsequent readiness to behave in a variety of circumstances—making some behaviors more likely, and other behaviors less likely. Out of all possible states of conditional readiness (or out of all possible configurations of tracks), the representation (or key) selects only a subset. And it is this selective function—of an actual state of conditional readiness, from an ensemble of possible states of

² Perhaps the simplest, and yet most important, mode of enclosure is evident in a seemingly innocent expression like *three bits of information* (as well as related expressions like *100 gigabytes of data*, and so forth). Such an expression presumes that we can quantify (via a number like *three* and a unit like the *bit*) a particular quality (via a utility, or a relatively desirable and potentially useful substance, like *information*). This is how use-value, in Marx's original sense, gets projected onto meaning. Such use-values, needless to say, are concomitantly caught up in economic value: for example, they can have prices associated with them. Moreover, they can be subject to deontic value: there can be laws, norms, and conventions that govern their usage. In this way, issues arise such as how much does a certain amount of storage space (channel capacity or processing speed) cost, as well as how much space (capacity or speed) is one entitled to have or required to provide. And such expressions are also caught up in semantic value, taking their place alongside analogous constructions like *three bushels of wheat*, *four bricks of gold*, and *two hours of time*. And, as per Whorf's original formulation, and through the lens of Sapir's notion of projection, information seems to be a formless substance (qua mass noun) in need of a substanceless form (qua unit), and thereby subject to precise calculations as to its quantity (Kockelman, 2006b; Bernstein and Kockelman 2013). Shannon's original formulation was particularly important, then, not only because it defined the quality (information qua utility) so carefully, and clarified what was to be meant by the basic unit (a bit), but also because it provided a relatively precise and general way to calculate the number of units of the quality in question for a given symbolic system.

³ That said, anyone who has ever tried to calculate the selectional information-content of a particular message, or ensemble of messages, should know that the calculation is similar to Marx's understanding of how value (or abstract temporality) is to be calculated. And so selectional information-content (which might seem highly 'symbolic', and thus relatively conventional and context-independent) is also highly indexical and iconic: "indexical because in any statistical ensemble each part is related to every other part of the whole; iconic because inversely-proportional as part is to whole" (Kockelman, 2006, p. 93).

conditional readiness—that MacKay took to be the operationalizable essence of meaning. As he phrased it, the meaning of a message is “its selective function on the range of the recipient’s states of conditional readiness for goal-directed action” (1969c, p. 24).

Note, then, that just as selective information-content (or Shannon information) turns on the relation between a message and an ensemble of possible messages (given structural and metrical information-content), meaning for MacKay turns on the relationship between a state of conditional readiness and an ensemble of possible states of conditional readiness. This is crucial: while meaning was, in some sense, ‘in the head’ (and body and world) of the receiver (and thus difficult to measure, even though its repercussions might be eminently observable), if it could be measured it would have the same metric (mathematically speaking) as selective information-content, just applied to a different ensemble (1969e, p. 71). (Indeed, while MacKay did not take it up, there is no reason not to think that the ensemble of responses, like the ensemble of messages, depends on a frame of relevance and a degree of resolution—but now one that is grounded in the interpretation of a message rather than its signification.⁴)

In short, MacKay’s theory of information focused on three interrelated processes: the production of representations, the replication of representations, and the interpretation of representations. Producing (systems of) representations was the work of scientific research; and structural and metrical information-content were its most appropriate measures. The replication of representations was the work of communication engineers, who designed systems which would reproduce a given signal (from an ensemble of possible signals) at a different point. Shannon’s measure of information, or selectional information-content, was designed with such transmissions in mind. And MacKay worked hard to show how it presupposed structural and metrical information-content—for together they determined the size of the ensemble of possible representations that could be sent. Moreover, they were the key means by which the representation made contact, or had features in common, with the state of affairs so represented. Finally, the interpretation of a representation involved the effect a message had on the ensemble of states of conditional readiness of the receiver. If such states of readiness could be observed, or counted over, then this would have a measure identical to selective information-content: they just turned on different ensembles, the relation between a message and an ensemble of possible messages (given some code); or the relation between a state of readiness and an ensemble of possible states of readiness (given some mind). While the numerical values might be different (because the ensembles are different), MacKay thought Shannon’s measure could still be applied here.

3. MacKay as read by Hayles and Hansen

How We Became Post-Human (1999), by Katherine Hayles, and *New Philosophy for New Media* (2004), by Mark Hansen, were highly influential humanist critiques of certain trends in cybernetics and digital media studies. In these books, Hayles and Hansen were concerned with the relation between meaning and information; and both articulated their concerns, in part, by contrasting the ideas of MacKay with those of Shannon. In particular, both thought MacKay had the broader and more embodied theory of meaning; and so, by engaging with his otherwise relatively forgotten work, scholars might be able to think beyond the (seemingly) ahumanist or posthumanist stance of cybernetic theory. Given the foregoing account of MacKay’s key ideas, which tried to be faithful to both his terminology and his conceptual framework, we may now ask how well Hayles and Hansen understood him.

We may begin with a quote from Hayles:

MacKay’s first move was to rescue information that affected the receiver’s mindset from the “subjective” label. He proposed that both Shannon and Bavelas were concerned with what he called “selective information,” that is, information calculated by considering the selection of message elements from a set. But selective information alone is not enough; also required is another kind of information that he called “structural.” Structural information indicates how selective information is to be understood; it is a message about how to interpret a message—that is, it is metacommunication (1999, p. 55).

