Peirce's Concept of Abduction (Hypothesis Formation) across His Later Stages of Scholarly Life

Martin Potschka

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Peirce's concept of abduction (hypothesis formation) across his later stages of scholarly life

Martin Potschka

martin.potschka@univie.ac.at

abstract: The subject of this communication is Peirce's ideas about abduction which is just one step in his larger scheme of evidence-based hypothetico-deductive epistemology. Since Peirce repeatedly changed his mind, the aim is to construct a "definitive Peirce" on this particular subject. A short list of quotations from the large corpus of Peirce was assembled (some 440 items extracted from 122 bibliographic units have been documented) and this annotated bibliography was used to interpret Peirce's intentions. Several stages in the development of his ideas can be demarcated. A classification of his late life into a methodological stage (logic of discovery), and a noetic stage (psychology of discovery) is confirmed. Peirce gives up on applying syllogistic inference to abduction in preference of Socratic interrogations, but this development is overlaid by ever increasing emphasis on a guessing instinct. Peirce's contradictions are best rendered as tetralemma; like fibers in a rope extending in time and not unicursal stages. His ideas about creativity turn from historical (breaking new ground) to psychological (ontogeny recapitulates phylogeny) and reveal much of his personality and health. Peirce's epistemology is compared with that of Popper, who was a nominalist. My study also sheds light on a number of related issues: Peirce anticipates Rupert Sheldrake's theory of morphic fields, whereas he was still unaware of chaos theory. Nor did he recognize that behind instinctual guidance some inference via 2nd order variations is at work. The status and reality of hypothetical entities will be discussed briefly. In spite of Peirce's emphasis on evidence, verisimilitude remains to be negotiated.

/Keywords: abduction, creativity, evidence-based hypothetico-deductive epistemology, personality traits, Peirce, nominalism, Darwinism, chance, categories, instinct/

Subject of my present study is epistemology, specifically the scientific method, which Peirce had almost ready long before Popper became famous for it. While Peirce initially approached the subject from a semiotic perspective, it turns out that little of our quintessential Peirce, the semiotician, will be found next to his endeavors into abduction (a term coined by Peirce to concern the formation of hypotheses). This fact then allows me to trace Peirce's concept of abduction in isolation from most of his other work. Nonetheless, what needs to be considered makes my text longer than I wished it to be.

I critically read Peirce's concept of abduction against contemporary hegemony of scientific method, i.e. from the point of view of natural science as practiced (readers with background in the humanities will have to draw analogies to instrument-based empirical evidencing). Abduction is the creative part of what is called evolutionary evidence-based hypothetico-deductive epistemology (for introduction and review see [Potschka 2018a][1] and Figure 1)[2]. It is all about "an intellect capable of learning by experience" [Peirce 1897c: CP 2.227]. All knowledge can be recast as deductive inference with just the right premises added [Musgrave 2012: 127] (context of justification). Abduction provides the point of departure for therelike deductive schemes. My point of reference is a nominalist reading which is generic but for the purpose of comparison may be identified as basically Popperian (some differences between Popper an contemporary state-of-the-art epistemology notwithstanding). Briefly, abduction proposes hypotheses proper, deduction articulates their consequences and evidence-based induction evaluates them (pertinent quotes will be given throughout the text). Peirce contributed significantly to this epistemology in his search for a unified theory of scientific method. There are at least 4 separate methodological steps in evolutionary evidence-based hypothetico-deductive epistemology (see Figure 1) whereas Peirce only distinguishes 3 modes. Peirce's notions are, however, superior to the HD-scheme which is an earlier version of said epistemology. There are in fact different types of abduction, such as creative vs. selective[3], but Peirce never distinguished them. Abduction dealing with creativity, I also touch on Peirce's ideas on creativity.[4]

Peirce held different opinions at different stages of his life [Apel 1967: 38-41; Fann 1963; Fisch 1967; Burks 1946; Boler 1963: 151; Madden 1960: 248; Murphey 1961; Esposito 1979; Anderson 1986: 145; Deledalle 1987; Brent 1993; Richter 1995: 167-180; Maddalena 2005; Kruijff 2005][5], changing his views gradually and also independently from one item to another (summarized in Table 1). The stages of scholarly life that I am going to use are a modification

[1] To improve legibility square brackets [...] will be used to insert references, pointed brackets <...> to make insertions into verbatim quotes, and parentheses (...) belong to the flow of the body text.

[2] "The function of hypothesis is to substitute for a great series of predicates forming no unity in themselves, a single one (or small number) which involves them all, together (perhaps) with an indefinite number of others. It is, therefore, also a reduction of a manifold to unity" [Peirce 1868b: CP 5.276].

[3] In simple AI programs there is a large database containing hypotheses from which a suitable one is selected for the purpose at hand. Advanced AI explores true ampliative strategies (self-learning). I leave it open how human creativity really works.

[4] The term creativity was coined by Whitehead [1927], cf. [Wallas 1926; Simonton 1999; Dacey 1999, Albert & Runco 1999; Runco & Albert 2010].

[5] Apel's book was translated into English in 1981. Fann's thesis was published in book form in 1970.

of Apel's proposal; just for the sake of abduction slightly different year-dates would come more natural. Apel's work has largely been ignored in the community of Peirce scholars. In each of those stages, construed for didactic purposes and subject to interpretation, Peirce easily got carried away and was not always consistent: "His extant writing seems fragmentary" [Forster 2011: ix]. "The sign of a truly original <thinker ...> is inconsistency" [Freeman & Skolinowski 1969: 514]. Peirce pursued the implications of different hypotheses, and as a consequence varied his terminology from paper to paper [Burks 1946: 301]. No systematic unity is to be found in Peirce's thought [Murphey 1961], a thesis my study is going to exemplify. To arrive at some definitive received view of Peirce therefore is a difficult task. In the temporal development of these stages one recognizes oscillation of his preoccupations, not linear development, suggesting that his death may only have prevented him from just another balancing correction. For sure, his last words cannot be construed to be the most mature final word without qualifications. Yet Peirce himself hold the belief that there exist final opinions that are independent of arbitrary and individual thought and to which men converge in the long run [Peirce 1871 CP 8.12], so the quest is legitimate.

To this end, it is important to consider the corpus of Peircean texts in quantity, but it is not quantity, which might be repetitious, but the quality of arguments that does or does not converge in the long run (irrespective of independent opinions on the subject matter which might still be different from Peirce, our definitive Peirce so constructed). It is desirable that such a received view is rooted in rational scholarly exegesis and not left to casual readers uncritically picking from an undated text.

My analysis by stages ultimately reveals a plurality of transiently coextending yet conflicting trends, like fibers of a rope (a metaphor Peirce himself used [Peirce 1868b: CP 5.265]). To provide an example: syllogism, Socratic interrogation, other forms of inference[6], and instinct (the catchwords for contradictions well documented in the literature) all turn out to be complementary poles in Peirce's analysis of abduction rather than unicursal temporal stages. I hence propose to treat them – and other examples – as tetralemma[7].

In my paper I have excluded a comprehensive documentation of Peirce's early theory of abduction (stages I to III) [Murphy 1961: 113-114; Fann 1963: 11-27; Anderson 1987: 19-23; Riemer 1988; Richter 1995: 15-105] that are of interest to the historiographer, but contribute

[6] Inferences are cognitive processes of all kinds. Inference is "the conscious and controlled adoption of a belief as a consequence of other knowledge" [Peirce 1893e: CP 2.442]; cf. [Peirce 1902c: CP 2.144; 1903e: CP 5.109]. "There are <...> operations of the mind which are logically exactly analogous to inferences excepting only that they are unconscious" [Peirce 1903e: CP 5.108]. "The inferred conclusion is <thought to be> true because in any analogous case an analogous conclusion would be true" [Peirce 1903f: CP 5.130]. In stage VI Peirce does not treat instinct as subconscious inference, there he is up to something else.

[7] The tetralemma is of central concern to Buddhist logicians (like Nagarjuna):

> It *is* this.
> It *is not* this, since it is that.
> It *is both* this and that.
> It *is neither* this *nor* that, but a third.

A tetralemma is used to describe a totality by means of its non-dual extremes.

little to identify a (late) definitive Peirce. The focus of my analysis lies on differences within the late Peirce, i.e. on differentiating research stage V from stage VI.

What follows in part is a dating exercise of some technical terms as far as they seem relevant to abduction. Peirce gives the concept changing names: Reasoning a posteriori (1864-1865), hypothesis (1865-1900), abduction (1867, 1878, 1893 and 1896-1898), retroduction (1896-1898), presumption (1901), abduction (again 1901-1906), retroduction (again 1905-1914), hypothesis (again 1910).[8] With the exception of hypothesis (dubbed Peirce's early theory of abduction), which is mentioned but not exhaustively documented since Peirce explicitly distanced himself from it, all other terms are considered part of the development of Peirce's concept. I thereby assume a continuity of subject matter which Peirce looked at from different perspectives, with different emphasis, and with different labels on different occasions.

Although retroduction was Peirce's last word, a number of topical studies have established abduction as conventional term [Weiss 1940; Burks 1946; Frankfurt 1958b; Fann 1963; Alexander 1965; Chomsky 1967: 90-98; Sharpe 1970; Andersen 1973; Thagard 1976, 1977, 2007, 2010; Haack & Kolenda 1977: 89-95; Gutting 1980; Savan 1980; Harris & Hoover 1980; Brown 1983; Shanahan 1986; Anderson 1986, 2005; Roth 1988; Danneberg 1988; Graybosch 1989; McCarthy 1989; Kapitan 1990, 1992, 1997; Turrisi 1990; 2005; Santaella-Brega 1991; Santaella 2005; Staat 1993; Paul 1993; Hobbs et al. 1993; Josephson & Josephson 1994; Mayer & Pirri 1996; Gooding 1996; Psillos 1996, 2002, 2009; Pape 1997a; Hintikka 1998; Hendricks & Faye 1998; Brogaard 1999; Hoffmann 1999, 2010; Burton 1999; Niiniluoto 1999, 2004, 2011; Wirth 1999; ; Flach & Kakas 2000; Nesher 2001; Mullins 2002; Dubois & Gadde 2002; Mullins 2002; Kraus 2002; Aliseda 2003, 2005, 2006; Bertilsson 2004; Merrell 2004, 2005; Merrell & Queiroz 2010; Walton 2004; Paavola 2004ab, 2005, 2006ab, 2011, 2014; Queiroz & Merrell 2005ab; Cunningham et al 2005; Chauviré 2005; Chiasson 2005; Colapietro 2005; Dazzani 2005; de Morentin 2005; Gonzalez & Haselager 2005; Hookaway 2005; Houser 2005; Kruijff 2005; Maddalena 2005; Marcus 2005; Moroni et al. 2005; Nubiola 2005; Petrilli 2005; Ponzio 2005; Rosenthal 2005; Tiercelin 2005; Magnani 2001, 2005; 2006, 2009, 2011, 2013, 2015; Gabbay & Woods 2005; Woods 2012; Haig 2005, 2008, 2010; Vertue & Haig 2008; Prendinger & Ishizuka 2005; Ibri 2005; Meheus & Batens 2006; Richardson & Kramer 2006; Pizzi 2006; Hilpinen 2007; Reichertz 2007; Arrighi & Ferrario 2008; Hansen 2008; McKaughan 2008; Schurz 2008; D'Agostino et al. 2008; Carson 2009; Shotter 2009, 2011; Campos 2011; Plutynski 2011; Lycke 2012; Park 2012, 2015; Gauderis 2013; Estrada-González 2013; El Khachab 2013; Beirlaen & Aliseda 2014; Niño 2014; Tschaepe 2014; Flórez 2014; McAuliffe 2015; Tohmé et al. 2015, Shook 2016].[9] (Please note that the reflections on abduction only start in the 1940s. Even Frankfurt [1958b] remains confused.) A few authors prefer "retroduction" [Hanson 1958: 85-92; 1959; 1961; Simon 1965; Achinstein 1970; Ayim 1974;

[8] Some odd occurrences originate from Peirce's recollections, others are more substantial. The expression "presumption" has been forced upon Peirce by Baldwin as editor ([Peirce 1901d CP 2.776-277, 791]). The term reduction, found in the literature, was never used by Peirce.

[9] The Web-of-science database lists some 450 papers with the term abduction in the title (excluding kidnapping and medical connotations), but only 1 with "retroduction". As topics the respective numbers are about 1100 and 20. My own list of references is a subset of citation networks (more than one cluster). A number of papers listed here were not retrieved in my search.

Nickles 1980b: 22-25; McMullin 1992; Pietarinen & Bellucci 2014]. There are also publications that discuss ampliative reasoning by other terms [Blachowicz 1989; Simon 1973]. Achinstein [1970] and Laudan [1980: 182] in my opinion misrepresent abduction, so their critique of Peirce and Hanson is more a critique of what they themselves construe[10]. Just about any book about Peirce, of which there are many [Buchler 1939; Feibleman 1946; Gallie 1952; Wiener 1949; Goudge 1950; Murphey 1961; Thompson 1953; Reilly 1959, 1970; Apel 1967; Davis 1972; Rescher 1978a; Almeder 1980; Esposito 1980; Skagestad 1981; Hookway 1985; Anderson 1987; Tursman 1987; Deledalle 1987; Levi 1991; Rohr 1991: 80-111; Delaney 1993; Rosenthal 1994; Richter 1995; Brunning & Forster 1997; Parker 1998; Forster 2011; Gabbay & Woods 2005; Mayorga 2007; Bertilsson 2009; Bellucci et al. 2014; Oleksy 2015; Pietarinen 2015; Atkin 2016], also mentions abduction. But "there are still very few books concentrating on Peirce's interpretation of abduction" [Paavola 2011: 256][11]. Only very recently publications on the late still unedited manuscripts started to appear: Pietarinen & Bellucci [2014], while an excellent source of material, deserve some reinterpretation in my result section. (I shall quote unedited manuscripts by footnotes.)

Auxiliary concepts considered relevant for a judgement on abduction are: doctrine of universals, evolution, psychophysical parallelism. They are not presented in their own right but only to the extent needed for arguments about abduction.

With such a list of secondary literature, there is little that has not been claimed both one way and to its opposite. The task of my study therefore was to sort things out (and discover a few novel aspects on the way). To this end I reanalyzed Peirce's source texts. I shall provide a consistent narrative in large part using paraphrases and quotes, relating my thick description [Geertz 1973] to detailed references where further discussion of the subject can be found.[12] By letting Peirce speak himself, I remain exegetical at all times and any differences of his opinions and those of the present author will be transparent. I was compelled to write this paper by problems which are outside Peircean studies (cf. [Popper 1963: 71-72]): to what extent did Peirce anticipate the hegemonic epistemology of 20th century science, tacitly taking Karl Popper as one of its representatives?[13] Comparisons of Peirce with Popper have been published [Freeman & Skolinowski 1969; Haack & Kolenda 1977; Niinilouto 1978; Rescher 1978b; Chauviré 2005] and what has been said will not be repeated here. In fact my recourse to Popper is largely implicit – Popperian not Popper. This is an occasion to reiterate that the present study is not a tabula rasa but presupposes a certain epistemological a priori shaped by this very evolutionary evidence-based hypothetico-deductive methods in science – not specifically my inventions but a generic methodological canon of contemporary science. To

[10] A detailed analysis is beyond the scope of this paper, but my remark should help anyone reading their papers after reading mine.

[11] Amongst them Richter [1995] in german language, and Fann [1963] rather brief.

[12] Even though the number of refereed paragraphs seems large, they amount to less than 5% of CP and some 1% of Peirce's oeuvre (crude estimate).

[13] Excluded from discussion is Poppers falsificationism, which state-of-the-art consensus has since improved, and minor idiosyncratic positions held. Popper was not familiar with Peirce's ideas until reading Gallie [1952] [Popper 1963: 240n; 1972: 215n16]. Einstein already practiced what I call hegemonic epistemology of the 20th century (I could not find any evidence that Einstein was familiar with Peirce). The role of Popper is akin to a scribe who puts the theory all together. [Popper 1935] was first translated into English in 1959.

my knowledge this is a first in Peircean studies. Occasionally my conclusions are at variance with the published literature, and this will be mentioned, except for many minor discrepancies, that I let go unnoticed. I herewith present my study as a contribution to the collective efforts to establish a definitive Peirce.

1. **Methods**

The recent chronological edition far from completion [Peirce W], the principal source to Peirce are the *Collected Papers* [Peirce CP][14] which in their editorial policy arrange text by topics. The internet dictionary by [Bergman & Paavola 2003] proved useful. The unpublished manuscripts have not been considered systematically.

Since we can never be sure to have archived everything, one always will have to work with and extrapolate from a limited corpus. The present corpus has previously been divided into those manuscripts worth publishing (the Collected Papers CP, since then enlarged by NEM, EP and others) and a remainder of lesser and redundant manuscripts. This assumption may not entirely hold true. It is well known that editors in general tend to eliminate juvenilia and works of latest hand from their canon. Most humans decay in their last years and the last professional will is not necessarily the very last word uttered. Just where to draw the line? Work on the remaining unedited manuscripts remains definitely necessary. It is however of some methodological interest to see just how robust the corpus as presently edited really is, and it will take years to study the remaining manuscripts. For the meantime let me define some research questions.

To this end, a short list of quotations was selected from the corpus primarily by including occurrences found in the secondary literature and deemed relevant. Inevitably then my study is more comprehensive and balanced in the use of source quotations than most previous studies. I am very grateful to the large number of authors who have previously published on the subject and on whose work I could build. Their papers also helped me identify week points that deserved further study. I am suspicious that some disagreements in the literature are the result of using different subsets of the corpus. This is a longstanding deficit of Peircean studies: “Evidently each of us is going to have his own Peirce” [Feibleman 1946: 184]. However, space limitations demanded to focus my present study on Peirce himself and not to deal comprehensively with the evolution of ideas in the secondary literature (exceptions notwithstanding). Hence no cross index (matrix) of source to secondary literature will be provided and my suspicions remain undocumented for the moment.

