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IDEALIZATION, COUNTERFACTUALS, AND THE CORRESPONDENCE PRINCIPLE

1. Introduction

In a recent revision (chapter 4 of Nowakowa and Nowak 2000) of an older article Leszek Nowak (1992) has attempted to rebut Niiniluoto's 1990 critical suggestion that proponents of the Poznań idealizational approach to the sciences have committed a rather elementary logical error in the formal machinery that they advocate for use in the analysis of scientific methodology.[1] In this paper I criticize Nowak's responses to Niiniluoto's suggestion, and, subsequently, work out some of the consequences of that criticism for understanding the role that idealization plays in scientific methodology.

1.1. The Poznań Theory of Idealization

The defenders of the Poznań approach to the philosophy of science wisely attribute great significance to the operation of idealization, and they are to be commended for this as more traditional methodological analyses of science almost completely ignored the role that idealization

[1] Especially that methodology as worked out in Nowak's classic (1980).

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plays in science. Moreover, those more traditional methodological approaches that did bother to mention the role that idealization plays in the sciences wholly failed to offer anything like an adequate formal analysis of the concept of idealization and the complex role it plays in science as a whole. This is not, however, true of the Poznań school, and its methodology based on the following core insight:

> A scientific law is basically a deformation of phenomena being rather a caricature of facts than generalization of them. The deformation of fact is, however, deliberately planned. The thing is to eliminate inessential components of it. (Nowakowa and Nowak 2000, p. 110)

So the idea is that there are essential features that phenomena possess, and that science operates primarily by seeking to identify non-essential features of phenomena so that they can be explicitly ignored in formulating law statements.

The result is that science seeks to discover idealized laws purged of inessential content; laws that reveal the hidden, essential, structure of the phenomena. What scientists are supposed to be doing is to identify the essential structures from among the complex observed phenomena that are cluttered with interfering contingencies. Subsequent to the identification of hypotheses concerning these essential features of phenomena we are supposed to add the interfering contingent factors back into more concrete versions of the law statement in question in order to bring the highly idealized essentialist hypothesis into rough congruence with the actual complexity of the phenomena. When we have achieved a sufficient degree of congruence between a concrete hypothesis and the phenomena we can empirically test the concrete hypothesis directly and the idealized hypothesis indirectly.[2]

Formally, the Poznań methodology is rather simple and the fundamental concept employed by the Poznań school is that of an *idealizational statement*, where such a statement is simply a conditional with an idealizing condition in the antecedent. Consider the candidate phenomena F. The structure of F is given as a sequence

[2] Nowak notes that this methodological approach is ultimately Platonic in origin, but that its development is the result of combining Hegelian and Popperian insights (Nowakowa and Nowak 2000).

of idealization statements, **T**: $T^k, T^{k-1}, \ldots, T^1, T^0$. Each element of the set **T** is an idealization law of the following form:

T^k: if $(G(x) \;\&\; p_1(x) = 0 \;\&\; p_2(x) = 0 \;\&\; \ldots \;\&\; p_{k-1}(x) = 0)$, then $F(x) = f_k(H_1(x), \ldots, H_n(x))$.

$T^{k-1}, \ldots, T^1, T^0$ are the concretizations of T^k such that:

T^{k-1}: if $(G(x) \;\&\; p_1(x) = 0 \;\&\; p_2(x) = 0 \;\&\; \ldots \;\&\; p_{k-1}(x) = 0 \;\&\; p_k(x) \neq 0)$, then $F(x) = f_{k-1}(H_1(x), \ldots, H_n(x), p_k(x))$,

. . . .

T^i: if $(G(x) \;\&\; p_1(x) = 0 \;\&\; p_i(x) = 0 \;\&\; \ldots \;\&\; p_{i+1}(x) = 0 \;\&\; p_{k-1}(x) \neq 0 \;\&\; p_k(x) \neq 0)$, then $F(x) = f_i(H_1(x), \ldots, H_n(x), p_k(x), \ldots, p_{i+1}(x))$,

. . . .

