Veridical Idealizations

“I don’t believe in hypothetical situations, Mr. Donaghy. That’s like lying to your brain.”

- Kenneth Parcell (30 Rock, The “Oprah” Episode)

Is idealization a counterexample to scientific realism? The realist says scientists aim at a true description of reality. Many realists go on to say we are justified in believing in the existence of the laws and entities postulated by scientists because that provides the best explanation of the accuracy of their predictions. W. V. Quine frames this as commitment rather than entitlement; ontological honesty compels us to accept any entity that is indispensable to our best theory. If that means accepting the existence of sets or other abstract entities, then so be it. Thus, Quine, a former nominalist, soldiers on from scientific realism to mathematical realism.

Idealization appears to break up this forced march from science to metaphysics. Scientists wittingly employ false assumptions to explain and predict. Falsification is counter-productive in the pursuit of truth. So scientific realism appears to imply that idealization would be worse than ineffective. Yet scientists do idealize.

The instrumentalist says the scientist merely aims at the prediction and control of phenomena. For instance, Milton Friedman denies that the falsehood of assumptions is relevant: “theory is to be judged by its predictive power for the class of phenomena which it is intended to explain” (1953, 8). Even false predictions are tolerable – as long as they occur outside the intended range of the theory. Given that scientists are indifferent to the truth and often believe idealizations will promote prediction and control, the instrumentalist predicts that the scientists will idealize.

Consequently, idealization looks like a crucial experiment for philosophy of science. The instrumentalist predicts that scientists idealize. The realist predicts they do not. Since scientists idealize, the instrumentalist prevails.

The instrumentalist deserves extra credit if his prediction is correct. For his prediction is bold and counter-intuitive. If explanation implies understanding and understanding implies truth, idealizations should never be explanatory. Yet scientists do sate their curiosity with idealizations.

Catherine Elgin infers that understanding is not factive. She feels no need to substitute truths that could serve as the objects of understanding. She analyzes idealizations directly as felicitous falsehoods. Elgin struggles to reconcile this liberality with the practice of debunking “explanations” by exposing the falsehood of their premises (just stroll through the graveyard of explanations founded on phlogiston, ether, and Vulcan).
I shall emulate Elgin’s directness with the help of the indirect propositional attitude of supposition – the stance adopted in conditional proof and *reductio ad absurdum*. Since suppositions clearly contribute to understanding within mathematics, we acquire an “off the shelf” account of why *asserted* falsehoods are explanatorily malignant but *supposed* falsehoods are benign.

Examples of veridical idealization show that idealization does not reveal any scientific role for deliberately false *assertion*. They are intended as vivid checks on the analogy between idealization and lying.

**Nature of Supposition**

Scientific realism is compatible with classical logic. Classical logic has inference patterns in which a premise is temporarily assumed for the sake of argument:

<table>
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<tr>
<th>Conditional Proof</th>
<th>Reductio Ad Absurdum</th>
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<td>1. Suppose P</td>
<td>1. Suppose P</td>
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<td>2. From P derive Q.</td>
<td>2. From P derive some contradiction.</td>
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<td>3. Conclude that if P then Q.</td>
<td>3. Conclude not-P.</td>
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In contrast to an assertoric proof, only the conclusion is asserted in a suppositional proof.

Proofs commonly incorporate a mixture of asserted premises and suppositional premises. Logicians segregate each suppositional branch by indentation. The indented statements are inactivated; they cannot license un-indented steps in the derivation.

Thanks to the salience of indentation, a student in the back of the lecture hall can spot a suppositional section of a proof even if he is too far away to discern the fine print. The ensuing detachment from the truth can be understood even if the student’s autism makes him incapable of make-believe (Stanley 2001). Supposition requires no departure from literality. An autistic student who is baffled by idioms, proverbs and metaphor may be fluent in the idealizations of Euclid, Archimedes and Isaac Newton. Indeed, many autistic students excel in mathematics, physics, and engineering (Baron-Cohen, et. al. 2007). It is also striking that their empathic peers are often poor at supposition. Pragmatic proficiency pollutes suppositional reasoning with conversational implicatures only appropriate to *testimony*.

Effective supposition draws on systematicity rather than empathy. The empathic are self-conscious about their inferential promiscuity. They compensate by adopting the perspective of the rigidly literal thinker (the dual of the autistic strategy of “hacking into” the social world by
adopting strategies such as behavioral mirroring, memorizing social scripts and applying maxims of politeness like algorithms).

The propositional attitudes underlying the speech acts of assertion and supposition differ dramatically. Belief is involuntary. Just as a compass needle is built to point north, beliefs are magnetically attracted to truth.

