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nonselfCONSCIOUS INTERPRETANTS within the biology of mind¹

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Contemporary examples provided for Interpretants within Semeioses² typically presuppose interpretants that involve self-consciousness. In developing the concept of Interpretant, the modern founder of Semeiotic, Charles Peirce, was careful to avoid specifying the interpreting function in a Semeiosis as *exclusively* being an *Interpret-er*,³ a *self-conscious human in other*

¹ With thanks for research assistance from Chandler Culberth.

² This essay assumes that the reader is familiar with the basics of Semeiotic and with the fact that "Semiotics" is not an identical scientific stance. *Semeiotic* is Peirce's experimental scientific theory of Semeioses or realistic interpretative phenomena—see Fisch 1986; Savan 1987; Liszka 1996; Peirce 1992 [1898] French translation in Peirce 1995 [1898]; 2009 [1891 f.] (ed. E. Bisanz); *ISP* 2011, 2015, 2019; Ketner 2011. Concerning semiotics see Morris 1946; Percy 1975, 2018, and especially Rochberg-Halton 1986, 71-94.

Semiotics research plans typically do not include experimentation. They rely on imposing a presupposed theory onto given phenomena without testing whether that process results in a truthful output; also typically they presuppose an exclusively dyadic relational resource base. This tends to deploy a "school of thought" approach. When differing schools of semiotics come into conflict, there is no testing procedure; instead, there is a debating procedure, a contest, not an inquiry. There is no resolution of the conflict except to say, "You go your way, I go mine," or if emotions are really high, there is a war.

Semeiotic research plans have a starting theoretical overt presupposition, based (as well as possible) upon previous objective research. Then the method requires an experimental approach to predesignated research questions. Applications of the presupposed background theory are open to revision based on experimental results. Such a method is an evolving, self-correcting approach that incrementally adds to knowledge.

³ For example, Peirce to Welby 14 December 1908 in Hardwick 2001, 81; one may track other references to "interpretant" in the concordance of that volume.

words [Isc]. He hypothesized that interpreting *functions* other than those provided by a self-conscious agent could also serve as the interpreting component in a semeiosis. It is sometimes assumed that any candidates for interpreting functions other than humans would also be self-conscious: perhaps an inter-galactic visitor or a fully self-conscious artificial intelligence. This essay explores the possibility that *Interpretants that do not include self-consciousness [Insc]* may also be observed in nonmechanistic semeioses within phenomena examined by various objective research disciplines. For such semeioses to be present, *Insc* Interpretants should be identifiable in contexts that lack *self*-consciousness, but which include some minimal level of consciousness. Pre-cognitive levels of neurological phenomena provide various settings in which the difference between *Isc* and *Insc* semeioses can be explored; physics⁴ is another possible source of such examples.

On a closely relevant background theme within neuroscience, the contemporary tendency is to think of neuronal precognitive processes as "mechanisms" that are understood as cause-effect (or stimulus-response) dyadic-relational chains (for instance, *passim* in Kandel 2006, and Kandel *et*

⁴ In physics, see Beil and Ketner 2003, 2004 (US Patent on Semeiotic in quantum computing), 2006; Beil 2004, 2012; Murdoch 1989 (concerning Høffding and the pragmatists). As we now see, Peirce was a self-described physicist—see Peirce in Bisanz, ed. 2009 [1891 f.], 36.

al. 2021). As a test case, the present working hypothesis is to examine deployment of the NonReductionTheorem [NRT] from Peirce's relational logic onto semeioses employing *Insc* in experimental applications within neuroscience (and eventually into other fields of science). That theorem states that it is not possible to construct triadic relations by way of combining resources only consisting of dyadic relations. In the mid-twentieth century, NRT was in doubt, but recent research has vindicated its reliability; *ISP* 2011 summarizes that research and outlines NRT.

