Operational Closure and Self-Referentiality
Hume's Theory of Causal Inference from the Standpoint of Second-order Cybernetics

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This article deals essentially with the problem of how operationally closed systems can construct a reality and therefore get their bearings in the world. But rather than looking for new and therefore original theoretical solutions, it suggests going back to the empirical philosophical tradition of early modernity, in order to find some of the roots of a solution. Following a suggestion by the leaders of both first- and second-order cybernetics, Wiener and Foerster, this article reframes David Hume's theory of causal inference in order to make the case that Hume not only anticipated second-order cybernetics in interesting ways, but also that we can use Hume and second-order cybernetics to inform each other leading to a better understanding of both. Starting from the statement according to which the problem of causality represents "one of the most sublime questions in philosophy," the article goes deeply inside the problem of causality in order to argue that the modern approach to epistemology has to conceive it as a process of internalization of cognitive facts. This search path leads to casting a new light on the paramount concept of sign, conceived of as the possibility that certain environmental events or data again set off the self-reference of a cognitive system, which thus switches from memory to expectation. The aim of this article is finally to show that the main results of an interdisciplinary theory of cognition such as second-order cybernetics are particularly congruent with the speculations of the Scottish philosopher, and that Hume's reflections maintain an extraordinary relevance regarding the most advanced elaboration of the main epistemological problems.

I

Hume described the problem of causality as "one of the most sublime questions in philosophy" (T 1.3.14, p. 156).[2] His inquiry still represents a turning point for everyone who deals with the same problem. However, his impact goes beyond the simple question of causality, as can be explained by reference to the modern revolution in the theory of cognition. In this article we argue that such a revolution has to be conceived of as a process of internalization of cognitive facts. This leads Hume to see causality not as a metaphysical phenomenon but as a construction of the mind, according to its capacity to co-ordinate, during its observations, both self- and hetero-reference, and to structure the outcome of that co-ordination in the form of a cognitive memory. In order to follow Hume's reasoning we will use some fundamental concepts of second-order cybernetics, showing that the main results of that interdisciplinary theory of cognition are particularly congruent with the speculations of the Scottish philosopher; at the same time, we will show that Hume's reflections still have, for the

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2. We will adopt the international standard way of citing, according to the critical editions prepared by L. A. Selby-Bigge and P. H. Nidditch: EHU=Hume (1975); T=Hume (1978).

same reason, an extraordinary relevance regarding the most advanced elaboration of the problems of cognition.[3] The aim of such comparison is not simply to link together historically remote theories of human knowing in order to look eventually for forerunners, but rather to contribute to the setting-up of an as sharp as possible constructivist theory of cognitive systems. This path of search goes through a strict rethinking of the main outcomes of the operational closure and leads to cast new light on the paramount concept of sign conceived of as an operationalizing form of the unity of the difference between system and environment, according to the original intuition of first-order cybernetics about the capability of complex enough systems to compensate their lack of direct contact with the external environment through the building of internal structures. In this way a new possibility arises for semiotics to settle down in the theoretical frame of reference of cybernetics, opening up a searching space that is still largely unexplored. The text we shall constantly refer to in order to start up such a work is the enlightening synthesis of the theory of causal inference in which Hume maintains that: "after a repetition of similar instances the mind is carried by habit, upon the appearance of one event, to expect its usual attendant, and to believe that it will exist" (EHU 7.59, p. 75).

II

Second-order cybernetics holds the distinction between system and environment to be the starting point for every explanation of cognitive problems, and labels as *observing systems* all those which are able to use distinctions (for example: before/after, cause/effect) in order to observe reality. Such an approach has some fundamental implications for the construction of a general theory of cognition: since system/environment is a distinction which has to be used by some observing system to observe observing systems, such a theory excludes the possibility that the world can be observed from the outside, because it always includes the observer itself into the world of observation. This is a turning point compared to the first-order cybernetics, because it implies an epistemological shifting from a linear paradigm, based on the principle of teleology, to a circular paradigm, based on the principle of self-referentiality.

For first-order cybernetics the matter was that of clarifying the presuppositions of natural or artificial machines having a *purposeful behavior*, that is to say which are able to use the results of previous movements (output) as information (input) to control and eventually correct their next movement and reduce in such a way the deviation from a fore-established distinction (Wiener, Bigelow & Rosenblueth, 1943). For second-order cybernetics the matter is instead that of clarifying, how complex enough machines can compute consistent indicators of external reality, that is *eigenbehaviors*, without confusing such a reality with their own operations (Foerster,

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3. We don't obviously assume that Hume is a second-order thinker (such a conclusion would be in fact anomalous and anachronistic) but rather that the outcomes of his speculations are congruent with the result of second-order cybernetics, as already recognized both by Wiener and by Foerster (see section III).