T^1: if $(G(x) \;\&\; p_1(x) = 0 \;\&\; p_2(x) \neq 0 \;\&\; \ldots \;\&\; p_{k-1}(x) \neq 0 \;\&\; p_k(x) \neq 0)$, then $F(x) = f_1(H_1(x), \ldots, H_n(x), p_k(x), \ldots, p_2(x))$,

T^0: if $(G(x) \;\&\; p_1(x) \neq 0 \;\&\; p_2(x) \neq 0 \;\&\; \ldots \;\&\; p_{k-1}(x) \neq 0 \;\&\; p_k(x) \neq 0)$, then $F(x) = f_0(H_1(x), \ldots, H_n(x), p_k(x), \ldots, p_2(x), p_1(x))$.

$G(x)$ is supposed to be some realistic assumption (typically the specification of a type of system), $p_i(x)$ are idealizing assumptions, and the consequent $F(x) = f_0(H_1(x), \ldots, H_n(x), p_k(x), \ldots, p_2(x), p_1(x))$ specifies the crucial features of phenomenon $F(x)$ given the impact of the idealizing assumptions in place in that particular case.

Each element of **T** is then ultimately a sub-theory derived from T^0 on the basis of the correspondence principle, which typically is presented as follows:

(CP) $[T_{k+1} \;\&\; (p = 0)] \supset T_k$

This general schematic principle establishes a sort of asymptotic connection between two theories, T_{k+1} and T_k, under the assumption that were some relevant factor in T_{k+1} set to 0 we could derive T_k. In effect, the CP relates theories as precursor and successor.[3] The iterated application of CP allows for the derivation of each element of **T** by

[3] See Krajewski (1977) and Radder (1990) for an extended discussion of the interpretation of the correspondence principle.

setting more such factors to 0.[4] T^0 is then a factual statement as all interfering contingencies have been added back in, while **T** is a complex statement that includes this factual statement as well as a series of non-factual statements generated by successively applying CP to T^0. Strictly speaking, an idealizational law T^k for F is that statement that is most idealized in the sense that in such a statement all non-essential factors have been neglected. The crucial idea then is supposed to be that at least one of the concretizations of T^k will be such that it empirically testable, typically this will be true of at least T^0, or one of the theoretical statements close to T^0. The confirmational status of the various other theories in **T** is, due to the CP, supposed then to be logically parasitic on the concretization of T^k that is testable. So the confirmational status of the various other theories in **T** is wholly a matter of the formal relations that the non-testable elements of **T** bear to the testable concretization(s) in **T**, ideally the realistic theory T^0.

2. Niiniluoto's Critical Observation

While I think that there are severe unresolved methodological problems with the account of the testability of such statements in the Poznań approach and with the overt adherence to a form of essentialism on which that methodology is based, my immediate concern here is more basic and formal. When we examine the formulations of the elements of **T**: $T^k, T^{k-1}, \ldots, T^1, T^0$ it is clear that Nowak intends the conditionals therein to be interpreted as ordinary material conditionals of the "if . . . , then . . ." sort (Nowakowa and Nowak 2000). Niiniluoto (1990) pointed out that the conditionals in $T^k, T^{k-1}, \ldots, T^1$ really ought to be interpreted as counterfactual conditionals of the form "if it were the case that . . . , then it would be the case that . . . ". Thus, we would rewrite the whole sequence of idealizing claims as follows:

[4] This principle plays a prominent role in Bohr's and Poincaré's philosophies, and it has received considerable philosophical attention in Krajewski (1976; 1977), in Post (1971), and in Zahar (1983; 2001).