My study provides a consistent narrative using paraphrases and quotes, occasionally including blocks of enumerative source texts to present shades. These latter occasions employ a style suitable to the context of discovery which is closer to the logical structure of abductive thought; seemingly unfinished and notelike they escape the conventions of the finished research report (context of justification). Though, my text provides both approaches. Almost all my quotes will be one-liners. Paraphrases or ideas without quotation marks are always

[14] Works not quoted from the *Collected Papers* (CP) did not appear there.

followed by citations to whom they refer. I have refrained from quoting longer passages for two reasons: first, reasons of limited space available in a journal article; I recommend to consult the passages quoted in the source-references along a second reading of my text (a detailed bibliography is prepared for the convenience of the readers to this end). Second, it turns out that the association of brief ideas (sometimes rendered in paraphrase) altogether covers Peirce's message quite well. Ultimately the pattern of associations insinuates some peculiar reading of the text, which of course is mine – but being based on quotes this remains easy to double check for authenticity by the reader.

Unfortunately Peirce's enigmatic remarks are not a sufficient basis for understanding abduction, in fact one will find them most useful, if one is already familiar with the subject matter (cf. [Fann 1963: 5; Frankfurt 1958b: 593]). I therefore had to interpolate his text occasionally from the background of actual scientific research praxis. Moreover, I use deep-psychological hindsight to fill some gaps in the record.

Definitive Peirce shall mean his most major and latest judgement on any one subject matter, regardless of the stage of scholarly life when he arrived at this view; and irrespective of whether he accomplished his task. Whenever he seems to destroy what is already achieved, I shall explicitly state so.

2. Results

My results section is organized by topic and each topic by stage of Peirce's scholarly life. It is common to distinguish juvenile, early and late authority, the situation is only more complicated with Peirce and a consensus of 6 stages seems to emerge in the secondary literature (Deledalle [1990] explicitly includes the juvenile point of departure within stage I, only Murphey [1961] and Fisch [1967] divide stage I further up, see Table 1). Division into stages may help the reader to date individual utterings, but the ultimate criterion is the date a manuscript was first drafted (and set aside) or published, and it is those dates that rigorously are used to reference the papers.

After developing a subject Peirce often retained his opinions for the rest of his life. Dissatisfaction with his results made him, however, reconsider some matters throughout his life time. Peirce, though without success, certainly tries to give coherence to his philosophy. To give an example: The juvenile Peirce is a Nominalist and impressed by Darwin, whom he correctly judges to be a nominalist. He later turns both anti-nominalist and anti-Darwinist. In part this is due to his dislike of social Darwinism. However, I believe it also is related to his anti-nominalism.

The purpose of epistemology as described in Figure 1 is to discover laws or habits piecemeal by iteration. Phenomenological laws are a beginning. A successful elaboration of a theorem leaves as new problem the search for axioms. In nature fundamental laws define their respective models which are subsequently approximated by phenomenological laws [Cartwright 1983; Weinert 1995]. "The supreme task of the physicist is to arrive at those universal elementary laws from which the cosmos can be built up by pure deduction" [Einstein

1934: 125]. Abduction is a crucial step in this scheme, quite independent from the particular hypothesis considered. However, Peirce discusses the status of laws as part of his demanding analysis of the categories. His opinions on the doctrine of universals are relevant to his categories and the latter are also important to understand how abduction is engendered and all the subtle differences between stage V and stage VI about how abduction works.

Finally Peirce's views on evolution are of relevance to abduction since abduction is a part of evolutionary evidence-based hypothetico-deductive epistemology, current day standard in the sciences (Induction selects among hypotheses).

The principal part of my study starts with section 2.4 on abduction, which some readers might want to read first.

2.1 Doctrine of universals

The doctrine of universals is relevant to the question of abduction in two respects: First, being part of evolutionary evidence-based hypothetico-deductive epistemology, abduction identifies candidate hypotheses and these hypotheses belong to one or another class of universals (a constraint, like a number of others, to the structure in Figure 1). Second, abduction draws its hypotheses from a deeper realm that itself must be viewed from this perspective of the doctrine of universals. Peirce's writings on abduction are therefore indirectly informed by his stance on the doctrine of universals.

Early in his life (*Peirce stage I*, 1855-1871, see Table 1) the products of mind, this non-psychic interpretant (after 1887 called Thirdness) were vacua nomina, he later recalls [Peirce 1892b: CP 6.103][15]. He is very much a Kantian till 1865 [Murphey 1961]; "<I> was a pure Kantist until <I> was forced by successive steps into pragmaticism" [Peirce 1905b: CP 5.452]. In respect to nominalism Peirce's scholarly life falls into 3 parts: Initially only "Seconds" were real, in 1868 he recognized "half of the falsity of nominalism" ("denial of the reality of Thirds"), towards 1889 he also adopted the reality of Firsts [Peirce 1909c]. He became increasingly extreme in later years [Fisch 1967: 184n3]; "I am myself a scholastic realist of a somewhat extreme stripe" [Peirce 1906d: CP 5.470]. Peirce later recommends to always start with nominalism, "giving nominalism a fair trial before you go on to realism" [Peirce 1897b: CP 8.251]; cf. [Peirce 1902c: CP 2.166-168]. "Pragmaticism would hardly have entered a head that was not already convinced that there are real generals" [Peirce 1905c: CP 5.503].

The Cambridge Metaphysical Club (1871-72) brought Peirce once more close to the nominalist-empirist tradition (*Peirce stage II*, 1871-1883). But with [Peirce 1871] "I declared for realism" [Peirce 1903i: CP 1.20]. Peirce's arguments are not always convincing, e.g. [Peirce 1903e: CP 5.93-101]. But "the hypothesis of reality serves the construction of the reality of hypotheses" [Nordmann 2009: 336].

Let me interrupt my chronological presentation and discuss some of the conclusions reached by Peirce.

[15] Besides recollections, I occasionally place auxiliary references of a later stage anachronistically, if this helps the argument.

A Kantian might say, the scope of abduction is limited to what we are able to perceive (condensed into Thirdness) and not what actually is (Secondness). But this is too Kantian for Peirce. The percept is the reality [Peirce 1901e: CP 5.568]. Hence "*pragmatism*" means: "consider what effects, that might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object" [Peirce 1903h: CP 5.195-200]. "We have direct experience of things in themselves. Nothing can be more completely false than that we can experience only our own ideas" [Peirce 1903j: CP 6.95]. "If one can define accurately all the conceivable experiential phenomena which the affirmation or denial of a concept could imply, one will have therein a complete definition of the concept, and there is absolutely nothing more in it." [Peirce 1905a: CP 5.412], cf. [Peirce 1905b: CP 5.438, 1905c: CP 5.525, 1878a: CP 5.402]. Peirce justifies theories by examining their consequences [Laudan 1980: 188]. The meaning of a judgement is entirely exhausted with its practical consequences .

Strictly speaking, we perceive Thirdness, the laws, only indirectly. "Hypothetic reasoning infers very frequently a fact not capable of direct observation" [Peirce 1878d: CP 2.642]; cf. [Peirce 1967a: CP 2.511n; 1901g: 7.91] This is to say, unobservable entities within hypotheses are acceptable but only as far as they lead to factual observations [Peirce 1903k: CP 5.599; 1903h: CP 5.209-212; Weiss 1952: 178]; I tacitly extend sensations to include sense-enhancing instruments. We "attempt to explain phenomenally given elements as products of deep-lying entities" [Peirce 1891b: CP 8.60] [16]. "Abduction <...> suggests a statement in no wise contained in the data from which it sets out" [Peirce 1901l: HP 2.898]. "Abduction leads to a hypothesis which is entirely foreign to the data" [Peirce 1901l: HP 2.899]. "Knowledge <does not> come from experience alone, <...> science consists of conjectures checked by experience" [Peirce 1901k: 227] (aside: a totally Popperian position about the fact that knowledge is more than empiricism). "Thirdness pours in upon us through every avenue of sense" [Peirce 1903g: CP 5.157], albeit we don't evidence thirdness itself.

There is no reality beyond the world of experience which is produced jointly by mind and nature. Thought is an active factor in the real world [Peirce 1903i: CP 1.348]. "Mind is <...> connected with all matter. <...> It would be a mistake to conceive of the psychical and the physical aspects of matter as two aspects absolutely distinct. Viewing a thing from the outside <...> it appears as matter. Viewing it from inside <...> it appears as consciousness" [Peirce 1892d: CP 6.268].

Peirce's realism is similar to but more extreme than Duns Scotus' [McKeon 1952; Bastian 1953; Boler 1963; 1980; Moore 1964, Haas 1964; Fisch 1967; Almeder 1980: 160-182; Fred 1988; Haack 1992; Tiercelin 1992; Mayorga 2007; Oleksy 2015; Peirce 1871; 1893d: CP 4.50]; see also [Peirce 1909a: CP 1.27; Skagestad 1981; Wohlgemuth 1992: 6-86; Hausman 1993; de Waal 1996; Hookway 2000; Forster 2011]. "I should call myself an Aristotelian of the scholastic wing, approaching Scotism, but going much further in the direction of scholastic realism" [Peirce 1903e: CP 5.77n1]; cf. [Peirce 1868b: CP 5.312, 1871: CP 8.19, 1893b: CP 6.605]. "Duns

[16] This and the following statements were directed against Compte's and Poincare's version of positivism. Modern science takes Peirce's side. Cf. [Peirce 1967c: CP 2.511n, 1903h: CP 5.198; 1903k: CP 5.597; 1905a: CP 5.423].

Scotus inclines too much towards nominalism" [Peirce 1905g: CP 1.560]; cf. [Peirce 1905e: CP 8.208; 1871: CP 8.11].

Put briefly, for Duns Scotus, there are "three modes of being" [Peirce 1904b: 15]: metaphysical, physical and logical universals. Haecceity is the individuating principle [Almeder 1980: 162]. The logical universal is a second intention (it refers to a common nature in physical and metaphysical reality, but is not itself operative; this comes close to what I call Popperian nominalism). The logical confers intellectual universality but no real commonness [Tiercelin 1992: 57]. In thomistic legacy, universals existed before things in the mind of God, otherwise they exist in things and they exist after things as abstract concepts of the human mind. To exist means to be real. "Only individuals exist <(for Duns Scotus)> in the strict sense of the term" [Harris 1927: 2.92; Almeder 1980: 163].

In comparison, Peirce talks of ultimate, positive and ideal reality, respectively [Peirce 1900d: NEM 3.773]. "By a reality, I mean anything represented in a true proposition" [Peirce 1900d: NEM 3.773]. Reality means a certain kind of nondependence upon thought" [Peirce 1905c: CP 5.503], cf. [Peirce 1871: CP 8.12]. To "exist" means to "react with other like things in the environment" [Peirce 1906c: CP 6.495], cf. [Peirce 1896b: CP 1.457; 1905c: CP 5.503]. "Individuals alone exist" [Peirce 1905a: CP 5.419][17] (see Table 2). Positive physical reality he later calls category of *secondness* (actuality, first life).[18]

What we think of it is – in later diction -- *thirdness* (nomen)[19]. This Thirdness, if referred to catholic consensus that emerges in the long run and which constitutes truth, however, may be considered real as well [Peirce 1871: CP 8.12-15, 1900b: CP 8.103]. For Peirce, "the real is that which is not whatever we happen to think but is unaffected by what we may think of it". [Peirce 1871: CP 8.12]. Reality is, "something upon which our thinking has no effect" [Peirce 1877: CP 5.384]; cf. [Peirce 1878a: CP 5.407]. All knowledge is man made, bit it nevertheless transcends particular men. Knowledge (episteme) is real, opinions (doxa) are not. "There are real things whose characters are entirely independent of our opinion about them." Our sensations about this reality differ, but in the long run "we can ascertain by reasoning how things really are" [Peirce 1877: CP 5.384]; cf. [Peirce 1901e: CP 5.565; 1901f: CP 2.781; 1903a: CP 7.666; 1906c: CP 6.495]. "Different minds set out with the most antagonistic views, but the progress of investigation carries them by a force outside themselves to one and the same conclusions" [Peirce 1878a: CP 5.407]. Human reason alone does not suffice to establish firm beliefs, "some external permanency – something on which our thinking has no effect" is needed. [Peirce 1877: CP 5.384]. After all It is a matter of definitions; if reality is defined as that what is external to mind, nominalism is the only valid opinion to the doctrine of universals [Peirce 1871: CP 8.12]. Evidently Peirce follows a different definition of reality. [20]

[17] Platonic realism equates real with exist, which is not what Peirce does.

[18] "I call them the conceptions of First, Second, Third" [Peirce 1891a: CP 6.32].

[19] See note 18. Thirdness includes second life.

[20] Group selection theories of evolution presuppose some superindividual reality akin to Peirce. "Man's circle of society <...> is a sort of loosely compacted person, in some respects of higher rank than the person of an individual organism" [Peirce 1905a: CP 5.421].

Peirce promotes a concept of likelihood: "I cannot infallibly know that there is any truth" [Peirce 1908d: LWL 26]; "we can never be absolutely sure of anything" [Peirce 1897a: CP 1.147]. Peirce draws the following analogy: "What we call π is an ideal limit to which no numerical expression can be perfectly true" [Peirce 1901e: CP 5.565]. "Reality is only the object of the final opinion to which sufficient investigation will lead" [Peirce 1878b: CP 2.693]. "The origin of the conception of reality <...> involves the notion of a community" [Peirce 1868b: CP 5.311]. "Reality depends on the ultimate decision of the community" [Peirce 1868b: CP 5.316]. "Reality consists in the agreement that the whole community would eventually come to" [Peirce 1869: CP 5.331]. "Real is ens such as would stand in the long run" as opposed to an "ens relative to private inward determination" [Peirce 1868b: CP 5.311]. "I defend <...> law as a reality" [Peirce 1893b: CP 6.605]. "The third category <...> is precisely that whose reality is denied by nominalism" [Peirce 1903c: CP 5.62].

Mediated by signs, Thirdness is not reducible to mere conjunctions of actual individual instances as nominalists would hold. Thirdness is a superstructure. "The realist will <...> believe in the objectivity of all necessary conceptions, space, time, relation, cause, and the like" [Peirce 1871: CP 8.16][21]. For the nominalist, abstraction is a function of the symbol and does not reflect a generality independent of the mind. For Peirce, abstracta refer to objects of thirdness that are real, i.e. potent and productive and which exist apart from the mind. Peirce does not differentiate causa materialis and causa formalis in his judgement.[22] "General principles are really operative in nature. That is the doctrine of scholastic realism" [Peirce 1903e: CP 5.101]; "Thirdness is operative in nature" [Peirce 1903e: CP 5.93]; but "an object of representation is not ipso facto real" [Peirce 1903e: CP 5.96].[23] "Not only may generals be real, but they may also be physically efficient" [Peirce 1905a: CP 5.431]. "Even Duns Scotus is too nominalistic when he says that universals are contracted to the mode of individuality in singulars, meaning, as he does, by singulars, ordinary existing things." [Peirce 1905e: CP 8.208]. In this sense, for Peirce "laws are real" [Boler 1963: 164], albeit not a substance like the realities of secondness, whereas for Duns Scotus laws only reflect properties that are part of individual things, i.e. common nature contracted in individuals (which Peirce denies). For Ockham and other nominalists (like Popper), common nature only exists logically.

There is hence one significant difference between Peirce and Popper. For Popper [1978] there is some reality (World I) and there is a nominalist hypothesis about reality (World III) which is descriptive rather than potent and productive. Popper emphasizes theoretical distance towards the objects of reflection and to this end separates theory and praxis. In his practical

[21] Pierce discusses the absolute-relative motion controversy and sides with Newton [Davis 1972: 60], he also discusses Mach [Peirce 1898f: CP 7.484-488]. By 1905 Einstein argued that Newton's empty space, etc., does not exist. Peirce VI should have commented to this effect and reconsidered and possibly revised his earlier realism.

[22] Peirce rules out that individual existences have and share their specific material cause without supervening form, i.e. law (Thirdness); hence his biased view on Nominalism, cf. [Haack 1992]. He idiosyncratically accuses nominalism to maintain that a diamond is not hard but undefined until pressed upon [Peirce 1905e: CP 8.207]; cf. the role of the observer in 'Schödinger's cat'. "The universal in re is not a singular having anything in common with all the singulars of its species but law" [Tiercelin 1992: 61].

[23] "Real common nature, reality, does not follow, ipso facto, from the existence of the adequate term" [Tiercelin 1992: 61].

pursuit man modifies the objects according to his will. In his theoretical pursuit he passively tries to understand in order to best realize his praxis. Hypotheses are mental maps of a reality we never really know (following Kant), are meta-epistemic constructions. So much for Popper. Peirce is not a nominalist and for him hypotheses lead to reality itself [Nordmann 2009]. He does not differentiate theory and praxis. Are we allowed to start with nominalist conjectures if in the end Thirdness is real, the reality of hypotheses, and potent? Peirce continued his anti-nominalist stance throughout his life. Please note the difference in nomenclature: Firstness = World II and Secondness = World I for Peirce and Popper respectively.

Let me now resume chronological presentation.

Over time Peirce placed his *categories* into ever new contexts and made them unite diverse ideas (see Table 2). "The metaphysical categories of quality, fact, and law, being categories of the matter of phenomena, do not precisely correspond with the logical categories of the monad, the dyad and the polyad or higher set, since these are categories of the forms of experience" [Peirce 1896b: CP 1.452]; cf. [Peirce 1896b]. The categories take on shape only after 1887 and undergo further changes later (*Peirce stage IV*, 1891-1898 and *stage V* 1898-1905). It is a veritable Trinitarian theology (in set-order: father, son, Hl. Ghost).[24] Phenomenology deals with Firstness, normative science with Secondness and metaphysics – which nominalists have difficulty to understand – with Thirdness [Peirce 1903f: CP 5.121-124].