As seen in this passage, Hayles is not careful to maintain MacKay’s distinction between information and information-content. This is a minor point, to be sure; but it is surprising given MacKay’s own insistence on the difference (as well his consistent usage of the terms); and it has repercussions for her ability to make sense of his theory. More importantly, she also creates a false opposition between “selective information” and “structural information” (or rather information-content), by removing metrical information-content altogether.⁵ Moreover, her definition of structural information-content has almost nothing to do with what MacKay said (as described in the last section). Indeed, the term ‘meta-communication’ is not used

⁴ Indeed, if the signer and the interpreter are using the same code (such that their frames of relevance and degrees of resolution are identical), then the selectional information-content of both the message and the response would be the same. But they can also be different. To go back to our example: if the receiver of the representation only cares about (and would be ready to act on) where something is located along the x -axis, and not in the x - y plane, then of the 10,000 possible messages that could be sent, only 100 different groups of messages make any difference. In other words, because the receiver’s frame of relevance is different from the sender’s, the information-content of the message is different from the information-content of its meaning.

⁵ In (1969c, p. 27), MacKay contrasts structuralist approaches to meaning (exemplified by Russell) and functionalist approaches to meaning (exemplified by the later Wittgenstein). One possibility is that Hayles is using this sense of structure (in opposition to function, qua meaning or effect) to mean both structural and metrical information-content.

by MacKay, and the concept (messages about how to interpret messages) is not articulated by him.⁶ Rather, this idea is usually attributed to Bateson (1972 [1954], *inter alia*), as most carefully elaborated by Goffman (1974, 1981).⁷ Furthermore, neither structural information-content, nor metrical information-content, are ‘messages’ at all. Indeed, selective information-content is not a message either; it is a way to measure the surprise-value of a message (or the average surprise-value of an ensemble of possible messages). So Hayes’s failure to distinguish between information in the lay-sense and information-content in the technical sense, also leads her to speak of selective and structural information-content as if they were messages, rather than properties of messages given ensembles of possible messages and the relation between messages and referents.

Finally, perhaps most surprising given her stated aims, Hayes leaves out MacKay’s theory of meaning altogether. In particular, structural (and metrical) information-content were well known to physicists (and, I assume Shannon) before MacKay introduced them, even if they were called something different (e.g. phase space), and not related to selective information-content per se (but rather entropy). And so MacKay’s more original contribution is his account of meaning—or how to conceptualize the effects of messages on the receiver’s mind. Strangely, Hayles seems to think that structural information-content (which, for MacKay, turns on the sign-object, or message-referent, relation) is really about meaning (which, for MacKay, turns on the sign-interpretant, or message-response, relation): “Since structural information indicates how a message should be interpreted, semantics necessarily enters the picture. In sharp contrast to message probabilities, which have no connection with meaning, structural information was to be calculated through changes brought about in the receiver’s mind” (1999, p. 55). We saw above how structural information-content is to be calculated; here Hayles has conflated it with meaning. Finally, Hayles suggests that, “The problem was how to quantify the model. To achieve quantification, a mathematical model was needed for the changes that a measure triggered in the receiver’s mind. The staggering problems this presented no doubt explain why MacKay’s version of information theory was not widely accepted” (1999, p. 56). Assuming that Hayles is here talking about meaning, rather than structural and metrical information-content (which were certainly quantified), MacKay had precisely offered a quantifiable model of meaning: in particular, he thought one could use selective information-content (with all the rich mathematical machinery that Shannon had provided) as applied to a different ensemble. The problem with MacKay’s account of meaning was not mathematical quantification; the problem was empirical measurement.

Now we may turn to a key passage from Hansen:

MacKay’s whole theory of information is . . . concerned with reconciling two processes, or two *sides* of the process of communication: on the one hand, the production of representations, and on the other, the effect or function of representations, which is equivalent, as we shall see to their reception (though not to their observable behavioral consequences). MacKay distinguishes these two sides of the process of communication as *selection* and *construction*; the former corresponds to Shannon’s technical definition of information, and the latter designates factors that specify the context for the operation of selection (2004, p. 78).

While Hansen, in part, builds on Hayles, he offers a more nuanced account of MacKay (and, indeed, gently critiques her interpretation in a footnote). Nonetheless his account is also very far off from what MacKay said. In particular, as seen in this passage, while Hansen justly focuses on the relation between the production of representations and the effect of representations, he maps these onto selection and construction, respectively. Selection is just Shannon’s measure of information-content. In contrast, Hansen uses the term construction to “[designate] factors that specify the context for the operation of selection” (2004, p. 78). To see how far off this is from MacKay, first note that the term “construction” was not a technical term for MacKay (in fact, one has to hunt to find it in his writings). And when it is used, it refers to the combination of structural and metrical information-content (as opposed to selective information-content). One may take these to turn on what Hansen calls “factors that specify the context for the operation of selection” (2004, p. 78); and, indeed, this is what Hayles seems to have in mind when she characterizes structural information-content as “[indicating] how selective information is to be understood” (1999, p. 55). But then notice how watered down these descriptions would be given MacKay’s actual account of structural and metrical information-content.

More importantly, while Hansen pairs the effect of representations with construction, and the production of representations with selection, it was precisely structural and metrical information-content that MacKay thought went into the production of representations (as opposed to their replication or effect). In this way, Hansen gets the mapping wrong (and, indeed, the size of the domain and range of the mapping wrong). The appropriate mapping should really be: construction (of representation) maps onto structural and metrical information-content; replication maps onto selective information-content; and effect maps onto meaning, or change in conditional readiness (which itself, as shown above, may be measured in terms of the selective information-content of a different ensemble).⁸ That said, Hansen does justly identify the importance of MacKay’s ideas to be in his insistence on the interpreter’s framing of the meaning of the message, and hence the effect of the message on the receiver’s state of conditional readiness.

⁶ MacKay does refer to file boxes (1969c, p. 26). And at one point he mentions meta-communication like functions; but these are never used in the way Hayles says.