The needle of supposition is neutral. The freedom with which we suppose makes us slavishly suggestible at a superficial level. You cannot resist my command ‘Suppose there is a largest prime number’. The only defiance you can muster is a refusal to invest inferential energy. Even this passive resistance requires techniques of self-distraction that are apt to be swamped by automatic mental processes. Natural selection has favored parents who actively deduce threats to their naïve offspring – even though they often find this preoccupation distressing (and eventually annoying to their maturing children).

Perhaps delusion is more a matter of runaway supposition than runaway belief. The delusion is a “given” that requires no evidence to initiate and cannot be disconfirmed by evidence – yet it is capable of incorporating new evidence (thanks to reasoning that involves a mixture of assertion and supposition). Suppositions are incorrigible – except for the failures of expression known as “slips of the tongue”. Tellingly, the deluded will acquiesce when they have misarticulated their delusion.

The involuntariness of beliefs explains why beliefs do not vary with context. You cannot believe there is a largest prime number for one purpose and believe there is no largest prime for another purpose.

Belief is also sensitive to peer disagreement. News that we disagree over a calculation demonstrates that at least one of us mishandled the evidence. If we believe that there is no difference in our reliability, then we both lose belief in our respective conclusions. David Christensen (2007) argues that philosophers should have a parallel lose of confidence in their philosophical opinions (because there is almost always a peer who disagrees). However, if philosophers are merely varying in what they suppose, then they ought to be undeterred by diversity.

Supposition is permissive. Belief is not (White 2005). When neighboring logic students discover that they have made different suppositions in a proof, the news has the same significance as the discovery that they walked different paths from the same dormitory to reach the classroom. The variation does not entail any error. There is only pressure to make the same supposition when the reasoners are engaged in a joint project that demands coordination. The strategies for eliciting this convergence contrast with the strategies for eliciting agreement. For instance, I can appeal to
the consequences of the supposition to justify making it: “There is extra credit for those who use conditional proof” or “The instructor will think you lazy if you resort to *reductio ad absurdum*”. But I cannot persuade you to *believe* there is a largest prime number with “Your mother will be pleased if you believe there is a largest prime”. Nor is belief even sensitive to inducement of many true beliefs: “If you adopt a Protestant work ethic, this belief will make you work hard as a scientist and discover many new truths”. Belief has the same myopia as natural selection, never having the foresight to take one step back to take two steps forward.

Supposition is an arena for style, taste and panache. For there is genuine choice. Whereas belief is like digestion, supposition is like cooking.

Beliefs are a little grandiose, aspiring to an ideal of agglomeration (enshrined in Jaakko Hintikka’s “doxastic logic” as the principle that belief collect over conjunction: from \[Bp \land Bq\] infer \(B[p \land q]\)). Beliefs *ought* to fit together in a coherent whole. This synoptic ambition is in tension with the fact that belief must be sensitive to the risk of error. Since small chances of error commonly add up to a big chance of error, a conjunction of beliefs does not entail that there is a belief in that conjunction. Thus the author of a book has grounds to apologize in the preface for the errors that are bound to be in the text.

No such humility is in order for the author of a conditional proof. Suppositions are non-committal, so no risk is taken. This is a different type of safety than offered by stipulated truth. A mother can be confident in the names of her children because her saying so, makes it so. Confidence is not an issue for the supposer because he is not taking a stand on the supposition’s truth-value.

Suppositions agglomerate in the sense that supposing \(P\) and then making the subordinate supposition \(Q\) in the same is equivalent to supposing \(P\) and \(Q\). The analogous rule of inference for conditionals is exportation: ‘If \(P\), then if \(Q\), then \(R\)’ is equivalent to ‘If \(P\) and \(Q\), then \(R\)’. However, suppositions do not agglomerate when made in parallel. If I suppose the \(P\) to deduce \(R\) and then suppose not-\(P\) to deduce \(S\), then I have not thereby supposed \(P\) & -\(P\).

These points about agglomeration show that supposition cannot be reduced to belief in conditionals -- contrary to Peter Langland-Hassan (forthcoming) Beliefs in conditionals fail to agglomerate because of the standard concern about accumulated uncertainties. Suppositions agglomerate unreservedly with their subordinate suppositions and *sharply* resist agglomeration with their parallel suppositions. (The resistance is not based on a gradual accumulation of risk.)

We attribute belief only when we wish to attribute potential reasoning. This means a capacity for conditional proof and *reductio ad absurdum*. The reasoner wishes to make valid inferences. So we need to picture the reasoner as being able to pose a suppositional question:
“Suppose the premises are true; does the conclusion follow?” The attribution of belief and supposition comes as an inseparable package. Given this unbreakable bond, there is no parsimonious advantage in getting by with only belief. (As Donald Davidson notes in our difficulties avoiding over-sophistication of animal beliefs, content tends to be holistic; attributing a little content pressures attribution of ancillary content. A weaker holism extends to propositional attitudes; attributing one attitude pressures the attribution of ancillary attitudes.)