Monads, Diads and Triads is all that is needed. All relations of a greater number can be reduced to triads [Peirce 1903i: CP 1.347; Herzberger 1981; Burch 1991]; at variance [Mertz 1979].

In *Peirce stage VI* (1905-1914) the three phaneroscopic[25] categories (Firstness, Secondness, Thirdness) no longer are classifications of signs but possible kinds of being. "My view is that there a three modes of being ..." [Peirce 1903i: CP 1.23] Secondness becomes equated with compulsion and experience, Thirdness with rationality and law (this is an interesting parallel to Sigmund Freud's Id and Superego) (see Table 2). Peirce also talks of universes of experience [Peirce 1908a: CP 6.455], modalities of being [Peirce 1908b; Moore 1964: 406-407].

"The laws of nature are ideas <...> in the mind of some vast consciousness, who, whether supreme or subordinate, is a Deity relative to us" [Peirce 1903e: CP 5.107].

In spite of the details provided, this section does not do justice to the categories in their own right, but I have provided all necessary background to follow the intricacies of Peirce's argument on abduction (see section 2.4).

2.2 Evolution theory

[24] Peirce was raised Unitarian and 1862 followed his wife into the Episcopal Church, which is Trinitarian [Wagner 2013: 151]. But he retained his sense for empiricism (the Unitarian view was that empirical knowledge was an essential aid in judging faith [Wagner 2013: 20]).

[25] Peirce invents the term phaneroscopy late in 1904 to improve phenomenology, his definitions remaining inconsistent [Tienne 1989]. For a review see [Rosensohn 1974].

Another auxiliary concept relevant to the topic of abduction is evolution theory, given a structuralist analogy between Neodarwinian Logic and evidence-based hypothetico-deductive epistemology in its present day Einstein-Popper consensus [Potschka 2018a].

In *Peirce stage II* (1871-1883), his interest for probability and *evolution* is documented; "the Darwinian controversy is 'in large part' a question of logic" [Peirce 1877: CP 5.364]. Darwinism is a kind of Nominalism [Peirce 1871: CP8.38]! For a review on Peirce and evolution see [Burks 1997; Skagestad 1979].

Peirce stage IV (1891-1898): Peirce, in critical distance to Darwinism of his day, viz. Social-Darwinism, holds his own version of *evolution theory* [Peirce 1893a][26]. But from a modern perspective, he can be quite ignorant , e.g. [Peirce 1893b: CP 6.606]. Claiming that mechanical necessity cannot by itself lead to diversity [Hwang 1989: 271] a separate principle of chance (Tychism) is introduced. He is fundamentally wrong in this regard (cf. chaos theory). His three stage theory of evolution – Tychism (absolute chance), Synechism (continuity), Agapism (love) – exhibits remarkable parallels to Teilhard de Chardin [Peirce 1902b: CP 2.86; 1893ab]. "To say that the future does not influence the present is untenable doctrine" [Peirce 1902b: CP 2.86]. Peirce, having found analogies between tychism - abduction and synechism - induction, is irritated that the logical consequence of a relation agapism - deduction does not work out well. Note that synechism is at variance with Mendelian discreteness though still gradual [Burks 1997: 507] The existing universe, the whole platonic world which in itself is equally real, is evolutionary in its origin, too [Peirce 1898g: CP 6.194].

Natural laws (Thirdness) are evolutionary products still evolving [Peirce 1903i: CP 1.348; Wiener 1949: 94-95; Peirce 1898f: CP7.480].[27] The deterministic systems of today are evolutionary products of earlier chaos. "The premises of Nature's own process <...> which the necessitarian supposes to have been all in existence from the foundation of the world, but which the Tychist supposes are continually receiving new accretions" [Peirce 1903e: CP 5.119]. "At present, the course of events is approximately determined by law. In the past that approximation was less perfect, in the future it will be more perfect. <...> All things have a tendency to take habits. For atoms and their parts, molecules and groups of molecules, and in short for every conceivable real object, there is a greater probability of acting as on a former like occasion than otherwise" [Peirce 1887: CP 1.409]; cf. [Peirce 1898f: CP 7.514] (Albeit it is independent of what a community happens to believe! see section 2.1). This is effectively Rupert Sheldrake's theory of morphic fields [Sheldrake 1981: 68-77, 106-110; 1988: 160-172; Dürr & Gottwald 1997: 18-21, 38-39; Davis 1995: 260-263; Balashov 1992; Whitehead 1925, 1933: 143; Weinert 1995: 25][28]. (Note, unified theories of everything, the big-bang theory, etc. all presuppose eternal laws, and much of physics and cosmology would need to be rewritten.)

[26] This is the last of 5 articles in *The Monist* on the subject of cosmology.

[27] Peirce holds a Cartesian mechanical notion of law; however, not divine laws of nature but positive statute laws [Zilsel 1942]; cf. [Ruby 1986; Milton 1981; Peirce 1901k].

[28] A controversial thesis rejected by the Editor of Nature [Maddox 1981].

Moreover, laws (Thirdness) is secondary to the facts (Secondness) which exist. Secondness is being "regardless of any law, although it may conform to a law" [Peirce 1903d: CP 5.66].

Peirce stage V (1898-1905): His remarks on *evolution* are now toned differently. "I don't doubt <...> evolution. But as for explaining evolution by chance, there has not been time enough" [Peirce 1903g: CP 5.172]. Evolution depends on something akin abduction (namely evolution-of-evolution in general, and evolution of mind in particular [Potschka 2018a]); abduction "is not unlike those fortuitous variations in reproduction which played so important a role in Darwin's original theory" [Peirce 1905d: CP 2.755]. "I point to the infinite variety of nature as testifying to her originality of power of abduction"[29]

And vice-versa about abduction: "you cannot say that it happened by chance, because the possible theories, if not strictly innumerable at any rate exceed a trillion <...> and therefore the chances are too overwhelmingly against the single true theory" [Peirce 1903k: CP 5.591]; cf. [Peirce 1883: CP 2.753; 1903g: CP 5.172; 1905a: CP 5.431]. Peirce's solution to the impossibility of chance, however, is instinct except for one occasion [Peirce 1903a: CP 7.680] where it might have occurred to him that the search space is organized hierarchically, as in fact it is [Potschka 2018a]. I could not find any hint, however, that Peirce ever considered 2nd order variation (see Table 3). His analysis stops with calling it instinct. "The chicken has an innate idea of doing this <...> why should you think that to man alone this gift is denied?" [Peirce 1903k: CP 5.591].

Peirce stage VI (1905-1914): "In the evolution of science, guessing plays the same part that variations in reproduction take in the evolution of biological form, according to the Darwinian theory", which Peirce adds he does not believe [Peirce 1907: CP 7.38].

2.3 Psychophysical Parallelism

Peirce maintains a tradition of *psychophysical parallelism* [Peirce 1896a: CP 1.121; 1902b: CP 2.86; 1903a: CP 7.680; 1907: CP 7.38]: "all animals derive by inheritance (presumably by natural selection) <...> ideas which adapt them to their environment" [Peirce 1883: CP 2.753], cf. [Peirce 1883: CP 2.749]; "the reasoning mind is itself a product of this universe" [Peirce 1903k: CP 5.603], cf. [Peirce 1903k: CP 5.604]. "Our minds having been formed under the influence of phenomena <...> readily guess at what the laws are" [Peirce 1891a: CP 6.10]. "As the animal would have an immense advantage in the struggle for life whose mechanical conceptions did not break down in a novel situation <...> there would be a constant selection in favor of more and more correct ideas of these matters" [Peirce 1878c: CP 6.418].

In this tradition Peirce can claim a "natural instinct for truth", that "the human mind is akin to the truth in the sense that in a finite number of guesses it will light upon the correct hypothesis" {Peirce 1901a: CP 7.220]; truth is "the opinion which is fated to be ultimately agreed to by all who investigate" [Peirce 1878a: CP 5.407]; cf. [Peirce 1901j: CP 6.530; 1903k: CP 5.591; 1908a: CP 6.476]. There exists "a natural instinct for truth" [Peirce 1901a: CP 7.220];

[29] In ms "Detached Ideas continued and the dispute between Nominalists and Realists (NR)" [Peirce 1898: MS 439.30-31].

a natural adaptation to imagining correct theories of some kind" [Peirce 1903k: CP 5.591]. "Those instincts had some tendency to be true, because they had been formed under the influence of the very laws that we were investigating" [Peirce 1898f: CP 7.508]. "The only hope of retroductive reasoning ever reaching the truth is that there may be some natural tendency towards agreement between the ideas which suggest themselves to the human mind and those which are concerned in the laws of nature" [Peirce 1896a: CP 1.81]. "Now, the adaptations of nature <..> are never found to be quite perfect; so that argument is quite against the absolute exactitude of any natural belief" [Peirce 1892a: CP 6.50].

In Humean tradition of *psychophysical parallelism*, he claims: "Unless man have a natural bent in accordance with nature's, he has no chance of understanding at all" [Peirce 1908a: CP 6.477], cf. [Peirce 1907: CP 7.39][30]. "Man's mind must have been attuned to the truth of things in order to discover what he has discovered" [Peirce 1908a CP 6.476], cf. [Peirce 1911a: NEM 3.204]. "The existence of a natural instinct for truth is after all the sheet-anchor of science" [Peirce 1901a: CP 7.220]. In respect to the similarity of the evidence-based hypothetico-deductive method with Darwinian evolution he writes: "There is something in nature to which the human reason is analogous" [Peirce 1903e: CP 1.316].

Peirce kept these opinions throughout his life and they become ever more important in stage VI.

2.4 Abduction

I now start with the principal results and review Peirce's utterings on abduction, all well dated.

2.4.1. *Peirce I* (1855-1871, early semiotics), the young scholar, starts with philosophical premises he will soon modify. In 1866/7 he speaks, in reference to Kant, about reducing the multitude of sense data by means of hypotheses [Apel 1967: 52]. Around the same time he introduces the concept of abduction, then in perspective of a *logic of justification* [Peirce 1965: W 1.180, 266-267[31]; 1866; 1867B: W 1.108; 1867b: CP 1.559[32]; 1868b: CP 5.268-276] There he talks of the three syllogistic permutations "deduction, induction and Hypothesis" [Peirce 1900a: HP 2.876], i.e. uses the word Hypothesis[33] also as synonym to abduction. "Deduction or inference à priori, Induction or inference à particularis, Hypothesis or inference à posteriori" [Peirce 1965: W 1.267]. This trichotomy replaces the hitherto conventional dualism of deduction and induction as branches of logic.[34] He also considers a forth type,

[30] also in ms "Suggestions for a course of Entretiens leading up through Philosophy to the Questions of Spiritualism, Ghosts, and finally to that of Religion" [Peirce MS 876.5], not dated.
[31] calling it: reasoning a posteriori.
[32] Peirce planned to republish this paper and a number of others from this period in book form (*Search for a method*) in 1893 but never did so.
[33] Peirce himself always wrote Hypothesis with capital H to distinguish it from the product of Hypothesis, i.e. hypothesis (a discussion of the subtle meanings of this term can be found in [Potschka 2018b]).
[34] "I have always, since early in the sixties, recognized three different types of reasoning, viz. 1st Deduction <...>, 2nd Induction <...> and 3rd, Retroduction or Hypothetic Inference" [Peirce 1913a: CP 8.385].

analogy, later arguing that it is a combination of the three primary types. [Peirce 1903h: HL 282].

Each kind of reasoning needs to be proved by its own means, the principle of abduction abductively [Peirce 1865: W 1.280-281]. The outcome of an abduction is an hypothesis. The crucial question is: is this outcome justified by itself or is it in need of inductive justification? As we shall see, Peirce stages V and VI oscillate between these alternatives.

"The principle of hypothetic inference", i.e. abduction, "must relate to the symbolizability of forms." [Peirce 1865: W 1.281]. Abduction, i.e. "Hypotheses give us our facts. Induction extends our knowledge. Deduction makes it distinct" [Peirce 1865: W 1.283].

"Hypotheses non fingo, said Newton, striving to place his theory on a basis of strict induction. Yet it is hypotheses with which we must start" [Peirce 1865: W 1.283] This is a clear recognition of the non-bijective mapping in epistemology (see Figure 1).

Abduction, i.e. hypothetic inference, means: "a character which is known necessarily to involve a certain number of others, may be probably predicted of any object which has all the characters which this character is known to involve" [Peirce 1868b: CP 5.276].

Peirce introduces a research program in semiotics that will keep him busy throughout his life. He presents a concise early account ca. 1867-68. A neat interim account is worked out in stage III and IV and finally presented in 1903. "His speculative, rambling and incomplete Final Account" dates from 1906-1910 [Atkin 2006]. Words of caution about Peirce's decaying health during stage VI?

Peirce's early theory of abduction is mathematico-logical in line with his semiotic research program. Starting in 1891 (Peirce IV) his late theory of abduction takes on its own dynamic leading up to a logic of discovery and finally a psychology of discovery.

2.4.2 *Peirce II* (1871-1883, early pragmatism), the widely read at his time. He continues to use "Hypothesis" synonymous to "abduction" [Peirce 1878d: CP 2.623] and confuses it with "induction" [Peirce 1883: CP 2.706-707]. Pragmatism deals with the economy of research in an age of methods; and logic is the art of devising methods [Peirce 1882: CP 7.59].

Peirce introduces several original ideas (pragmatism – in 1873 [Peirce 1910a: CP 6.490], synechism, abduction, three universal categories) which in part he developed later. He already speaks of innate instincts as relevant to science [Peirce 1878c: CP 6.416; 1883: CP 2.754]. (For a classification of kinds of instincts see [Paavola 2005].) The basic laws of nature are all probabilistic.

I contend that Peirce stage II did not fully grasp the epistemological scheme of Figure 1. Thus, he reports of classificatory sciences being purely inductive and sets them apart from hypothetical sciences [Peirce 1878d: CP 2.644], viz. some research is inductive independent of and without being a stage of evidence-based hypothetico-deductive epistemology, which Peirce only develops later. Peirce later distances himself from his earlier work (see section 2.4.4). However, Peirce's theory of predetermination, viz. traits must be defined before a

statistical sample is drawn [Peirce 1878c: CP 6.409] already presupposes a hypothesis and prefigures the methodological turn of 1901; cf. [Peirce 1883: CP 2.739].

The hypothetic inference is a week kind of argument which must be put as a question [Peirce 1878d: CP 2.634].

Peirce compares Abduction (hypothetic inference) with the emotions that various sounds of orchestral instruments yield when striking the ear. "Hypothesis produces the sensuous element of thought" [Peirce 1878d: CP 2.643]; cf. [Peirce 1868b: CP 5.291-292; 1866: W 1.471-472] (a consequence of preconscious information processing and not necessarily the result of instinct). Abduction, i.e. hypothetic inference, "supposes something of a different kind from what we have directly observed, and frequently something which it would be impossible for us to observe directly" [Peirce 1878d: CP 2.640]; ... "a *fact* not capable of direct observation" [Peirce 1878d: CP 2.642], i.e. a *reality*.

Concerning abduction, "there is some secret here which remains to be discovered" [Peirce 1878c: CP 6.418].

2.4.3. *Peirce III* (1883-1891, "logic"), the obscure privateer (cf. [Peirce 1903c: CP 5.59]), lacks attention span. His affiliation with Johns Hopkins University ends 1884 with a moral scandal[35], and he never will hold a University position again. Peirce also quits 30 years of government service as surveyor in 1891, after several years of tensions. He moves to Milford in rural Pennsylvania in 1887 "to escape distraction from my studies in logic".[36]

Let me insert some general remarks on Peirce's health pertaining to his entire career: William James calls Peirce "a hopeless crank and failure in many ways, but a really extraordinary intellect" [James 1903]. His life remains economically marginalized from 1883 till his death. Peirce identifies himself with Galileo when claiming "it is a bitter thing to be put into the world by God to do a special great piece of work, <...> and to be prevented by the jealousies and coldness of man. Galileo did something for the world; but he did not do half what he might have done <...> had helping hands been extended to him"[37].

But he remained a life-long scholar learning himself and not learning through his students. Throughout his life, it is quite typical for Peirce to draft something like "I believe it to be the most important part of the book" [Peirce 1902b: CP 2.102] when referring to parts that never become written (in this particular instance something most illuminating about abduction), besides drafting one book after the other without ever succeeding to publish.[38] For many items there exist several drafts in his manuscripts, that he never succeeded to consolidate into

[35] His marriage disrupted, he started to live with another woman, whom he later married, prior to divorce.
[36] Unpublished ms "On an unpretentious argument for the reality of God" [Peirce 1908: MS 905]; this particular quote reproduced in [Peirce NEM: 4: v-vi].
[37] Unpublished ms "12th Lowell lecture", [Peirce 1892: MS 1283]; cf. [Eisele 1964: 176].
[38] He finished one book, a collection of essays previously published, for which he found no publisher. The remaining book projects remained incomplete in Peirce's hands. In spite of myriads of unpublished manuscripts he did succeed to publish some in journals.

one definitive one. Last not least, Peirce likes to invent idiosyncratic terminology[39] (still unfamiliar outside a narrow community of Peircean specialists).

This is an expression of the sad aspects of Peirce's life that all too often are censored from the record. His poor state of health did not prevent him from making great contributions to semiotics and epistemology, but they are a fact on their own. William James had reason to complain as of 1903 (maybe a significant repetition of Peirce's fate in 1883; i.e. comparing Peirce stage II with V and Peirce stage III with VI). What I do insinuate is that Peirce's capacity to communicate his extraordinary intellect suffered from his poor health and this needs to be considered when dealing with his oeuvre. Nor can his outlook on creativity be separated from his well-being (see below). His poor health in turn is a product of social forces, of the particular modes of production, and not a matter of blame or shame. His extraordinary achievements came at a price, he suffered for his art. I see parallels in Wittgenstein's career and with many other outstanding scholars.