⁷ Goffman (1981) used the term ‘key’ to refer to any semiotic means we have for indicating how our message is to be understood: for example, an intonation pattern might indicate that we are reporting someone’s words rather than composing our own; or a wink may indicate that our utterance is meant to be ironic rather than serious. As seen above, MacKay also uses the word ‘key’, but only in his metaphor of the switch-box and train tracks. So Hayles might have been invoking Bateson and Goffman.

⁸ What may have happened is that Hansen took MacKay’s description of two key trends in the philosophy of language—structural and functional—and mapped selection onto the former and construction onto the latter.

The point of all of this is not to simply critique Hayles and Hansen: their scholarship is usually careful; their arguments are often compelling; and their books were well received and widely cited. But one may wonder why MacKay, when sympathetically read by two scholars who want to recover his ideas in order to challenge certain kinds of technical myopia, is so badly misread. Moreover, one may ask why they go to MacKay, rather than a range of other thinkers, to get the ideas that they attribute to MacKay—in particular, the idea that he somehow had a solution to Shannon's banishment of meaning from a theory of information; or the idea that his theory of meaning was most fully 'embodied'.⁹

As a contemporary of Shannon, as a co-participant in many conferences, and as a once contrasting but now faint voice, there are good reasons to recover MacKay's ideas; but a far more prescient theory of meaning, itself inclusive of MacKay's key ideas, and much larger in scope, had already been introduced. So instead of answering these questions per se, the next two sections will describe some of the ideas of Charles Sanders Peirce insofar as they resonate with key ideas of MacKay and Shannon regarding meaning and information, and insofar as they resonate with key concerns of contemporary scholars of literature and aesthetics, like Hayles and Hansen, regarding embodiment and affect.

4. Peirce's theory of meaning

Peirce (1839–1914) was an American philosopher, mathematician and logician. He is perhaps best known for his theory of semiotics, with its focus on logic and nature, and the ways this theory contrasted with Saussure's semiology, with its focus on language and convention. In particular, he foregrounded iconic and indexical relations between signs and objects, theorizing the way meaning is motivated and context-bound. And he foregrounded inferential relations between signs and interpretants, foregrounding the role of abduction (or hypothesis) over deduction and induction, and thereby the role of context over code.

He is particularly relevant in the context of the information sciences for a number of other reasons. For example, 50 years before Shannon's famous masters thesis (1937), Peirce had seen the connection between Boolean algebra and electrical circuits (Chiu et al., 2005, p. 22). Writing between the eras of Babbage and Turing, Peirce had thought about logical machines (1887; and see Mirowski, 2001, pp. 31–43); and he offered two compelling definitions of virtuality (1902; and see Skagestad, 2010). Like Shannon and MacKay, Peirce was interested in the statistical nature of information, and measurement more generally, being the first to put confidence intervals on a proper philosophical footing (Hacking, 2001, p. 266). And, perhaps most importantly, before Shannon's mathematical theory of information, Peirce had developed a complementary theory of information, which itself was a small part of a broader theory of meaning. Rather than explore all of these fascinating connections, this section and the next focus on two pieces of Peirce's thought: first, his understanding of interpretants of signs (which are akin to MacKay's responses to messages, or 'meaning'); and second, his understanding of information, or the production of new knowledge, within his broader theory of meaning.

For Peirce, a meaningful process has three components: a sign (whatever stands for something else); an object (whatever is stood for by a sign); and an interpretant (whatever a sign creates so far as it stands for an object). These components easily map onto some of the terms used above, such as message (sign), referent (object), and response (interpretant); but, as will be shown below, they are much broader in scope. They also map onto Shannon and Weaver (1949), in his famous introduction to Shannon's *Mathematical Theory of Communication*, between three levels of communication: the technical level (qua reproduction of signs); the semantic level (qua signification of objects); and the effectiveness level (qua creation of interpretants). As Weaver also notes in that introduction, Shannon's theory of information (what MacKay calls selective information-content) deals with the first component (even if it may have repercussions for the second and third components, as MacKay tried to show).¹⁰

While Peirce's distinction between sign and object maps onto Saussure's distinction between signifier and signified (with a few caveats), Peirce's real contribution for the current argument is his foregrounding of the interpretant, and how it relates to the sign-object relation. In particular, any meaningful process relates these three components in the following way: a sign stands for its object on the one hand, and its interpretant on the other, in such a way as to make the interpretant stand in relation to the object corresponding to its own relation to the object (Peirce, 1955a, pp. 99–100). What is at issue in meaningfulness, then, is not one relation between a sign and an object (qua 'standing for'), but rather a relation between two such relations (qua 'correspondence'). The logic of this *relation between relations* is shown in Fig. 1.

For example, *joint-attention* is a meaningful process (Kockelman, 2005). In particular, a child turning to observe what her father is observing, or turning to look at where her mother is pointing, involves an interpretant (the child's change of attention), an object (what the parent is attending to, or pointing towards), and a sign (the parent's direction of attention, or gesture that directs attention). As Mead noted (1934), any *interaction* is a meaningful process. For example, if I pull back my fist (first phase of an action, or the sign), you duck (reaction, or the interpretant) insofar as my next move (second phase of action, or the object) would be to punch you. Generalizing interaction, the *pair-part structures* of everyday interaction—the fact that questions are usually followed by answers, offers by acceptances, commands by undertakings, assessments by agree-

⁹ Which is itself one of the most problematic of terms, so I wouldn't put much weight on it myself.

¹⁰ The following six paragraphs are adapted from Kockelman (2005, 2007b). Crucially, this is a bare-bones and somewhat idiosyncratic interpretation of some of his ideas. Colapietro (1989) and Parmentier (1994) offer very careful and helpful discussions of his writings in their own terms. Finally, it should be emphasized that this essay is not meant to endorse Peirce's ideas per se. Rather, in regards to meaning, and significance and selection more generally, he may be understood as offering a small (albeit crucially important) piece of a much larger puzzle (see Kockelman, 2013, Chapter 2, for details).

