Husserl Studies
https://doi.org/10.1007/s10743-022-09315-3

Phenomenology as Proto-Computationalism: Do the Prolegomena Indicate a Computational Reading of the Logical Investigations?

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τότε ἐπιστάμεθα ὅταν τὴν αἰτίαν εἰδῶμεν – Aristotle, *Posterior Analytics* (71b31-2).

1 Introduction

Ever since Hubert Dreyfus and Harrison Hall presented *Husserl, Intentionality, and Cognitive Science* (1982), the question of the relation of phenomenology to cognitive science has been, if not answered, at least discussed. Dreyfus tried to answer this question in terms of the work of Jerry Fodor. From a Husserlian "point of view," Dreyfus contended, "Fodor is rediscovering a very important discipline: the phenomenological theory of cognition, which Hume and Kant saw dimly and which Husserl brought into its own" (15). This answer, however, proved to be very unpopular (though see Pokropski 2020), and was immediately rejected by Husserlians, both before (McIntyre, 1986) and after (Brown, 1990; Woodruff Smith, 1995, 342) the discovery of the potential of neural networks as an explanatory apparatus for cognitive phenomena (Rumelhart and McClelland, 1986; Smolensky, 1991).

In light of the newfound promise of multilayer networks, and without heeding the warnings of the rediscoverer of phenomenological cognition (Fodor & Pylyshyn, 1988), the journal *Phenomenology and the Cognitive Sciences* was born. The guiding framework for the journal was established by the work of Varela, Thompson, and Rosch in *The Embodied Mind* (1991). This work explicitly opposed the orientation of both Husserl and Fodor (Varela et al., 1991, 19, 102). As a result, the explanatory apparatus favored by Fodor—the computational theory of mind—was to be displaced by the newfound powers of neural networks, recognized by the authors to be "associationist" in character (98). The rejection of associationism by Husserl and Fodor for

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Published online: 20 September 2022

the explanation of cognition and its characteristic properties (productivity, systematicity, etc.) could therefore be ignored with theoretical consistency.

For the purposes of this article, the above scholarly history is only meant to raise the issue of the explanatory apparatus appropriate to Husserlian phenomenology. If it cannot be associationism, a fortiori neural networks, what could it be? Actually, Dreyfus answered this question as well: "Husserl's theory of intentionality developed through two stages. The first stage corresponds exactly to what Jerry Fodor… calls the representational theory of mind, and, we shall argue, the second stage may be linked to what Fodor calls the computational theory of representations" (1982, 3). Dreyfus thought the transition between the *Logical Investigations* and *Ideas I* was essentially the transition from the representational theory of mind (RTM) to the computational theory (CTM). Whereas the former work (*Logical Investigations*) is largely concerned, according to Dreyfus, with the descriptive listing of the kinds of representations available to consciousness and the objects made possible thereby, the latter work (*Ideas I*) is concerned with explicitly referring these objects to cognitive structures governed by (computational) rules (1982, 11). It is these rules that "make intentionality possible" (ibid.). Since the computational theory of mind *just is* the theory that the mind is governed by rules defined over formally structured representations, Dreyfus thought he was making an easy inference.

In fact, Husserl's descriptions of intentionality can be more than "linked" to the computational theory. This is because Husserl had earlier formulated the present-day conception of the computational theory of mind, as theoretically distinct from associationism, in 1891 (Lopes, 2020). What is more, he discusses this theory, and its relation to the subsequent *Logical Investigations*, in the *Prolegomena to Pure Logic*, which serves as a sort of introduction and foundation to the work as a whole. That he discusses his earlier discovery of computationalism in the *Prolegomena* has not been noticed in the literature, though it was pointed out with great honesty by Theodor Adorno in his *Against Epistemology* (1956), which is a systematic critical analysis of the whole of Husserl's corpus, with special emphasis on the two magna opera: *Logical Investigations* and *Ideas I*. We shall limit ourselves to a consideration of the former magnum opus to ask our principal question: whether the *Prolegomena* indicate some necessary connection between the phenomena of the *Investigations* and CTM, something Dreyfus had not anticipated. With a view to this, we turn to relevant passages in the *Prolegomena*.

Before doing so, it may be appropriate to forestall objections deriving from McIntyre's great article on Husserl and Fodor (1986). For did not McIntyre's rejoinder to Dreyfus rule out the line of inquiry that this paper investigates? McIntyre's article is very helpful, and I have myself benefitted from reading it. Nevertheless, McIntyre's central thesis is quite mistaken. McIntyre believes the central difference between Husserl and Fodor is that Husserl does not want to reduce intentionality to syntax, whereas Fodor does. This contrast, however, is incorrect.

The original debate between Dreyfus and McIntyre was greatly impoverished by the fact that neither considered the causality of syntactic form (in a computer) and its explanatory possibilities as a mental mechanism for nomological theory. Fodor, recall, was an intentional *realist*—that is, he believed in a "non-reductive" account of meaning and intentionality implemented by computational mechanisms (Cain, 2002,

114). The nomological laws of cognitive science subsume the property of intentionality. Anything subsumed by a law, according to the philosophy of science, has an ontological claim to reality. Insofar as Fodor's (1974) special-science thesis holds, any property of any special science law cannot be reduced to any other. Intentionality is no exception.

It was therefore incorrect to say that Fodor and Husserl parted ways with regard to intentional content. The real difference is that one but not the other actually achieved nomological unity between intentional properties and computational mechanisms. As I shall show below, this unity is more than hinted at in the *Prolegomena*. In short, the theoretical structure of nomological-explanatory theory is absent from McIntyre's discussion, which leads him into the error of claiming that Fodor wishes to "reduce" meaning to syntax, and that he knows of no passage in Husserl that suggests such a reduction. Actually, in *Formal and Transcendental Logic* (1929), Husserl points out that "categorial form"—which it is the business of the *Logical Investigations* to elucidate—is derived from syntax: "To each cognition-objectivity, as a judgment-objectivity, there belongs a 'categorial' form deriving from the κατηγορεῖν (or from its syntactical actions), a syntactical form" (1969 110). But for the syntax, the categorial forms would not appear; for categorial forms "deriv[e]" from the syntax. These forms constitute the phenomenology that goes beyond empiricistic associationism. This does not constitute a *reduction* of cognized objects to syntax, though it does show what makes them transcendentally possible.

In the years since McIntyre's article, Sokolowski (2003) has also inadvertently contributed to the discussion by showing that the *Logical Investigations* as a whole is already primarily concerned with, and culminates in, a description of the discretely syntactic structures of logical experience. I consider this work to be strong independent evidence for the line of inquiry examined here.

But again, according to Fodor, any property expressed by a law is real; hence if there are intentional laws, intentionality is fully real—and there is absolutely no claim that the property is to be reduced to the syntax of its implementing mechanism. McIntyre's misleading view of Fodor recurs in Zahavi's otherwise excellent *Phenomenology: The Basics* (2019, 49). Fodor was aware that this erroneous view was circulating by 1987 (one year after McIntyre's article). Fodor laments:

> Norbert Hornstein has recently ascribed to me the view that "the generalizations of psychology, the laws and the theories, are stated over syntactic objects, i.e., it is over syntactic representations that computations proceed." But: the claim that mental processes are syntactic does not entail the claim that the laws of psychology are syntactic. On the contrary, the laws of psychology are intentional through and through. This is a point to the reiteration of which my declining years seem somehow to have become devoted. What's syntactic are not the laws of psychology but the mechanisms by which the laws of psychology are implemented. (1990, 145-6)

It is certainly unfortunate for the field of phenomenology that McIntyre has been seen as offering a decisive argument against Dreyfus, since McIntyre's main argument is, for the above reasons, unfounded. But it may also have been fortunate, since we

can now build a sturdier theoretical edifice than the one Dreyfus offered, through an examination of the topics below.

2 Husserl's *Denkmaschine*

Perhaps the most important source of evidence for the determination of our question can be found in that semi-famous passage of the *Prolegomena* (1900) where Husserl reveals a commitment to the computational nature of thought processes (1975 , 79/2001, 50). I shall examine this passage before critically reviewing comments on it by two Husserlians.