2.4.4. *Peirce IV* (1891-1898, transition)[40] starts to publish in *The Monist* (till 1909), but only recovers gradually. "In almost everything I have printed before the beginning of this century I more or less mixed up hypothesis and induction" (using induction in a context of discovery rather than confirmation), he later admits [Peirce 1910b: CP 8.227-228][41], cf. [Peirce 1898c: RLT 141; 1900a: HP 2.876-877; 1902e: NEM4.22-24; 1903h: HL 282; Frankfurt 1958b: 593n1; Riemer 1988][42]. "My opinions, I confess, have wavered" [Peirce 1903f: CP 5.146]. "I have since <1871 ...> revised my philosophical opinions more than half a dozen times" [Peirce 1903i: CP 1.20]. "My doctrine <on abduction> has been immensely improved since my essay <[Peirce 1883]> was published" [Peirce 1902b: CP 2.102], where he goes into some details[43]. Others have concluded from this that "Peirce himself did not perceive any radical discontinuity between his earlier and later views" [El Khachab 2013: 164].

My decision was that his early "theory"[44] of abduction (from stage I to IV) under the label "Hypothesis" will not be considered further and my systematic inquiry starts once Peirce calls it variably abduction or retroduction [Peirce 1896a: CP 1.89, 1.65, 1.68; 1898c]. This coincides with what has been called Peirce's late "theory" of abduction [Kruijff 2005], but which needs further differentiation into stage V (itself heterogeneous) and stage VI. Most information about abduction is concentrated in section Peirce V, which makes it the largest section of my text.

[39] Not limited to neologisms like: pragmaticism, methodeutic, phaneroscopy, ubility, primity, etc.
[40] [Apel 1967] combines stages III and IV. [Burks 1946; Fann 1963] recognize only 3 stages: early, transitional (stage IV), late. [Brent 1993] identifies a transition stage 1891-1900 (see Table 1).
[41] This includes the exploration in "Grand Logic" of 1893 (not quoted), a completed but unpublished book.
[42] Peirce's confusion of abduction and induction carries on in the early AI literature.
[43] Some useful comments on the transition stage IV may be found in [Fann 1963: 28-31].
[44] Other authors talk of Peirce's early and late theory of abduction. I use quotation marks to indicate that it is no more than some hypothesis, a thesis, strictly speaking, cf. [Potschka 2018a].

Peirce discontinues the label “Hypothesis” with [Peirce 1892b CP 6.144-146]. He introduces changes in the concept of abduction after 1892, maybe as late as 1896[45].

An hypothesis “is adopted for some reason, <...> and that reason is being regarded as lending the hypothesis some plausibility” [Peirce 1867a: CP 2.511n1][46]. “Some reason” here carries dual meaning: “Progress in science depends upon the observation of the right facts by minds furnished with appropriate ideas” [Peirce 1893b: CP 6.604]; but also “Certain premises will render an hypothesis probable” [Peirce 1867a: CP 2.511n1] (isn’t this a Harmanian mind set? – see below). Peirce’s exemplar (paradigm case) of abduction is Kepler [Peirce 1902b: CP 2.96-97; 1896a: CP 1.72-74]; cf. [Harris 1970: 124-139].

He was familiar with the work of Whewell [Peirce 1887: CP 1.404; 1893b: CP 6.604; 1896a: CP 1.70] and develops similar ideas. In abduction “various tentative explanations <...> are modified by omission, insertion, or change in the point of view, in an almost fortuitous way” [Peirce 1896a: CP 1.107]. Besides this Darwinian mode, hypotheses also progress in a Lamarckian fashion [Peirce 1896a: CP 1.108]; and thirdly in cataclysmic revolutions [Peirce 1891a: CP 6.17; 1896a: CP 1.109], which anticipates Kuhn [1962]. Some time later (stage V) Peirce specifically mentions Whewell’s Doctrine of Chances [Peirce 1903i: CP 1.15], which his work now tries to disqualify (see below section 2.4.5).

Psychophysical parallelism assures our guessing instinct [Peirce 1891a: CP 6.10]. A retroductive conclusion “is only justified by its explaining an observed fact” [Peirce 1896a: CP 1.89]. “Any scientific proposition <...> is always liable to be refuted and dropped at short notice. <...> The best hypothesis <...> is the one which can be the most readily refuted if it is false” [Peirce 1896a: CP 1.120]. “Agreement <with observation> does not show the guess is right, but if it is wrong it must ultimately get found out” [Peirce 1896a: CP 1.121]. Any instrumentalist success impedes the truth seeking of science [Peirce 1898b: CP 1.668], which implies that ideally Thirdness is unproductive and not potent (a transient deviation from Peirce’s general outlook).

“All inferences are really performed under the influence of the law of association, <... and> unconsciously” [Peirce 1893c: CP7.444]. Peirce will return to this idea not earlier than stage VI.

Peirce early in his career was interested to logically analyze how scientists arrive at new ideas. Great scientific inventions are rare and from the hand of exceptional people, so individual biography does matter, but is it the exceptional professional training or the above-human genius that counts? Peirce’s own mind set seems to have been disposed to what Einstein later will describe as educated guess, casuistic, biographical memory, novelty to mankind, in any case learned and not innate [Potschka 2018a]. Similar preferences have been articulated by [Andersen 1973; Savan 1980]. Simonton points out that “scientists most often rely on conscious, objective, and deliberate processes <of creativity>, whereas artists more often depend on unconscious, subjective and involuntary processes” [Simonton 2009; 2010: 170].

[45] Wiener dates the manuscript [Peirce 1896a] to 1892 [Paavola 2006a: 25]. There are also two unedited manuscripts dated to 1894 (see below).
[46] This note dates from a revision in 1893.

But Peirce gave up on it (if not by 1886 then by 1903) having made a number of mistakes; and philosophically predisposed to *psychophysical parallelism* and more concerned with novelty to ordinary individuals, he gradually drifted towards innate instincts. The dichotomy just described might be labeled historical (breaking new ground) vs. psychological creativity (new to us) [Boden 1990; Hoffmann 2010: 585], strategic inference for science vs. instructive faculty for the 'world' [El Khachab 2013], scientific vs. common-sense, or creativity of individuals vs. creativity of the masses. The definitive Peirce as we know him, is closer to the latter part of this dichotomy. Growing awareness of alien psychology lead to deterioration of his former capacities.

2.4.5 *Peirce V* (1898-1905, methodology[47]) is famous senior of pragmatism with regained energy (but without employment). He lives in poverty for the rest of his life. Abduction is now analyzed in the context of *logic of discovery* [Peirce 1902b: CP 2.107], it is a first step in a larger methodological process. His focus is heterogeneous and he gives up on syllogism only later.

Philosophers of science usually distinguish a context of justification[48] (the evidence-based hypothetico-deductive epistemology) from a context of discovery, and they furthermore distinguish context from the more specific logic (procedures that reliably generate interesting hypotheses). Logic is usually understood to be normative. But abductive logic is special insofar as recommended strategy does not guarantee achievement. Abduction is a term applicable to any sort of creativity, algorithmic or not, epistemic or psychological, and it plays a role in both contexts of discovery and contexts of justification. Peirce V assumed that a formal logic of discovery exists, and a few authors have insisted on manualization, e.g. [Kelly 1987; Simon 1973; Hanson 1958: 71]. Simon [1973] suggests that manualization may be the course that normal science takes whereas creativity is strictly restricted to revolutionary turns. I do not agree. Any successful manualization of logic of discovery would be infallible [Laudan 1980: 183]. Peirce, however, considers this desirable, namely that abduction could be reduced to necessities. "Among <the> opinions which I have constantly maintained is this that while abductive and inductive reasoning are utterly irreducible, <...> yet the only rational of these methods is essentially Deductive or Necessary" [Peirce 1903f: CP 5.146]. It may have never occurred to him that this amounts to a contradiction to his own claim pro fallibility (falsifiability).

Peirce VI becomes skeptical that an epistemic logic of discovery exists, and recent authors outright deny this; e.g. [Nickles 1990, Shah 2008] who do allow for content-specific logics of discovery, though. Finally there are those who deny that algorithmic creativity of any kind exists, e.g. [Popper 1935: 31; Hempel 1945: 4; Carnap 1950: 192-193; Achinstein 1970; Thagard 1981].

[47] methodeutic

[48] A context of justification concerns how results are presented which often differs from how they were obtained. But the notions about the term vary; for example, Reichenbach [1938] considers induction under this rubric, as justification of some hypothesis.

Principally abduction is a description how a short list of hypotheses is generated by guesswork instinctively guided with success rates far above random chance [Peirce 1900a; 1901a: CP 7.219-220]. Nonetheless this shortlist contains more wrong than right answers [Peirce 1903g: CP 5.173]; all beliefs that come upon us are fallible. Peirce overall confirms this view as late as 1909: "Retroduction <...> in the whole leads us closer to the truth than we can otherwise come"[49] However, in the context of the 1909 quote it is clear that by then retroduction provides truth on its own which it does not for Peirce V.

"Induction is the experimental testing of a theory" [Peirce 1903f: CP 5.145]. Of terminological relevance is that Peirce distinguishes 3 kinds of inductions: crude (Bacon's induction by simple enumeration), qualitative induction (pre-1900 called Hypothesis), and quantitative induction (statistical induction) (pre-1900 simply called induction) [Peirce 1905d: CP 2.756-759; 1901j: CP 6.526; Santaella 2005: 183; Fann 1963: 32-33; Madden 1960: 249]. Induction is the inversion of a statistical deduction [Peirce 1883: CP 2.702], albeit it is "an absurd attempt to reduce synthetic to analytic reason" [Peirce 1878b: CP 2.685], cf. [Pinkham 1967; Cheng 1969]. Abduction is induction from qualities [Peirce 1892b: CP 6.145] -- this is a precursor of IBE, i.e. Harmanian inference (see below section 2.4.6) [McAuliffe 2015: 308] --, which later is set apart from abduction / retroduction proper [Peirce 1911a: NEM 3.205; Thagard 1976: 273]. Reichenbach eventually demonstrated that crude induction is self-corrective [Laudan 1973: 243, 250n62; Levi 1980]. Peirce erroneously claimed that quantitative induction is self-corrective[50] [Peirce 1905d: CP 2.770]. (Popper shared Peirce's mistake.) Peirce fails to show that retroduction is self-corrective but proceeds as if he had demonstrated it [Laudan 1973: 241]: "induction tends to correct itself" [Peirce 1898e: CP 5.576], cf. [Peirce 1906b], "reasoning tends to correct itself" [Peirce 1898e: CP 5.579], "all scientific inquiry is self-corrective in nature" [Peirce 1898e: CP 5.582], "intelligent guessing may be expected to lead to the one which will support all test" [Peirce 1901j: CP 6.531], cf. [Peirce 1896a: CP 1.121].

The process of inquiry converges on a limit and that limit is reality. "The object of a logical method is to bring about more speedily and at less expense the results which is destined, in any case, ultimately to be reached" [Peirce 1901a: CP 7.185]. "Reality, thereby, can only be regarded as the limit of the endless series of symbols" [Peirce 1904a: NEM 4.261]. Later in his life (Peirce VI), the sublime intelligence of Firstness will guarantee success.

"If we only had at our command at this moment a really scientific logic and metaphysics, which might serve as guides in the choice of a hypothesis" [Peirce 1900c: CP 8.109]. This is the research program I shall now go to detail.

"All valid reasoning is either deductive, inductive, or hypothetic" [Peirce 1868b: CP 5.274]. On one occasion in 1901 he writes about "induction, deduction and presumption (for which <he> proposes the name abduction)" [Peirce 1901d: CP 2.774]. Let me repeat myself: Abduction proposes hypotheses, deduction articulates their consequences, and induction evaluates

[49] unedited ms "(Meaning Preface)" [Peirce 1909: MS 638.14-15].

[50] Newton's method of approximating the roots of an polynomial equation was a paradigm case for the self-corrective theory (David Hartley), what Peirce calls in-the-long-run (i.e. asymptotically), even though the iterations sometimes are chaotic – as we are aware today and it is strange that mathematicians did not report this fact for so long. It is in fact wrong that quantitative induction always is self-corrective.

them. The (for him triadic) evidence-based hypothetico-deductive process is comprehensively described for the first time in [Peirce 1901a: 7.202, 203, 206], or in greater detail [Peirce 1901a: 7.202-219], also [Peirce 1908a: 6.469-473]. Key papers are [Peirce 1903h; 1901/3], also [Peirce 1878d, 1896a, 1898c, 1901d][51]. Abduction, deduction and induction, which used to be three different kinds of reasoning irreducible to one another, thus in 1901 become three different stages of scientific inquiry (Methodological turn) [Fann 1963: 31-32; Riemer 1988][52] (see Table 1 and Figure 1).

Incidentally Peirce's stage V corresponds to the formative years of Albert Einstein working on the new physics and applying the very epistemology that Peirce puts to paper. I have not found any evidence that Einstein then knew of Peirce. It was simply very timely to have such epistemologic ideas.[53]

Peirce equates "abductive inference" to the authentic meaning of απαγωγή[54] in Aristotle *Prior Analytics* [Peirce 1901d: CP 2.776-777; Aristotle AP: #2.25.69a20], cf. [Peirce 1901a: CP 7.251; 1903f: CP 5.144; 1898c: RLT 140-142; 1896a: CP 1.65; 1903l: CP 1.188; 1901a: CP 7.249; 1867c: W 2.108; Kruse 1986; Kempski 1988; Kraus 2002; Floréz 2014; Magnani 2015][55]. Julius Pacius employed the latin abductio to translate απαγωγή [Peirce 1867c]; W. D. Ross translates "reduction". Not untypical for the attire of Peirce, he laments on no less than six occasion [Peirce 1901d, 1903f; 1896a, 1903l; 1898c; 1905e] about errors in the transmission of Aristotle AP 2.25 and only once provides proper text-critical clarification [Peirce 1901a: CP 7.249-254].

Moreover he will altogether revise his opinion later [Peirce 1905e: CP 8.209; 1903h: CP 5.212], c.f. Peirce VI. "I was too much taken up in considering syllogistic forms <...>" (he recollects already in reference to 1883) [Peirce 1902b: CP 2.102]. Even though Aristotle was the namesake for the concept, Peirce shifted his interest to a different approach which he calls interrogation (while retaining the term abduction). I contend that a narrow syllogistic interpretation can be excluded in the long run from a lasting "definitive Peirce" and will give several further arguments in support of my thesis throughout my paper.

At the same time Peirce entertains a mutually exclusive view, namely that abductive inference is a (pre-syllogistic) *interrogation* [Peirce 1901j: CP 6.524-525, 528; 1901l: HP 2.899; 1903n: EP 2.287; 1908a: 6.469], "the interrogative suggestions of retroduction" [Peirce 1905d: CP

[51] Abduction figures prominently in Peirce's lecture series: Harvard lectures of 1865, Lowell lectures of 1866, Cambridge lectures of 1898, Harvard lectures of 1903, and Lowell lectures of 1903. I let start stage V with the Cambridge lectures of 1898 and believe that a date of 1902 or 1903 is already at the height of regained publicity and is too late (see Table 1).

[52] Cf. ms "Retroduction (Retr)" [Peirce 1906: MS 756.1], for Robin undated; ms "A neglected argument for the reality of God (☉) (🙈)" [Peirce 1908: MS 843], for Robin undated; ms "One two three" [Peirce 1908: MS 905]; ms "Reasoning" [Peirce 1914: MS 752]; and [Pietarinen & Bellucci 2014: 355]. Peirce stages I- IV (early Peirce) sorts the three kinds as deduction, induction and hypothetic inference; Peirce V-VI (late Peirce) sorts the three stages on a temporal scale as abduction, deduction and induction (on one transitory occasion he writes: induction, deduction, presumption); see Table 1.

[53] Peirce was aware in principle about multiple discoveries [Peirce 1893a: CP 6.316-317].

[54] Not to be confused with επαγωγή (induction).

[55] also: "How to Reason: A critick of Arguments: Advertisement" [Peirce MS 857.4-5], not dated; and [Peirce 1894: MS 397, 398]. In total a period from 1884 (if not 1882) to 1903 (if not 1905).

2.758][56], cf. [Hintikka 1998: 519-520; Eco & Sebeok 1983; Tiercelin 2008]. He also calls it investigative [Peirce 1905f(2)]. It is abduction qua interrogation that will last (see Table 1).

This leaves us with methodology and noetics to be judged; i.e. to what extent his noetic stage takes precedence over his earlier methodology stage, in our effort to construct a definitive Peirce. In his Harvard Lectures of 1903 he presented a tentative summary perspective. However he repeatedly returns to the issue thereafter, which indicates that he was not satisfied with his 1903 synthesis.

Abductive inference means [Peirce 1903h: CP 5.189; Hanson 1958: 85-90][57]:

Result (3): The surprising fact C is observed. [φ]
Rule (1): If A were true, C would be a matter of course. [$\psi \rightarrow \varphi$]
Case (2): Hence, there is reason to suspect that A is true. [ψ]

(My postscript: A being true does not exclude A', A''; A''' etc. also being true. Abduction provides a class of potential answers [Levi 1991: 71]; it narrows down the number of guesses needed.)
It is to be investigated whether A is not true (fallibilism).
Abductive instinct means:

A not being known, guess A.

In both cases, A *may be* true (no more than that). A might be known to us but needs justification to be associated to the problem at hand[58], more likely A is an ad-hoc modification of something known[59]. If A is not known to us consciously it still may be known to Firstness (c.f. Peirce VI). If A is entirely unknown some A' may, more vaguely, associate and be tried. There are a number of restrictions as to what constitutes a valid hypothesis (see below s.v. constraints).[60] Abduction helps to find suitable hypothesis, however it never justifies an hypothesis (this is a task of induction).