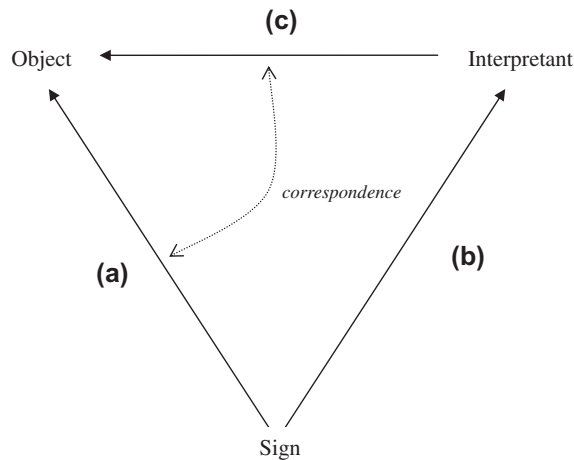


Fig. 1. Semiosis as a relation between relations. A sign stands for its object on the one hand (a), and its interpretant on the other (b), in such a way as to bring the latter into a relation to the former (c) *corresponding* to its own relation to the former (a).

ments, and so forth (Sacks et al., 1974)—consist of meaningful processes in which two components (the sign and interpretant) are foregrounded. In particular, a type of utterance (or action) gives rise to another type of utterance (or action) insofar as it is understood to express a proposition (or purpose).

Indeed, the constituents of so called ‘material culture’ are meaningful processes (Kockelman, 2006a, 2013). For example, an *affordance* is a semiotic process whose sign is a natural feature, whose object is a purchase, and whose key interpretant is an action that heeds that feature, or an instrument that incorporates that feature (so far as the feature ‘provides purchase’). For example, walking carefully over a frozen pond (as an action) is an interpretant of the purchase provided by ice (as an affordance), insofar as such a form of movement heeds the slipperiness of ice. An *instrument* is a meaningful process whose sign is an artifacted entity, whose object is a function, and whose key interpretant is an action that wields that entity, or another instrument that incorporates that instrument (so far as it ‘serves a function’). For example, a knife (as an instrument) is an interpretant of the purchase provided by steel (as another affordance or instrument), insofar as such a tool incorporates the hardness and sharpness of steel. Indeed, even commodities are meaningful processes (Kockelman, 2006b): the sign-component is a use-value (such as an instrument or affordance); the object-component is a value; and the interpretant-component is an exchange-value. For Peirce, then, meaning is as much embedded (in the people and things around us, and their relations to each other), as it is embodied and enminded.

While many scholars are familiar with Peirce’s distinction between icons, indices, and symbols, most are not familiar with his threefold typology of interpretants—and so these should be fleshed out in detail. In particular, as inspired by Peirce, there are three basic types of interpretants (1955c, pp. 276–277; Kockelman, 2005). An *affective interpretant* is a change in one’s bodily state. It can range from an increase in metabolism to a blush, from a feeling of pain to a feeling of being off-balance, from sweating to an erection. This change in bodily state is itself a sign that is potentially perceptible to the body’s owner, or others who can perceive the owner’s body. And, as signs themselves, these interpretants may lead to subsequent, and perhaps more developed, interpretants. *Energetic interpretants* involve effort, and individual causality; they do not necessarily involve purpose, intention, or planning. For example, flinching at the sound of a gun is an energetic interpretant; as is craning one’s neck to see what made a sound; as is saluting a superior when she walks by; as is wielding an instrument (say, pounding in a nail with a hammer); as is heeding an affordance (say, tiptoeing on a creaky floor). And *representational interpretants* are signs with propositional content, such as an assertion (or explicit speech act more generally). Thus, to describe someone’s movement as ‘he raised his hand,’ is to offer an interpretant of such a controlled behavior (qua sign) so far as it has a purpose (qua object). And hence while such representations are signs (that may be subsequently interpreted), they are also interpretants (of prior signs). Finally, it should be emphasized that the same sign can lead to different kinds of interpretants—sometimes simultaneously and sometimes sequentially. For example, upon being exposed to violent image, one may blush (affective interpretant), avert one’s gaze (energetic interpretant), or say ‘that shocks me’ (representational interpretant).

Finally, each of these three types of interpretants may be paired with a slightly more abstract double, known as an ultimate interpretant (compare Peirce, 1955c, p. 277). In particular, an *ultimate affective interpretant* is not a change in bodily state per se, but rather a disposition to have one’s bodily state change—and hence is a disposition to express affective interpretants (of a particular type). Such an interpretant, then, is not itself a sign, but is only evinced in a pattern of behavior (as the exercise of that disposition). Analogously, an *ultimate energetic interpretant* is a disposition to express energetic interpretants (of a particular type). In short, it is a disposition to behave in certain ways—as evinced in purposeful and non-purposeful behaviors. And finally, an *ultimate representational interpretant* is the propositional content of a representational interpretant, plus all the propositions that may be inferred from it, when all of these propositions are embodied in a change

of habit, as evinced in behavior that conforms to these propositional contents. For example, a *belief* is the quintessential ultimate representational interpretant: in being committed to a proposition (i.e. ‘holding a belief’), one is also committed to any propositions that may be inferred from it; and one’s commitment to this inferentially articulated and indexically grounded set of propositions is evinced in one’s behavior: what one is likely or unlikely to do or say insofar as it confirms or contradicts these propositional contents. Notice that these ultimate interpretants are not signs in themselves: while they dispose one toward certain behaviors (affectual, energetic, representational), they are not the behaviors per se—but rather *dispositions to behave* in certain ways.