1981a; 1985, esp. pp. 114-115; 1992, p. 10f.). The topic, that is, the behavior, remains the same; what changes is the way of facing it: whereas first-order cybernetics is bound to a perspective, which is in some way still realist, and deals with the environment as if it were an autonomous space, second-order cybernetics tries to explain how it is possible for a self-referential system to face a reality that appears as an external correlate of its internal operations. Among the systemic references which lend to this type of explanation the most studied is without any doubt the human mind: it still represents the ultimate standard for the construction of learning machines, just as contemporary cognitive sciences try to explain its functioning as if it were a cybernetic machine.

Hume (EHU 2.12, p. 18) supposes that on an operative level the mind is able to connect and compare to each other only the operations (he speaks of perceptions) which are reproduced by the mind itself. Between mind and world there is therefore a clear break that prevents the mind from directly accessing the external environment, while at the same time preventing the environment from contributing in any way to the reproduction of perceptions in the mind. Such a principle of operational closure is by no means new: Aristotelian-Thomist epistemology already supported the thesis that the mind's activity (*intelligere*) is not a transitive action (*actio transiens*).[4] Berkeley (1998, I, § 8, p. 105) however radicalized that principle by maintaining that it is not possible to verify whether or not there exists outside the mind something that matches the idea we have of reality, since an idea can be compared only with another idea and not directly with reality itself. Hume scrupulously assimilates Berkeley's enquiries, reaching the conclusion that what happens in the environment cannot have information value for the observer who makes experience of reality. A clear example, in causal terms, is that of Adam, who, though his rational faculties were perfect from the start, could not have inferred from the transparency of water, without any experience of it, its power to suffocate.[5] However, the fact that operational closure makes it impossible to transfer information from the environment into the system (and vice versa) becomes even clearer if the environment is conceived of temporally as time-to-come; a system can only operate in the current present, when it operates, whereas the future still remains by definition unreachable—a crucial point in Hume's theory of causal inference to which we shall return.

From this theoretical background there emerges a fundamental bifurcation on which the very development of a modern theory of cognition depends. Whereas the Aristotelian-Thomist tradition conceived of operational closure as a problem to be solved by answering the question of how it is possible for human reason to know reality despite the fact that it cannot operate beyond its own boundaries, for Hume it represents rather an essential requirement for the construction of structures which allow the mind to keep a distance from the surrounding environment and thereby gain,

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4. Thomas Aquinas, *De unitate intellectus*, III, 70-71; V, 107.
5. "No object ever discovers, by the qualities which appear to the senses, either the causes which produced it, or the effects which will arise from it; nor can our reason, unassisted by experience, ever draw any inference concerning real existence and matter of fact" (EHU 4.23, p. 27).

on a cognitive level, a proper autonomy. Closure forces every operation (every perception of the mind) to become part of a recursive network of other operations of the same kind, which every current operation is referring to, setting off what in cybernetic terms may be described as a self-organizing dynamics from which contingent indicators of reality (i.e., invariants) arise, and can be used by the system to get its bearings in a world that appears on the empirical level different every time. All Hume's reasoning aims to demonstrate that any causal inference is nothing but the *arising* outcome of such self-organizing dynamics. What we aim to clarify is the essential dynamics of such dynamics; that is, how it works.

III

As we have shown, according to Hume causality cannot be learned by gathering information coming directly from the reality of which the mind makes experience; nor can it be learned a priori on the basis of logical-deductive reasoning: the simple idea of a stone [APA does not use single quotation marks, nor are concepts marked] is not enough to suggest ~~the~~ an event that follows (i.e., the fact that, after being thrown in the air, the stone falls back down rather than staying in suspension). The only option is experience.[6] This opens up two fundamental questions. First, how is it possible for the mind to become able to produce inductive inferences starting from empirical experience? Secondly, what depends on the reliability of conclusions drawn out in such a way from experience? Since in Hume's opinion the last question "may be of more difficult solution and explication" (EHU 4.28, p. 32), we shall start by attempting to give an adequate answer to the first.

When Hume speaks of experience, he is referring, in modern terms, to the mind's operation of observation in which self- and hetero-reference are actively concomitant. Outside the mind there exists a real world, which the mind can experience only in the form of an idea. Or to put it in traditional terms: When the mind is thinking of a stone, there is no stone in the mind, but only the idea of the stone (Aristotle, *De anima*, III, 8, 431b28-432a3). This implies, as we have seen, that the mind cannot compare idea and reality with each other to verify whether they have the same form (i.e., whether they are isomorphic). The only thing the mind can do is operationally relate ideas with other ideas, and from this difference try to gain information. Any causal inference is a mental performance, consisting simply of a peculiar union of ideas. Such a union is a form of association.