N^k: $(G(x)\ \&\ p_1(x) = 0\ \&\ p_2(x) = 0\ \&\ \ldots\ \&\ p_{k-1}(x) = 0\ \&\ p_k(x) = 0) \Rightarrow F(x) = f_k(H(x))$

N^{k-1}: $(G(x)\ \&\ p_1(x) = 0\ \&\ p_2(x) = 0\ \&\ \ldots\ \&\ p_{k-1}(x) = 0) \Rightarrow F(x) = f_{k-1}(H(x), p_k(x))$

. . . .

N^1: $(G(x)\ \&\ p_1(x) = 0) \Rightarrow F(x) = f_1(H(x), \ldots, H_n(x), p_k(x), \ldots, p_2(x))$

N^0: $G(x) \Rightarrow F(x) = f_0(H(x), p_k(x), \ldots, p_2(x), p_1(x))$

where '$\Rightarrow$' symbolizes the counterfactual conditional as opposed to the material conditional.

Independent of Niiniluoto's suggestion, I have advocated an approach to law statements that incorporate idealizing conditions in terms of counterfactuals, and so it should come as no surprise that I am sympathetic to Niiniluoto's observation that the conditionals in **T** *should* be interpreted as counterfactuals.[5] Recently, however, Nowak has critically responded to Niiniluoto's suggestion, and he has argued that serious semantic and epistemological problems arise if we substitute counterfactuals for the material conditionals in the expressions **T**: $T^k, T^{k-1}, \ldots, T^1, T^0$. Here I will address these responses, and, after doing so, I will suggest that interpreting the conditionals in **T** as material conditionals has some very real and very serious negative consequences for the Poznań methodology. I will also argue that interpreting the conditionals in **T** as counterfactuals has several desirable consequences, not the least of which is that doing so yields a much more realistic view of how science actually operates.

3. Nowak's Semantic Response

Nowak's first response to Niiniluoto's suggestion about the interpretation of the conditionals in **T** concerns the semantic status of **T** as a whole; specifically it involves the claim that **T** is supposed to be, at least in some sense, a factual statement. T^0 is clearly is intended to be a statement purged of idealization via the process of concretization, and so is intended to apply to the actual world. Take G_i to be the domain of

[5] See Shaffer (2000; 2001) for an extended argument for this point.

statements of the i-th degree of idealization where $\boldsymbol{G}$ is the universe of discourse as follows:

$x \in G_0$ *iff* $x \in \mathbf{G}$ & $p_1(x) \neq 0$ & $p_2(x) \neq 0$ & . . . & $p_{k-1}(x) \neq 0$ & $p_k(x) \neq 0$,

$x \in G_1$ *iff* $x \in \mathbf{G}$ & $p_1(x) = 0$ & $p_2(x) \neq 0$ & . . . & $p_{k-1}(x) \neq 0$ & $p_k(x) \neq 0$,

. . . .

$x \in G_{k-1}$ *iff* $x \in \mathbf{G}$ & $p_1(x) = 0$ & $p_2(x) \neq 0$ & . . . & $p_{k-1}(x) = 0$ & $p_k(x) \neq 0$,

$x \in G_k$ *iff* $x \in \mathbf{G}$ & $p_1(x) = 0$ & $p_2(x) = 0$ & . . . & $p_{k-1}(x) = 0$ & $p_k(x) = 0$.

G_i is the domain that T^i strictly refers to, but N^0 refers not only to G_0, but also to $G_1, \ldots, G_{k-1}, G_k$, the ideal elements of the universe $\boldsymbol{G}$, and so Nowak claims that N^0 is a "supra-factual" statement; i.e. N^0 appears to refer both to the factual domain G_0 and to the non-factual domains $G_1, \ldots, G_{k-1}, G_k$. Nowak appears to hold that T^0 is, however, supposed to be a factual statement referring only to G_0. As a result, Niiniluoto's revision would get the semantic status of T^0 wrong. Implementing this suggestion would treat T^0 as a sort of counterfactual statement and that, *ipso facto*, would be to treat T^0 as non-factual in some problematic sense.