While such a sixfold typology of interpretants may seem complicated at first, it should accord with one’s intuitions. Indeed, most *emotions* really involve a complicated bundling together of all these types of interpretants. For example, upon hearing a gunshot (as a sign), one may be suffused with adrenaline (affective interpretant); one might make a frightened facial expression (relatively non-purposeful energetic interpretant); one may run over to look what happened (relatively purposeful energetic interpretant); and one might say ‘that scared the hell out of me’ (representational interpretant). Moreover, one may forever tremble at the sight of the woods (ultimate affective interpretant); one may never go into that part of the woods again (ultimate energetic interpretant); and one might forever believe that the woods are filled with dangerous men (ultimate representational interpretant). In this way, most so-called emotions, or affective and cognitive responses more generally, may be decomposed into a bouquet of more basic and varied interpretants. And, in this way, the seemingly most subjective forms of experience are reframed in terms of their intersubjective effects (Kockelman, 2011).

Having reviewed Peirce’s understanding of interpretants (and meaning more generally), it is worth comparing his ideas with those of MacKay. For example, in a passage that Hansen cites approvingly (2004, p. 80), MacKay says that the meaning of a message “can be fully represented only in terms of the full basic symbol complex defined by all the elementary responses evoked. They may include visceral responses and hormonal secretions and what have you. . . . [A]n organism probably includes in its elementary conceptual alphabet (its catalogue of basic symbols) all the elementary internal acts of response to the environment which have acquired a sufficiently high probabilistic status, and not merely those for which verbal projections have been found” (1969d, p. 54). While Peirce’s account of the varieties of interpretants (affective, energetic, representational, and ultimate) is not the same as MacKay’s description of a “conceptual alphabet” or “complex defined by all the elementary responses evoked,” it clearly resonates with it. Indeed, it provides a textured way to think about this complex, regardless of where it is located (and, indeed, whether it can be located somewhere)—say, in the body, *qua habitus*; or in the mind, *qua conceptual alphabet*.

However, the real resonance between Peirce and MacKay rests in MacKay’s relatively latent and somewhat rudimentary pragmatism, which emerges in his definition of meaning, as articulated through the metaphor of a railroad switching yard. In particular, Peirce had famously characterized pragmatism in terms of Bain’s maxim: a belief is “that upon which one is prepared to act” (1955c, p. 270). From the perspective of their roots, as we just saw, beliefs are ultimate representational interpretants of prior signs. From the perspective of their fruits, as we now see, different beliefs are different modes of conditional readiness (or contingent preparedness, or dispositions) to act. And so a key effect of a sign, *qua response* or ‘meaning’, is precisely a change in one’s subsequent disposition to act (say, by expressing signs for others to interpret) or respond (say, by interpreting the signs that others have expressed). Indeed, from a semiotic stance, a ultimate representational interpretant is akin to a status: an ensemble of (normatively regimented) commitments and entitlements to signify and interpret in particular ways. Framed mechanically, a key interpretant of many signs is really a change in the interpreter’s subsequent potential to map signs onto interpretants (by way of their objects).

In short, the theory of meaning that scholars like Hayles and Hansen want to recover from MacKay (as a means to offset the negative effects of Shannon’s banishment of meaning), is essentially a restatement (and indeed watering-down) of the classic pragmatist stance. If MacKay’s understanding of meaning is interesting, it is because it shifts the Shannon measure, or calculation of selective information-content, from the message or sign (given an ensemble of possible messages) to the response or interpretant (given an ensemble of possible interpretants); and so invites one to apply the mathematical machinery of the former to the calculation of the latter.

5. Peirce’s theory of information

From one perspective, meaning and information are closely related, corresponding more or less to Peirce’s object: whatever could be stood for, or represented by, a sign. In this framing, information (or meaning) is simply the object of a sign, such that knowing something about the sign (including its mere existence) allows one to know something about the object. And a sign is said to encode information, or be informative, depending on the novelty and relevance of its object to an interpreter. Peirce had a beautiful definition of the object-*qua-information* in this sense: “that which a sign, so far as it fulfills the function of a sign, enables one who knows that sign, and knows it as a sign, to know” (quoted in Parmentier (1994, p. 4)). Indeed, from the standpoint of an observer, the object may also be understood as a correspondence-preserving projection from the ensemble of possible interpretants of a sign. It is thus *a kind of virtual center*, itself determined by and determining of the range of appropriate responses within some semiotic community. But Peirce also offered two relatively narrow and complementary definitions of information. Like MacKay’s non-technical definition of information, both were characterized in terms of changes in knowledge. In particular, one turned on the information contained in a term (like ‘dog’ or ‘electron’), and the

other turned on the information contained in an assertion (like ‘dogs are mammals’ or ‘electrons are charged particles’). We will take them up in turn.

For Peirce, working in a logical tradition, the *denotation* of a term like ‘dog’ is the set of entities it refers to (within a given semiotic collectivity, community, or commons). It might include all the members of all the different breeds known to this collectivity. In contrast, the *connotation* of a term like ‘dog’ is the set of features such entities have in common. It might include predicates like ‘has fur’, ‘is loyal friend’, ‘chases cats’, and so forth. Both of these are, of course, well-known ideas which correspond more or less to modern understandings of the extension and intension of a term. Finally, in a metaphor that harkens back to MacKay, and goes beyond traditional understandings, Peirce defined the *information* of a term like ‘dog’ as the product of its denotation (or ‘logical breadth’) and connotation (or ‘logical depth’). As he put it:

The totality of the predicates of a sign, and also the totality of the characters it signifies, are indifferently each called its logical *depth*. This is the oldest and most convenient term. ... The totality of the subjects, and also, indifferently, the totality of the real objects of a sign, is called the logical *breadth*. ... Besides the logical depth and breadth, I have proposed (in 1867) the terms *information* and *area* to denote the total of fact (true or false) that in a given state of knowledge a sign embodies (1998 [1904], p. 305; and see Peirce, 1992 [1867], p. 10).