It is clear at the cognitive level that one commonly finds triadic relations as well as triadically relational semeioses—a good example is interpersonal communication that requires interrelation of a speaker, a message, and a hearer (interpreting functions in such cases typically would be *Isc*). If there are only dyadic relations—mechanisms—at pre-cognitive levels, and if (as mechanistic biologists propose) cognitive phenomena could develop through dyadic processes from pre-cognitive dyadic phenomena, then NRT would predict that the mechanistic process, whereby the transition from mechanistic neurons to mechanistic cognition should occur, would be a mystery, inasmuch as primary components (communication processes) of cognition are triadic semeioses that are not mechanistic, and cannot be derived from mechanistic resources. (Such mysteries currently arrive as "problems" within issues such as neural binding or fusion

difficulties or computational intelligence—see below.) One might avoid this outcome by shifting, from currently employed mechanistic background methodological hypotheses, to a replacement consistent with **NRT** that incorporates robust features for studying interpretation—without, of course, losing sustainably reliable previous research results. (Scientific background theories such as the large-scale theory of *Mechanism* are also hypotheses, which of course can be disconfirmed on occasion; historically, this may be such an occasion.)

Consider this expanded overview:

[1.] According to the current dominant biological background theory, neuronal level processes are mechanistic—they operate exclusively via dyadic relations according to contemporary biological research presuppositions and explanatory practices. (As a side note, if one is exclusively looking for dyadic relations through mechanistic spectacles, one will most likely find only such mechanisms.)

[2.] Cognitive level phenomena incorporate a triadic relational format—incorporated within the process of semeiosis, which includes an interpreting function.

[3.] Adopt **NRT** as a working hypothesis. This step, then, might provide resources for noticing triadic relations within neuro-cellular contexts. Dyadic relations are not excluded, but other relational types could be added to the available tool base.

[4.] Based on [1-3], the "Biology of Mind" [**BM**] research program, which proposes to use mechanistic resources to move from dyadic neuronal phenomena to triadic cognitive phenomena, could not succeed *if* **NRT** applies. This is due to the failed proposal that only mechanistic (dyadic) relational neuronal processes plus mechanistic presuppositions could lead to observed triadic cognitional processes. Such a transition from dyadic neurons plus a mechanistic transfer to triadic cognition will not be possible according to the principles of relational logic discovered through **NRT**.

[5.] However, the difficulty raised in [4] might be resolved if triadic relational phenomena are found at the neuronal level, thus allowing a transition to cognition that is consistent with **NRT**. Another way to express the suggestion: If what are presumed to be exclusively mechanistic dyadic relations within neuro-cellular contexts were discovered also to include triadic relations within semeioses that feature *Insc* interpretants, then the needed pathway (as required in the **BM** strategy) from nerve cells to cognitive phenomena featuring triadic *Isc* interpretants would not be blocked. That is, without an antinomy, semeioses using *Insc* can connect with cognitive semeioses incorporating *Isc*, whereas neural dyadic non-semeioses will not connect with cognitive semeioses that use *Isc*.

Hereby we can envision this mystery within the current mechanistic **BM** strategy as being identified as the *Biological Mechanism Blockage Problem*.

Considerations similar to the above issues might also apply to the present state of research exemplified in such current difficulties as the "binding problem" in neuroscience (Feldman 2013) or the "fusion problem" in systems research (Nozawa 2000, Burch 2000) or some aspects of the attempt to construct an artificial computational intelligence (Megill 2022). It might be possible to resolve these mysteries by re-examining whether triadic semeiosis relations (featuring *Insc*) also are present pre-cognitively, contrary to the presupposition that all pre-cognitive neuronal processes are exclusively mechanistic. These tables summarize the situation.

- Blocked Biology of Mind program
(and Binding, Fusion, AI blocked)*
1. Only mechanisms (dyads) at nerve cells
 2. Working Hypothesis: apply **NRT**
 3. Semeioses *Isc* observed at cognitive level
 4. **NRT** halts mechanistic path from neurons to cognition
 5. Program of **BM** neuron to mind is blocked

- Biology of Mind program has a path
(as might Binding, Fusion, AI)*
6. Mechanisms *and* semeioses *Insc* at Nerve cells
 7. Working Hypothesis: apply **NRT**
 8. Semeioses *Isc* observed at cognitive level
 9. **NRT** enhances passage from neurons to cognition
 10. Full program of **BM** is operational via semeiotic

Thus, the presently conceived mechanistic Neural Biology would eventuate in a Mind functioning mechanistically, a picture of cognition that is classically suggested in historical speculations about minds as machines.