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6. "I shall venture to affirm, as a general proposition, which admits of no exception, that the knowledge of this relation is not, in any instance, attained by reasonings *a priori*; but arises entirely from experience" (EHU 4.23, p. 27). See also Hume (EHU 4.25, p. 29). In the *Treatise* (T 1.3.1, p. 69) Hume speaks of abstract reasoning: "'Tis evident *cause* and *effect* are relations, of which we receive information from experience, and not from any abstract reasoning or reflexion". And to seal the question: "'Tis easy to observe, that in tracing this relation, the inference we draw from cause and effect is not deriv'd merely from a survey of these particular objects, and from such a penetration into their essences as may discover the dependence of the one upon the other. There is no object, which implies the existence of any other if we consider these objects in themselves, and never look beyond the ideas which we form of them. ... 'Tis therefore by *experience* only, that we can infer the existence of one object from that of another" (T 1.3.6, pp. 86-87).

According to Hume, every association is a strong connection that makes one idea readily recall another. Three different kinds of association can be distinguished: resemblance (as for example that between the idea of father and the idea of son); contiguity in time or space (as for example that between the idea of apartment and the idea of other apartments in the same building); and the relation of cause and effect (T 1.1.4, pp. 10-11; EHU 3.19, p. 24). In the last case the association does not arise spontaneously in the mind, but is produced through the experience of the constant conjunction of at least two contiguous phenomena, one of which is precedent while the other is successive; for example, heat compared to flame. Such an experience can also be produced experimentally, as the theory of conditioned reflexes has demonstrated; the association occurs here at the level of the central nervous system, therefore in a psychological dimension, between environmental data working concomitantly and physiological stimuli which can activate in the organism some unconditioned reflex.[7] This approach raises two questions: what conditions will *trigger* in the mind an association of this kind? And how is it possible, in the second place, to set off the same association again in all time-different concrete situations? [You need to explain why you want these items italicized. Italics are not used for emphasis and these are not unusual terminology.]

First of all, Hume stresses the fact that among the phenomena we make experience of the mind can recognize a relationship of contiguity and temporal priority: one event (or object) occurs before the other, but according to a relation of contiguity perceived immediately in the mind, there will be an impression that some strong connection must exist between them.[8] If instead too much time passes between the occurring of a certain event (or object) and the occurring of the following linked one, the mind could make experience in the meantime of countless other events (or objects) and would no longer be able to determine what should be associated with what. Everything could be connected with everything, with the consequence that nothing would be definitively connected with anything. The world would appear, in other terms, too complex, and the mind would end up forgetting that there exists a relationship between the phenomenon P_1 and the attendant phenomenon P_2. The associating connection works, on the contrary, as a reduction form of the environmental complexity which the system (the mind) uses to make expectations about what could happen. These expectations are never necessary, but rather always contingent: sooner or later each observer has to admit that stones don't fall down on the moon in the same way as on the earth. Necessity, on the other hand, is the correlate of expectation; and it exists, as we shall see, only as a projection produced by the mind which has learned to infer.

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7. See Pavlov, 1927. First-order cybernetics had explicitly drawn attention to the importance of the concept of association in relation to the problem of learning in machines, and it acknowledged Hume and Pavlov as the two best forerunners in this field of research (see Wiener, 1961, chapter 5).

8. "We remember to have had frequent instances of the existence of one species of object; and also remember, that the individuals of another species of objects have always *attended* them, and have existed in a regular order of contiguity and succession with regard to them" (T 1.3.6, p. 87; italics added).

To the relationship of priority and contiguity has to be added the principle of repetition. According to Hume it is not enough that the conjunction of two phenomena has been experienced once; the mind needs rather to compare other similar instances (i.e., phenomena of the same set), in which the same causes have in the past produced the same effects, although the conditions were different every time. Only in this way can the impression that between such causes and their effects there is a conjunction, change itself into the certainty that there is a necessary connection. In the *Treatise* it is clearly suggested that "we have no other notion of cause and effect, but that of certain objects, which have been *always conjoin'd* together, and which in all past instances have been found inseparable" (T 1.3.6, p. 93). Further, in the *Enquiry* Hume confirms that causality "arises entirely from experience, when we find that any particular objects are *constantly conjoined* with each other" (EHU 4.23, p. 27; italics added). Even the idea of necessary connection between causes and effects "arises from a number of similar instances which occur of the *constant conjunction* of these events," after which the mind has experienced that "one particular species of event has always, in all instances, been conjoined with another" (EHU 7.59, pp. 74-75; italics added). Hume defines the outcome of such past repetition as 'habit' or 'custom' (T 1.3.8, p. 102), and maintains that this alone pushes the mind to associate one idea with another, because "the repetition of any particular act or operation produces a propensity to renew the same act or operation, without being impelled by any reasoning or process of understanding." This leads to the conclusion that "all inferences from experience ... are affects of custom, not of reasoning" (EHU 5.36, p. 43).