Most of the *Prolegomena* is concerned with rejecting a view called psychologism, and Sect.22 is no different. Psychologism is "the doctrine that the laws of mathematics and logic *can be reduced to or depend on* the laws governing thinking" (Moran & Cohen, 2012, 266, italics added). And for Husserl the laws of logic include the laws of meaning: "logic evidently is the science of meanings as such [*Wissenschaft von Bedeutungen als solchen*]" (1984, 98/2001, 225). Hence psychologism would be entailed by any reduction of meaning to causality. This was perhaps most notoriously attempted by Hume. In Sect.22, however, the philosopher who wishes to effect the reduction is Theodor Lipps, otherwise famous for his "theory of empathy" (Moran & Cohen, 2012, 193). Lipps's view, Husserl says, is that "the laws of thought count [merely] as natural laws characterizing the peculiarity of our mind qua thinking" (1975, 76/2001, 48). This cannot be true without reduction. Lipps is therefore guilty of psychologism.

Several paragraphs later, Husserl is still charitably imagining scenarios in which Lipps's view might seem plausible. This leads him to imagine (in imitation of Sigwart) an ideal person (*Mensch*) whose thoughts not only *never* deviate from logical law but *could* not ever deviate. Would logical law, in such a case, theoretically count merely as a natural law of thought, as a result of this absolute and principled coincidence? Of course not. And it is at this exact point that Husserl brings in the idea of a computer (unlike Turing, as a *non*-human calculating machine, but like Ullman (1979, 2)) in order to explain why this being's principled lack of deviation from logical law is nevertheless of no reductive significance:

> The example of a computer makes the difference quite clear. The arrangement and connection of the figures which spring forth is regulated by natural laws which accord with the demands of the arithmetical propositions which fix their meanings. No one, however, who wants to give a physical explanation of the machine's procedures, will appeal to arithmetical instead of mechanical laws. The machine is no thought-machine, it understands neither itself nor the meaning of its performances. But *our own thought-machine* might very well function similarly, except that the real course of one kind of thought would always have to be recognized as correct by the insight brought forward in another. (1975, 79/2001, 50, italics added)

There are several important points in this passage, most significantly the reference to "our own thought-machine."[1] The first point is that the meanings of the syntacti-

[1] The text is unclear because "our own" is possibly the 'royal we possessive' referring to Husserl's personal sense of ownership over the idea of the ideal human being occurring earlier in the original paragraph: "Demgegenüber genügt es, folgende Erwägung anzustellen. Wir fingieren einen Idealmenschen, in dem alles Denken so vonstatten geht, wie es die logischen Gesetze fordern. Natürlich muß die Tatsache daß es so vonstatten geht, ihren erklärenden Grund haben in gewissen psychologischen Gesetzen, welche den Verlauf der psychischen Erlebnisse dieses Wesens von gewissen ersten ‚Kollokationen' aus in einer gewissen Weise regeln. Ich frage nun: Wären diese Naturgesetze und jene logischen Gesetze unter den gemachten Annahmen identisch? Die Antwort muß offenbar verneinend ausfallen. Kausalgesetze, nach welchen das Denken so ablaufen muß, wie es nach den idealen Normen der Logik gerechtfertigt werden könnte, und diese Normen selbst – das ist doch keineswegs dasselbe. Ein Wesen ist so konstituiert, daß es in keinem einheitlichen Gedankenzuge widersprechende Urteile fallen, order daß es keinen Schluß vollziehen kann, der gegen die syllogistischen Modi verstieße – darin liegt durchaus nicht, daß der Satz vom Widerspruch, der modus Barbara u. dgl. Naturgesetze seien, die solche Konstitution zu erklären vermöchten. Das Beispiel der Rechenmaschine macht den Unterschied völlig klar. Die Anordnung und Verknüpfung der hervorspringenden Ziffern wird naturgesetzlich so geregelt, wie es die arithmetischen Sätze für ihre Bedeutungen fordern. Aber niemand wird, um den Gang der Maschine physikalisch zu erklären, statt der mechanischen die arithmetischen Gesetze heranziehen. Die Maschine ist freilich keine denkende, sie versteht sich selbst nicht und nicht die Bedeutung ihrer Leistungen; abert könnte nicht unsere Denkmaschine sonst in ähnlicher Weise funktionieren, nur daß der reale Gang des einen Denkens durch die in einem anderen Denken hervortretende Einsicht in die logische Gesetzlichkeit allzeit als richtig anerkannt werden müßte? Dieses andere Denken könnte ebensogut zu der Leistung derselben wie anderer Denkmaschinen gehören, aber ideale Bewertung und kausale Erklärung blieben immer noch heterogen" (1975, 78–9). The final sentence is the source of the thesis that the Denkmaschine provides the causal explanation for phenomenological ideal evaluation ("ideale Bewertung"), i.e., the 2nd kind of thought that intuits ideal logical structure and correctness of computational procedure (e.g., in "Modus Barbara" form). It is okay for the line of inquiry of this paper if the Denkmaschine = the ideal human being in the beginning of the paragraph, since Husserl is, in any event, likening a human being to a computational device (a "Rechenmaschine") and then relating this to a causal explanation for ideal evaluation. I happen to think, however, that "unsere Denkmaschine" does not refer (at least not equivalently) to the ideal person in the beginning of the paragraph, if only because the thought-machine is said to be a possible "causal explanation [kausale Erklärung]" for phenomenological "ideal evaluation [ideale Bewertung]" in the sense that the 2nd kind of thought – insightful thought concerning logical structure and correctness – "could be the product [Leistung] of the same or other thought-machines" (1975, 79/2001, 50). My mind is unable to understand how an ideal person (as opposed to a real thought-machine) could be the *causal* explanation behind the 2nd kind of thought – except in the sense of a psychological application; and so my mind makes a distinction: for ideal people cannot properly be said to cause anything, unless we convert the idea into a real (i.e., causally efficacious) mechanism. Hence if one believes the terms should be, if not equated (*per impossibile*), at least more related, one can naturally be open to the idea that our causally explanatory thought-machines approximate (in the sense of sometimes going wrong in their inferences) the non-causally-explanatory thought-machine of the ideal person (whose computations and effective procedures never go wrong). Turing machines are precisely ideal persons in this sense (with an infinite memory), while also providing causal explanations when applied to (real) human psychology (see Ullman 1979, 2; cf. Adorno, 1956/2013, 62). Accordingly, Husserl, when elsewhere discussing our thought-machine, or the "natürlichen psychologischen Mechanismus des symbolischen Schließen" (1970, 363), argues that "it must be possible to state a parallel logical process which explains the mechanism of this type of judgment process logically, and conceives of it, so to speak, as if it had been rationally devised by means of that logical process" in the ideal (error-free) sense (1970, 359/1994, 37–8). This is correct procedure, even though the real, causally efficacious thought-machine is only "on the average free from error in its effects" (1970, 358/1994, 37; cf. Fodor 1994, 8–9). Although therefore we approximate the ideal Turing machine or human being qua mathematical object, we must remember that mathematical objects do not causally explain anything – only real mechanisms (of human psychology) can do that (by definition). One might recall, in this connection, that Aristotle (1957, 27–8) very famously criticized Plato's ideal entities for being, qua ideal, causally inert and therefore incapable of causally explaining anything.

cal "figures" are "fix[ed]" by "arithmetical propositions," presumably once conventions are set. The need for these conventions is often taken as a decisive disanalogy between minds and computers. As is evident from the above passage, however, Husserl does not consider this to be a decisive disanalogy between minds and computers. This contradicts the claims of several thinkers, some of whom explicitly base themselves on Husserl for the supposed decisiveness of the disanalogy (Searle, 1992, 2002; Horst, 1996; Woodruff-Smith 1995, 342). The second point is that Husserl is committed to "physical explanation" in terms of "mechanical laws" for the "computer," but because it cannot "understand" itself or "the meaning of its performances" it cannot be deemed a "thought-machine." This is why the computer "is no thought-machine." If it *could* "understand" the meaning of its syntactic operations, it would become a "thought-machine."