Successfully performing processes envisioned in the Biology of Mind research program would abandon an exclusive mechanistic methodology and require a clear understanding of the logic of pre-cognitive semeioses having interpretants that aren't self-conscious: hence the task of this essay. The neurotransmitter concept will be considered as one example for possibly working out a framework for *Insc* interpretants within pre-cognitive neuronal semeioses.

1. NEUROTRANSMITTERS RE-EXAMINED:

The *current notion of a neurotransmitter function* (in summary) appears to be the following:

1. An Ejector unit within nerve cell₁ ejects a chemical, presently designated as a Neurotransmitter, into the media of a cleft between cell₁ and the adjoining cell₂. This ejection process presently is considered to initiate a causal⁵ relation: Ejector (**E**, cause_a) produces Neurotransmitter (**N**) in cleft (effect_a).
2. The presence of the same Neurotransmitter in the particular cleft media (effect_a now acting as cause_b) in turn causes a nearby particular sensitive Receptor (**R**) in cell₂ to activate (effect_b) in an appropriate manner. This also

⁵ Of the various possible senses of "cause," what is meant here is "efficient cause": if C is present, E is present; if C is absent E is absent; C precedes E in time.

is analyzed as a causal relation: presence of Neurotransmitter in the cleft media causes specific Receptor activation in cell₂.

3. This process is conceived as a chain of causal relations: E_a causes N_a , N_a in turn causes R_b , so E_a causes R_b (ENR). This is one example of a "mechanism" (Kandel 2006 *passim*) among biological scientists. This ENR analytical strategy displays the logical form known as Hypothetical Syllogism.⁶

The process described in (3) is not communication in the full sense of the notion as found in normal human cognitive phenomena. In human cognitive activity one sees genuine communication involving a triadic semeiosis relation irreducibly incorporating three co-relates: an Object, a Representamen, and an Interpreting *function*. A rigorous analysis of genuine communication (as opposed to merely causal interchanges inappropriately disguised as such communication) is available within Semeiotic (see *ISP* 2019, 45-47).

At present the Biology of Mind research program within neuroscience proposes to connect neuronal level processes—dyadic "mechanisms"—to

⁶ Although this is a side issue within the main argument, it is useful to consider how the current mechanistic notion of neurotransmitter might be a good example of how biologists overlook background triadic relations, even in features conceived as mechanisms. In a Hypothetical Syllogism structure, the transitivity relation is used to connect (where ">" means "implies") three prior independently observed *separate* dyads [1], [2], [3] such as: [1](x)($E_x > N_x$); [2](x)($N_x > R_x$); [3](x)($E_x > R_x$) with the form [$p > q$] and [$q > s$] to conclude [$p > s$]. In order to perform the operation of combining three separate dyadic sentences into the Hypothetical Syllogism argument structure, one must use the concept of triple identity $x=x=x$ or *Teridentity* in which three items are *at once* identical—in this case the application of teridentity involves the occurrence of the variable x onto three separate concepts, **E**, **N**, **R**. From that combination, expression [4] results: [4] (x) [($E_x > N_x$) and ($N_x > R_x$) to imply ($E_x > R_x$)]. In [4] the quantified variable x is applied, *at once*, to the three concepts **E**, **N**, and **R**. This example shows a pattern in which a series of dyadic relations are involved, but an unmentioned background triad (in this case teridentity) is also added without overt notice. Unnoticed background events of that kind are probably common throughout "mechanistic" biological practice. By using tools such as Peirce's Semeiotic that allow for better analyses of dyadic and triadic relations, more *sub rosa* puzzles in Biology of Mind research practice might be surmounted.

triadic "Mind" cognitive phenomena. That approach encounters a blocking difficulty because triadic cognitive events cannot arise only from sequences of dyadic neuro-mechanisms. If **NRT** and Semeiotic (Peirce's scientific Semeiotic—not semiotics lacking experimentation and lacking a full logic of relations) are added to the resources available within the Biology of Mind program, that difficulty might be overcome. This suggests a focus on a more relationally inclusive analysis of neuronal level processes to determine whether they incorporate overlooked triadic features that could support the eventual development of Mind phenomena that appear to consist of triadic Semeiosis processes (*ISP* 2019). Consideration of the Neurotransmitter process (or other neuronal level processes) as being *only* analyzable in terms of causes might block the Biology of Mind research program, because in terms of semeiotic analysis, which is guided by **NRT**, one cannot construct triadic relations from resources containing only dyadic, causal, mechanistic relations. If Semeiotic is used at both the neuronal level and the cognitive level, and if it is found that some ambiguous terminology or unnoticed processes at the neuronal level has obscured what really are triadic processes there, and if replacing the ambiguous terms with improvements that really do show triadic features among neurons, then following out the processes from neurons to higher levels will not be blocked, and the mystery could be resolved. Testing the appropriateness of using Semeiotic as the tool of