The result of this seemingly complicated process is to make the mind able to go beyond the evidence of sensations, by separating itself on the temporal dimension from its own environment through the performing of anticipations, which make it possible to transfer acquired experience to all instances which have been not yet experienced.[9] This particular transcendence can be performed only on a high level of abstraction, which cannot be reached by perception, since it is always inevitably bound to the transience of sensations. This is the reason why custom works on the basis of ideas in the mind, and finally constitutes "the great guide of human life" (EHU 5.36, p. 44). Without inference, as Jerrold Katz (1962, p. 5) has clearly propounded, our knowledge of the world would be dependent everywhere on the present situation, and would be confined to what we could directly observe. Such a dependence on the concrete situation would force the observer, who would not wish to face a perpetually new and surprising (because unpredictable) reality, to map one-to-one the surrounding world and to compare present situations with past maps. Yet this

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9. "All reasonings concerning matter of fact seem to be founded on the relation of *Cause and Effect*. By means of that relation alone we can go beyond the evidence of our memory and senses" (EHU 4.21, p. 26). Custom works so that "in all cases we transfer our experience to instances, of which we have no experience, either *expressly* or *tacitly*, either *directly* or *indirectly*" (T 1.3.8, p. 105). Custom is therefore "that principle alone which renders our experience useful to us, and makes us expect, for the future, a similar train of events with those which have appeared in the past" (EHU 5.36, p. 44).

would lead rapidly to an information overload, which would slow down the system's operations until they stop. For Hume this means that it is not necessary to recall the memory of all past instances in which one has experienced a certain object (as if one were rewinding a tape upon which all past experiences have been recorded), to infer the future occurrence of its attendant events (T 1.3.8, pp. 103-104). The way out is for the mind to abstract from its own experience and produce a symbolic representation of external reality, by means of which it is possible to forget almost everything except what remains the same and is therefore worth being recorded.[10] Such a computation of invariants (or universals) is a process of *generalization* from the concomitance of P_1 and P_2, that enables the observer to state, of anything that has the property P_1, that it also has the property P_2, leaving aside the concrete peculiarity of the object in which the property P_1 is recognized or the particular moment at which the event P_2 can occur (Katz, 1962, p. 3; see also Foerster, 1969, p. 27). This does not help the mind (the observer) to gain information about the external reality and to know thereby what would be better to do; the external environment remains operationally unreachable and therefore always inevitably uncertain. In other words: the mind has no way to reach the real world, but can isolate from the data of its own experience only that which recurs and condense it in the form of meaningful patterns (e.g., flame heats) or patterns of reaction, which are kept available to be confirmed in future experiences.[11]

Regarding this, second-order cybernetics speaks of eigenbehaviors (or *eigenvalues*) as tokens for dynamic equilibriums which function as indicators of reality for observing systems (Foerster, 1981c; Kauffman, 2005, pp. 133ff., 2009, pp. 122ff with the model of a infinite nest of boxes). Hume's concept of habit or custom is the common name which denotes, one could say, all indicators of this sort: they are not simply psychological qualities, but rather cognitive functions which make it possible to anticipate a not-yet-present effect starting from the actual experience of certain causes, or to go back to the no-longer-present causes starting from the actual experience of their effects. Obviously the inferential performance makes present what is absent not on the level of concrete reality, but on the level of symbolic elaboration of ideas; thus any inference can only be performed by the mind, that is to say in the form of observation, not simply in the form of operation. The advantage, in cognitive terms, is clear: the mind does not have to make experience of any objects in the world which belong to a certain set (e.g., ball), in order to understand what kind of object it is dealing with; it's enough that it does recognize, by referring to the currently available data, the quality: to be usable as a ball, and ascribes such quality to the object, coming thus to the conclusion: This is a ball. In this sense objects are *tokens*, a statement that clearly de-ontologizes the concept of object. [If what follows a colon is a complete sentence, the first word is capitalized, otherwise not.]

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10. See the important essay of Foerster, Inselberg & Weston (1968, esp. pp. 34-35). Second-order cybernetics speaks of *cognitive memory*, because memory works without record (Foerster, 1981b).
11. I use the concepts condensation and confirmation in the same sense as Spencer Brown's *Laws of Form* (1979). Concepts are not marked. Acceptable alternative: I use the terms *condensation* and *confirmation* in the same…

Hume expresses this point of view when he states that, on coming upon a river, a person does not have to take into consideration all the qualities of the surrounding world, but can foresee the consequences of proceeding forward by referring to himself and his past experience (T 1.3.8, p. 103)—a form of reference which has finally a value of information (of a particular conjunction of causes and effects). But how is it possible to make habits operative again if they are themselves not operations, but rather meaningful patterns? In other words, how can that association of ideas which makes causal inference possible, be set off again?