From a modern perspective, ab-duction is not some addition based on existing understanding, but a modification, something bound to arrive at inconsistencies with the body of associations from which it emerges, a variation of some mental state in existence, not a new design without precedent and bias, a potential ab-use of previously accumulated intentions. Peirce himself primarily talks about analogies. This incidentally is the chief reason why in my opinion evaluation (code preserving) and abduction (code modifying) are fundamentally different

[56] For a poetic description of interrogatory retroduction see unpublished ms [Peirce 1906: MS 756], quoted in Graybosch 1989: 98].
[57] Less known, this is identical with [Peirce 1878d: CP 2.624].
[58] From a standard methodology perspective. Let me remark that taken as syllogism one frequently comes across deadlock of analytical philosophy exegesis, as pointed out by [Frankfurt 1958b] and others.
[59] Peirce's wording is analogy, viz. strictly speaking only a subset of possible modifications.
[60] Kapitan [1992: 6, 16; 1997: 486] has therefore suggested to modify the syllogism, which I now modify further, also paying attention to Shook [2016: 161]:

The surprising set of facts C = {C_1, C_2, ...} is observed.
If A were true, C would be a matter of course.
A fulfills the constraints better than the envisioned competitors.
Hence, there is reason to suspect that A may be true.
A is recommended for further examination.

This syllogism does not go beyond the details provided by Peirce.

processes (Figure 1). Abduction is the only step that introduces new ideas [Peirce 1902b: CP 2.96; 1903f: CP 5.145, 127; 1903g: CP5.171; 1908a: CP 6.475; 1898c: RLT 139]; It does so in the way outlined, which, however, goes beyond Peirce.

Writing a paper on creativity it seems appropriate to quote Peirce in a list of associations, suitable to a logic of inquiry but untypical for a finished research report. But let me try to group then with the following key-words: Basic attributes, guessing, reason, logical form, more attributes, etymology, no belief, evidence-based, abduction also starts with evidence, abduction to predict novel evidence, what gets abduced?, evaluation, instinct, falsification / fallabilism, constraints on abduction, pragmatism.

Basic attributes!: abduction is a process of adopting a hypothesis [Peirce 1902b: CP 2.96, 64; 1901a: CP 7.202; 1903h: CP 5.189]; "an inferential step which I propose to call abduction" [Peirce 1901j: CP 6.525]; "retroduction is the provisional adoption of an hypothesis" [Peirce 1896a: CP 1.68]; acceptance on probation [Peirce 1902b: CP 2.96]; "the process of choosing a hypothesis" [Peirce 1901a: CP 7.219]; abduction suggests an explanatory hypothesis [Peirce 1903g: CP 5.171], albeit "problematically" [Peirce 1901d: CP 2.777], cf. note[61]. "The first <...> is an inferential step which I propose to call abduction" [Peirce 1901j: CP 6.525]. Peirce and his exegetes let abduction adopt, generate, suggest, infer, choose, create, construct hypothesis, which thereafter are evaluated. Abduction is not the first instance but a process of developing guesses (this distinction in blurred in stage VI). The fundamental presupposition is that "the facts in hand admit of rationalization" [Peirce 1901: CP 7.219].

Guessing!: Not direct induction from data but intermittent abduction from guesses leads to hypothesis. "Abduction is nothing but guessing" [Peirce 1901a: CP 7.219], cf. [Peirce 1901l: HP 2.898-899, MS 692.24; 1906b: NEM 4.320]; in 1900 he still writes "Hypothesis is guessing" [Peirce 1900a: HP 2.878] referring to abduction; "the stimulus to guessing, the hint of the conjecture, was derived from experience" [Peirce 1905d: CP 2.755], cf. [Peirce 1878d: CP 2.623]; "we guess out the laws bit by bit" [Peirce 1902b: CP 2.86]. "We begin, and must begin, almost every inquiry by making a guess" [Peirce 1901l: MS 692.29]. Guessing piecemeal [Tschaepe 2014]. "We may be aided by previous knowledge in forming our hypothesis. <...> we still have to guess, only we shall select our guess from a smaller number of possible hypotheses" [Peirce 1907: CP 7.37].

Reason!: We separate 'reasonable' guesses from poor ones.[62] "Abduction <...> furnishes the reasoner with the problematic theory" [Peirce 1901d: CP 2.776]. "Reasoning cannot be unconsciously performed" [Peirce 1902c: CP 2.182]. Hence abduction (as of stage V) cannot be an unconscious process (but guessing which is the first step may be (see below). But Peirce admits that "there are <...> operations of the mind which are logically exactly analogous to inferences excepting only that they are unconscious" [Peirce 1903e: CP 5.108] . Abduction is a process not fully conscious [Peirce 1903h: CP 5.181].

[61] And also ms "Hume's argument against miracles, and the idea of natural law (Hume)" [Peirce 1908: MS 873.22-23], for Robin not dated.
[62] Ms note 61 [Peirce 1908 MS 873.11].

Logical form!: Abduction is both logical inference and instinctual insight which suggests that instinct includes unconscious logic (To us today there are many kinds of logic besides classical syllogisms: dream logic, multivalent logic, fuzzy logic, etc.). Peirce admits that abduction follows its special logic [Peirce 1898h: CP 6.218]. "Abduction <...> is little hampered by logical rules <...> but nonetheless <has> a perfect logical form" [Peirce 1903h: 5.188]. The rational of abduction is (logically) necessary [Peirce 1903f: CP 5.146]. There is no "use of psychology in logic" [Peirce 1903g: CP 5.157]. In summarizing his many utterings on the subject, a logical form is supposed to exist though he never came to identify it. The logical form is expected to overcome the predicament of chance as such. There are of course algorithmic strategies to limit the search space and hence to improve the chances of guessing, but this is not what I read into Peirce's quest for a logical form, namely to overcome chance, as will emerge with stage VI's retro-duction.

More attributes!: Abduction is an ongoing argument of which the facts of the premise contribute an icon [Peirce 1902b: CP 2.96]. "Something corresponding to iteration may or may not take place" [Peirce 1898e: CP 5.581]; "abduction <...> covers all the operations by which theories and conceptions are engendered" [Peirce 1903k: CP 5.590]; "deduction proves that something *must* be, induction shows that something *actually* is operative, abduction merely suggests that something *may* be" [Peirce 1903g: CP 5.171], cf. [Peirce 1911a: NEM 3.203-204; 1910b: CP 8.238; 1903n: EP 2.287-288]; critical [Kapitan 1992]. "The conclusion of an abduction is problematic or conjectural" [Peirce 1903h: CP 5.192]. "Probability proper has nothing to do with the validity of abduction" [Peirce 1902b: CP 2.102], cf. [Peirce 1902e: NEM 4.22-24]. Abduction is a time consuming process [Richter 1997][63], cf. [Magnani 2001: 44]. All human knowledge is perceptual judgements [Richter 1995: 135] (on judgements about percepts, and not on percepts themselves).

These quotes show that Peirce was up to something, that he argued correctly for some framework of methodology, but carefully reading his full texts does not add the details one needs to expect.

Etymology!: Peirce also provides some etymology (which I have slightly amended). Abduction ("leading away from", German: entführen, ableiten, French: enlèvement), cf. ab-solute etc.; retroduction ("deliberately leading backward", reverse inference from consequent to antecedent, German: Rückführung); reduction (a concentrate, German: Einengung), deduction (development, explicates, scholastic demonstration, literally "leading to separation", German: Ableitung, Umführung)[64]; induction (evaluates, literally "leading to inclusion"; cf. [Peirce 1908a: CP 6.469, 475]. "Abduction seeks a theory; induction seeks for facts" [Peirce 1901a: CP 7.218] (historically induction used to mean: given a sample seek for the whole). Peirce stage III still writes: Abduction leads to causes, induction leads to the discovery of laws [Peirce 1883: CP 2.712].

[63] unedited ms "The Bed-Rock beneath pragmatism" [Peirce 1908: MS 300.47-48], originally dated to 1905.
[64] Peirce considers deduction to be non-ampliative. This is not entirely true, cf. Gödel's theorem about axiomatic systems that are not closed.

"Abduction <is> my general name, which will be defended" [Peirce 1902e: HP 2.1031][65] Peirce switches to the term retroduction in 1905 after it was pointed out to him that this supposedly were the better translation of apagoge [Kraus 2003]. Typical for Peirce, he does not tell us the reasons. Etymologically, abduction is more proper then retroduction for a modern perspective of the subject matter.

On many occasions he simply makes use of the term, e.g. [Peirce 1901a: CP 7.218-220; 1902a: EP 2.287]; and sometimes he speaks of abduction without even mentioning the word: <abduction means,> "in an analogous case an analogous conclusion would be true" [Peirce 1903f: CP 5.130]; or: the triad "conjecture, deduction of predictions from the conjecture, testing predictions by experimentation (<...> trial)" [Peirce 1903a: CP7.672]; deduction develops the necessary consequences of an hypothesis [Peirce 1903g: CP 5.171]; logical consequences of a concept tell us what that concept is [Peirce 1902e: NEM 4.62].

No belief!: Abduction is not a matter for belief [Peirce 1898e: CP 5.589; 1908a: CP 6.469-470], belief is out of place in science [Peirce 1898a: CP 1.635; 1903c: CP5.60]. One does not belief a newly abduced hypothesis but puts it on probation awaiting further evidence. In stage VI Peirce will write of "uncontrollable inclination to believe" [Peirce 1908a: CP 6.469-470]. Peirce seems to have undergone traumatic experiences of instinct, cf. [Peirce 1910d: CP 2.662], and these are most characteristic for a turn from stage V to stage VI.

Evidence-based!: He claimed (in one way or another) that the rational of abduction lies in the deductive relation between hypothesis and data [Peirce 1896a: CP 1.89; 1899: CP 1.139; 1897a: 1.170; 1903f: CP 5.146; 1902a: EP 2.287][66]; abduction concerns hypothesis construction and not the truth of a hypothesis; "abduction <...> furnishes the reasoner with the problematic theory which induction verifies" [Peirce 1901d: CP 2.776]; abduction "commits us to nothing. It merely causes a hypothesis to be set down upon our docket of cases to be tried" Peirce 1903k: CP 5.602]; it is not sufficient that an hypothesis should be justifiable, any hypothesis which explains facts is justified critically [Peirce 1902e: NEM 4.62]; "A retroductive conclusion is only justified by its explaining an observed fact" [Peirce 1896a: CP 1.89]. Abduction is followed by induction, the gathering of new evidence. "The presumptive conclusion is accepted only problematically, that is to say, as meriting an inductive examination" [Peirce 1901d: CP 2.786][67]; abduction seeks a hypothesis to account for facts [Peirce 1902a: EP 2.287; 1903h: CP 5.189]; "a hypothesis adopted by abduction could only be adopted on probation, and must be tested" [Peirce 1901a CP 7.202]; "a hypothesis <...> must be capable of being subjected to experimental testing" [Peirce 1901a: CP 7.220]; "every hypothesis should be put to the test" [Peirce 1903k: CP 5.599]; "the end of abduction is that

[65] Six years earlier, in [Peirce 1896a: CP 1.65], he prefers retroduction and reserves the term abduction to a misunderstanding. Three years later Peirce switches to retroduction again. His tempered statements obviously have meaning only for the time being and demand a dated exegesis. Alternatively, as done in the NEM edition, the word 'general' is replaced by 'present'.

[66] A deductive process is performed on the abducted hypothesis to set up an inductive test. "Induction consists in starting from a theory, deducting from it predictions of phenomena, and observing those phenomena in order to see how nearly they agree with the theory" [Peirce 1903g: CP 5.170].

[67] the paragraph continues: "as induction is proved to be valid by necessary deduction, so this presumptive inference" i.e. abduction, "must be proved valid by induction from experience" [Peirce 1901d: CP 2.786].

the deductive consequences of it may be tested by induction" [Peirce 1903h: HL 283]. Retroduction suggests the theories that induction subsequently verifies; not every possible consequence of a hypothesis must be tested at once, but merely must be capable of being tested [Peirce 1896a: CP 1.68]. Hypotheses should be "tested by experiment so far as practicable" [Peirce 1901j: CP 6.524]. "All physical theories originate in human conjectures, and experiment only lops off what is erroneous and determines exact values" [Peirce 1903a: CP 7.687].

Abduction also starts with evidence!: Strictly speaking, abduction is always preceded by experience [Buchler 1939: 80-86; Reilly 1970: 25-30]. It never starts unmotivated. "Adopting a hypothesis as being suggested by facts is what I call abduction" [Peirce 1901a: CP 7.202]; "the facts suggest the hypothesis <by way of> resemblance – the resemblance of the facts to the consequences of the hypothesis" [Peirce 1901a: CP 7.218]; "this kind of reasoning by which theories are formed under the inspection of facts I call abduction" [Peirce 1905f(1)]; cf. [Peirce 1893e: MS 595.37; 1901l: MS 692.27-36]. "Induction from past experience gives a strong encouragement to hope that <abduction> will be successful in the future" [Peirce 1903m: CP2.270]; "abduction consists in studying facts and devising a theory to explain them" [Peirce 1903f: 5.145], cf. [Peirce 1905e: CP 8.209]. Abduction is a non-random modification of extant knowledge -- the lineage even gives credibility to such a novel hypothesis [Peirce 1896a: CP 1.74] --, i.e. for Peirce abduction always remained contextual and never was mere intuition [Anderson 1987: 37-38].

Abduction to predict novel evidence!: abduction must end with new facts as much as it started with facts; "Abduction <is> the process of selecting a hypothesis to be tested" [Peirce 1901a: CP 7.245]. Abduction does not provide definite probabilities or likelihoods. Hypotheses are produced by way of abduction but their only means of justification are the empirical evidences obtained following deduction. Prior data may be recovered in the procedure but only provide ad hoc consequentialist justification. It is not enough that a hypothesis explains ad hoc some initial data, the hypothesis must be tested independently within novel contexts [Peirce 1901a: CP 7.182]. Singular evidence is powerless, we must assure widespread application of theory. (Peirce is more radical than Nickles [1985] who accepts that the quality of abduction contributes to justifying an hypothesis.)

"Induction is an argument which sets out from a hypothesis resulting from a previous abduction, and from virtual predictions, drawn by deduction, of the results of possible experiments, and having performed the experiments, concludes that the hypothesis is true in the measure in which those predictions are verified, this conclusion, however being held subject to probable modification to suit further experiments." [Peirce 1902b: CP 2.96]. "Induction is the experimental testing of a theory. <...> It sets out with a theory and it measures the degree of coincidence of that theory with fact" [Peirce 1903f: CP 5.145].

These quotes are fully compatible with Popper's epistemology. Both, Popper and Peirce rely on evidence – but differ about nominalism, more specifically about the potency of Thirdness. The methodology is the same but properties of World III (Popper) and Thirdness (Peirce) differ.

What gets abduced?!: Only parts of an hypothesis are abducted and then assembled by deductive faculties [Peirce 1903h: CP 5.193], or the idea to assemble known parts is abducted [Peirce 1903h: CP 5.181] whereas elaborating its details is left to further processes (cf. Figure 1). Abduction often uses well-understood principles in novel ways; i.e. abduction does not always create new hypotheses, it chooses in a given context and it chooses for goodness [El Khachab 2013]. Abduction makes recommendations about which available hypotheses are to be tested [McKaughan 2008: 452].

Evaluation!: "Our thinking about the hypothesis really consists in making experiments upon it" [Peirce 1903b: CP 1.322]. This amounts to Dennett's Popperian inner selective environment that previews candidate acts [Dennett 1995: 373-380]. Eventually there is selection among competing hypotheses [Peirce 1901j: CP 6.525]. Most of the time evaluation for Peirce is a step that follows abduction proper.

Instinct!: Besides abductive inference, he continues to develop his stage II focus on (animal) *instinct* [Peirce 1883: CP 2.754; 1893b: CP 6.604]. "It is really instinct that procures the bulk of our knowledge" [Peirce 1902c: CP 2.181]. "It has certainly not been <acquired> by a selfcontrolled and critical logic" [Peirce 1903g: CP 5.173]. He now ties instinctive guessing explicitly with abduction [Peirce 1898a: CP 1.630; 1901l: HP2.900; 1903k: CP 5.591;]; At first, Peirce considers guessing to be a deliberate process of reason, but observing above-chance success he turns to instinct. Guessing is the surface to an instinct from below. <Abduction is> instinctive insight into thirdness [Peirce 1903g: CP 5.173] ; no exact reason can be given even for the best guesses (i.e. abduction cannot be demonstrated) [Peirce 1903g: CP 5.173]. Referring to Galileo Peirce talks of *il lume naturale* [Peirce 1891a: CP 6.10; 1896a: CP1.80-81; 1898a: CP 1.630; 1903k: CP 5.604; 1908a: CP 6.477][68] not as Cartesian intuition but as expression of innate instincts. "The power of retroduction <... is an> instinct of just reasoning"[69]. Abduction is both a guess and an inference [Peirce 1901l: HP 2.899]. "We are constrained to be conscious of <something> by an occult force residing in an object, which we contemplate. The act of observation is the deliberate yielding of ourselves to that *force majeure*" [Peirce 1898e: CP 5.581] (note Peirce's version of psychophysical parallelism). The retroduced hypothesis is similarly irresistible.

Falsification / Fallibilism!: "People cannot obtain absolute certainty concerning questions of fact" [Peirce 1897a: CP 1.149]. "Agreement does not show that a guess is right; but if it wrong it must ultimately got found out" [Peirce 1896a: CP 1.121]. I shall not discuss the details of Popperian falsificationism, cf. [Niiniluoto 1978: 305-313], which science since has improved and Peirce does not detail. "The best hypothesis <...> is the one which can be most readily refuted if it is false" [Peirce 1896a: CP 1.120]. Valid hypotheses must be fallible [Peirce 1902e: MS L75.285], hence there are no absolute first principles; nor must there be necessity in abduction.

[68] Cf. ms note 61 [Peirce 1908: MS 873.13-15], for Robin not dated. Also "The architecture of theories" [Peirce MS 956], not dated; cf. [Eisele 1964].