analysis, in place of a strictly dyadic method, might produce an experimental result in the form of removal of presently blocked "arising" or "emerging" Mind phenomena. Of course, the proposal to employ semeiotic resources is only a hypothesis (not a dogma); experiments along the above lines would be required to find whether that hypothesis is more productive than the original *merely mechanistic* Biology of Mind project.

2. RE-CONCEPTION USING SEMEIOSIS

As a contribution to such a revision, consider whether the current dyadic analysis of neurotransmitter processes could fruitfully be re-conceived as semeioses to replace the currently exclusive causal concept. Before comparing the two approaches, here are further details about how an analysis based on Semeiotic might be set up (see *ISP 2019* for basic semeiotic strategies). First, a change in terminology is suggested. The *Ejector* could be changed to the **Object (O)** of the proposed semeiosis model; *Neurotransmitter* would be modified to be **NeuroRepresentamen (NR)** and *Receptor* would be dropped in favor of **Interpretant** using *Insc* (as opposed to **Interpretant** using only *Isc*). Further clarification of these terms is indicated. In the case of Ejector/Object within the proposed semeiosis analysis, the Ejector is no longer considered solely as a cause. In the context of an appropriate semeiosis pattern, the Ejector-in-action constitutes an item to be interpreted

by an interpreting function through a Representamen. For the interpreting function, a NeuroRepresentamen—the ejected chemical—represents or means the active state of the Ejector/Object. The Interpreting Function is a property of the system under study that can be described as "Systemic ability to distinguish between (1) the presence of NeuroRepresentamen in the cleft media or (2) lack of its presence. This could also be described as the *hard habit* (ISP 2019, 28 f.) of the systemic properties of the immediate surroundings of this event, a habit that permits of registering (as a systemic condition) whether the NeuroRepresentamen is present in the cleft media. Alternatively expressed, the immediate surroundings of the event has a built-in option: *Detect or not-Detect* the presence of NeuroRepresentamen in this setting. In this location, sometimes **NR** will be detected and sometimes **NR** will not be detected. That is, from the system standpoint, the presence of a particular **NR** at this place is meaningful, and the lack of **NR** at this same place, at other times, is also meaningful. So, the Interpretant in the case of a NeuroRepresentamen is the contextual nonselfconscious systemic hard habit at that particular context and location.

This suggests that in this example the specific type of semeiosis involved is an *Index*, and the Interpretant (interpreting *function Insc*) is the system habit-based capacity to distinguish the presence of specific **NR** in the cleft media, *OR* the nonpresence of such **NR**.

The classic example of an Indexical Semeiosis is a Weathervane. For a capable Interpretant (interpreting function), the originating direction of the wind (Object) is indicated by the pointing direction (Representamen) of the vane. The Interpretant is functional incorporation in the overall system which here *includes a knowledgeable conscious human observer* (unlike an NR context that lacks self-consciousness) that wind flow is dyadically aligned with the vane and rotational bearing properties of the weathervane apparatus.