IV

A first point to which we have to draw attention concerns the temporal dimension of the availability of eigenvalues. Habit is the arising outcome of past experiences, but it is always present to the mind, which can make it operative from time to time when facing the same data or environmental events. Hume clearly states: Custom is that "belief, which attends the present impression, and is produc'd by a number of past impressions and conjunctions" (T 1.3.8, p. 102). This attendant relationship constitutes a crucial point in the analysis of causal inference. In order to imagine, starting from the data currently available, what future development events will have, the mind must be able to refer to the outcomes of its past experiences, condensed by means of symbolic representations in an abstract and generalized form. But this implies that the mind refers to itself while referring to something different from itself, in order to give meaning to the current situation. It has thus to co-ordinate concomitantly, during its own observations, self- and hetero-reference,[12] allotting primacy to self-reference. This is unlike what happens in non-inferential observations, in which it is rather the fact that the mind can refer to something different from itself that allows the mind to refer to itself and to its own operations (since we first of all think of something, we know that we are thinking). *Primacy* here does not mean exclusion. Rather, and paradoxically, the environment becomes informative on the basis of what can be taken for granted. During the association that impels the mind to infer the idea of effect from the idea of the related cause (or vice versa), the mind coordinates the redundancy that it has drawn out through abstraction from its past experiences (habit, custom) with the variety of the currently concrete situation, and uses such redundancy as an *attractor* for further information processing. Such a process might be summarized in the following schema:

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12. Costa (1986, p. 144) speaks of a system of perceptions that intertwines with a system of ideas of memory to produce the percipient's internal representation of reality; however he doesn't explain the nature of this intertwining.
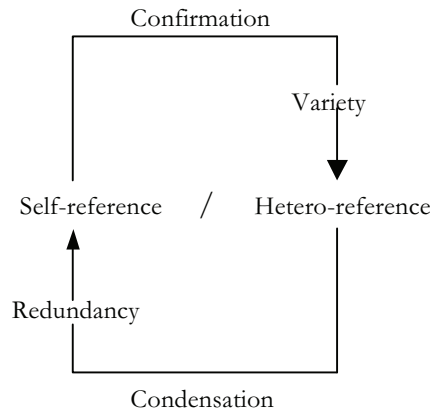
Figure 1: Form and Structure of a Cognitive Memory

This process goes on, however, not arbitrarily. In order for the theory to be plausible, we need to explain what compels the mind to refer to itself rather than simply to something different from itself. The repetition of the attendant relationship that is experienced by the mind between an environmental event and a contiguous one, does indeed transform the very nature of the event: In other words, it acquires the function of a signal. On this point, Hume rigorously summarizes Berkeley's survey. Starting from a semiotic analysis of language, where "a word becomes general by being made the sign, not of an abstract general idea but, of several particular ideas, any one of which it indifferently suggests to the mind," Berkeley (1998, Intro., §§ 11-12, p. 94) comes, on the basis of the same reasoning, to the conclusion that there are no abstract general ideas: The idea is always an idea of something particular and individual, which becomes general only because it is used to *represent* or to *stand for* [I don't understand why you wish stand for italicized, but not represent. Of the two, represent is the technical term; stand for is common vernacular.] all other particular ideas of the same sort. For Hume this is without any doubt "one of the greatest and most valuable discoveries that has been made of late years in the republic of letters" (T 1.1.7, p. 17) and his opinion is that it could be further enhanced by adding an explanation of how the process makes signs arise.

The starting point is always the paradox "*that some ideas are particular in their nature, but general in their representation* [italics in original? Please answer this question!]" (T 1.1.7, p. 22). This paradox can be solved if one takes into account the fact that, after having repeatedly experienced similar objects, the mind ascribes the same name to these objects, putting aside any differences which depend on secondary properties, such as quality or quantity (T 1.1.7, p. 20). Such an acquired custom contributes decisively to ensure that the particular idea can be used in a general way; it is indeed only the *customary conjunction*, revived by the general term which has been

annexed to that idea, that readily recalls to the mind all other ideas of the same sort (T 1.1.7, pp. 21-22). Thus the idea is ever particular regarding to the object but becomes general regarding its use as a sign of any other particular ideas of such an object. If then the customary connection concerns two environmental data or events, the idea of the one can become for the mind a sign that refers to the idea of the other, putting into being that association which underlies the relationship between cause and effect. As experiments on conditioned reflexes have also demonstrated, this *signity* is neither an intrinsic property of some environmental objects—there are no such things as signs— nor a particular system's operation. The existence-place of a sign is, so to speak, neither inside (in the system), nor outside (in the environment), but in their 'between'.[13] Every sign is therefore the arising result of the difference between system and environment and signity represents the possibility that certain environmental events or data *again set off* the self-reference of the involved system, which thus switches from memory to expectation. Water is for example a signal for the mind which is carried by habit to infer its suffocating power, just as a footprint on the beach is a signal of the fact that someone has walked there – which could not be inductively inferred, if one did not know from experience that foot pressure on the sand leaves a print.