While this definition may sound odd at first, it was meant to capture our understanding of what it means to gain new information. Suppose, for example, that members of some semiotic collectivity do not know where to place chihuahuas taxonomically. If they subsequently learn (through experiment, testimony, etc.) that chihuahuas are a breed of dogs, they have increased the denotation of the term ‘dog’, and hence the term’s information. Similarly, suppose that members of some semiotic collectivity, who have long known that dogs are furry and bark, subsequently learn that dogs are also territorial. They have thereby increased the connotation of the term, and hence its information. In short, knowledge practices—which seek to find new members for old classes (expand denotation) or new features for old members (expand connotation)—are aimed at increasing the information of a term. In this sense, information was a product of the semantic depth and breadth of a term, as it was used by a semiotic collectivity.

Note, then, the following similarities between this kind of information and MacKay’s characterization. First, there is the spatial metaphor: for Peirce, information is the product of breadth (denotation) times depth (connotation); whereas MacKay likened selective information to volume, structural information to area, and metrical information to width. Next, while Peirce offered no absolute way to measure the information of a term, he did offer a relative measure which could be used to track increases or decreases in the extension and intension of a term. Finally, in one early essay (1969d), MacKay attempted to define information in terms of something like connotation. That is, rather than counting over the possible places an entity could be in a physical environment (recall the example from Section 2), one could count over the possible predicates a substance could have in a logical or semantic environment. For example, if we count over all possible predicates any entity could have, along with the relative probability it has any of these (given our current knowledge), we may thereby obtain a measure of our surprise that it has a particular set of such predicates.

Peirce’s second key definition of information arises most forcefully in his logical typology of ten different kinds of signs (1955a, 1998 [1903], pp. 289–299). While the full development of his typology is outside the scope of this essay, we may focus on the way the term information is used in this text.¹¹ In particular, Peirce makes a distinction between signs (or components of composite signs) that point to objects, and signs that provide information about such objects. A weathercock, for example, simultaneously indexically points to the wind (in the sense that its position is caused by the wind) and provides iconic information about the wind (in the sense that knowing its position, one knows the direction of the wind). Similarly, a photograph simultaneously directs the interpreter’s attention to the person so portrayed (say, Lawrence Olivier), and provides information about this person (say, what they were wearing, or how old they were, etc.). Crucially, this distinction is the pre-symbolic equivalent of the distinction between subject and predicate, or topic and focus. Indeed, Peirce will later describe propositions as consisting of two composite parts: one to “express its information” and the other to “indicate the subject of that information” (117). This division is so important for linguistics, and the study of discourse more generally, that it is worth taking up at length.

Many current linguists, like Lambrecht (1996; and see Van Valin and LaPolla, 1997), distinguish between the topic and focus of an utterance. For example, in a sentence like ‘my dad died’, *my dad* is the topic and *died* is the focus. In particular,

¹¹ For readers wanting a more technical discussion, Peirce distinguishes between *rhetic iconic signs*, or “any object of experience in so far as some quality of it makes it determine the idea of an object” (115), and *rhetic indexical signs*, or “any object of direct experience so far as it directs attention to an Object by which its presence is caused” (115). That is, the first kind of sign (which is relatively iconic) embodies a quality which conjures up (to the interpreting mind) the idea of an object. For example, a diagram. And the second kind of sign (which is relatively indexical) directs the interpreting mind to an object so far as it was caused by that object. For example, a spontaneous cry. Crucially, the word information does not arise until Peirce defines *dicent indexical signs*, which are themselves composite signs that incorporate both a rhetic indexical sign and a rhetic iconic sign. In particular, these are defined as: any object of direct experience, in so far as it is a sign, and, as such, affords information concerning its Object. ... This it can only do by being really affected by its Object; so that it is necessarily an Index. The only information it can afford is of actual fact. Such a Sign must involve an Iconic Sinsign [i.e. a Rhetic Iconic Sinsign] to embody the information and a Rhetic Indexical Sinsign to indicate the object to which the information refers. But the mode of combination, or *Syntax*, of these two must also be significant (115–116).

the topic is that part of an utterance that constitutes 'old information': the speaker presumes that its referent is already known (or at least readily identifiable) to the addressee. The focus is that part of an utterance that constitutes 'new information': the speaker presumes that the addressee is unaware of its applicability to the topic.¹² While most utterances have both a topic and a focus, some utterances have only a focus. For example, existential constructions such as 'there was an old woman' are designed to topicalize referents, such that subsequent utterances can predicate features of this topic via their own foci: 'and she lived in a shoe'. Indeed, just as the interpretant of one semiotic process may be the sign of a subsequent semiotic process, this example shows that the focus of one utterance can be the topic of a subsequent utterance. For present purposes, what is important is that such an utterance involves some relatively indexical sign (that points to some referent, qua topic) and some relatively iconic sign (that predicates features of such referents, qua focus). While both kinds of signs constitute 'information' in the general sense, foci are that part of composite signs that constitute 'new information', or information proper (in the non-technical sense of providing 'new knowledge').