The third point, however, is often missed. "[O]ur own thought-machine," Husserl asserts, "might very well function similarly [to a computer]"—in other words, the computational theory of mind *definitely does* apply to our own thoughts (i.e., "our own thought-machine" *which Husserl asserts not even hypothetically*) and *consequently* its functional architecture may be *very similar to* what is on display in the unconscious "computer." Both aspects of this point are fascinating. The first aspect is that Husserl is obviously fully committed to the real existence of computational thought processes—which seems to be missed in every discussion of Husserl's thought except Dreyfus (1982) and Adorno (1956) (though only Adorno refers to the Denkmaschine passage for proof). The second aspect is closely related to Turing's work, which would appear 36 years later. Any computing machine will have a functional architecture, regardless of physical composition. A fortiori, "our own thought-machine" will have a functional architecture. And as Husserl says, this may "function similarly" to a "computer." Whether or not one is a neural network modeler (a finite state modeler) or a Turing machine theorist (an infinite tape theorist) depends on the choice of functional architecture. Although Husserl did not spell out his functional architecture in this passage, it is significant that he saw no objection to functionally comparing minds and machines. In this respect, Husserl anticipated Turing, who similarly compared humans functionally with an imaginary computing machine, marking an epoch in human thought.

I have just extracted three points from Husserl's text. (1) The meanings of the symbols of the computer are fixed by arithmetical propositions. (2) The computer is no thought-machine but could become a thought-machine if it understood its syntactical operations. (3) We are thought-machines insofar as we are able to understand our syntactical operations. Now a fourth point. For the sake of my reader I repeat the last line of the above passage: "But *our own thought-machine* might very well function similarly, except that the *real* course of one kind of thought would always have to be recognized as correct by the insight brought forward in another."[2] Here we have

[2] Compare the German original: "aber könnte nicht unsere Denkmaschine sonst in änlicher Weise funktionieren, nur dass der reale Gang des einen Denkens durch die in einem anderen Denken hervortretende Einsicht in die logische Gesetzlichkeit allzeit als richtig anerkannt werden müsste ?" (1975, 79). Findlay dropped the question mark from his translation, but notice that if we were to translate it, Husserl's degree of assuredness concerning the Denkmaschine is rather heightened than diminished. For compare the two sentences: (1) The mind might be like a computer. (2) Might not the mind be like a computer? The first

a stunning admission by Husserl. The mechanism of syntactic operations is declared to be "one kind of thought"—a *genuine* kind of thought, which moreover is "real" [*reale*]—in contrast with another equally genuine kind of thought, which is "ideal" [*ideale*], the kind that checks on and comprehends the validity of the deductions of the well-formed formulae (wffs) of the system *from* the syntactic rules. This obviously connects with Dreyfus' point about *Ideas I* being "linked" with the computational theory of mind on the ground that it is concerned to refer objects to structures derived from rules (1982, 3). These experiential structures would therefore be the wffs of the transcendental system. Except this is the *Prolegomena* of 13 years earlier, the first volume in the German editions of the *Logische Untersuchungen*. In sum, there are two kinds of thought according to Husserl: the "real course" of the computational mechanism itself, and the ideal evaluation of the forms projected from the syntactic mechanism.

Husserl seems to have limited his thinking about these machines to a possible role as an explanatory mechanism generative of intuitions concerning ideal evaluation in the non-empiricistic domains of logic, mathematics, syntax, and semantics.[3] This is made clear in the sentence that immediately follows the last sentence we examined in the text. I repeat the previous sentence again for clarity:

> [O]ur own thought-machine might very well function similarly [to a computer], except that the real course of one kind of thought [i.e., the computational] would have to be recognized as correct by the insight brought forward in another [i.e., the phenomenological]. This latter thinking could be the product of the same or other thought-machines, but ideal evaluation and causal explanation would none the less remain disparate. (1975, 79/2001, 50)

Husserl relates the previously described two kinds of thought by a "causal" relation: one is "the product" of the other[4]. In particular, it is the computational level that causally produces what will come to be identified as the phenomenological. In other words, ideal evaluation—the descriptive level used throughout the *Logical Investigations*—is hypothetically assumed to be the causal product of the Denkmaschine. This is surprising given the literature on Husserl's relation to cognitive science. Nevertheless, there seems to be little doubt that "the insight" of the 2nd kind of thought is to be causally explained by "the real course" of the 1st kind of thought. It is possible that the literature has missed this relationship for so long (with the possible exception of Adorno) because Husserl reminds the reader that the levels "would none the less remain disparate." The levels, of course, must remain "disparate" on pain of psy-

sounds more like a concession, whereas the second sounds more like someone coaxing a skeptic into making a theoretical leap.

[3] Famously he extends these thoughts to the case of perception: "The logic expressed in syntax does not just govern our thoughts but also enters into the manifestation of things" (Sokolowski, 2003, 116). In other words, the syntax of the mechanism unearthed in the *Prolegomena* is the theoretical (causal) explanation behind the phenomenological descriptions, inter alia, of states of affairs (*Sachverhalten*), much emphasized in the Sixth Investigation.

[4] One should note that "product" is a translation of Leistung which can also mean "function" or "performance."

chologism. What this means in theoretical practice is that the system of knowledge descriptively apprehended in phenomenological reflection must not be influenced or essentially shaped by what one knows about the likely causal explanation of this apprehension.

Now one might object at this point that I've neglected the issue of normativity. Ideal norms are beheld in ideal evaluation—the 2nd kind of thought. The causal explanation behind such ideal evaluation, Husserl claims, lies in the thought-machine—the 1st kind of thought. This does not mean they are identical. "Causal laws," as Husserl says, "according to which thought must proceed in a manner which the ideal norms of logic might justify, are by no means identical with those norms" (1975, 79/2001, 50). The thought-machine explains our ability to apprehend these ideal norms, but that does not mean these norms—or any intentional objects (e.g., categorial forms) that the machine allows us to intuit—are to be reduced to the operations of the machine. The machine functions in *accordance* with ideal norms but is not *guided* by these norms.

It is apparent that the rich theoretical possibilities and implications of the Denkmaschine passage have been neglected by the literature. For example, Held (2003) notes that for Husserl "the mechanics of a calculator—or the electronics of a computer (i.e., hardware)—follows a completely different set of laws (namely, physical laws) [from] the chains of symbols that one calculates with the machine (i.e., software)" (11). Although correct, Held does not mention the causal relation between the two, and the consequent causation, according to Husserl, of the phenomenology of the 2nd kind of thought. Hence this way of putting Husserl's thought makes it sound like there's an *occasionalism* at work between hardware and software, with phenomenology coming under the umbrella of software. It seems as though the meaning of Husserl's "disparate" in the above passage is being equated with Held's "completely different." No doubt, there is a lack of *isomorphism* between the two levels. For instance, the software might calculate an irrational number, which will not be able to be represented fully by the hardware. Nevertheless, there must be *some* connection if there is a causal relation, as opposed to a pre-established harmony, between the two. I would like to remind the reader that it is Husserl—not I—who demands the causal relation and not any sort of pre-established harmony.[5] Hence it appears that readers like Held perhaps have fallen victim to a certain deceptiveness in this passage, which causes one to quickly glance over it, mystifying the relation between hardware and software.

Interestingly, Adorno(1956/2013) empathizes with the reader who has been led astray by first impressions. "[T]he comparison with machines," Adorno says, "is deceptive" (62). He explains:

> The fact that in machines the mathematical correctness of the results and the causal-mechanical conditions of their functioning seem to have nothing to do with each other is due solely to a disregard for the construction of the machine. That construction demands some sort of connection between arithmetical prop-

[5] Husserl's general, career-long aversion to pre-established harmonies has been perspicuously noted by Webb (2017)—hence the necessity of a mechanism.

> ositions and the physical possibility of operating according to them. Without such a connection the machine would not produce correct answers, though that is the point of constructing it. (ibid)

To illustrate what Adorno has in mind here, consider the simplest machine with a readable memory: a binary counter. A counter, of course, will physically implement the arithmetical operation of addition, the fundamental operation of quantitative computation. If one places a marble into a counting machine, for example, it will flip or flop various toggles, changing the state of the machine with each input. The sequence of flips and flops *left behind* reveals what is to be added. Turing forced us to notice that the machine itself could compute this sequence (Gallistel & King, 2010, 139). The point, however, is that the mechanics of the counter cannot be totally divorced from the nature of the computation that it performs: the counter must be physically appropriate to the computation, for otherwise it could never causally explain the arising of "correct answers" or the comprehension of them (Adorno, 1956, 62). For if it were not physically appropriate, it would be a divine miracle that the mechanism produced "correct answers." The causal connection between the mechanics and the computation in fact is Husserl's point of view—indeed Adorno is explicating Husserl. The Denkmaschine passage is clear: the ideal evaluation of the correctness of the result (the 2nd kind of thought—phenomenological *Evidenz*) is thought to be "the product" and hence is to be causally explained by the 1st kind of thought—the "thought-machine" (1975, 79/2001, 50).