[69] In ms "'The fixation of belief' <[Peirce 1877]>: notes for future editions" [Peirce MS 334] not dated.

Constraints on abduction!: The structure of Figure 1 is empty without a number of constraints in choosing hypotheses. One I have just mentioned is falsifiability. Trivially it also should explain the facts, reduce a manifold to unity (from theorems to axioms, etc.). If there is a limit to a series of observations (namely a model or law), the method is sufficient to discover it in the long run. Hypotheses must provide such a limit, hence this too is a constraint on abduction [Nordmann 2009: 321]. "We must not make hypothesis that will absolutely stop inquiry" [Peirce 1898f: CP 7.480][70]. There are also other constraints on abduction, such as reasonableness [Peirce 1903h: CP 5.196-197], potency and productiveness (see section 2.1). Then the principles of pragmatism: observable consequences in Comte's sense [Peirce 1901a: CP 7.203, 220][71] (but see note 16), conceivably modify our practical conduit [Peirce 1903h: CP 5.196], economy (money, time, resources, effort) [Peirce 1901a: CP 7.220; 1901h: MS 691.93, 1902e: MS L 75.284; 1903k: CP 5.602]. Further, predictability [Peirce 1901a: CP 7.186]; comprehensiveness [Peirce 1893c: CP 7.410]; modularity (readily broken down into its elements and studied) [Peirce1901l: MS 692.33]; the hypotheses' analogy with familiar knowledge[72]; past success in related matters. Peirce also subscribes to Galileo's principle of simplicity[73] [Peirce 1908a: CP 6.477]. "In order that the process of making an hypothesis should lead to a probable result <some> rules <...> are absolutely essential" [Peirce 1878d: CP 2.634-635] (On this occasion he does not speak of rules for how abduction works, but of rules for the evolutionary evidence-based hypothetico-deductive epistemology as such).

Pragmatism!: Abduction is the method of pragmatism, and pragmatism the logic of abduction [Peirce 1903g: EP 2.224; 1903h: CP 5.196, HL 282], since it is the economy of preselecting hypotheses best worth trying, which expedites the process of inquiry. "From the pragmatical principle <...> a different conception of the function of hypothesis and of the logic of hypothesis necessarily results" [Peirce 1901i]. The purpose of abduction is "to recommend a course of action".[74]

"An old idea of mine is just beginning to make some noise in the world of philosophy – pragmatism. Some of the converts carry it to extravagant length" [Peirce 1901h], cf. [Peirce 1908a: CP 6.482]. By 1905 he found it necessary to ridicule in public the culture he had helped to start as Pragmatism [Peirce 1905ab; 1906a; 1905e: CP 8.205, 209; 1910a: CP 6.490][75].

Last not least, a Peirce stage V can still write: "I do not approve of mixing up religion and philosophy" [Peirce 1903e: CP 5.107].

[70] Is Instinct already such an illicit hypothesis? Theistic concepts certainly run danger to be. Whenever people find no explanation they resort to a God. But what is it good for? In the next step they need to explain God.
[71] As well as unpublished notebook "Multitude and Continuity" [Peirce 1903 MS 316.59-60], lecture notes for Harvard University 15 MAY 1903.
[72] Ms note 61 [Peirce 1908: MS 873.16]
[73] Also known as Ockham's razor [Peirce 1898d: CP 4.1] Simplicity means: More facile to the mind, logical, the easiest to work with, adding least to what is observed, instinctively preferred.
[74] Ms "(meaning preface)" [Peirce 1909: MS 637.5].
[75] Peirce called his version *Pragmaticism*.

2.4.6 *Peirce VI* (1905-1914, Noetics), turns to a *psychology of discovery*. (For a distinction of psychological and logical context see [Ayer 1936: 85-86].) He takes this next step, into the unconscious, already in 1903 (this justifies to distinguish a methodology stage V from a noetics stage VI).

"Our logically controlled thoughts <only> compose a small part of the mind, the mere blossom of a vast complexus, which we may call the instinctive mind" [Peirce 1903h: CP 5.212]. This is a farewell remark by the extra Harvard lecture of 1903 which steps beyond what else he had lectured to this point[76] and which eventually leads to stage VI. I date the dominance of this new focus to after the monist papers [Peirce 1905ab; 1906a], and take support for a split of late Peirce into two stages also from [Maddalena 2005: 250, 256-257], who uses the date 1905, and others; Apel's book ends around 1907 and has nothing to contribute.

Another reason to chose 1905 as transition date is the fact that Peirce started to resume usage of the term retroduction in 1905, although he uses abduction till 1906. We should assume these transitions to be gradual and he may well have initiated a change in his mind starting in 1903 before changing terminology in 1905. Imagine Peirce having just completed his Harvard and Lowell lectures of 1903, sitting back and reflecting about what to do next.

For a while Peirce VI was ignored, in part because his ideas start to deviate from the main-stream developments of epistemology (whereas Peirce V in many respects was state-of-the-art) and there was suspicion of senility. Though he never uses these words, abduction for Peirce stage V is a guided chance event compatible with Einstein-Popperian epistemology. For Peirce VI this no longer is so. Peirce develops his long standing interest in preconscious information processing and unconscious associations (stage II, IV, and IV) into some outright guessing *instinct* (stage VI) and further towards channeling by an omniscient creator (stage VI). In what follows, I shall argue that this stage should none the less be taken seriously. A number of issues and preferences clearly set this period apart from earlier ones. At the same time this stage presents more parallel and contradictory strands than previous stages; possibly Peirce's attention span is declining again.

Abduction he now again calls retroduction [Peirce 1905d; 1908a: CP 6.474; 1910b: CP 8.228; 1913a: CP 8.385; 1911a][77]. "I call it retroduction because it starts at consequents and recedes to a conjectural antecedent"[78]. There are "rules that ought to be followed in retroduction"[79]. Three aspects may have motivated Peirce to switch names again; a better etymological choice (see section 2.4.5); to emphasize that knowledge of the facts matters in abduction, we deal with educated-guesses; and a renewed attempt for a syllogistic solution of the problem. While Peirce repeatedly confirms dependence on observation, some of his statements now certainly express his secret desire to do without.

[76] Only 6 lectures were planned and remunerated, which raised (unwarranted) suspicion that this is a manuscript never presented (Burks in [Peirce CP 8.294], Turrisi in [Peirce HL 13-14]).
[77] Also in "A logical criticism of the articles of religious belief", unedited ms [Peirce 1911: MS 856.3-4].
[78] In unedited ms [Peirce 1908: MS 905]. Another justification for using „retroduction" is given in unpublished manuscript "Lecture I" [Peirce MS 857.5], not dated.
[79] In unedited ms [Peirce 1908: MS 905].

But the principal concept remains unchanged: “Retroduction is simply a conjecture which arises in the mind” [Peirce 1911a: NEM 3.204]. Peirce IV: “Retroduction is the provisional adoption of a hypothesis” [Peirce 1896a: CP 1.68].

As stated earlier, retroduction means deliberately leading backwards. His choice suggests that Peirce was not fully aware of the Popperian unidirectional nature of evidence-based hypothetico-deductive epistemology [Potschka 2018a] (see Figure 1).[80]

Moreover, abduction is not a process of “modification of chance as the Darwinian suggests. <...> It would be ridiculous to suppose our science to have so come to pass” [Peirce 1908a: CP 6.476]. To be precise one needs to distinguish Neodarwinian random chance variation, equivalent to Campbell’s blind-variation-and-selective-retention mechanism (the original version of it!) [Campbell 1960], from guided variation which is what mind-full agencies do to improve their chances [Potschka 2018a]. To properly interpret Peirce’s statement one needs to know that guided chance processes were not known to the early Darwinists. What counts is that Peirce never acknowledged (in stage V) that his overall process remains one of chance. Dissatisfied he rather resumed the need for rules in stage VI.

Peirce once describes retroduction as follows [Pietarinen & Bellucci 2014][81]:

> If A were true, C would be observable.
> A is true.
> Therefore C is observable.

Just how do we come to know A as true. This is the real epistemological question. What Hintikka [1998: 508] and Pietarinen & Bellucci [2014] seem to have in mind is the following case:

> C is deductively predicted from A.
> eventually C is observed.
> Hence there is reason to suspect that A is true.

This is a trivial variant of the classical scheme [Peirce 1903h: CP 5.189] presented earlier. More interesting is the following variety:

> C is deductively predicted from A.
> A is made.
> Hence C is observed.

I shall consider this variety in a forthcoming publication.

Peirce turns away from syllogism around 1901/2 [Peirce 1901j; 1902b] though an isolated reading of his statements on retroduction after 1905 may suggest that he still hoped for manualization (this seems to be the exegesis of [Pietarinen & Bellucci 2014]). He remains contradictory, however, also making some strong claims against. Thus, he is now unconvinced that any one syllogistic form covers all hypothetical inferences [Peirce 1911a: NEM 3.203-204]. “Abduction <...> is any reasoning of a large class of which the provisional adoption of an explanatory hypothesis is the type” [Peirce 1906a: CP 4.541n1], cf. [Peirce 1911a: NEM 3.204].

[80] He also seems to have forgotten his own stage II theory of predetermination.
[81] In unedited ms [Peirce 1908: MS 843.41].

“There is no necessity for supposing that the process of thought, as it takes place in the mind, is always cut up into distinct arguments” [Peirce 1902b: CP 2.27].

And, he continues to work on a Socratic pre-syllogistic solution of the problem (see section Peirce stage V containing quotes from 1901 till 1908). Socratic interrogation means something methodologically broader that cannot be related to a plain imperative of I-ask / you-answer. It is conceivable that Peirce VI was (mis-)lead to a noetic imperative by reflections on aspects of interrogation, cf. [Hintikka 1998; Pietarinen & Bellucci 2014].

Peirce now increasingly turns away from semiotics of Thirdness (his triadic theory of signs) [Peirce 1867b: CP 1.558; 1868b: CP 5.283] to Firstness, the realm of icons in relation to its objects (second life), after becoming aware that movements in reality are prefigured and anticipated in the deployment and articulation of signs (which may suggest that he started to suffer hypnotic dissociation). Incidentally, this is also a turn from necessity (Thirdness) to potentia (Firstness). Moreover it is a turn from secondary causes to God’s will.

“Though we cannot think any thought of God’s we can catch a fragment of His Thought, as it were” [Peirce 1906c: CP 6.502]. “Thought is not necessarily connected with a brain” [Peirce 1906a: CP 4.551]. “Our thinking only apprehends and does not create thought” [Peirce 1909a: CP 1.27] This is a character disposition where nothing can be grasped by our intellect without first being ordered by a creative intellect. Thought is a conversation of the soul with society treated as a person [Peirce 1905a: CP 5.421] (which is telling of Peirce’s dialogical Menschenbild, cf. [Peirce 1907: 271]). ”A person is not absolutely an individual. His thoughts are what he is ‘saying to himself’, that is, saying to that other self” [Peirce 1905a: CP 5.421]. Hermans [2002: 151] considers this progressive; cf. [Lewis 2002; Montaigne 1580: 196-197]. This constitution is widespread among the popolus and explains the stylistic attractiveness of Plato’s dialogues. Monological minds (Aristotelian type) are minority programs.

Hypotheses are not generated fortuitously [Peirce 1908a: CP 6.476; 1903k: MS 475.20]. He comes to believe that abduction was plausible if it had instinctual appeal and he justifies it with *psychophysical parallelism* (“guessing <...> with the instinct of animals <...> entirely explained by <...> natural selection” [Peirce 1910a: CP 6.491]), notwithstanding that retroduction, i.e. abduction, “does not afford security, the hypotheses must be tested” [Peirce 1908a: CP 6.470]. All knowledge comes from observation [Peirce 1908a: CP 6.469]. “Whatever one finds an impulse to believe one should develop into so definite a form that experiment and observation may have fair opportunity to refute it” [Peirce 1908c: NEM 3.892]. “By plausibility, I mean that a theory that has not yet been subjected to any test <...> is in itself of such a character as to recommend it for further examination.” “Highly plausible justify us in seriously inclining toward belief in in.” [Peirce 1910d: CP 2.662] By plausibility I mean the degree to which a theory ought to recommend itself to our belief” without evidence other than instinct [Peirce 1910b: CP 8.222-223] (cf. section 2.4.4. s.v. plausibility). Peirce here distinguishes plausibility from belief – one never shall belief in abduction; instinct is a reason for plausibility in stage VI but never was in stage IV or V (cf. section 2.4.5. s.v. belief).

Instinct controls abduction in the long run [Peirce 1913b: EP 2.464-465]. “Instinct seldom errs, while reason goes wrong nearly half the time” [Peirce 1905b: CP 5.445]. “Instinct is the great

internal source of all wisdom" [Peirce 1906c: CP 6.500]. "Our faculty of guessing corresponds to a bird's musical and aeronautic powers, <...> the loftiest of our merely instinctive powers" [Peirce 1907: CP 7.48]. "Reason is inferior to instinct in several respects <...>".[82]

There exists a cerebral limbo as a timeless (?) – read: ontological -- ensemble of potential abductions. [Queiroz & Merrell 2005b: 5-6]. At that point, hypothesis generation (guessing) may well be deductive [Kapitan 1997: 483]; cf. [Peirce 1903f: CP 5.146]; viz. a deduction from this cerebral limbo. In Peirce I no absolute deduction from first truth is deemed possibly, only empirist evidence [Peirce 1868a]. This changes for the late Peirce (Peirce VI) for whom abduction starts from firstness!

The abductive instinct (retroduction) itself figures with Firstness, and includes a self-corrective evolutionary character (Tychism [Peirce 1903e: CP 5.119]). It is, by implication, a musement [Peirce 1908a: CP 6.458, 461]; musement is not reverie [Peirce 1908a: CP 6.458], it is sloppy thinking, "is a brain endowed with automatic control" [Peirce 1908a: CP 6.462]. "Logical analysis can be put to its full efficiency in musement" [Peirce 1908a: CP 6.461]. A rational instinct produces these musements {Peirce 1913b: EP 2.464, 472]; note, a rational instinct is not quite the same as animal instinct (of which Peirce talked earlier on). Peirce being philosophically predisposed to psychophysical parallelism easily comes to state that "man's mind has a certain power of divining the truth"[83]. It is evident that one strand of Peirce stage VI could be happy to rely on Firstness without need to empirical confirmation.

"One should be careful not to repress day-dreaming" [Peirce 1911b: EP 2.460]. Retroduction is "the spontaneous conjectures of instinctive reason" [Peirce 1908a: CP 6.475], a suggestion [Peirce 1908a: CP 6.476]. "The abductive suggestion comes to us like a flash" [Peirce 1903h: CP 5.181][84], cf. [Peirce 1908a: CP 6.476], "with uncontrollable inclination to believe" [Peirce 1908a: CP 6.469], "irresistible belief" [Peirce 1908a: CP 6.476]. "The strength of the impulse is a symptom of its being instinctive" [Peirce 1908a: CP 6.476]. This flash is a percept, abduction the subsequent perceptual judgement which then is rigorously elaborated to task (interpretative elements). "Manifest psychosis is the extreme case of abductive processes" [Spinks 1983: 204]. "Where then in the process of cognition does the possibility of controlling it begin? Certainly not before the percept is formed" [Peirce 1903e: CP 5.115][85]. Perceptual judgments are to be regarded as a limiting case of abductive inference [Peirce 1903h: CP 5.186]. Abduction "is a surrender to the insistence of an Idea" [Peirce 1898e: CP 5.581], Albeit, for a man who controls his passions, abduction takes place voluntarily [Peirce 1903f: CP 5.130]. It is a "force majeure" [Peirce 1898e: CP 5.581], a hint that comes straight from our <...> creator [Peirce 1911a: NEM 3.206].

[82] Unpublished manuscript „Reason and Instinct" [Peirce MS 832], undated.
[83] unedited ms "(Meaning preface)" [Peirce 1909: MS 638.14-15].
[84] „Abductive inference shades into perceptual judgment without any sharp line of demarcation between them <...;> perceptual judgments are <...> extreme case<s> of abductive inference, from which they differ in being absolutely beyond criticism <...;> the abductive suggestion comes to us like a flash. It is an act of insight although of extremely fallible insight." [Peirce 1903h: CP 5.181].
[85] "The psychological operations by which perceptual judgements are formed <...> are utterly beyond our control and will go on whether we are pleased with them or not" [Peirce 1903c: CP 5.55].

A mysterious guessing power operating subconsciously, whereby a mass of facts are taken into account at the same time, is not analyzed any further but replaced by theistic interpretations [Paavola 2005: 146]. Others did not stop there: abduction uses a "second-order map <which is> relatively invisible yet it reveals itself indirectly (like a neurotic symptom) as, for example, in the stupidity that a scientist feels in not having seen the simple (first order) answer sooner" [Blachowicz 1989: 457]. I believe that Peirce has amply demonstrated his capacity for critical introspection and that it would have been only a matter of time that was no longer given to him, and he would have analyzed beyond a theistic limit.

Does Peirce preferentially use the word abduction in the context of inference (Thirdness) and retroduction in the context of instinct (Firstness)? The answer probably is negative and the process is in any case more complicated than Peirce ever resolved to detail. The term retroduction is used for purposes of methodology in contradistinction to the specific notion of abduction in Aristotle, but so is the word abduction still used in this other sense over a certain period of time.