3.1. Counterfactuals, Idealization and Reference to the Facts

To Nowak's first criticism of Niiniluoto's suggestion, there is an obvious and direct response that concerns the semantics of counterfactuals as typically understood in the sense of Lewis and Stalnaker, but, more specifically, as understood in Shaffer (2000). First, as counterfactuals are logically weaker than material conditionals, it is virtually trivial to treat T^0 as an idealizing counterfactual with no idealizing conditions in the antecedent position, i.e. as N^0. Thereby, all the conditionals in **T** can be treated as being logically of the same type, and it is not really a problem that N^0 refers to the whole of $\boldsymbol{G}$, but is true only in model G_0. In possible worlds accounts of counterfactuals, such expressions have always been understood to refer to the set of worlds, and they indicate relations of similarity between those worlds/models. In Shaffer (2000), I offered a semantic account of counterfactuals concerning models ordered in terms of simplification that corresponds nicely to the relational structure of the elements of $\boldsymbol{G}$. In brief, an idealizing counterfactual is true at some world just in case the consequent is true in close but simplified worlds where the idealizing conditions in question are met. As such, a factual claim is just an idealizing counterfactual that happens to hold in a complete world free of idealizing conditions.

So, it is simply false that Niiniluoto's suggested rendering of **T** is semantically incorrect in a way that cannot be easily dealt with; factual claims are just special cases of counterfactual claims. As it turns out, in point of fact, the semantics of the elements of **T** are much more peculiar on Nowak's rendering. This is especially true when we consider the motivation behind the operation of idealization, viz. deliberate, but false, simplification. It seems difficult to interpret idealizing conditionals as anything other than counterfactuals when it is clear that the antecedents of such expressions are known to be false, but which are hypothetically entertained on the basis of the utility of simplification.

Nevertheless, if we reject Niiniluoto's proposal and, as Nowak does, we treat all the conditionals in **T** as material conditionals, then all of $T^k, T^{k-1}, \ldots, T^1$ turn out to be trivially true as every such element of **T** has a factually false antecedent relative to G_0, and so accepting Nowak rendering of **T** would require either that we accept some revision to the model theoretic theory of truth such that statements cannot be considered in reference to various models, but only to the appropriate model that it mysteriously corresponds to, i.e. T^0 is only interpretable in G_0, T^1 only in G_1, etc., or that we can consider idealized theories in reference to various models but that all idealization statements are true at G_0 as the antecedents of all the elements of any **T** except T^0 are false at G_0. It is hard to see how one could reasonably accept either option in light of the great success of model theory in general, especially its specific application to the semantics of counterfactuals matical extension of classical mechanics.[11] The semantics of such theories that are related as precursor and successor are often massively different, and to consider only the formal relations between the equations of two theories as the CP suggests, even if there are such formal similarities between successor and predecessor theories, overlooks the differences in the meanings of those theories. Scientific theories are not merely formal systems, the development of which requires only formal syntactic operations. If science were that easy then the development of science would be no more than a trivial exercise in deductive explanation, but, sadly, this is not the case.

5.2. The Correspondence Principle and Conservative Belief Change

Historical inaccuracies of Nowak's views aside, one might still be tempted to argue that treating the conditionals in **T** as material conditionals is methodologically correct and that the CP provides justification for this. In other words, the CP is a methodological norm that ought to be obeyed in the construction of theories. Recall that the CP is typically stated formally as follows:

(CP) $[T_{k+1} \,\&\, (p = 0)] \supset T_k$.

When read as a methodological imperative, CP tells us that successor theories like T_{k+1} ought to logically entail their simpler, more idealized, predecessors like T_k. But what exactly is the motivation for accepting that we ought to obey this imperative in progressive theory development/construction? Unless we accept the CP on the basis of mere intuition, we ought to be able to offer some justification in support of the principle, especially in light of its manifest historical inaccuracy.[12]

Typical discussions of the CP say little or nothing about its justification other than alluding to the insight that we ought to try to retain as much of a previously confirmed theory as is possible when we

[11] See Friedman (2000; 2001) for a defense of this point.