To illustrate what this means, consider Husserl's own example concerning the thought-machine: transitive relations among symbols. The real course of the 1st kind of thought might involve the computation of such equivalences as "a=b, b=c, c=d, d=e" (1970, 361). The inferential insight might then be: "a=e" (ibid.). If this becomes conscious, we intuit a=e with evidence, given the prior series of equivalences; this intuition being involved in the 2nd kind of thought. But we might not be conscious of our Denkmaschine having computed the prior series of equivalences, this being the "real course" of the 1st kind of thought. No one has insight into causal relations. But the causality of syntax is special: we can, in ideal evaluation, backtrack and discover what the derivation might have been; this is the pattern of explanation in cognitive science (Fodor, 1975), and thus the theory for all phenomenological insight that might derive from syntactic operations (Jackendoff, 1987), which are said by Husserl himself to underlie categorial intuitions (e.g., Object, State of Affairs, Number, Part-Whole Relations etc.).[6] The basic intuition is that we can infer and see with evidence the results of syntactical processes to which we do not have immediate, as opposed to theoretical, access; but due to the logical nature of syntax, we can work out a derivation, and theorize concerning the rules that led us to the intuitively correct or well-formed results.

[6] To see how Husserl anticipated the thinking of cognitive science, compare the Denkmaschine passage with page 2 of Shimon Ullman's *The Interpretation of Visual Motion* (1979).

3 The Psychological Mechanism of Procedural Thought

We now turn to Chap.9 of the *Prolegomena to Pure Logic*. This part of the *Prolegomena* is more overlooked in the literature, although Adorno points to its importance. Husserl with this chapter effectively "sanctioned… fascination with the wonderful improvement of calculators" while at the same time observing "no scandal in the paradoxicality of 'thought machinery'" (Adorno, 1956, 65–6). The reason for this was hidden from (or overlooked by) Adorno, for this section contains a very brief recapitulation of Husserl's most profound insight from his 1891 essay "On the Logic of Signs (Semiotic)"[7] concerning *how mental processes preserve truth*, which has been called "the most important fact we know about minds" (Fodor, 1994, 9). Husserl reaffirms and briefly summarizes[8] the specific reasoning behind his then almost decade-old assumption of a computational implementation (as opposed to a biological) of reasoning toward true conclusions via a mechanism of symbolic inference in everyday life (1975, 205/2001, 128).

As in his earlier essay, but now with an anti-psychologistic twist, Husserl opposes Humean associationism and Darwinian "teleology" (what we would now call the "teleosemantic program" [Millikan, 2017, 95]) in the form of the positivistic doctrines of Richard Avenarius and Ernst Mach as being inadequate to "the actual facts" concerning the truth-preservative nature of "the psychological mechanism [*psychologischen Mechanismus*] of the thought-procedure [*Denkverfahrens*]" (1975, 205/2001, 128).

Avenarius and Mach (and their modern descendants, e.g. Millikan, 2017; Shea, 2018) espouse the psychologistic view that *reduces* the meaning of the content of representations and judgments to *surviving in an environment* and one's accumulated experience (typically via associations) therein: "The relation," Husserl says—though not the reduction—"to self-preservation and preservation of the species is obvious: Animal actions are determined by presentations [*Vorstellungen*] and judgements, and if these were insufficiently *adapted* to the course of events, if past experience could not be put to *use*, if novelties could not be *anticipated*… their self-preservation would not be possible" (1975, 198/2001, 124, italics added). Avenarius's biosemantics is guided by the "Principle of Least Action" while Mach's is conducted by "the principle of the Economy of Thought" (1975, 196/2001, 123). Husserl does not reject these principles; he accepts the connection of both to biology: the organism in an environment cuts caloric costs by representing and judging *very quickly* through symbolic thought-trains. This results in *better adaptation* to an environment due to reduced energy expenditure. Having recognized such symbolic thought trains as "promoting survival, one can treat them from an economic standpoint" and understand "actual performances from a teleological angle" (1975, 200/2001, 125). Similar comments are made concerning "Humean" and "Darwinian principles" in the earlier essay "On the Logic of Signs" (1970, 358–359/1994, 37).

[7] Fisette (2012) notices the connection of Chap.9 with the 1891 essay but says nothing further and even wonders why Husserl is opposed to Mach.

[8] The work that follows is based on Lopes (2020).

But just as in the earlier essay, Husserl does not think a *biological* interpretation of the thought-economy is adequate to "the most important fact we know about minds"—namely, that mental processes preserve truth (Fodor 1994, 9)[9]. If a biological interpretation *were* adequate, then the preservation of truth in the "psychological mechanism of… thought-procedure" could *not* be the "foundation" of logic as "a technology of knowledge" (1975) , 205/2001, 128). This is ultimately because Darwinian explanations reduce the formal inferential operations of the machine to goals of the organism in an environment; and this negates the *rationality* of the process, since a goal relative to an environment distorts the quasi-logical nature of the machine, which is properly directed toward truth. Both Husserl and Fodor are interested in preserving the rationality of this process. Failure to preserve the incipient logic of the machine results in psychologism.

The above argument is developed by Husserl throughout Sect.54. We must go over it in detail, since it reveals Husserl's retained commitment to his earlier computational (syntactic) solution to the "apparent teleology of the natural process" of thought, as against a *biological* solution (1970, 363–364/1994, 42). Husserl begins, as in his 1891 essay (1970, 340/1994, 20), by wondering how the sciences are even possible, given that our "intellectual powers are [so] severely limited" (1975, 201/2001, 126). This consideration parallels the 1891 consideration of "the essential imperfections of our intellect" (1970, 349/1994, 29). If the meanings of our symbolic representations are limited to relatively simple thoughts chained to our environment by our "embodiment," then it becomes "a most serious problem how mathematical disciplines are [at all] possible, disciplines not conducted in terms of relatively simple thoughts…" (1975, 201/2001, 126). Such disciplines, on the contrary, reveal "towering thought-piles" and "thought-combinations intertwined in a thousand ways" (1975, 201/2001, 126). Most importantly, these symbolic mountains "are moved about with the most sovereign freedom" which makes little sense biologically or via "embodiment" (1975, 201/2001, 126). It is rather the logical development of (inauthentic) symbolic representations— representations that are not entrained in synchrony with any environmental stimulus—that allows for this. This logical development is a development of "art and method" which "permit an indirect achievement by way of symbolic processes [*symbolischer Prozesse*]" (1975, 202/2001, 126).

This *Leistung*, however, "arise[s] in history, and in the individual [ontogenetic] case, out of certain natural processes of thought-economy" (1975, 202/2001, 126, italics removed). This parallels Husserl's earlier insistence that "the source for the conventional modes of procedure lies in the natural ones" (1970, 366/1994, 44). The natural thought-procedure refers to Husserl's "spontaneously generated [*naturwüchsige*]" (or perhaps "innately arising") natural "psychological mechanism of symbolic inference [*psychologischen Mechanismus des symbolischen Schließen*]" (1970, 361–363/1994, 40–42). Consciousness is accorded the role of "perfect[ing]" the already existing and not consciously directed operations of the natural mechanism of symbolic inference by artificially constructing the "towering thought-piles" of the sciences (1975, 202/2001, 127). This perfection, oddly enough, consists of a

[9] For the same reasons, Fodor (1990) criticized Millikan's biological interpretation of thought-economy (65–9).

"far-reaching reduction of insight to mechanism in our thought-processes [*Reduktion der einsichtigen auf mechanische Denkprozesse*]" which precisely parallels what the natural mechanism of symbolic inference itself naturally does, but now on a higher, artificial plane (1975, 202/2001, 127). For what is logically done "for reasons of knowledge, is [already] done by the [natural] mechanism […] out of blind causality" in accordance with the (syntactic) structure of representations (1970, 364/1994, 42–3). As a result "such a [consciously intended] reduction [of insight to mechanism] rests on the psychological nature of signitive-symbolic thinking [*signitiv-symbolischen Denkens*]" (1975, 202/2001, 127).