Thus, compare:

Object Wind direction	Representamen Vane pointing	Interpretant <i>Isc</i> Cognizance of the relation of wind on vane, thus direction.
Object Ejector (cell ₁) is active	Representamen Presence of NR in cleft	Interpretant <i>Insc</i> System ability to detect NR or notNR via cell ₂ receptor habit

It is important to be clear about the difference between a strictly causal sequence and a semeiosis of the Indexical type. In the weathervane case one can imagine a natural vane-like structure, perhaps a leaf floating on a pond. The larger part of this leaf is like the vane on a constructed device, while the leaf/water boundary serves like the ball-bearing of a vane device that allows lateral rotation due to wind flow. As a strictly causal event there are lots of floating leaves/wind vanes responding causally to wind. So far, this is not

an Indexical Semeiosis because there is no Interpreting Function. This is Dynamical Action, or—in parallel with *Semeiosis*—one could label such a strictly causal relational process as *Dynamis*. A child can detect the presence of wind and see floating leaves moving on a pond but without access to a wind-direction Interpreting Function (in this case, of the *Isc* kind), the child can only notice pond/leaves/wind but has no capacity for Indexical Semeiosis at that stage. A parent, as a teacher, could call attention to the Interpreting Function (something the parent has learned independently or was previously taught) by saying "The wind direction, leaf area, and the float bearing orient the stem toward the direction of the wind, and it orients toward the wind direction in the past, in the present, and will do so in the future; that is why we can *expect* these processes to show direction in later experiences." When this Interpreting Function becomes available to the child, there is now present an Indexical Semeiosis that is no longer merely a set of experiences nor a chain of causes but is a triadic relation—a fact about three items that resulted eventually from an experimental process.⁷ Within this semeiosis the Object is "Direction of the Wind," the Representamen is the Orientation of the Vane (leaf), the Interpretant (Interpreting Function) is the presence in the system (child in this case) of the child's learned shared cultural habit that through understood causal law the vane (leaf) does so

⁷ Note Percy's discussion of a similar process he ascribed to the young Helen Keller: Percy 2019, 55.

indicate wind direction. Note that the Interpretant is not itself the effect of a cause; it is a future-governing habit relation embedded (in this case) in the system of the child or other encultured persons. The child's observation of the vane while lacking an Interpretant is not a semeiosis. And the causal processes that orient a vane toward wind direction do not cause an *Isc* Interpretant. If such were the case, every action of wind direction on vane causal sequence *would in itself cause* an *Isc* Interpreting output. The very common situation of a child lacking the above wind-direction Interpretant is an experiment showing that mere observation of wind vane causal action does not causally produce an effect equal to presence-of-an-*Isc*-Interpretant-concerning-wind-direction.

Canadian Geese constitute another relevant natural example. After they alight upon a pond, they often proceed to shore to rest. When they rest, one notices that their head is oriented toward the wind direction. Some causal features of their sensitive organs make that possible in a manner similar to a wind vane action. Yet the geese are enacting a genuine Index, the *Insc* interpreting function of which is a hard habit of their system. The geese may not be self-conscious of this habit—perhaps it evolved as a survival adjustment (to escape a predator it is aerodynamically easier upwind to get airborne, as opposed to downwind). Such an evolution within geese suggests a system component *Insc* that features various habits as relevant

interpretants. Situations such as these suggest possible lines of study involving semeioses within evolutionary and ethological settings.

Why, within biology and other sciences, would a re-conceiving of "Neurotransmitter" (and other mechanistic processes) be useful? Worthy of note is the fact that one doesn't know *if* it would be useful. It is a hypothesis. Hypotheses require tests. But one can speculate about value a hypothesis *might* have if it were successfully tried. In the Biology of Mind research approach the hope is that there may be scientific and objectively real processes that directly connect smaller level neuronal triadic activities with the "Mind" level of human intelligence. If the assumptions used to study the neuronal levels remain strictly causal, strictly in terms of stimulus and response, strictly in terms of dyadic relations (in other words), then a pathway, for connecting that micro level with a macro level that does indeed display semeioses as essential features, would appear to be incapable of realization. That is because in terms of analyses of the logic of relations no triadic relation can be constructed from, or reduced to, resources containing only dyadic and monadic relations. Because any semeiosis is a triadic relation involving co-relates composed of an Object, a Representamen, and an Interpretant, **NRT** and other features of relational logic apply to semeioses. Of course, use of the logic of relations and Semeiotic as needed components in this biological setting is *in itself* another hypothesis. Tests of

these hypotheses might be feasible if the revised analysis methods were used to design experiments. If the experiments began to show paths that would clear blockage problems associated with moving from micro levels to macro levels in Biology of Mind studies, then these hypotheses would gain in confirmation. Another consideration: by revising cases such as the dyadic Neurotransmitter analysis in favor of triadic NeuroRepresentamen analyses, no essential result of the earlier strictly causal analysis is lost. Furthermore, by going to an approach similar to the NeuroRepresentamen example, increased possibilities appear for successfully linking micro level "neuronal" activity to macro "mind" phenomena.