In the CP-corpus retroduction on one occasion is specifically used for a recursive mental simulation [Peirce 1908a: CP 6.469], Dennett's Popperian inner selective environment that previews candidate acts [Dennett 1995: 373-380; Potschka 2018a] For science, a content-optimized search strategy, the purpose of abduction is to find hypotheses that do not become operative until the whole hypothetico-deductive wheel has been iterated and a number of evidences have been gathered and none of them have falsified the hypothesis. The hope that abduction will be successful in the future [Peirce 1903m: CP 2.270], cf. [Peirce 1903k: CP 5.599, 603], is irrelevant or rather reduces to economic efficacy. On the other hand inference-to-the-best-explanation (IBE) models [Harman 1965; Psillos 1996, 2002; Lipton 1991, Minnameier 2004; Paavola 2006a; Salmon 2001; Fumerton 1980; Kuipers 2004; Day & Kincaid 1994; Thagard 1978, 1992; Fetzer 1998; Campos 2011; Mackonis 2013; McAuliffe 2015], critical [Hintikka 1998; Okasha 2000; Peirce 1903k: CP 5.599], intend to provide operative explanations based on the data at hand without predicting new data-acquisition and just compare different hypotheses. IBE is related to what Peirce calls abductive induction (see above section 2.4.5). Whenever in there-like time-optimized information processing abduction goes operative right away, when we start to believe what is merely plausible [Peirce 1910b: CP 8.223], this hope is essential (Peirce is often ambiguous about just which of the two cases he happens to address). It is then mandatory that a mental simulation of inductive evidence must be included to select among candidate hypotheses. It is this extended process that Peirce mentions in [Peirce 1908a: CP 6.469] giving it no distinct name other than retroduction. Being a mix of abduction, deduction and induction [Magnani 2009: 18], it should not be called that way (i.e. not included with the abductive steps of this procedure). In honor of its inventor, it has come to be called Harmanian inference.

Amongst the many unpublished manuscripts from Peirce VI, some are in striking conflict with Peirce V's claims that abduction provides guesses upon which empirical evidence (induction) alone decides. He now writes: The justification of retroduction "must rest upon certain

explanatory conjectures"[86]. Retroductive inference is valid if it is "the result of a method that must lead to the truth"[87]. "Retroduction <...> sheds the light of reason upon the state of facts <...> rendering it <...> likely (if not certain)"[88] Apparently his mind set at that time was focused on inference-to-the-best-explanation. It is not exclusive to his use of the term retroduction, since – let me repeat two quotes from stage IV -- "a retroductive conclusion is only justified by its explaining an observed fact" [Peirce 1896a: CP 1.89]; retroduction suggests the theories that induction subsequently verifies [Peirce 1896a: CP 1.68].

I agree with Pietarinen & Bellucci [2014: 355] that the terms abduction and retroduction have been used largely interchangeably denotating the process of hypothesis formation. It is the details of the concept that do repeatedly change almost independently of names given.

In 1909 Peirce learns about having deadly cancer. He starts to look back at his life and writes his last letters; and he continues to draw notes (he will die in 1914).

His latest (almost post-noetic) utterings on the subject call abduction "a conjecture which arises in the mind" [Peirce 1911a: NEM 3.204]. For a while, mind had been a matter of thirdness, whether syllogistic or otherwise (dream logic), and firstness/instinct flashed the conjecture into thirdness/mind. Now it was conscious inference from clues again.

3. Discussion

Kapitan [1997: 477-478], who does not differentiate stage V and VI, has formulated a minimum consensus for a definitive Peirce as follows: (1) Abduction includes inferential processes (inferential thesis); (2) scientific abduction generates new hypotheses and selects them for further examination (Thesis of Purpose); (3) Scientific abduction includes all the operations whereby theories are engendered (Comprehension thesis); (4) abduction is distant from, and irreducible to, either deduction or induction (Autonomy thesis). This statement has been endorsed by subsequent authors [Hintikka 1998; Estrada-González 2013]. Kapitan supports it mostly albeit not exclusively with quotes from stage V. In his study, Kapitan deliberately addresses inference and ignores its tension with instinct, viz. another strand already present in stage V but receiving elaborate ornamentation in stage VI. "Peirce insists that <abduction> is a form of inference, but he tells us little of what that form actually is" [Harris 1970: 313].

The early theory of abduction discredited by Peirce himself, the principal task left was to dissect Peirce's later theory of abduction into a stage V and stage VI. Somewhat simplified I have summarized my results in Table 3. It includes mutually contradictory line-entries. I have emphasized the stagewise trend in Table 3 by enlisting only those positions of stage VI that are most divergent from stage V, but all aspects are presented in the result section. In this Table 3 I also include a column describing the position of modern consensual "evolutionary

[86] unpublished ms "Sketch of some proposed chapters on the Sect. of Philosophy called pragmatism" [Peirce 1905: MS 328.46].
[87] unpublished ms "Miscellaneous Journal" [Peirce 1910: MS 276.39]; cf. [Peirce MS 876.3-4] undated.
[88] unpublished ms "A logical criticism of the article of religious belief" [Peirce 1911: MS 856.3-4].

evidence-based hypothetico-deductive epistemology" in its Popperian nominalist variety. A more detailed discussion of this epistemology may be found in [Potschka 2018a].

The noetic turn with its emphasis on firstness principally justifies to introduce another stage of scholarly life (I thereby confirm Maddalena [2005][89]). But there remains more than one tendency at any one time. Peirce's scholarly record holds no systematic unity, it cannot even be broken up into neat unicursal stages, and remains full of unresolved contradictions: Thus he entertains Socratic pre-syllogistic interrogation, while continuing belief in a syllogistic Aristotelean program. Then he terminates this venue only to resume different logical pursuits after a little while by the name of retroduction. He is not ready to explicitly propose a proper abductive (retroductive) logic, rather hopes for one in vain. He reaches the modern epistemologic consensus in stage V (fallible and evidence based, Socratic) but leaves it behind toward new contradictions in stage VI (sometime its fallible, at other times there is necessity in abduction). His attention span did not even allow him to recognize these contradictions from one manuscript to another (Peirce is generally quite honest with explicit refutation of past errors). For sure he was dissatisfied in having failed with a logical answer.

I contend that syllogistic interpretations can be excluded from a lasting Peirce. My evidence is as follows:

> Abduction is ampliative, not necessary and certainly not a syllogism in narrow sense;
> Abduction, if successful, increases the likelihood that an hypothesis will pass the test of evidence - even so, more wrong than right answers are produced, according to Peirce;
> Peirce comes to favor his method of (Socratic pre-syllogistic) interrogation;
> he explicitly distances himself from his απαγωγή-approach later in his life.

I concede that Peirce pursued under the changed name of retroduction a hope for a different kind of syllogism, and grant him that he learned from his failures and looks for a non-classic alternative.

My conclusions justify my premise that abduction may be studied in isolation from most of his other work. Hintikka [1998] agrees with my judgement. Pietarinen & Bellucci [2014] and presumably a large number of Peirce scholars are of different opinion. One may accuse me of not finding what I was not looking for. However I have not found any unresolvable and compelling argument against my reading in the extant literature. Richter [1995], too, rejects a logical and mathematical justification of abduction [Pape 1997a: 216]. For him Peirce's alternative is free-floating plausibility, while for me Peirce's decisive alternative is Socratic interrogation which already coexists with a theory of syllogisms during stage V. If a definitive Peirce means syllogistic interpretation of abduction, Peirce is wrong. But I don't believe this to be the case.

Let me recall the sequence of events as Peirce stage V views them: guessing, abducing, evaluating, next interrogation. All guesses turn out to be above-chance (which contradicts Whewell's Doctrine of Chance) and lets Peirce assume that guessing is ruled by instinct, guided by psychophysical parallelism. Guessing is followed by abduction proper, which is an

[89] A cited-author search in the Web-of-Science database reveals that Maddalena's paper has been totally ignored by the Peirce-community, Magnani [2009, 2011] being the singular exception.

inferential step, rational and conscious. Overall it takes on the stile of Socratic pre-syllogistic interrogation. Abduction leads to a short list of hypotheses which are ranked and the best selected for further action (such as induction). In stage VI the idea of instinct is elaborated. The sequence is now called: suggestive precepts (preverbal images), perceptual judgements (verbal text), evaluation, continue musement with next interrogation. Already the first step is now called abduction and holds reason behind the instinct. What was a force majeure (in stage V) now turns into a supreme being who tells us what to do. The relevant deep-structures are not further disentangled.

In my understanding abduction works differently by way of associations with different logical rules that are more related to dream-logic and never produce guaranteed conclusions. Various attempts to specifically model abductive logic have been presented in the more recent literature [Kakas et al. 1995; Magnani 2001; Gabbay & Woods 2005; Meheus & Batens 2006; Schurz 2008; Lycke 2012; Gauderis 2013; Beirlaen & Aliseda 2014].

Contrary to his hopes, Peirce in the end approaches Popper, who states: “The initial stage, the act of conceiving or inventing a theory, seems to me neither to call for logical analysis nor to be susceptible of it” [Popper 1935: 31] (logical always understood to mean classical logic). Scientists guess hypotheses, but afterwards they are compelled to give reasons how they formed their hypotheses (context of justification). Hence there is a definitive logical form while at the same time instinct, a psychological process, rules the context of discovery. This psychological process may use logical deep structures, but Peirce never analyzes those. They are known today as 2nd order inferences (see Table 3 and below). For Popper, in contradistinction, instinct is not the source of creativity but something to be overcome: “All learning consists of the modification <...> of some form of knowledge <...> and in the last instance of inborn dispositions” [Popper 1972: 71] (Niiniluoto [1978: 286] comes to a different conclusion).

Peirce never distinguished different types of abduction but others since have done so [Eco & Sebeok 1983; Kapitan 1997; Bertilsson 2004; Schurz 2008; Hoffmann 2010; Gabbay & Woods 2005; Magnani 2009; Thagard 1988, 2010; Eco 1983, Achinstein 1970; Park 2015]. Some disagreement about abduction may result from having different things in mind. In fact, Peirce’s shift of view from historical to psychological creativity (see section Peirce IV) also involves a shift in respect to types of abduction. This polarity between historical creativity and psychological creativity is paralleled by dual focus on inferential and instinctual aspects of abduction.

So-called historical creativity takes place before instinct consolidates. It uses unconscious inferences depending on individual biography and based on an associative mind-set. At the other extreme, psychological creativity recapitulates ontogenetically what phylogenetically has long been achieved. Peirce started his life with extraordinary talent and only later got to learn mass psychology. Doing so he failed to realize that scientific achievements require talent and take place according to idiosyncratic elitist character dispositions. It almost seems he had forgotten himself. What he has to say about psychology of abduction primarily concerns creativity of the masses.

There like tension between reason and instinct leads Goudge [1950: 6] to argue that Peirce was torn between two tendencies, and this tension between "inferential and "instinctual" ("insight") aspects of abduction has been noted ever since [Frankfurt 1958b: 594; Fann 1963, Anderson 1986, Kapitan 1990, Paavola 2005, El Khachab 2013].[90] The interpretation as tension can be avoided by considering abduction to be a two step process, first the stage VI emphasis on generation followed by stage V emphasis on rational filtering of the generated proposals (see Figure 1). There are many variants of a two step process: "Perceptual abduction provides us with the data to perform inductive tests, and interrogatory abduction provides the hypothesis we are testing" [Graybosch 1989: 89], a dubious if not false claim. Nor do I agree with Savan [1981], who eliminates this tension by calling it a synergy of rational experiment with instinctual abduction. Peirce's thought does not form a well knit system (as Savan and others have come to believe) but resembles a rope under tension with parallel fibers under temporal development.

Danermark et al. [2002: 80, 110] invent a distinction that Peirce never made: abduction is the hermeneutics of a creative mind followed by retroduction as a "serious logical operation" that engenders hidden conditions behind the appearances [Bertilsson 2004: 385]. What Danermark et al. [2004] seem to have in mind is the very extended process of [Peirce 1908a: CP 6.469], viz. related to the Harmanian mode, combined with Peirce's never ending bias to develop a logical justification.

Even more questionable in terms of exegesis, Rescher: abduction is hypothesis formation and retroduction is hypothesis testing [Rescher 1978b: 41]. Incorrect too is Hendricks & Faye who claim that retroductive inference is Peirce's original term for IBE [Hendricks & Faye 1998: 284].

Whatever the conclusions reached over this so-called tension, they do not, however, eliminate the shift from Thirdness to Firstness, which is the most characteristic feature of the noetic stage VI. Peirce gets worried about man-made physico-mechanical totalitarism, and starts to prefer divine first causes over (human, nay: real) secondary causation, no matter how well engendered.

Creativity is based on analogy, reframing, unification, extrapolation, diagrammatic manipulations etc.; either sentential or model-based[91]. It is also guided by paradigms. Whereas abduction for Peirce first of all is tacit internal processes, recent authors have pointed out the role of external diagrammatization [Magnani 2011, Hoffmann 2010, Queiroz & Stjernfelt 2011; Stjernfelt 2007; Radford 2009; Caterina & Gangle 2013; Bellucci 2013; Pietarinen & Bellucci 2016; Pietarinen & Stjernfelt 2015], the aid of diagrams being known to Peirce. "In a remote way abduction rests upon diagrammatic reasoning" [Peirce 1906b: NEM 4.320][92].

[90] Buchler [1939] and Goudge [1950] also identify a tension between the empirical and the metaphysical, two roots that exist but need not lead to inner conflict [Thompson 1953].

[91] A model is a set of objects satisfying a theory (set of axioms / hypotheses) [Giere 1998. 43]. Theories are loose collection of models [Harris 1998: 140]. Useful models are similar to actual reality in relevant respects, matching a subset of data that themselves often are derived from experimental models.

[92] similarly ms "The Basis of Pragmaticism (Basis)" [Peirce 1907: MS 283], originally dated to 1905. "A diagram is defined as an icon which, by analogy, represents relations between objects" [Stjernfelt 2014: 268]; cf. [Peirce

How do new ideas emerge in inquiry? This question many authors ask [Anderson 1986, Shanahan 1986, Roth 1988, Kapitan 1990, 1992, Hintikka 1998, Minnameier 2004, Paavola 2004a, 2006b, El Khachab 2013]. Going beyond Peirce I have provided a tentative answer in the results section, one that presupposes a difference between evaluation (preserving the code) and abduction (modifying the code), and calls for (all least) four temporal steps of inquiry. Modification of the code might well be a chance process within hierarchical search space, specifically using 2nd order variation techniques and unconscious performance [Potschka 2018a]. However, it may occasionally lapse into plain random chance variation (see Figure 1). This is my answer whereas Peirce get's stuck with a term he does not further dissect, namely instinct, which in turn leads him to divinatory power of guessing right and close to deduction from a preexisting divine realm.

No reader can escape to notice Peirce's penchant for numerological, in particular triadic organization of thought, and his forcing diverse ideas under such schemes. Hence one should always double check for matters overlooked simply because they would disturb number's harmony, e.g. value judgments, e-valuation (Kuhn) as a 4th methodological step in addition to abduction, deduction and induction (see Figure 1). Peirce includes e-valuation with abduction, but todays research praxis (first of all in the natural sciences) suggests at least two sociological distinct stages of inquiry: Evaluation tends to consolidate and preserve a knowledge base, abduction mutilates this knowledge base with odd variations. Or take the role of analogy (Paradigm) [Peirce 1911a: NEM 3.177; 1900a; 1898c: RLT 141]. "There are but three modes of inference, deduction, induction and abduction, a fourth, analogy, merely combines the principles of the other three" [Peirce 1903h: HL 282], cf. [Peirce 1905e: CP 8.209; 1910c: CP 7.98]. "I have consistently been on the alert for a forth kind of reasoning, and have yet never found the least vestige of any . <...> I think myself entitled to presume, for the present, that there is no such forth form"[93]. "I am unable yet quite to prove <it>" [Peirce 1911a: NEM 3.177].

Several counter arguments are to be stated: Discovery and evaluation amount to different sorts of considerations; stable reproduction of existing knowledge during evolution is almost the opposite from creative mutation in abduction; a rejected hypothesis can still provide elements and clues for new ideas (isn't history of science all about this); there exist kinds of thinking that are outside the hypothetico-deductive scheme of justification which do, however, interfere in the phase of evaluation; there are more than three steps in terms of typical organization and division of labor. There may well be only 3 logical modes but 4 stages of inquiry.

As stated in the methods section, a detailed reply to the extant literature is beyond the scope of this paper, but a few further comments shall be presented:

1903o: CP 4.418; 1902b: CP 2.77; 1896a: CP 1.54]. "Deduction consists in constructing an icon or diagram the relations of whose parts shall present a complete analogy with those of the parts of the object of reasoning <...>, and of observing the result so as to discover unnoticed and hidden relations among the parts" [Peirce 1885: CP 3.363].

[93] "A logical criticism of the articles of religious belief", unedited manuscript [Peirce 1911: MS 856.6-9].

Richter does not contribute much to differentiate Peirce V and VI [Richter 1995: 164], but he notes that the late Peirce (after 1891) is more heterogeneous than expected [Richter 1995: 172]. His book rather presents in broad strokes the development from early to late Peirce.

El Khachab [2013], an otherwise excellent recent article, does not quote [Maddalena 2005] and basically uses Burks 1946 periodization (early and late Peirce). This is what most scholars do. Davis [1972] even fails to distinguish the two versions of abduction, early and late. This is typical for the older literature. Moreover, he simply fails to understand Peirce when he claims that "scientific reasoning does not depend on induction at all" [Davis 1972: 34]. Peirce's method is evidence-based, abduction only prepares for mandatory induction. A similar problem occurs with Danneberg [1988: 325]: I maintain that the divinatory power of guessing right increases the likelihood of guesses but does not provide verisimilitude, which depends on evidence.

Paavola [2011: 253] lets Peirce's syllogistic interpretation end in the 1890s (with stage IV) instead of with stage V (see Table 1). McKaughan [2008: 446-447] includes comparative evaluation of hypotheses with abduction, even though this is primarily a matter of deduction and the entire wheel of Figure 1 iterated in mental simulation (Dennett's [1995] Popperian inner selective environment, mentioned above). Of Plutynski's [2011] "Four problems of abduction" the so-called boundary problem of dealing with distinctive kinds no longer exists being answered with my Figure 1. Park [2015] deals mostly with early Peirce, what for Peirce became obsolete after making abduction, deduction and induction steps of evidence-based hypothetico-deductive epistemology.