Husserl then proceeds in the *Prolegomena* to accord great power to this psychological mechanism. He seems to think of it as the engine behind formalization in the sciences, which results in (1) their assurance and (2) their expansion (1970, 366/1994, 44). In other words, he seems to think of the psychological mechanism of symbolic inference, which naturally arises in the human mind as a computational mechanism inferring true conclusions from true premises in formal and systematic fashion, as *the* causal force behind what is apparently the result of conscious application in the formal sciences. For in the conventional thought procedures,

> genuine thought is replaced by surrogative, signitive thinking, an economy which leads imperceptibly to formal generalizations of our original thought-trains, and even of our sciences. In this manner, almost without specially directed mental labour, deductive disciplines arise having an infinitely enlarged horizon. Out of arithmetic... formal arithmetic arises in more or less spontaneous fashion [...]. (1975, 203/2001, 127)

This "spontaneous" enlarging of the horizons only occurs, according to Husserl, because everything originally rests on the "psychological nature of signitive-symbolic thinking" (1975, 202/2001, 127). This mechanism is constantly at work and naturally results in "formal generalizations of our original thought-trains" (1975, 203/2001, 127). From the perspective of consciousness, these generalizations *look* spontaneous, even though they must in fact have perfectly good causal explanations as inferential results of the natural mechanism of symbolic inference. In other words, these generalizations are the causal effects of "the systematic forms of conjunction" structuring "the thoughts" being processed by the psychological mechanism, since computational mechanisms do not intuit semantics (hence no homunculus) and cannot therefore make generalizations based on the *meanings* of the symbols (1970, 363/1994, 42).

Immediately after commenting on the spontaneous generalizations behind the development of the formal sciences *on the basis of the psychological mechanism of symbolic thought*, Husserl criticizes Avenarius and Mach. His criticism is this: *their* thought-economy, which refers only to biological "mechanisms which save energy" cannot explain "how the operation of blind mechanism can coincide in outcome with the demands of insight" (1975, 204/2001 128). But Husserl *can* do this, because his foundation for the formal (syntactic) development of the sciences is not a *biological* mechanism but rather a *computational* mechanism which can *formally preserve truth*:

> To throw light on the teleology of pre-scientific or extra-scientific procedures... one must establish the actual facts, the psychological mechanism of the thought-procedure in question. The economy of thought achieved is made plain when *we show our procedure to be one whose results can, in logically perspicuous fashion, be indirectly proved to accord with the truth* (whether of necessity, or with a certain, not too small, probability). If the natural origin of the machinery which economizes thought is not to remain a miracle—or, what is the same, a product of a peculiar, creative act of divine intelligence—we shall have to start with a careful analysis of the naturally dominant circumstances and motives of the ordinary man's ideas... *and show on this basis how a procedure which has had such success could and must have issued spontaneously out of purely natural causes*. (1975, 204–205/2001, 128 italics added)

Notice how Husserl claims not only that this mechanical "procedure" of thought "could" have arisen from "purely natural causes"—it "must" have arisen from "purely natural causes." This is in spite of the fact that we are *not* dealing with a *biological* explanandum, to be explained in Humean or Darwinian fashion. To properly explain this *logico-semantic* phenomenon—that a blind inferential mechanism results in *true* conclusions—we have to start with "the ordinary man's ideas"—what Jerry Fodor called vindicating "folk psychology" (Cain, 2002). This is precisely what Husserl does in "On the Logic of Signs." There, Husserl begins with "a careful analysis… of the ordinary man's ideas" in terms of a distinction between authentic and inauthentic representations. He notices that inauthentic, i.e., symbolic, representations dominate the "rapid flow of thought" in everyday life (1970, 352/1994, 31). In our ordinary and constant "rapid flow of thinking" we are not consciously aware that we are thinking symbolically, and that chains of judgments are being set up and inferences drawn from those chains (1970, 357/1994, 36). Since we are unaware that we are constantly making inferences (unaware precisely because constant), we are not being *guided* by motives of knowledge (or ideal norms), and therefore the psychological mechanism is epistemologically unjustified (1970, 358/1994, 37). Nevertheless "[i]f a characteristic type of judgment process, although not guided by motives of knowledge nevertheless leads to correct results then we still *must* seek and *find in its inner structure… the grounds* why it is suited to produce truth" (1970, 359/1994, 37–38, italics added). These "grounds" are found in the "natural psychological mechanism of symbolic inference" (1970, 363/1994, 42) just as they are in the *Prolegomena to Pure Logic* where these grounds again "must have issued spontaneously out of [the] purely natural causes" of the "psychological mechanism of the thought-procedure" (1975, 205/2001, 128). Husserl here signals his commitment to a kind of computational nativism.

Husserl used this theory to explain how mental processes operating on symbolic mental representations could preserve truth without any awareness or conscious intention of doing so. This is naturally effected if the right symbols are syntactically arranged so that there is a formal preservation of truth, *regardless of associative strength; a fortiori regardless of environmental contingency or adaptation* (1970, 363–364/1994, 42). In this way, Husserl claimed to show that empiricistic associationism and Darwinian adaptationism (which he calls an "apparent teleology") are

inadequate to the mental preservation of truth, since associationism does not give an account of formal preservation of content in the context of unconscious mechanical inference (1970, 364/1994, 42). Husserl argues that mechanical (unconscious) inference toward true conclusions is an undeniable fact of our (daily) mental lives and must be explained on the model of logical and conscious inference, *without* reducing trains of thought to illogical, non-truth-preservative associations, and/or adaptations to one's environment. In other words, he argues for a syntactic format for symbolic mental representations. In the *Prolegomena* it becomes clear that a Humean (Avenarian) or Darwinian (Machian) reduction would entail psychologism; and this is what the *Prolegomena* account of the formal preservation of truth by a naturally occurring psychological mechanism of symbolic inference adds to the account in "On the Logic of Signs."

It should therefore be clear that Husserl's procedural thought-machine is not Bayes-like. That is precisely because Bayesian machines are understood to be environment-relative (Gallistel & King, 2010, 27–42). Bayesian inference models are necessarily psychologistic if used to causally explain our apprehension of logic, mathematics, and non-sensuous meaning, for the same reason that behaviorism is a psychologism: both appeal to conditioned *strength* as a determiner of meaning, and effectively assert that all meaning is externally controlled by the environment and therefore reducible to causation (or the statistical frequency of environmental causes), with no independent formal (syntactic) parameters. This constitutes, even if inadvertently, a reduction of the ideal to the real, and a denial of Husserlian(-Fodorian) phenomenology (cf. Fodor, 1994, 9). Categorial intuition involved in ideal evaluation requires independent formal (syntactic) parameters, over and above environment-relative parameters. To relativize truth-preservation in thought-trains to environmental history via probabilities, as the biological Bayesians insist, would be a form of psychologism. This is in fact Husserl's charge against Ernst Mach, who did not consider how mental processes preserve truth. For "probability cannot wrestle with truth" on pain of psychologism (1975, 75/2001, 48). But, as we have just learned, our own thought-machine *can* (and does) wrestle with truth (Lopes, 2020). It might be interesting to note that Husserl's criticism would apply just as much to Yoshimi's *Husserlian Phenomenology* (2016), which is much concerned with attaching Husserl to the psychologistic paradigm of Bayes-like belief update and dynamical systems theory more generally. That this results in psychologism has been argued elsewhere (Lopes, 2021; cf. Hinzen, 2007, 176[10]).

[10] Hinzen (2007) argues that computationalism avoids and undermines Fregean worries about psychologism, since it means we 'share' access to logical objectivities as correlates of judgement, without being forced into Platonic realism in the manner of Frege's *drittes Reich*. This may help explain Husserl's explicit rejection of "Platonic realism" (1984, 127/2001, 248) along with the fact that he acknowledges objectivity to, say, the Pythagorean theorem only insofar as it is 'valid' for our judgement, i.e., "merely to assert the validity of certain judgements" beheld in ideal evaluation, which is the product of the Denkmaschine (1984, 106/2001, 230–31). Avoiding the absurdity of a 3rd world, and avoiding metaphysical hypostatization, may be as simple as rejecting empiricism and going beyond associationist psychology.