3. EXPLORING CONSEQUENTIAL PATHWAYS

Further review of the preceding discussion seems to open the possibility that we can now distinguish two types of Indexical Semeioses: (1) an Index having an *Insc* interpretant function [Index_{Insc}] and (2) an Index with an *Isc* interpretant function [Index_{Isc}]. One is now capable of separating these two types of Indexical Semeioses, a result that will enable a clear delineation of processes that are strictly causal from processes that are in effect semeioses [Index_{Insc}], but which are unconsciously and automatically misplaced as only dyadic events, as noted in the case of mechanistic

biological research presuppositions. These distinctions may be relevant to future experimental activities.

Another consequence worthy of consideration is examination of other processes within the Biology of Mind project that might facilitate connections between $\text{Index}_{I_{nsc}}$ and $\text{Index}_{I_{sc}}$. How might the two processes be interrelated? Can patterns expanding within the former type lead to occurrences of the latter type or even with other types of semeiosis such as Symbols or Icons. In any case, the door appears to be open for some new nonmechanistic experimental research patterns within the Biology of Mind, or indeed with other disciplines.

REFERENCES

Beil, R. G. 2004. "Peirce, Clifford, and Dirac." *International Journal of Theoretical Physics*. Volume 43: 1301-1315.

_____. 2012. *The Ralph Gregory Beil Memorial Volume: Papers in Theoretical Physics*. Edited by Thomas G. McLaughlin. With an introduction by Vladimir Balan. *Peirce Studies* number 9. Lubbock: Institute for Studies in Pragmaticism.

Beil, R. G. and Ketner, K. L. 2003. "Peirce, Clifford, and Quantum Theory." *International Journal of Theoretical Physics*. Volume 42, number 9, September 2003, 1957-1972.

_____. 2004. *Quantum Switches and Circuits*. United States Patent 6,819,474. Washington: United States Patent and Trademark Office. Retrieved
https://www.depts.ttu.edu/pragmaticism/collections/docs/US-PATENT_6819474b2.pdf

_____. 2006. *A Triadic Theory of Elementary Particle Interactions and Quantum Computing*. Lubbock: Institute for Studies in Pragmaticism.

Burch, Robert W. 2000. "Semeiotic Data Fusion." In *Proceedings of the Third International Conference on Information Fusion*. Paris, France.

Copi, Irving M. 1973. *Symbolic Logic*. Fourth Edition. New York: Macmillan.

Feldman, Jerome. 2013. "The Neural Binding Problem(s)." *Cognitive Neurodynamics*. Volume 7 (1): 1-11.

Fisch, Max Harold. 1986. "Peirce's General Theory of Signs," in *Peirce, Semeiotic, and Pragmatism: Essays by Max H. Fisch*. Edited by K. L. Ketner and C. J. W. Kloesel. Bloomington: Indiana University Press.

Hardwick, Charles S. 2001. *Semiotic and Significs: The Correspondence between Charles S. Peirce and Victoria Lady Welby*. Second edition revised. *Peirce Studies* number 8. Lubbock: Institute for Studies in Pragmaticism.

Interdisciplinary Seminar on Peirce (ISP). 2011. "Peirce's NonReduction and Relational Completeness Claims in the Context of First-Order Predicate Logic." *Kodikas/Code*, volume 34, number 1-2. Tübingen: Gunter Narr Verlag.

_____. 2015. "'Betagraphic': An Alternate Formulation of Predicate Calculus." *Transactions of the Charles S. Peirce Society*. Volume 51: 137-172.

_____. 2019. "Toward Understanding the 'Biology of Mind' Hypothesis." *Applied Interdisciplinary Peirce Studies*. Edited by Elize Bisanz. *Peirce Studies* number 10. Berlin: Peter Lang, 17-57.

Kandel, Eric R. 2006. *In Search of Memory: The Emergence of a New Science of Mind*. New York: W. W. Norton.

Kandel, Eric. R. et al. Editors. 2021. *Principles of Neural Science*. Sixth edition. New York: McGraw Hill.