The transition from memory to expectation is not a real process that takes time. Hume emphasizes that, on the contrary, habit works *immediately*, i.e. before there is time to reflect or to recall to the memory all past instances that have been experienced.[14] And he adds that "'twill here be worth our observation, that the past experience, on which our judgments concerning cause and effect depend, may operate on our mind in such an insensible manner as never to be taken notice of, and may even in same measure be unknown to us" (T 1.3.8, p. 103). Habit works, in other words, without being an object of attention, and in this sense memory, like redundancy, acts as the "invisible hand" [If this is a reference to Adam Smith's terminology, I think quotation marks are appropriate.] of the system. To draw inferences the mind does not need to link together two different operations; all it has to do is combine in the same operation of observation two different references which may be distinguished from each other on an analytical, but not empirical, level. This is possible because the mind operates recursively and every emerging effect is the correlate of a computation of computations, to put it in the terms of second-order cybernetics. This implies that each operation of observation comes into being as the unity of the difference between a reference to the past and a reference to the future; that is to say, as a result of previous and a presupposition of subsequent operations of the same sort.[15] Since every link

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13. Such a starting point opens up a new field of research, which gets near what has been labeled *cybersemiotics* — understood not as a semiotic theory of cybernetics, but as a cybernetic theory of semiotics. See above all the pioneering works of Brier (2008, esp. pp. 78ff. about library and information sciences; 2010, esp. pp. 31-32).
14. For Hume the belief that a certain effect follows the occurring of a certain cause "arises *immediately*, without any new operation of the reason or imagination" (T 1.3.8, p. 102; italics added). And shortly afterwards he states that "when we are accustom'd to see two impressions conjoin'd together, the appearance or idea of the one *immediately* carries us to the idea of the other" (T 1.3.8, p. 103; italics added). Finally: "The custom operates before we have time for reflexion" (T 1.3.8, p. 104).

between operations renews their referring relationship to each other, the ability to draw inferences depends ultimately on the memories available to the mind (the system). Or, in terms of second-order cybernetics: Drawing inferences means "to compute future events from past experience" (Foerster, 1981b, p. 96; cf. also Foerster, 1967; Foerster, 1969, pp. 25ff.; p. 43), which is possible only if the observer is supplied with memory—an assumption already clearly established by Hume, who states that every causal inference would be impossible "without the help of our memory and experience" (T 1.3.1, p. 70). This implies, at the same time, that the inferential capability, as well as the sign quality of environmental data, is not a natural power but depends on the observer, the consequence being that the same environmental datum can be differently informative according to the habits to which it is compared.[16] These results allow us to draw some conclusions about the theory of causality in particular and about the significance of Hume's philosophical contribution for the modern theory of cognition in general.

V

The aim of Hume's survey on causality is to try to explain how it arises and what the function of the idea of necessary connection is. Yet if one compares the results of the *Treatise* with those of the *Enquiry*, the first impression could be that on this point there is some ambiguity. In the *Treatise* Hume states explicitly that the idea of "necessary connexion depends on the inference, instead of the inference's depending on the necessary connexion" (T 1.3.6, p. 88); but at the same time he believes that necessary connection, together with contiguity and temporal priority, represent a fundamental requisite for the activation of that association of ideas on which the processing of any causal inference depends (T 1.3.6, p. 87). In the *Enquiry* the distinction between *conjunction* and *connexion* is even stronger, and Hume confirms that to expect from habit the conjunction of a certain effect with a certain cause is not yet sufficient to justify the arising of the idea of a necessary connexion between them (EHU 7.54, pp. 69-70). In short: "One event follows another; but we never can observe any tie between them. They seem *conjoined* but never *connected*" (EHU 7.58, p. 74). But later Hume solves the question by maintaining that because "one particular species of event has always, in all instances, been conjoined with another, we make no longer scruple of foretelling one upon the appearance of the other ... . We then call the one object, *Cause*; the other, *Effect*. We suppose that there is some connexion between them ... . It appears, then, that this idea of a necessary connexion among events arises from a number [but how many?] of similar instances which occur of the constant

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15. For Deleuze (1981, pp. 95-96) custom combines in the same dynamics the push of the past with the rush into the future; such a synthesis of times is an *inventive* synthesis of the subject and it consists of putting the past as a rule for the future.
16. For Ashby (1956, § 6/21 and § 6/22) the unpredictability of any system's behavior (machine or organism) is the correlate of such dependency of the observer upon memory. The behavior of the dog which rushes off and hides itself on hearing the roaring of a car cannot be explained until the observer is informed that two months ago the dog was knocked down by a car.