4 Descriptive Sciences Necessarily Transform into Explanatory Sciences

We now turn to our final passage which will unify the two previous. It is perhaps the most challenging, though the least paradoxical, of the three.

Already in Chap.9, Husserl anticipates his general theory of science which he details in Chap.11 of the *Prolegomena*. There he describes how "[w]e perspicuously see" a "supreme goal" for all science consisting in "the ideally justified drift of all explanation which transcends mere description" (1975, 209/2001, 131). In a clear anticipation of Hempel and Oppenheim's (1948/1988) deductive-nomological theory of scientific explanation, Husserl argues that if all "matters of fact obey laws," then "there must be some minimum set" for each domain (1975, 209/2001, 131). This "minimum set" will be "of the highest generality and maximum deductive independence, from which all other laws can, by mere deduction, be derived" (ibid). For example, Galileo's law of free fall can be deduced from Newton's laws, which in turn cannot be derived from any others (Hempel and Oppenheim 1948/1988, 10). Newton's laws *therefore* exhibit "the highest generality and maximum deductive independence" (1975, 209/2001, 131). The Newtonian revolution is a paradigm of science because Newton's laws are "laws of supreme coverage and efficacy, whose knowledge yields the absolute maximum of insight in some field, which permits the explanation of all that is in any way explicable in that field" (1975, 209–210/2001, 131). Such examples allow us to idealize and infer that "there are no limits to our power to deduce and subsume" (1975, 210/2001, 131).

In Chap.11, Husserl expands on these thoughts. He prefaces the chapter by saying that the discussion of science therein provides "a provisional image… of the goal aimed at by the individual discussions [*im II. Bande*] which follow these Prolegomena" (1975, 230/2001, 144). In other words, what is said in this chapter holds for the rest of the book. Husserl's doctrine of science contained in this chapter, therefore, has theoretical scope over the whole of the *Logical Investigations*. This is important for our argument, since with this one assumes that everything that follows the *Prolegomena* is descriptive and therefore capable of being explained.

Husserl announces at the start that he is interested in "what makes science science" (1975, 230/2001, 144). He has already given us a provisional sketch in terms of basic laws for each domain from which derivative laws may be deduced (cf. Hempel and Oppenheim 1948/1988, 24). These laws may govern facts and explain their causal interactions and relationships, *provided a mechanism can be identified*. This is very important for our argument, since Husserl has previously in the *Prolegomena* identified a mechanism (the thought-machine) that might explain the descriptions (in ideal evaluation) that follow the *Prolegomena*.

Knowledge of the necessity of interactions, which may be related to a mechanism, is knowledge of their grounds. As a result, "[s]cientific knowledge is, as such, grounded knowledge"—i.e. grounded in law (1975, 233/2001, 146). "To know the ground of anything," Husserl explains, "means to see the necessity of its being so and so" (ibid). For example, to see the lawful ground of the facts of Galileo's free fall is to see "the law-governed validity of the state of affairs in question" (ibid). And to see this law as deriving from Newton's laws is to have a deeper explanation

of "the state of affairs in question." Such laws as Newton's are "in their essence, i.e. intrinsically… not further proveable" (1975, 234/2001, 146). These are "basic laws" for the domain in question (ibid.). Hence "we possess theories in this strict sense… in mathematical astronomy," i.e., with Newton's theory (1975, 235/2001, 147; see Newton 2014). As a result, "[t]he possibility of taking on the function of explanation is an obvious consequence of the essence of a theory in our absolute sense" (1975, 235/2001, 147).

Husserl proceeds to distinguish explanatory sciences from descriptive sciences (1975, 237/2001 148). Whereas explanatory sciences are unified by a set of hierarchical laws, according to which facts interact and causally relate, descriptive sciences are unified by "the unity of the thing" (1975, 237/2001, 148). These are also called "concrete" as well as "ontological" sciences (1975, 237/2001 148). These can have great predictive power, as in "meteorology" (1975, 237/2001 148). Nevertheless "the unity of the concrete science" is "extra-essential" because description centered on "the object or the class" does not pertain to the essence of science, or what makes science science, which is essentially explanatory (1975, 237/2001, 148). As a direct result, "the word ['description'] should of course not be so understood as if descriptive sciences aimed at mere description, which would contradict our guiding concept of science" (1975, 237/2001, 148).

Now one might object that Husserl is surely not talking here about formal-eidetic descriptive sciences but rather specifically about empirical-natural sciences. But this objection would be mistaken. The distinction between description and explanation is more general than the distinction between natural-empirical and eidetic. It is also closed (*geschlossen*) from the latter distinction (1975, 256/2001, 160). Husserl does not specifically consider empirical-natural sciences until the very last section of Chap.11, where he notes that the entire preceding discussion "does not include, as a special case, the ideal conditions of empirical science in general" (1975, 256/2001, 160). The conditions of science reviewed above hold for all sciences, empirical or eidetic. Phenomenology would nevertheless be unique in identifying a causal mechanism behind its eidetics.

According to the nature of science, therefore, or "what makes science science" the *Logical Investigations* which follow the *Prolegomena* are necessarily preliminary to a possible transformation toward explanatory science, on pain of contradicting the ultimate aim of science (1975, 230/2001, 144). The seeing of the necessity of this transformation is itself a phenomenological result, since it pertains to the essence of science. We therefore have the following argument according to Husserl's *Prolegomena*:

1. All descriptive sciences necessarily transform into explanatory sciences whenever possible.
2. Phenomenology is a descriptive science.
3. Therefore phenomenology must transform into an explanatory science, if possible.

But of course phenomenology is not just any descriptive science: it is an *eidetic* science; it is concerned with categorial forms and structures as they descriptively relate

to consciousness. This means that it is not susceptible to explanation in terms of the empiricist theory of abstraction or, more broadly, associationism, which constitutes the explanatory apparatus of non-phenomenological psychology, both then and now (e.g., artificial neural networks and dynamical systems theory—see Lopes, 2021). Husserl opposes associationism and the empiricist theory of abstraction because such empiricism entails the reduction (hence psychologism) of our apprehension of categorial forms to the past history of encountered factual instances (1975, 191/2001, 120). Categorial forms and the ideal evaluation in which they are apprehended could never arise for consciousness given such a reduction. Phenomenology as eidetics, therefore, is rather a descriptive science that charts categorial forms in ideal evaluation (or categorial intuition) (Moran & Cohen, 2012, 93). Now I ask: what could lawfully give rise to ideal, phenomenological evaluation of categorial forms without reduction to empiricistic psychophysics and (environment-relative) neurobiology, i.e., without reduction to Humean and Darwinian (or Bayesian-biological) explanations? Husserl has already said what *could* lawfully give rise to the intuition of the forms of ideal evaluation: the Denkmaschine (1975, 79/2001, 50). This would be a causal explanation behind the possible laws of the eidetic science of phenomenology.

Now how would this eidetic science with its laws implemented by the Denkmaschine explain the phenomenology? Recall that there are precisely "two sorts of sciences" as Husserl says earlier in Chap.11:

1) nomological-explanatory.
2) descriptive.

This distinction is (again) more general and abstract than the empirical/eidetic distinction, which latter distinction corresponds (I believe) to the two main types of intuition on display throughout the *Logical Investigations*:

α) sensuous.
β) categorial.

Empiricism concerns itself descriptively with α, and its Humean explanatory apparatus of associationism causally explains α. Phenomenology, by contrast, commands our attention by going *beyond* empiricism and descriptively highlighting β; and *its* explanatory apparatus is, I claim, computationalism, which causally explains β. This accords with Husserl's own use of "causal explanation" in relation to the computer analogy and ideal evaluation of logic, which I assume results in categorial intuition.

Empiricistic associationism fails, according to Husserl, as an explanatorily adequate nomological theory because it moves too hastily from description to explanation. Husserl charges Hume with this explicitly in the Second Investigation: "Hume's genetic analyses certainly cannot claim theoretical completeness and finality, since they lack a foundation in an adequate descriptive analysis" (1984, 194/2001, 292). It follows that if one had an adequate descriptive analysis—i.e., one that includes categorial intuition (β above)—then one could move to a theoretically complete and final causal explanation (in terms of computationalism).