[12] See Laudan (1981) for a host of historical examples that violate the CP.

propose a more sophisticated successor.[13] What this amounts to is a less than explicit appeal to version of the principle of epistemological conservatism as it applies to belief change, and the CP is, in fact, based on an ultra-conservative and wholly implausible version of the principle of epistemological conservatism as it applies to belief dynamics. I shall attempt to show that this is so in what might appear to be a rather roundabout way, and I will begin by introducing what is currently the most influential theory of belief change, the theory defended by Carlos Alchourrón, Peter Gärdenfors, and David Makinson (AGM).[14]

5.3. The AGM Theory of Belief Dynamics

The purpose of the AGM theory is to provide us with a theory of the rationality of belief *change*, and this sort of theory stands in sharp contrast to traditional theories of epistemic rationality that almost universally deal with belief *support* or *justification*; with the rationality of belief as such. So the AGM theory of belief revision ought to be viewed as a theory of the dynamics of belief states, as opposed to a theory of the static features of belief states. The essential idea behind this epistemological theory is that there are normative rules that govern how one ought to change one's beliefs in light either of acquiring new beliefs or revising beliefs that one already holds.

The AGM theory is fundamentally based on the concept of a belief state, belief set or a corpus of beliefs, K, satisfying the following minimal conditions where it is assumed that belief states are given a representation in some language **L** and where $a, b, c, \ldots$ are sentences of **L**:

(*Df* BS) A set of sentences, K, is a belief state if and only if (i) $\neg(K \vdash \bot)$, and (ii) if $K \vdash b$, then $b \in K$.

[13] See, for example, Post (1971) for an explicit defense of this sort of ultra-conservatism.

[14] Hansson (1999) offers an extensive, and considerably more detailed, introduction. (Gärdenfors 1988) is the canonical presentation of the theory, however. In what follows, I will remain faithful to both, but will also make use of elements of (Gärdenfors and Makinson 1984), (Olsson 1997), (Hansson and Olsson 1999), and (Rott 2000).

Here '$\vdash$' is a standard definition of logical consequence for **L**, and so (*Df* BS) requires that K is logically consistent and is closed under logical consequence. We can then define the content of a belief state as the set of logical consequences of K, so $\{b: K \vdash b\} =_{df} \text{Cn}(K)$. Given this basic form of epistemic representation, the AGM theory is intended to be a normative theory about how a given belief state K_i which satisfies (*Df* BS) is related to other belief states K_n satisfying (*Df* BS) relative to: (1) the addition of a new belief b to K_i, or (2) the retraction of b from K_i, where $b \in K_i$. Belief changes of the latter kind are termed *contractions* (÷), but belief changes of the former kind must be further subdivided into those that require giving up some elements of K_i and those that do not. Additions of beliefs that do not require giving up previously held beliefs are termed *expansions* (+), and those that do are termed *revisions* (∗).[15] As such, the dynamics of beliefs will then simply be the epistemically normative rules that govern rational cases of contraction, revision and expansion of belief states.

Expansion of K_i by a sentence b is defined using the notion of the content of a belief state as follows:

(*Df* +) $K + b = Cn(K \cap \{ b \})$

Moreover, revision can be defined in terms of expansion and contraction in accord with the *Levi identity* as follows:

(*Levi identity*) $K * b = (K \div \neg b) + b$

Combining the simple concept of belief state expansion defined above with some principled concept of belief state contraction then yields a complete specification of the possible dynamic belief changes relative to belief states. Contraction obviously then turns out to be the central concept of the AGM theory.