Crucially, not only can we think of every utterance pointing backward and forward in this way as to information structure, we may also think of every utterance pointing forward and backward as to logical argument, or reason. On the one hand, an utterance may be justified (logically or empirically, inferentially or indexically) by some previous utterance (qua proposition) or event (qua state of affairs). On the other hand, an utterance may justify a subsequent utterance or action. Peirce gets at this idea in two ways: first, as mentioned above, each sign (to be subsequently interpreted) may itself be an interpretant of a prior sign; and second, through his idea of the argument, as a sign that is interpreted as being the conclusion of a set of premises and some kind of logical inference. As he puts it, an argument is "a sign whose interpretant represents its object as being an ulterior sign through a law, namely, the law that the passage from all such premises to such conclusions tends to the truth" (1955a, p. 118–119; and compare Brandom, 1994). If propositions are important because they can be true or false (and thus have truth-value), arguments are important because they offer a reason for their truth-value.

Phrased another way, an argument focuses not just on the proposition per se (composed as it is of a topic and focus), but also where the proposition comes from (and where it goes), or its indexical and inferential roots (and fruits). Generalized, we may think of an argument as the evidentiary sources and logical inferences a proposition is grounded in and grounding of (Kockelman, 2007b). On the one hand, then, information should be justified (by past beliefs and utterances, experiences and events); on the other hand, information should be relevant (to future beliefs and utterances, actions and events). Loosely speaking, what is crucial about information is the difference it makes in a discourse. Theorists of modern forms of digitally encoded and network-distributed information, such as Benkler (2006, p. 68), stress very similar dimensions (which he calls accreditation and relevance) when they try to account for the importance of peer-produced modes of information. As should now be clear, however, information (and knowledge) have always been 'peer produced'.

In short, just as Peirce's first definition of information had three interrelated pieces (denotation, connotation, and information), his second definition of information had three interrelated pieces. First, there was a relatively iconic dimension, or focus (as exemplified by a term). Second, there was a relatively indexical dimension, or topic–focus relation (as exemplified by a proposition that incorporates a term). And third, there was a relatively symbolic dimension, or topic–focus–reason relation (as exemplified by the premises and arguments that lead to a proposition). More generally, there are signs that thematize, signs that characterize (features of a theme), and signs that reason (with this theme–character relation). And most composite signs are wholes that have such smaller signs as parts. Information in this second sense is thus directly tied to ultimate interpretants, as discussed in section 4, for the interpretant of such an informative sign is often precisely a justified and relevant belief, or a disposition on which one is strongly inclined to act.

We may now bring Peirce's two accounts of information together. In particular, notice how the relation between denotation and connotation relates to the relation between topic and focus. The first two foreground the information contained in a word (as recognized by members of a semiotic collectivity); the latter two foreground the information contained in an utterance (as unfolding in the discourse of two semiotic agents). In this way, one can keep separate what counts as new or old information to a semiotic collectivity on a historical time-scale, and what counts as new or old information to an individual (or relation between individuals, qua interacting agents) on a conversational time-scale.¹³ If the first kind of information binds a signer to a semiotic collectivity, the second kind of information binds a signer to an interpreter. And both kinds of information can be cause and effect, or root and fruit, of the other. For example, the information contained in a term provides a kind of background knowledge that members of a collectivity share in common, and so may never need to make explicit in an actual proposition. An actual utterance may thus index, yet never make explicit, such knowledge. Concomitantly, the members of a semiotic collectivity come to a large part of their shared knowledge precisely through a huge number of individual communicative events, whereby one informs another of something.¹⁴

¹² Crucially, the topic and focus are information-specific terms that need not map onto subject and predicate (as grammatical roles). For example, in a sentence like 'who took out the trash?', the focus is 'who', and the topic is 'took out the trash'. Indeed, such questions are precisely designed to indicate the contours of one's ignorance, so that an addressee can better illuminate it with an answer (compare MacKay on the function of questions).

¹³ See Enfield (2011) on the notion of enchrony, in relation to diachrony and synchrony.

¹⁴ That is, when we foreground denotation, connotation and information, we foreground the relatively tacit presuppositions of a semiotic community: what members would intersubjectively recognize to be the referent of a word, or the property of a referent. Only in extreme cases (children, foreigners, expert registers, etc.) do we say things like, 'that is a bird', or 'birds have wings'. When we foreground, themes, rhemes and arguments, we foreground the ongoing dynamics of a local interaction between semiotic actors—how their utterances presuppose and create intersubjectively known propositions, such as 'this is the guy I was telling you about' or 'his wife left him years ago'. Everyday information may, of course, go on to become expert information; and vice versa.

In short, if one attends to Peirce's first definition (qua denotation, connotation and information), one attends to information as it is structured in the lexicon (knowledge base or semantic culture) of a semiotic collectivity (community or commons). If one attends to Peirce's second definition (qua topics, foci and arguments), one attends to information as it unfolds in actual interactions between speakers and addressees (or signers and interpreters more generally). The former relates to information qua structure and history; the latter relates to information qua practice and interaction. Both frames are, to be sure, needed: if the latter is often the precipitate of the former; the former is often the well of the latter. And such frames are particularly important in that they function as a kind of stepping stone between information-content in the relatively specific and quantitative sense (Section 2) and meaning in the relatively general and qualitative sense (Section 4).

6. Conclusion: information is the enclosure of meaning

Before concluding, it is worth summarizing the various kinds of information that have been developed in this essay. First, we have the following four definitions of information from MacKay. There is information in the non-technical sense, or whatever constitutes new knowledge. There is selective information-content (the Shannon measure), or the 'surprise value' of a message, which scales with the improbability of an actual message (or sign) given an ensemble of possible messages (or signs). There is structural information-content, or the frame of relevance used to construct a mapping between a set of messages (or signs) and a set of referents (or objects). And there is metrical information-content, or the degree of resolution used to construct a mapping between a set of messages (or signs) and a set of referents (or objects).