If empiricism had been more patient with the phenomena in its descriptive researches, it would have discovered all of those formal concepts of experience revealed by the phenomenology of logical experience—e.g., the syntax of states of affairs, systematicity, productivity of meaning etc.—and which today we understand to be trivially explained by a rationalistic computationalism. It thus appears that the original intention of transforming the rationalistic descriptive psychology of the *Logical Investigations* into a nomological theory can be carried out, and, according to the ideal rationality of science, it must be.

Now we can explain what a nomological theory of phenomenologically evident laws using a Husserlian thought-machine might be like. The *Logical Investigations* throughout is concerned with the categorial intuition of the following, as is stated in Chap.11 of the *Prolegomena*: "Object, State of Affairs, Unity, Plurality, Number, Relation, Connection, etc. These are the pure, the formal objective categories" (1975, 245/2001, 153). In future work, I hope to go through all of these; but for a very clear example, consider the categorial intuition of "Relation." An eidetic law concerning the categorial intuition of Relation might be Fodor's systematicity law: any mind that thinks aRb must be able to also think *eo ipso*—i.e., without further sensory input or weight-strength adjustment—bRa. Now the description of this is *phenomenologically evident*. As Husserl says in the 3rd *Investigation*: "If a certain A stands in a certain relation to a certain B, this same B stands in a certain corresponding (converse) relation to that A; A and B are here quite freely variable" (1984, 258/2001, 20). The problem, of course, for empiricistic associationism is that A and B are not, given empiricism's explanatory apparatus, "freely variable." The fact that we see that they *are*, however, with eidetic insight, indicates that Hume and his descendants cannot claim theoretical completeness and finality. Now all of this is on the descriptive level. Switching to the explanatory side, Fodor's point was that this phenomenologically evident law is *trivially* causally implemented by a syntactic machine (qua causal-explanatory apparatus). The pattern of explanation is therefore this: insofar as we have categorial intuitions, we can develop an intentional law based on these, a law descriptively uncovered by an initially theoretically neutral phenomenology, which then trivially receives its causal explanation from a computational (Husserlian) thought-machine. Thus, insofar as the two types of intuition above are exhaustive, Husserlian phenomenology can be said to be the descriptive vanguard of a computational theory of mind, and, by the nature of science, really *must* be theoretically unified with it in terms of the description/explanation distinction.

With respect to phenomenology, then, explanation for Husserl means "causal explanation" in terms of some sort of form-generating mechanism, like that of a "computer" (1975, 79/2001, 50). This coheres well with Husserl's anticipation—as noted by Rose-Mary Sargent (1988)—of the deductive-nomological (D-N) model of scientific explanation, which was originally characterized by Hempel and Oppenheim as a theory of "causal explanation" (19,481,988, 14). This characterization is likewise affirmed by Hempel's student Jaegwon Kim, most memorably when he says the model should be understood as a "nomological analysis of causal relations" (2010, 195). He says this in part to meet objections which, without an appeal to causal rela-

tions, refute the D-N model[11]. The idea that explanation rationally demands causal mechanisms for laws has a distinguished history, running from Hobbes (1655) and Descartes (1665/1998), to Schopenhauer (1816/2012) and Darwin (1859/2009)—all of whom consciously revolutionized descriptive theories with explanatory causal laws—to Russell (1948; 1961, 501), Chomsky (1965; 1979), Salmon (1984; 1998), Lewis (1986), Simon (2000), Kim (2010), and of course Jerry Fodor (1990; 1994; 2008; 2015). If David Lewis, Fodor, and Jaegwon Kim all agree on something, it's probably an axiom (Bas van Fraassen notwithstanding; cf. Wiltsche, 2012). As a result, we have another argument on the basis of overwhelming authority, including most importantly Husserl's, which will give content to the one above:

If explanation for phenomenology → Causal explanation
If causal explanation → Denkmaschine
If explanation for phenomenology → Denkmaschine

Hence we may infer that if phenomenology as a descriptive science of the categorial εἴδη of consciousness is to transform into an explanatory science—as is rationally demanded (according to Husserl) by the nature of science—it will give a law-regulated account of the arising of such εἴδη in consciousness via the rules and syntactic transformations—*not biological realities per se*—of the Denkmaschine. The Denkmaschine alone is capable of anti-psychologistically generating formal (syntactic) phenomena like those observed in categorial intuition (*Wesensschau*); and that we observe syntactically regulated phenomena—from perception to universal grammar—is the central descriptive thesis of the *Logical Investigations* (Sokolowski, 2003 ,116). These include "Object, State of Affairs, Unity, Plurality, Number, Relation, Connection, etc. These are the pure, the formal objective categories" (1975, 245/2001, 153). These categorial phenomena which go beyond empiricistic associationism are derived from syntax (Husserl 1929/1969, 110). Now computationalism just is the explanatory apparatus of the causal consequences of syntax. Husserl in the *Prolegomena* has identified such a mechanism behind ideal evaluation where precisely these phenomena are intuited by categorial intuition. If description necessarily yields to explanation wherever possible; and if a "causal explanation" is possible for the descriptions of phenomenology that go beyond empiricism (categorial intuition) in terms of the thought-machine (1975, 79/2001, 50); then a computationalist reading of the *Logical Investigations* is, I think, more than indicated by the *Prolegomena*.

[11] Hempel had backed away from appealing to causal relations by the 1960s (due to Humean worries, according to Salmon), exposing thereby the D-N model to refutation. In a recent issue of*Husserl Studies*it's been argued that Husserl is a D-N unificationist (Williams & Byrne, 2022). This is of course right with regard to Husserl's discussion of laws and their inter-relationships; but it is also wrong, if I may say, because it leaves out causal explanation. Husserl is just as much a Salmonist as a Kitcherian: that's why he appeals to a thought-*machine*qua causal explanation. The fatal objections to deductive-nomology based on non-explanatory symmetry (e.g., the shadow objection) are rendered totally innocuous by appeal to causal explanation, as Salmon liked to point out.Indeed, Aristotle had earlier noted the non-explanatory symmetry of deduction and resolved the issue by appealing to causal relations in the *Posterior Analytics* (78a38-9). If Husserl countenanced causal explanation in scientific explanation - and he did (though one might never know this from the literature) - one can simply appeal to causal explanation, in terms of causal mechanisms, to meet the otherwise fatal objections to deductive-nomology.

5 Conclusion

The idea that the *Logical Investigations* is a set of descriptions concerning forms of consciousness which go beyond empiricism and eventually require a transformation into nomological-explanatory theory was seemingly regretted by Husserl in his *Formal and Transcendental Logic* (1929). There he appears to contradict his earlier self by claiming that some descriptive sciences cannot abide by "the ideal of 'theoretical' or 'nomologically explanatory' science," and he instances "logic as a theory of science" (1969, 102). With this, we do not necessarily disagree; after all, logic as a theory of science is precisely what Hempel and Oppenheim (1948/1988) tried to establish, especially in the third part of their famous article, and it does not make much sense that this logic itself would be nomological. Nevertheless, three critical points should be noted. First, Husserl's example is defective in that such a logic does not exist; this is connected with the total collapse of logical positivism and the consequent disunity of science (Fodor, 1974). Second, Husserl does *not* say the ideal of nomological-explanatory science is *not* rationally compelling *for phenomenology*, or that the nature of science outlined in Chap.11 of the *Prolegomena* has somehow changed. As a direct result, the transformation, if it can actually be effected, is still rationally mandated. Third, Husserl lacks an argument for how a descriptive science failing to transform into a nomological-explanatory science could avoid contradicting the idea of science. That it necessarily would is supposed by none other than Husserl himself in the *Prolegomena*.

By the time of the second edition of the *Logical Investigations*, there seem to have been two projects (Janus-faced) for phenomenology as Husserl conceived of it: (1) as a cognitive propaedeutic to the logic of the sciences (phenomenology as a foundationalism for all of the sciences) and (2) as a descriptive vanguard for the scientific establishment of an anti-empiricist and transcendental phenomenology (phenomenology as computational cognitive science, as Dreyfus insisted). Both sides were to be organized around logical form or syntax. Now (1) has by consensus failed—this is generally acknowledged (Fodor, 1974; Salmon, 1984) and historically involved the failure of the logical positivists (especially Carnap) to erect a logic of science as a foundation for the unity of science. So (1) has been historically ruled out. (2) is still a possible path for phenomenology and, with (1) ruled out, it's the only path. All of the necessary premises for taking this path and unifying phenomenology with (a Fodorian sort of) computationalism can be found in the *Prolegomena*. The next step must therefore be applying the results of the above argumentation to the lengthy magnum opus that is the *Logical Investigations*, since it seems to be the case that the *Prolegomena* indicate—indeed rationally demand—an explanatory development of the subsequent *Investigations* - though crucially not in terms of empiricist psychology.