Nordmann claims that, "the role of hypothesis in Peirce's philosophy <...> does not need to distinguish between various stages of his intellectual development" [Nordmann 2009: 319]. I do not agree in all details with Nordmann [2009], who relies too much on quotes from early Peirce and ignores that the concept of pragmatism and of abduction, and even details of his anti-nominalism after all are staggered.

Peirce seems to have considered Harmanian inferences to the best explanation in stage VI and Pietarinen & Bellucci [2014] interpret retroduction in this direction, notwithstanding their lip service to the contrary [Pietarinen & Bellucci 2014: 356]. Abduction as something justified by induction is indeed something else [Hintikka 1998, Minnameier 2004; Paavola 2004a; Tiercelin 2005; Campos 2011], and I suggest that Peirce retained his stage V view also during stage VI as opposed to Pietarinen & Bellucci [2014] who insinuate a turn (see Table 3). But Harmanian inferences become a new fiber to Peirce's rope.

It is not quite correct to claim that abduction mediates the logical and the empirical [Bertilsson 2009: 384], rather this is a tension within the semiotics of Peircean Thirdness which (being operative) includes the empirical. Nor do I agree without qualifications with [Freeman & Skolinowski 1969: 471] that Thirdness is directly perceived, it is the consequences of Thirdness that we are able to evidence.

The structural isomorphism between Neodarwinian logic and evidence-based hypothetico-deductive epistemology is rendered by Kruse [1994: 90] as "nature performs inferences similar

to those of human inquirers, <...> nature performs abductions, inductions and deductions". This almost sounds like intelligent design.

Much of Kapitan's [1992] concern about abduction is answered by Peirce calling it "may be" as opposed to "can be" (induction) and "must be" (deduction) (see Table 2), and by recognizing its distinct methodological place in Figure 1. Peirce was a practicing scientist for many years and must have filled the gaps in his utterings in a rather similar way to my choices and preoccupations. This makes clear what the task of abduction is all about. How this task is performed, Peirce never settled on a final interpretation and for this very reason he was inclined to believe in noetic instinct.

4. Summary

Peirce's theory of abduction-deduction-induction, rooted in Whewell's evidence-based hypothetico-deductive method, seems to have become common lore amongst scientists by the time Einstein applied it (ca. 1905) without knowing of Peirce. It took philosophy of science quite a while to pick up the theme (both, Popper starting in the 1930s and secondary literature on Peirce after 1940).

The principal differences between Popper and Peirce are as follows: Popper still considers abduction to consist of chance events whereas modern consensus invokes guided chance events (methodological Darwinism [Rescher 1978a, Potschka 2018a]). For Peirce there is a reason behind the abductive conjectures made instinctively.

Popper does not distinguish primary from secondary causes. Peirce's Thirdness is potent whereas Poppers World III is not (and turns potent only after being transcribed into World I and then willfully practiced).

The source of knowledge is not empiricism but authority (community of thought)!

Peirce's "in the long run" was written before chaos theory complicated the argument (with ramifications for the doctrine of universals).

A law is something that can be broken but ought not to be.

There is an evolution of the laws governing nature (theory of morphic fields).

Hypotheses are more than what empirical data provide. They include entities not directly observable (but presumed to be real).

Formal logic may be reducible to 3 branches, as far as it goes, but the evolutionary evidence-based hypothetico-deductive scheme seems to contain additional steps.

Hundred years after Peirce's death, AI-research is way ahead of things from where Peirce has left them. Still, Peirce may serve as exemplar for research into epistemology providing the preliminaries. Moreover, he is presumably a good specimen of genius in advanced studies, a victim of creativity marshalled by disciplined peers.

There is some logic behind instinct, but there may be more than one logical disposition depending on psychological traits.

Interrogative musement and flashes are psychological variants of the same fundamental phenomenon. All types of interrogation include an element of brain-storming.

Abduction has a double meaning: a third type of formal logic, and one of the steps of the grand scheme of evidence-based hypothetico-deductive epistemology, and Peirce's statements on methodology readily make sense from the latter perspective. Peircean semiotics may add to but cannot replace the totality of this scheme.

Peirce longs for a manualization of creativity (abduction), but failing he increasingly turns to some (innate) instinct instead.

Peirce recognizes that it is not enough to explain known data but that abduction needs to lead to novel predictions; his verbatim track-record is often not clear in this regard.

Even though the Aristotelian origins that caused the concept to be named abduction were retracted by Pierce, the word is etymologically more fitting than "retroduction".

If it was ever conceivable to Peirce that abduction may also originate from individual biography (associative memory of coincidental life time percepts), instinct had carried him away for the better part of his life.

In the tradition of abduction scholarship, Apel's periodization has been totally ignored. I propose a further division of late Peirce into a stage of methodology and a stage of noetics. A construct of definitive Peirce that is favorable to the author amounts to some extrapolative mix of both stages (which then defines a Peirce, not what other scholars including myself may consider to be true in substance).

My study confirms a noticeable oscillation of Peirce's mindset.

The growth of Peirce's philosophy is best described as parallel strands of ideas each having temporal development.

Judged by the many misled interpretations of Peirce, due in part to the contradictions that Peirce accumulated over the years, it seems best to read Peirce as tetralemma, and to apply a benevolent pragmatic approach.

The principal remaining dichotomies of this tetralemma are "inferential but not syllogistic" versus "instinct" (channeling), "evidence-based" versus Harmanian, historical creativity (epitome Einstein) versus psychological creativity (ontogenetic recapitulation of phylogeny).

Peirce's constitution and mind set shifted from a disposition à la Einstein early in life to mere psychological creativity later in life.

In the long run, Peirce would presumably have continued to develop methodology of abduction in noetic direction, but he may have retracted from overt theistic interpretations and started to ask new questions.

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Peirce	*1839 - †1914										Burks 1946 Fann 1963	Murphey 1961	Fisch 1967 (life period)	Apel 1967 (life period)	Brent 1993 (life period)	Boler 1963	Esposito 1979	Deledalle 1990	Upper 1992	Maddalena 2005	marriage
I	1855-1870	early semiotics	logic of justification		syllogistic inference			<reasoning a posteriori (1864-1865)>	3 kinds of reasoning	historic creativity	early	1857-1867	I	I	I	very early (till 1875)	1954-1872	1851-1870 New England period	1855-1870		1st (16.10.1862)
								Hypothesis (1865-1900) {retracted}				1868-1870	II								
II	1871-1883	early pragmatism										1871-1884	III	II	II	early	1872-1890	1871-1887 cosmopolitan period	1871-1887		
III	1883-1891	logic										1885-1896		III	III						2nd (26.4.1883)
IV	1891-1898							abduction, retroduction (1896-1898)		common sense creativity	transition	1896-1914	IV		IV	transition	1890-1908	1887-1914 Arisbe period	1887-1901		
V	1898-1905	methodology	logic of discovery	guessing instinct		$\alpha\pi\alpha\gamma\omega\gamma\eta$ {retracted}	interrogation	<Presumption (1901)> abduction (1901-1906)	3 stages of inquiry		late			IV	V (after 1900)	late (after 1903)			1902-1914	✓	
VI	1905-1914	Noetics	psychology of discovery					retroduction (1905-1914)												✓	

Table 1 : Stages of Peirce's scholarly life

Table 2: attributes that define Peirce's universal categories

FIRSTNESS	SECONDNESS	THIRDNESS	ref.
ultimate reality	positive reality	ideal reality	[Peirce 1900 MS: L73]
possibility[95]	fact/event or actuality[96]	law[97] or tendency[98], also necessity	in itself (... of Firstness) [Peirce 1887; 1903i: CP 1.23], cf. [Peirce 1896b: CP 1.418-420]
quality[99] (reference to a ground)	relation (reference to a correlate)	representation (reference to an interpretant)	vs. objects (... of Secondness) [Peirce 1867b: CP 1.555] [Peirce 1898d: CP 4.3]
quality of feeling[100]	reaction to some phenomenon	representation of some phenomenon	vs. mind - (... of Thirdness) [Peirce 1903d: CP 5.66]
universal / general	individual / particular	universal / general	[Peirce 1896b: CP 1.427, 434]
real[a]	real[b]	real[c]	[a][Peirce 1903e: CP 5.118], [b][Peirce 1902d: CP 6.349], [c][Peirce 1903f: CP 5.122]
monadic qualia	dialectic sensations	triadic conceptions	[Pape 1997a: 206]
potentia	actus	conditional necessity[98]	[Peirce 1896b: CP 1.427]
potential matter	haecceity	potential form	[Moore 1964: 411]
spontaneity	dependence	mediation	[Peirce 1892c: CP 3.422]
chance	reaction	continuity	[Peirce 1892c: CP 3.422] [Peirce 1898g: CP 6.202]
chance	law[101]	tendency to take habits	[Peirce 1891a: CP 6.32]
abduction	induction[102]	deduction	triadic logic (... of Thirdness) [Peirce 1898g: CP 6.202]
may be	can be	must be	[Wohlgemuth 1992. 254] [Peirce 1901c: CP 6.365]
icons	index	symbols	objects of triadic semiotics [Santaella 2005: 185]
vague experience (sensation)	observing (facts)	drawing inferences (mechanisms)	ontology [Bertilsson 2004: 373, 386]
feeling	experience	consciousness of future	[Peirce 1904c: CP 8.291] [Peirce 1909b: CP 6.345]
presentness	struggle	law: nominalism	[Peirce 1903c]
what just is	what acts and reacts	what has law like character	[El Khachab 2013: 160]
phenomenology	normative science	metaphysics	[Peirce 1903f: CP5.121]
Originality (being regardless of ought else)	Dependence (what another compels it to be)	Combination / Mediation (modification of Firstness and Secondness by Thirdness)	[Peirce 1902b: CP 2.89] [Peirce 1905h: CP 1.295-299] [Peirce 1891a: CP 6.32]
intrapersonal	social	cultural	relations [Silver 1989: 391]
God father	Son	Hl. Ghost	[103]
God	matter	mind	[Esposito 1980: 11-13, 44-45; Mertz 1979: 158]
	compulsion and experience (ID)	rationality and law (SUPEREGO)	[104]
mind	matter	evolution	[Peirce 1891a: CP 6.32]
Hume	Locke	Leibniz	paradigms [Bertilsson 2004: 386]

[95] On other occasions he calls the Firstness of Firstness more specifically: qualitative possibility [Peirce 1903i: CP 1.533]. This is part of a 3x3 matrix.

[96] Secondness is event and not individual substance (some particular); law is irreducible to event, hence real.

[97] A law is something that can be broken but ought not to be.

[98] tendency equals "In the long run". The set possibility, actuality, tendency extends scholastic duality: potentia, actus.

[99] On another occasions he calls the Firstness of Secondness: existence [Peirce 1903i: CP 1.533]. See note 95.

[100] On another occasions he calls the Firstness of Thirdness: mentality [Peirce 1903i: CP 1.533]. See note 95.

[101] Note that this usage is exceptional, Peirce most often associates law with Thirdness.

[102] Post-1900 the assignment changed to Firstness (abduction), Secondness (deduction), Thirdness (induction) [Santaella 2005: 185]. Yet already 1878 Peirce associates sensual(abduction), volitional (Deduction), habitual (induction) [Peirce 1878d: CP 2.643]. Apparently classification varies depending on criteria.

[103] Analogies according to conventional theology, not proposed by Peirce.

[104] Peirce uses descriptions that remind one of Sigmund Freud.

Table 3: major differences of opinion

	Peirce stage I	Peirce stage II	Peirce stage IV	Peirce stage V	new trend of Peirce stage VI	modern evolutionary evidence-based hyoptheico-deductive concensus
Inferential thesis				+	-	+
thesis of purpose				+	+	+
comprehension thesis				+	+	-/+
autonomy thesis				+	+	+
Logic of discovery				+	-	-
psychology of discovery				-	+	-
logic of justification	+			-	-	+
methodological				+	-	+
noetic				-	+	-
called abduction	-	-	+	+	-	+
called retroduction	-	-	+	-	+	-
focus on historical creativity		+	+?	-	-	+
focus on psychological creativity		-		?	+	(-)
Thirdness is potent and productive		+	-/+	+	+	-
Semiotics of Thirdness				+	-	+
emphasis on Firstness				-	+	-
theistic interpretations				-	+	-
psychophysical parallelism required		+		+	+	-/+
evidence-based / product of abduction, justified by induction			+	+	+	+
product of abduction justified by abduction / Harmanian mode			+	-	+	-
Darwinian random chance variation (hypothesis)		-	+	-	-	-/+
2nd order variation (methods) - inference				-	-	+
innate guessing instinct		+	+	+	++	-
deduction from first truth	-			-	+	-
fallible			+	+	(?)	+
logical form supposed to exist though not identified				-/+	+	-
abduction provides a class of potential answers				+	+	+
abduction is not truth preserving				+	-	+
preconscious information processing / associative mind set		+	+	+	+	+
guided chance process (not recognized as such)				+	+	+
non-bijective mapping	+			+	-	+
nominalism	+	-	-	-	-	+
syllogistic necessary abduction exists / abduction reducible to necessity				+	-/+	-
Socratic pre-syllogistic interrogations				+	+	+
force majeure				+		n.a.
qua God (channeling)					+	n.a.
voluntary act		+		+	-	n.a.
uncontrollable act (traumatic experiences on instinct)			-	-	+	n.a.
believing abduction				-	+	-
abduction on probation				+	-/+	+

Figure Legends:

Figure 1:
The cyclic (screw-like) process of evidence-based hypothetico-deductive methodology. Abduction is a step in this scheme. Alternatively, the wheel can also be triggered by chance variations. A reversal of direction is not possible. The cycle is iterated many times in the mind to eliminate logical flaws of deduction and to preselect hypotheses before new material experiments are actually conducted.

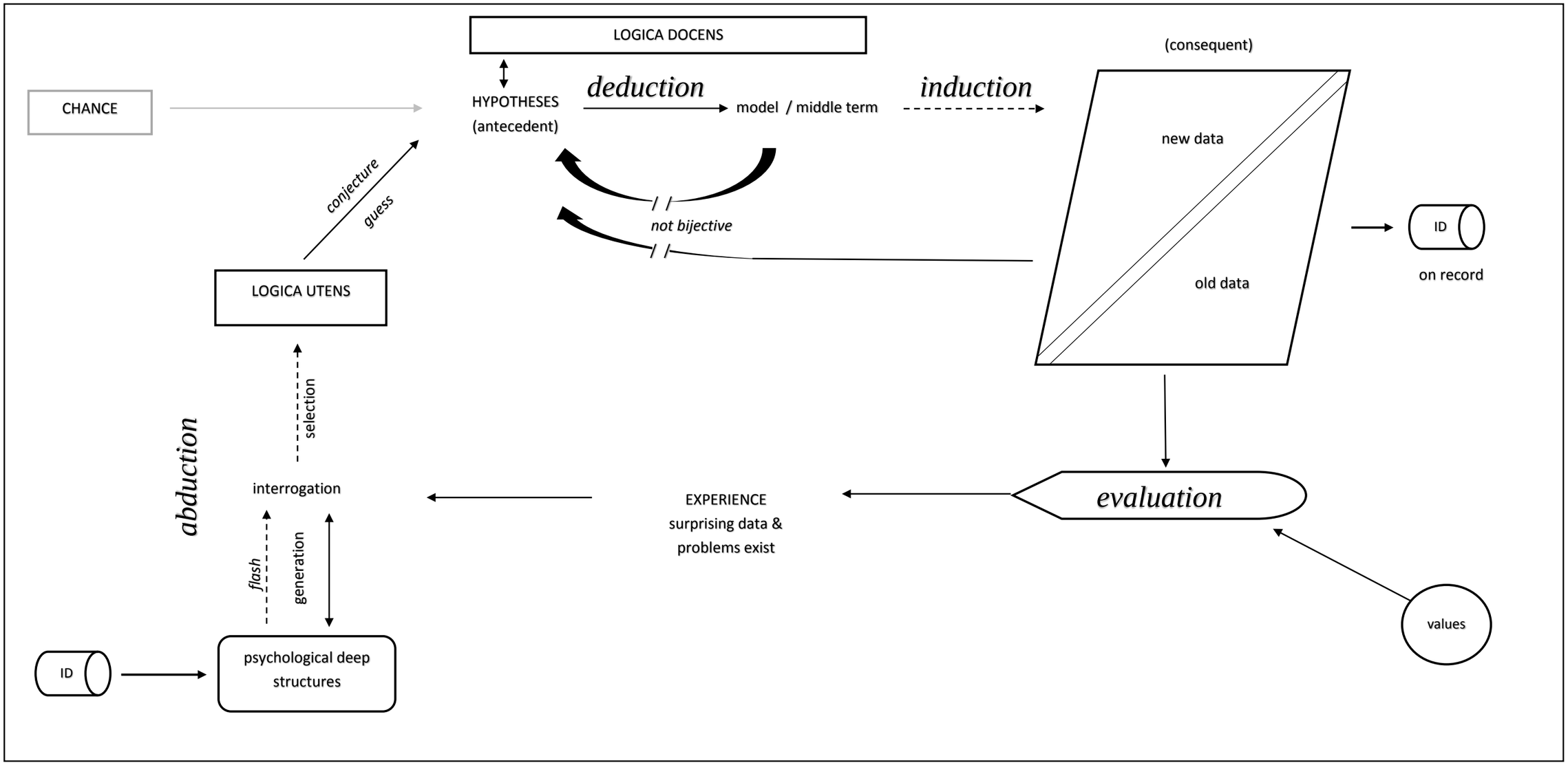
LOGICA DOCENS
CHANCE
HYPOTHESES
(antecedent)
deduction
model / middle term
induction
(consequent)
new data
old data
ID
on record
not bijective
conjecture
guess
LOGICA UTENS
selection
abduction
interrogation
flash
generation
EXPERIENCE
surprising data &
problems exist
evaluation
values
ID
psychological deep
structures

Figure 1