The fundamental insight behind the AGM theory is that belief changes that are contractions should be fundamentally conservative in nature; in other words, in belief changes one ought to make the minimal alterations necessary to incorporate new information and

[15] In point of fact, the AGM theory really only holds that there are two dynamical operations on belief states, as revision is defined in terms of expansion and contraction.

maintain or restore logical consistency. This fundamental assumption in the AGM theory is supposed to be justified in virtue of a principle of informational economy that holds that information is valuable and so we should retain it at all costs unless we are forced to do otherwise. Gärdenfors (1992) presents the informal version of this intuition, which he calls the principle of conservation (POC), as follows:

(POC) When changing beliefs in response to new evidence, you should continue to believe as many of the old beliefs as possible. (p. 381)

After having considered and rejected several interpretations of this basic intuition in (Alchourrón, Gärdenfors and Makinson 1985) and (Gärdenfors 1988), the POC was given formal explication in terms of the concept of partial meet contraction (PMC). Partial meet contraction is defined as follows:

(PMC) $K \div b = \cup\gamma(K \perp b)$

$K \perp b$ is inclusion-maximal set of subsets of K that do not imply b, γ is a selection function such that $\gamma(K \perp b)$ is a non-empty subset of $K \perp b$, unless b is empty. Where b is empty $\gamma(K \perp b)$ is just K. The so-called AGM postulates explicitly tell us what rules govern such changes, and they are as follows:

(*P1-Closure*)	$\text{Cn}(K \div b) = K \div b$,
(*P2-Inclusion*)	$K \div b \subseteq K$,
(*P3-Vacuity*)	If $b \notin K$, then $K \div b = K$,
(*P4-Success*)	If $b \notin \text{Cn}(\varnothing)$, then $b \notin K \div b$,
(*P5-Extensionality*)	If $b \leftrightarrow c \in \text{Cn}(\varnothing)$, then $K \div b = K \div c$,
(*P6-Recovery*)	$K \subseteq (K \div b) + b$.[16]

Various representation theorems show that ÷ on K is a PMC operation if and only if ÷ satisfies *P1-P6*.

In addition to the presentation of AGM belief dynamics based on PMC, Gärdenfors (1984, 1988), and Gärdenfors and Makinson (1984) showed that AGM belief dynamics could be interpreted in terms of the

[16] This presentation of the AGM contraction postulates follows Gärdenfors (1988) and Hansson and Olsson (2000) most closely with only minor notational variations to yield consistency of formalism.

concept of *epistemic entrenchment*, or epistemic importance, that also provides an intuitively satisfying explication of contraction in terms of the POC. The basic intuition behind this interpretation of belief change is that we ought to give up those beliefs that are least entrenched. Gärdenfors and Makinson (1988) explain,

> The epistemic entrenchment of a fact represents how important it is for problem solving or planning on the basis of the knowledge system and in this way determines the database *priority* of the fact. (p. 84)

In addition, using the older term epistemic importance, Gärdenfors (1984) explains that,

> My main thesis is then that when we have to give up some of our beliefs we retain those with greatest epistemic importance. (p. 137)

This concept of epistemic entrenchment is given a more formal presentation as follows. Given that a and b are sentences, '$a \leq b$' signifies that b is at least as entrenched as a, and '$a < b$' signifies that b is more entrenched than a where $a < b = a \leq b \;\&\; \neg b \leq a$. Epistemic entrenchment is governed by the following postulates:

(*E1-Transitivity*) If $a \leq b$ and $b \leq c$, then $a \leq c$.
(*E2-Dominance*) If $a \vdash b$, then $a \leq b$.
(*E3-Conjunctiveness*) For any a and b, $a \leq (a \;\&\; b)$ or $b \leq (a \;\&\; b)$.
(*E4-Minimality*) If *K is consistent*, then $a \notin K$ if and *only* if $a \leq b$ *for all* b.
(*E5-Maximality*) If $b \leq a$ *for all* b, then $\vdash a$.

These postulates yield a comparative ordering on K of all sentences a, b, c, . . . of K in **L**, and representation theorems show that $\leq$ on K is an EEC (*epistemic entrenchment contraction*) if and only if $\leq$ satisfies *E1-E5*.