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References

Adorno, T. (1956/2013). *Against Epistemology*. Malden: Polity.

Aristotle (1957). *Metaphysica*. New York: Oxford Classical Texts.

Brown, C. S. (1990). Husserl, Intentionality, and Cognitive Architecture. *Southwest Philosophy Review*, *6*(1), 65–72.

Cain, M. J. (2002). *Fodor: Language, Mind and Philosophy*. Malden: Polity.

Cain, M. J. (2016). *The Philosophy of Cognitive Science*. Malden: Polity.

Chomsky, N. (1965/2015). *Aspects of the Theory of Syntax*. Cambridge: MIT.

Chomsky, N. (1979). *On Language*. New York: New Press.

Darwin, C. (1859/2009). *On the Origin of Species*. New York: Penguin.

Descartes, R. (1665/1998). *The World and Other Writings*. New York: Cambridge University Press.

Dreyfus, H., & Hall, H. (1982). *Husserl, Intentionality and Cognitive Science*. Cambridge: MIT.

Fisette, D. (2012). Phenomenology and Phenomenalism: Ernst Mach and the Genesis of Husserl's Phenomenology. *Axiomathes*, *22*, 53–74.

Fodor, J. (1974). Special Sciences. *Synthese*, *28*(2), 97–115.

Fodor, J. (1975). *The Language of Thought*. Cambridge: Harvard University Press.

Fodor, J. (1990). *A Theory of Content*. Cambridge: MIT.

Fodor, J.(1994). *The Elm and the Expert. Mentalese and Its Semantics.*Cambridge: MIT.

Fodor, J.(2008). *LOT 2*. New York: Oxford University Press

Fodor, J., & Pylyshyn, Z. (1988). Connectionism and Cognitive Architecture: A Critical Analysis. *Cognition*, *28*(1–2), 3–71.

Fodor, J., & Pylyshyn, Z.(2015). *Minds without Meanings*. Cambridge: MIT.

Gallistel, C. R., & King, A. (2010). *Memory and the Computational Brain*. Malden: Wiley-Blackwell.

Held, K. (2003). Husserl's Phenomenological Method. In D. Welton (Ed.),*The New Husserl*(pp. 3-31). Bloomington: Indiana University Press.

Hempel, C., & Oppenheim, P. (1948/1988). Studies in the Logic of Explanation. *Theories of Explanation* (pp. 9–46). New York: Oxford University Press.

Hinzen, W. (2007). *An Essay on Names and Truth*. New York: Oxford University Press.

Horst, S. (1996). *Symbols, Computation, and Intentionality*. Berkeley: UC Press.

Husserl, E. (1891/1994). On the Logic of Signs (Semiotic). *Early Writings in the Philosophy of Logic and Mathematics*. Dordrecht: Kluwer.

Husserl, E. (1970). *Philosophie der Arithmetik mit ergänzenden Texten* (1890–1901). Edited by L. Eley. *Husserliana Band XII*. The Hague: Nijhoff.

Husserl, E. (2001). *Logical Investigations*. Edited by D. Moran. New York: Routledge.

Husserl, E. (1975). *Logische Untersuchungen.* Edited by E.Holstein. *Husserliana Band XVIII*. The Hague: Nijhoff.

Husserl, E. (1984). *Logische Untersuchungen.* Edited by U. Panzer. *Husserliana Band XIX*. Berlin: Springer.

Husserl, E. (1929/1969). *Formal and Transcendental Logic*. Translated by D. Cairns. The Hague: Nijhoff.

Jackendoff, R. (1987). *Consciousness and the Computational Mind*. Cambridge: MIT.

Kim, J. (2010). *Essays in the Metaphysics of Mind*. New York: Oxford University Press.

Lewis, D. (1986). Causal Explanation. *Philosophical Papers* Vol. II (pp. 214 – 40). New York: Oxford University Press.

Lopes, J. (2020). How Do Mental Processes Preserve Truth? Husserl's Discovery of the Computational Theory of Mind. *Husserl Studies*, *36*(1), https://doi.org/10.1007/s10743-019-09257-3

Lopes, J. (2021). On the Psychologism of Neurophenomenology. *Phenomenology and the Cognitive Sciences,*https://doi.org/10.1007/s11097-021-09773-8

McClelland, J., & Rumelhart, D. (1986). *Parallel Distributed Processing*. Cambridge: MIT.

McIntyre, R. (1986). Husserl and the Representational Theory of Mind. *Topoi*, *5*, 101–113.

Millikan, R. G. (2017). *Beyond Concepts. Unicepts, Language, and Natural Information*. Oxford: Oxford University Press.

Moran, D., & Cohen, J. (2012). *The Husserl Dictionary*. New York: Continuum.
Newton, I. (2014). *Philosophical Writings*. New York: Cambridge University Press.
Pokropski, M. (2020). Phenomenology and Functional Analysis: A Functionalist Reading of Husserlian Phenomenology. *Phenomenology and the Cognitive Sciences*, *19*, https://doi.org/10.1007/s11097-020-09694-y
Russell, B. (1948). *Human Knowledge: Its Scope and Limits*. New York: Routledge.
Russell, B. (1961). *The Basic Writings of Bertrand Russell*. New York: Routledge.
Salmon, W. (1984). *Scientific Explanation and the Causal Structure of the World*. Princeton: Princeton University Press.
Salmon, W. (1998). *Causality and Explanation*. New York: Oxford University Press.
Sargent, R. M. (1988). Husserl's Logical Investigations and Contemporary Issues in Philosophy of Science. *Journal of the British Society for Phenomenology*, *19*(2), 155–164.
Schopenhauer, A. (1816/2012). On Vision and Colors. *On the Fourfold Root of the Principle of Sufficient Reason and Other Writings* (pp. 199–302). New York: Cambridge University Press.
Searle, J. (1992). *The Rediscovery of the Mind*. Cambridge: MIT.
Searle, J. (2002). *Consciousness and Language*. New York: Cambridge University Press.
Shea, N. (2018). *Representation in Cognitive Science*. New York: Oxford University Press.
Simon, H. A. (2000). Discovering Explanations. In Frank C. Keil and Robert A. Wilson (Eds.).*Explanation and Cognition* (pp. 21–59). Cambridge: MIT.
Smolensky, P. (1991). Connectionism, Constituency, and the Language of Thought. In Robert Cummins and Denise Dellarosa Cummins (Eds.),*Minds, Brains, and Computers: The Foundations of Cognitive Science. An Anthology*(pp. 286–306). Malden: Blackwell.
Sokolowski, R. (2003). Husserl's Sixth Logical Investigation. In Daniel O. Dahlstrom (Ed.),*Husserl's Logical Investigations* (pp. 109–122). Dordrecht: Kluwer.
Ullman, S. (1979). *The Interpretation of Visual Motion*. Cambridge: MIT.
Varela, F., Thompson, E., & Rosch, E. (1991/2017). *The Embodied Mind*. Cambridge:MIT.
Webb, J. (2017). Paradox, Harmony, and Crisis in Phenomenology. In Stefania Centrone (Ed.), *Essays on Husserl's Logic and Philosophy of Mathematics* (pp. 353–408). Berlin: Springer.
Williams, H., & Byrne, T. (2022). Husserl's Theory of Scientific Explanation: A Bolzanian Inspired Unificationist Account. *Husserl Studies*, *38*, https://doi.org/10.1007/s10743-022-09302-8
Wiltsche, H. (2012). What is Wrong with Husserl's Scientific Anti-Realism?*Inquiry*, *55*(2), 105–130.
Woodruff Smith, D. (1995). Mind and Body. In Barry Smith and David Woodruff Smith (Eds.),*The Cambridge Companion to Husserl* (pp. 323–393). New York: Cambridge University Press.
Yoshimi, J. (2016). *Husserlian Phenomenology*. Berlin: Springer.
Zahavi, D. (2019). *Phenomenology: The Basics*. New York: Routledge.

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