Ketner, Kenneth Laine. 1981. "Peirce's Ethics of Terminology." *Transactions of the Charles S. Peirce Society*, volume 17: 327-347.

_____. 1984. "Peirce on Diagrammatic Thought: Some Consequences for Contemporary Semiotic Science." In K. Oehler editor, *Zeichen und Realität*, Tübingen: Stauffenburg Verlag, 305-319.

_____. 1990. *Elements of Logic: An Introduction to Peirce's Existential Graphs*. Lubbock: Texas Tech University Press.

_____. 1998. *His Glassy Essence: An Autobiography of Charles Sanders Peirce*. Nashville and London: Vanderbilt University Press.

_____. 2011. "Semeiotic." In *Das Bild zwischen Kognition und Kreativität*. Edited by E. Bisanz. Bielefeld: Transcript Verlag, 375-401.

Liszka, James Jakób. 1996. *A General Introduction to the Semeiotic of Charles Sanders Peirce*. Bloomington: Indiana University Press.

Megill, Jason. 2022. "The Lucas-Penrose Argument about Gödel's Theorem." *Internet Encyclopedia of Philosophy*. Retrieved <https://iep.utm.edu/lp-argue/>.

Morris, Charles. 1946. *Signs, Language and Behavior*. New York: Prentice-Hall.

Murdoch, Dugald. 1989. *Niels Bohr's Philosophy of Physics*. Cambridge: Cambridge University Press.

Nozawa, E. T. 2000. "Peircean Semeiotic: A New Engineering Paradigm for Automatic and Adaptive Intelligent Systems Design." In *Proceedings of the Third International Conference on Information Fusion*. Paris, France.

Peirce, Charles Sanders. 1992 [1898]. *Reasoning and the Logic of Things: The Cambridge Conferences Lectures of 1898 by Charles Sanders Peirce*. Edited by K. L. Ketner, with an introduction by K. L. Ketner and Hilary Putnam. Cambridge, Harvard University Press.

_____. 1995 [1898]. *Le Raisonnement et la Logique des Choses: Les Conférences de Cambridge*. Traduction de l'anglais par Christiane Chauviré, Pierre Thibaud, et Claudine Tiercelin. Paris: Les Éditions du Cerf.

_____. 2009 [1891 f.]. *Charles S. Peirce, The Logic of Interdisciplinarity: The Monist-Series*. Edited by Elize Bisanz. Berlin: Akademie Verlag.

_____. 2021. *Charles Sanders Peirce: Man of Science, A Self-Introduction*. Edited by K. L. Ketner. Retrieved https://www.kenketner.net/_files/ugd/dd0fee_bcb447780d8d488ea1173d6960851516.pdf

Percy, Walker. 1975. *The Message in the Bottle: How Queer Man Is, How Queer Language Is, and What One Has to Do with the Other*. New York: Farrar, Strauss, and Giroux.

_____. 1983. *Lost in the Cosmos: The Last Self-Help Book*. New York: Farrar, Strauss and Giroux.

_____. 2018. "To Take the Writer's Meaning: An Unpublished Manuscript on 'Peirce and Modern Semiotic' by Walker Percy." Edited by K. L. Ketner. In *Walker Percy, Philosopher* (edited by L. Marsh). Cham, Switzerland: Palgrave Macmillan.

_____. 2019. *Symbol and Existence: A Study in Meaning, Explorations of Human Nature, by Walker Percy*. Macon: Mercer University Press.

Rochberg-Halton, Eugene. 1986. *Meaning and Modernity*. Chicago: University of Chicago Press.

Samway, Patrick H. S.J. Editor. 1995. *A Thief of Peirce*. Jackson: University Press of Mississippi.

Savan, David. 1987. *An Introduction to C. S. Peirce's Full System of Semeiotic*. Toronto: Toronto Semiotic Circle.

Scott, Frances Williams. 2006. *C. S. Peirce's System of Science: Life as a Laboratory*. *Peirce Studies* number 7. Lubbock: Institute for Studies in Pragmaticism.

Smolin, Lee. 2013. *Time Reborn: From the Crisis in Physics to the Future of the Universe*. Boston and New York: Houghton Mifflin Harcourt.

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