Perhaps more interestingly, Gärdenfors (1988) proved the following central theorem of the AGM theory:

(AGMT) A contraction function $\div$ satisfies *P1-P6* if and only if $\leq$ satisfies *E1-E5*, where $b \leq a$ if and only if $b \notin K \div (a \;\&\; b)$ for all a and b in **L**.[17]

[17] Rott (1991) also includes a related proof that the concepts of epistemic entrenchment contraction and partial meet contraction are strictly equivalent

So, it should be obvious that the AGM concept of a contraction can be interpreted either in terms of the basic concept of minimal belief change (PMC) that satisfies *P1-P6* or in terms of the basic concept of epistemic entrenchment (EEC) that satisfies *E1-E5*.

In defense of the core conservative assumption of AGM, Gärdenfors essentially argues that information is an intrinsically valuable epistemic resource that should not be ceded lightly even in the face of undermining evidence.[18] Gärdenfors explicitly tells us that,

> When we change our beliefs, we want to retain as much as possible of our old beliefs; information is in general not gratuitous, and unnecessary losses of information are therefore to be avoided. (1992, p. 381)

Retention of information from theory to successor theory, then, in spite of evidential undermining, is a fundamental epistemic virtue for Gärdenfors. However, the AGM theory *does* allow for the loss of information in such belief changes in the cases of contraction and revision. So, while the AGM theory is conservative, it is not ultra-conservative in the sense that no information losses are allowed. Let us now return to our examination of the CP in light of our brief excursion into the theory of belief dynamics. What exactly does the Poznań/Nowak methodology, which is based on the CP, advise us to do when we find that a particular we theory we have entertained does not accord with the data?

Presumably, by the CP, we are supposed to propose a new theory that deductively implies the old theory when some parameter p is set equal to 0, even though we know that $p \neq 0$. We are always, at least in the case of mature sciences,[19] supposed to retain all of the precursor theory as a special case of the successor theory. In essence we are advised not to give up T_k, but rather to retain all of T_k because of its instrumental utility and its confirmational status. But, it is hard to see how this makes any sense on the Poznań/Nowak methodology. The correspondence principle makes it a normative matter that it should be

[18] Harman (1986) makes essentially the same point.

[19] See Krajewski (1977) for discussion of the relevance of the mature/immature science distinction in this context.

the case that $[T_{k+1} \,\&\, (p = 0)] \supset T_k$ for any two theories related as precursor and successor. However, the conditional in CP cannot then itself be a material conditional without rendering CP vacuously true as explicitly acknowledged by Krajewski (1976, p. 383) because, as a matter of fact, in applications of CP $p \neq 0$ in T_{k+1}.

Given the AGM theory, however, it is clear what the significance of the CP really is. The CP is a normative claim concerning the dynamic relation between successor and precursor theories, and it is manifestly ultra-conservative in a way that even the AGM theory is not. In AGM terms T_k is the revision of T_{k+1}, $T_{k+1} * p = 0$, which is equivalent to the contracting of T_{k+1} by removing $p \neq 0$, $T_{k+1} \div p \neq 0$, followed by the expansion of the resulting theory by $p = 0$. So by the Levi identity we see that if the CP is not utterly trivial it must really assert that:

(CP′) $T_k = (T_{k+1} * (p = 0)) = (T_{k+1} \div (p \neq 0)) + (p = 0)$.[20]

However, if this is true, then it may well turn out, even given the AGM version of the principle of epistemological conservatism, that T_k is not a special case of T_{k+1}, as the process of AGM revision may require significant mutilation of T_k in order to arrive at T_{k+1}.

The Poznań/Nowak methodology appears to be even more conservative than the AGM theorist's conservatism in legislating that T_k should be a special case of T_{k+1}, and defenders of the CP are thus faced with an undesirable dilemma: either they must accept that the CP, and not the CP′, is the correct rendering of their methodological principle and that the CP is vacuous, or they must offer some justification for the ultra-conservative, normative, restriction of the operation of belief revision to cases where T_k is a special case of T_{k+1}. The first horn of this dilemma is obviously not acceptable and so Nowak and the other defenders of the Poznań methodology must seemingly opt for the second horn. But is it plausible to believe that a principle stronger than the AGM POC, as formalized in PMC and EEC, ought to be imposed on changes of belief?