conjunction of these events" (EHU 7.59, p. 75). Hume suggests in this way that the complete change from the simple conjunction to the necessary connection depends on repetition. This is not a matter of calculating statistically the recurrence of the same concomitance of cause and effect in order to anticipate the probability of the occurring of a certain object (or event). Starting from current experience, according to Hume's theory of causality, the repetition works rather on the mind's ability to produce generalizations, which in turn, as we have seen, changes the nature of the mind's dealing with the same environmental data. This can now work as a signal, triggering in the mind inferential performances of an inductive kind. So when Hume asks: "What alteration has happened [in the mind of the observer] to give rise to this new idea of *connexion*?" and he answers by saying: "Nothing but that he now *feels* these events to be *connected* in his imagination, and can readily foretell the existence of one from the appearance of the other" (EHU 7.59, pp. 75-76), such apparent tautology—the idea of connexion arising only because the observer feels that events are connected—cannot be explained without taking into account the circularity of the process that gives rise to inference. The idea of necessary connection is nothing but the eidetic correlate of habit and, like any eigenvalues which constitute a system's redundancy, it is at the same time both the outcome of past experience and the presupposition by which the mind is compelled to associate the idea of effect to that of cause. In the *Treatise* Hume confirms unambiguously this concurrence between necessary connexion and habit, and thus the circularity itself of the functioning of causal inference, by maintaining that "the necessary connexion betwixt causes and effects is the foundation of our inference from one to the other. The foundation of our inference is the transition arising from the accustom'd union. These are, therefore, the same" (T 1.3.14, p. 165).

This theoretical approach allows us to re-examine a problem that has been so long debated: the possibility of justifying the principle of induction—a problem which has long proved insoluble.[17] For Hume, as is well known, the question concerns in general the possibility of extending past experience to future (EHU 4.29, pp. 33-34). Since the future is not available in an empirical way, one can legitimately ask on what the trustworthiness of such transfer of the outcome of experience from past to future is based. According to Hume such trustworthiness cannot be founded on reasoning (syllogism), because there is no medium to link the premises with the conclusion (EHU 4.29, p. 34); it cannot even be the result of probability reasoning, since the foundation of such probability would be another time experience and the reasoning would acquire in this way a circular movement (EHU 4.30, pp. 35-36). A pertinent observation might be that the objects on which experience would be transferred are similar to those already faced in the past, and it is a fact that "from causes which appear similar we expect similar effects" (EHU 4.31, p. 36). That is to say that from similar object (or events) "we expect similar powers and forces, and look for a like effect" (EHU 4.32, p. 37). But that prompts another objection: if it would be asked

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17. So Katz (1962, p. ix): "No justification of induction is possible" because "there can be no argument which is capable of fulfilling the conditions of the problem". And again: "Attempting to justify induction is attempting to do the impossible" (p. 22). To which one may reply: if there is no solution, then there is no problem.

what the efficacy of that similarity consists of, one would inevitably be forced to refer back to past experience. In short, the inductive inference cannot be explained either in an intuitive way, or in a demonstrative way; everyone who tries to justify it experimentally ends up begging the question because "all inferences from experience suppose, as their foundation, that the future will resemble the past" (EHU 4.32, p. 37). In other terms, the validity of the theory of habit cannot be based on habit, and from this vicious circle there is no escape.

On the other hand one could observe, as Gilles Deleuze (1981, p. 60) has done, that habit is a principle of human nature and that it consists of the habit of developing habits. This certainly does not solve the issue, but it at least suggests that another way to go might be to set up the question from the very beginning in a self-referential way. The mind does not need to produce scientifically verifiable hypotheses to switch from past to future. It is enough that it can refer to itself and to its own habits to make operationally present the concomitancy of a reference to the past and a reference to the future.[18] This self-referentiality is an unfounded property—a foundation without foundation, so to speak—by means of which the mind can structure relatively stable and consistent indicators of the reality it makes experience of every day. The consistency of such indicators depends neither on the order of the concrete reality, nor on the supposed stability of the laws of nature; rather, it depends on the constant comparing by the mind of current experiences with developed habits. The memory that allows causal inferences works in this sense as a check of consistency, whose failure (i.e., forgetfulness) is the pre-requisite of learning. Induction, for the same reason, does not help to distinguish between good and bad future trains of events (that fire burns is as informative for the observer as the fact that after the ringing of a bell there comes the giving of food), and nor even between true and false future trains of events—which would re-open questions about the procedures for the validation or vindication of truth. Not surprisingly Hume considers the expectation that one event follows another as simply a mind's *belief*, and defines the idea that between those events there is a necessary connexion as something "which we *feel* in the mind" (EHU 7.59, p. 75).