The last three kinds of information-content (selective, structural, metrical) constitute relatively technical definitions that may be used to operationalize, in a relatively precise quantitative manner, the first kind of information. Moreover, together structural and metrical information-content provide, in some sense, the ensemble of possible messages that selective information-content counts over. The actual features of the domain of referents, and the actual interests of communicating agents, will determine the relative probabilities of the messages in the ensemble. Loosely speaking, when all messages are equally likely, then selective information scales linearly with structural information-content and logarithmically with metrical information-content.

Finally, MacKay distinguishes between information, in the above senses, and meaning per se. In particular, meaning is the response of an addressee to the message it receives, where this response is not a behavior per se, but a conditional readiness to subsequently engage in certain goal-oriented behaviors depending on the context in which it finds itself. Crucially, this context may itself consist of further messages, and these behaviors may themselves consist of further responses.

Peirce, writing much earlier than MacKay, was focused on meaning rather than information. He thought meaningful processes involved three components—signs, objects and interpretants. These were the generalized equivalents of messages, referents and responses, respectively; and, being general, they could be used to understand embodied, embedded and enminded modes of meaning. He theorized a range of interpretants, loosely corresponding to feelings (affective interpretants), actions (energetic interpretants) and thoughts (representational interpretants). Crucially, he also theorized ultimate interpretants which were very similar to MacKay's understanding of meaning, in the sense of a change in one's conditional readiness to respond (be it affectively, energetically, or representationally).

As for information, Peirce offered three relevant definitions. First, there is information as the object of a sign (as evinced in the interpretants of a semiotic collectivity). Here information was whatever a sign may direct an interpreter's attention to. The information of a term (or word) was a product of the extension and intension of that word, where the extension was the set of possible referents (of that term) and the intension was the set of properties possessed (by such referents). The information of a proposition (or assertion) involved three interrelated parts: a component that thematizes, a component that characterizes (features of a theme), and a component that reasons (with this theme-character relation). While the focus (or the component that characterizes) is the stereotypic site of information (qua 'new knowledge'), the other two parts are just as important: the first indicating the referent that the predicate relates to; the third indicating the rational for this referent-predicate relation.

Finally, it is worth reviewing one more definition of information, grounded not so much in mathematics and science, or logic and language, as technology and media. In particular, Kittler (1996 [1993]) defines information as whatever can be stored (in a message), transmitted (along a channel), and processed (by an addressee). In some sense, Kittler was trying to understand the essence of information from its material instantiation in a modern computer wherein a single number can be read as a value (some kind of data), as an address (some place to put data), or as a command (some operation undertaken on the data located at some address). From a semiotic stance, however, storage may be understood to turn on a sign-object relation (a medium that can encode meaning, essentially by preserving difference). Transmission may be understood to turn on a signer-interpretant relation (a medium that can transport differences encoding meaning). And processing may be understood to turn on a sign-interpretant relation (a medium that can operate on old meaningful differences to produce new meaningful differences).

One way to think of the foregoing accounts of information is as follows. Start with Peirce, and his general theory of meaningful processes, turning on relations between signs, objects and interpretants. Such processes may be used to describe human and non-human communication systems, communicative and non-communicative signs, and meaning that is embodied and embedded as it is enminded. Next, note the various ways such meaningful processes can get relatively abstracted, reduced, quantified, objectified, captured—or, more generally, *enclosed*—by various theorists, in their attempts to

theorize informational products (Kockelman, 2007a). We have scholars like Shannon and MacKay who want to understand meaning in terms of mathematical expressions and experimental methods. We have scholars like Peirce (in some of his writings), and linguists like Lambrecht, who want to understand meaning in terms of logical propositions and linguistic utterances. We have scholars like Kittler who want to understand meaning in terms of media technologies and computational processes. And we have scholars like Benkler who want to understand meaning in terms of economic utility or market price—whether it be the storage, transmission, or processing of information; and whatever be the object of information (from patentable science to price differentials). That is, each attempts to render some aspect of meaning, and often a theory of meaning more generally, in terms that are relatively formal, quantitative, objective, and context-independent. If we think about meaning as disclosure—in the sense of bringing something to the attention of another—each of their understandings of information may be understood as an attempt to enclose disclosure.

Crucially, enclosure may be understood in a wide variety of ways (Elyachar 2005, 2012; Kockelman 2007a, 2013; and see footnote 2, above), not all of which were foregrounded here. In particular, for many readers working in a critical tradition, the most relevant senses of enclosure belong to Foucault (qua disciplinary enclosure, such as the prison, factory, or asylum) and Marx (qua enclosure of the commons, whereby the collective resources of many became the private property of a few). Needless to say, both of these more notorious kinds of enclosure are also operating with respect to information, and so intersect with the foregoing categories. In the first sense, we are confronted by informational enclosures from all sides: not just interfaces, algorithms, data structures, and protocols, but also the so-called walled gardens of our applications, platforms, and providers. With subtly shiftable frames of relevance and ever-increasing degrees of resolution, individuals have become the key topics (and denotations), and their likes and dislikes, friends and families, memories and plans, feelings and dreams, pictures and poems, interactions and transactions, cravings and crimes, have become the foci (and connotations). And, in the second sense, as intersecting with the first, we have willfully—indeed, happily—handed over all this information about ourselves—and about our kith, kin and acquaintances, and much else beside—to a handful of third parties (whom Shannon would have called enemies, and Serres would have called parasites).

Finally, and perhaps less pessimistically, all of these senses of enclosure are grounded in an imaginary that is tightly coupled, one might argue, to classic understandings of the beautiful (themselves closely linked to notions of form and boundedness). There may be a way out of enclosures yet by rethinking them, and re-relating to them, via categories and practices more closely linked to the sublime (and beyond), which are themselves much more difficult to subjectively experience, rationally conceive, discursively articulate, mathematically formulate, technologically produce, economically value, legally enforce, or parasitically intercept. But that is another essay.

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