Consider the POC again:

[20] Equivalently, the CP can be understood as claiming that T_{k+1} is the revision of T_k by $p \neq 0$, which involves the contraction of T_k by $p = 0$ followed by expansion with $p \neq 0$.

(POC) When changing beliefs in response to new evidence, you should continue to believe as many of the old beliefs as possible. (Gärdenfors 1992, p. 381)

This principle is itself unjustified in the AGM framework and taken only to be an intuitively plausible assumption by the AGM theorists. Moreover, the force of the intuition grounding this assumption is based on the rather imprecise principle of informational economy noted above. Nevertheless, it is no more than an assumption and if the weak version of the POC has no serious justification, then, *a forteriori*, neither does the principle defended by the Poznań school that asserts that we ought always to retain all old theoretical beliefs as special cases of our new theoretical beliefs. This is not to say, of course, that it is impossible to find such a justification. However, given that the history of science is characterized by belief revisions that utterly fail to even remotely conform to the POC, let alone any stronger principle, we ought to be at least a little suspicious that any such justification are forthcoming. The sheer implausibility of the conservatism of the principle defended by Nowak and the Poznań school seems obvious when one notes that, in entrenchment terms, they are asserting that all information is of precisely the same maximal value so, other things equal, no information should be lost in theory change. This seems simply to be false, as much information seems to be of little or no value whatsoever. Gärdenfors is acutely aware of this epistemic fact and he explains that,

> Not all sentences that are believed to be true are of equal value for planning or problem-solving purposes, but certain pieces of knowledge about the world are more important than others when planning future actions, conducting science, or reasoning in general. (1992, p. 387)

While this seems true, Gärdenfors is also candid in that he tells us that there is no accepted, or even well understood, account of the relative informational value of beliefs (1988, pp. 91-94). As a result, there is no real justification available for the AGM versions of epistemological conservatism, let alone for the ultra-conservative version defended by Nowak and the Poznań school, as there is nothing like a coherent understanding of the principle of informational economy on which it is supposed to be based to warrant our accepting this principle.

6. Conclusion

So what can we conclude from this examination of the views on idealization defended by Nowak and the Poznań school? The lessons are, I think, twofold. First, analytic philosophy of science owes a great debt to Leszek Nowak for taking the concept of idealization seriously and for offering up one of the most thorough and technical analyses of that concept. Second, that there are formidable logical problems with that methodology concerning the nature and semantics of conditionals it employs, with the correspondence principle on which that methodology is based, and with the accuracy of that methodology as a coherent reconstruction of the history of science. Nevertheless, as the topic of idealization in the sciences is one of supreme importance these problems should be viewed as opportunities for deeper investigation.

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SYNTHETIC AND NEUTRALISTIC THEORY OF EVOLUTION: THE ISSUE OF METHODOLOGICAL CORRELATIONS

The issue of the article has already been discussed in the Polish literature. It was covered, in an exquisite manner, by Prof. Jerzy Szweykowski (1987). The article can be characterized as a model of the analytical view of applying the neutralistic theory to the explication of the processes of molecular evolution Szweykowski's source materials and account were also used by W. Makałowski (1991) when he reconstructed the main theorems of Kimura's theory and sought to show the scope of its application to the empirical research. I point to the works selected, as I harbor no doubts that the biological aspects of the issue presented in my article have been dealt with in a model manner from the theoretical point of view.

The task of the present article is to confront the two theories and to show the methodological and theoretical consequences of such a comparison. One may ask what kind of approach that is. I believe that if one keeps certain independence of the reigning assertions (which can be achieved by means of certain simplifications without which science cannot function), then one is capable of presenting such aspects of the

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