If the whole reasoning so far developed is now revised, Hume appears as the first philosopher who indeed shifts the problem of causality from external reality to the observer (i.e., from the outside to the inside of the distinction system/environment). For Hume this means that the causal connection shall no longer be sought among qualities in the object, but must be found among the arising consequences of observations in the mind (T 1.3.14, pp. 164-165). Such a process of internalization involves a transition from reference to an observer-independent reality to reference to an observer-dependent reality; that is to say, from the primacy of hetero- to the

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18. Hume conceives of the immediacy of such concomitance as a determination from which the idea of necessity itself arises. "For after a frequent repetition, I find, that upon the appearance of one of the objects, the mind is *determin'd* by custom to consider its usual attendant, and to consider it in a stronger light upon account of its relation to the first object. 'Tis this impression, then, or *determination*, which affords me the idea of necessity" (T 1.3.14, p. 156).

primacy of self-reference, possible only if the observer is re-introduced into the horizon of his observations. In Hume this process deals with the attempt to explain how it is possible to jump from the succession of perceptions to the perception of succession. If on the empirical level of current sensations the instances of resembling conjunctions "are in themselves totally distinct from each other," the only remaining explanation is that they "have no union but in the mind, which observes them and collects their idea" (T 1.3.14, p. 165). Only on the symbolic level of ideas is it possible, in other words, to recognize the same in what is always different, or the necessary in what is always contingent, but this implies, at the very least, the necessity of referring to habits as internal states always available to the mind that deals with the external environment. For Hume "necessity ... is the effect of this observation, and is nothing but an internal impression of the mind, or a determination to carry our thoughts from one object to another" (T 1.3.14, p. 165). This determination arises not from reality or from some deity; rather it "belongs entirely to the soul, which considers the union of two or more objects in all past instances" (T 1.3.14, p. 166). In the *Enquiry* Hume states even more explicitly that "when we say, therefore, that one object is connected with another, we mean only that they have acquired a *connexion in our thought*, and give rise to this inference, by which they become proofs of each other's existence" (EHU 7.59, p. 76; italics added). Hume is perfectly aware that such a statement might seem extravagant and ridiculous, especially if it were superficially understood as a way of explaining causality as the outcome of direct emanation by the mind, "as if causes did not operate entirely independent of the mind, and wou'd not continue their operation, even tho' there was no mind existent to contemplate them, or reason concerning them" (T 1.3.14, p. 167). Yet Hume does not mean at all to deny the autonomy of reality compared to the observer; he starts rather from the assumption that every time a necessary connection between an effect and its related cause is observed, one may legitimately ask: who is the observer?

Pushing Hume's reasoning a little further, it might be said that it makes no sense to deny the existence of any reality, even assuming that suddenly every observer in the world would disappear. But at the same time one may state that in this case no such thing as reality would any longer exist, because it would lack the possibility of observing the world itself through the distinction real/unreal. So Hume's approach underlies the conviction that the claim to observe reality without any observer is essentially self-contradictory. This is the modernity of his thought. While the realist philosophical tradition bracketed the observer and attributed any causal relationships to the metaphysical qualities of the real, Hume does the opposite, bracketing reality and trying to understand how it is possible, in general, to produce inferential performances.[19] The final conclusion of his investigations is that reality is a construction of the mind, which goes on recursively by comparing the external correlates of its observations with the internal results of past experience.[20] The

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19. About the principle of bracketing the reality (or of objectivity in parentheses); see Varela (1985, p. 148) and above all Maturana (1990, esp. pp. 55-58).
20. For a constructivist analysis of the problem of causality (with references to Hume) see also Cevolini (2007).

modern concept of construction implies lack of arbitrariness: Hume does not support the relativism of any ideas of necessary connection. Equally, because such a hypothesis should be compared at least with the possibility of using, as a related term, an absolute idea of necessary connection, the question is: who observes that absolute idea, compared to which all other ideas may be conceived of as relative? Rather, the co-ordination of self- and hetero-reference enables to condense some temporary results (customs or habits), which provide the mind with some orientation; that is, they give instructions about the way to proceed in similar situations (e.g., how to use a handle to open the door), without needing to start all over again every time.[21] Such an orientation can be revised, that is it's contingent, but this takes nothing away from the fact that, until it works, that orientation must be felt by the mind as a right correlate of the necessary nature of reality. This explains, finally, why the observer is normally compelled to deal with his own experiences as if they were an observation of reality, and not with reality as if it were an experience of his own observations; and why only through reflection it may be clarified the internal dynamics of the construction of external reality.

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21. The problem instead of how is it possible that *different* observers share the *same* reality can not be explained on the level of the consciousness, i.e. of psychic systems, but only on a higher level, i.e., on the level of social systems (communication), but this is a topic for another essay.

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