I may suppose a hypothesis for one purpose and suppose its negation for another purpose – perhaps just to demonstrate the consequence is independent of the hypothesis. In a conditional proof, you can assume as many premises as you please and conjoin them at your discretion. There is no need to be thrifty because the result does not depend on the truth of the suppositions. The only pressure to economize comes from the three Gricean maxims that apply to supposition: only suppose what is germane (Relevance), only as much as needed to support the conclusion (Quantity), and in an orderly way (Manner).

The aim of supposition is success, not truth (although there is an indirect concern for the truth of its conclusion). The attitude of supposition is under the reasoner’s control. Although unfettered by truth, supposition is still corrigible. There can be a slip in which one fails to suppose what one intended to suppose. The physicist Murray Gell-Mann (1994, 263) credits a discovery about strange particle decay to a slip of the tongue. He was explaining why his earlier hypothesis failed. Gell-Mann intended to say “Suppose I = 5/2” but instead he said “Suppose I = 1”. This should have been a non-starter because the only admissible values for baryons were assumed to be integral values of a half such as 1/2, 3/2, 5/2 and so on. But having blurted out ‘I = 1’ Gell-Mann recognized its correctness.

David Hume correctly denied that there is an ethics of belief. Belief is involuntary. One cannot choose what to believe.

There is an ethics of supposition. One can choose to make a denigrating supposition. The nineteenth century opponent of natural selection, Fleming Jenkins, imagines a white sailor shipwrecked on an island of blacks. Strength of numbers will prevent island’s race from turning white -- or even yellow. Jenkins’ mental act demeans Asians and especially Africans.

Richard Feynman was once picketed by feminists for a hypothetical example involving a female motorist who dissect a police officer’s definition of speed.

“Why did it have to be a woman driver?” they said. “You are implying that all women are bad drivers.”
“But the woman makes the cop look bad,” I said. “Why aren’t you concerned about the cop?”

“That’s what you expect from cops!” one of the protesters said. “They’re all pigs!”

“But you should be concerned,” I said. “I forgot to say in the story that the cop was a woman!” (Feynman 1988, 75)

The content of a supposition can be supplemented at will. The content of belief is fixed by the evidence.

Since supposition can be turned on and off at will, it is temporary and episodic. The liberty is partly due to its indifference to truth. Supposition is not directly aimed at truth (as dramatized by reductio ad absurdum). Supposition is absolute rather than a matter of degree. Consequently, supposition does collect over conjunction. There is no preface paradox for supposition.

The speech act of supposition is governed by all of Grice’s maxims of conversation – except the maxim of quality (say only what is true). Evidence that the supposer is generating conversational implicatures is evident from the expectations built up for frustration by jokes: “Suppose you were an idiot. And suppose you were a member of Congress. But I repeat myself.” (from Mark Twain’s A Biography).

 Unlike fantasy, a supposition is intended to coerce a belief. Suppositions support assertions, never the reverse. For suppositions need no evidential support. A supposition cannot be criticized for being false, improbable, or unprovable.

 Nor can suppositions be criticized for being jointly inconsistent. A mathematician can give one conditional proof based on the supposition that the solution is an even number and another conditional proof based on the supposition that the solution is an odd number. The arguments are co-propoundable. Suppositional proofs are pluralistic. When a Bayesian wants to demonstrate how updating generates consensus, he will arbitrarily stipulate a variety of initial probabilities just to illustrate how divergent prior probabilities must converge on the same posterior probability.

 New evidence that an assertion is true always provides further reason to assert it. New evidence that a supposition is true does not always provide further reason to suppose it. Indeed, news of the truth of Fermat’s theorem provided decisive reason for some mathematicians to abandon their attempt to disprove the theorem by reductio ad absurdums.

 Our interest in suppositional proof is explained by our general interest in conditionals and impossibility theorems. Suppositional proof is topic-neutral. If we model idealization as
figuring as a premise of a purely assertoric proof, then the idealization will take on the air of a lie or fiction or metaphor or something even less well understood. Happily, idealization is an instance of something logicians understand well: the supposition that initiates conditional proof and *reductio ad absurdum*.

The versatility of suppositional proof explains why idealizations take such heterogeneous forms. Michael Weisberg is too pessimistic when he says that the disparate motives for idealizations splinters them in such a way that some classic, epistemic questions about idealizations will not have unitary answers. We cannot expect a single answer to questions such as: What exactly constitutes idealization? Is idealization compatible with realism? Are idealization and abstraction distinct? Should theorists work to eliminate idealizations as science progresses? Are there rules governing the rational use of idealization, or should a theorist’s intuition alone guide the process? (2007, 639)

Those who distinguish robustly between supposition and assertion can be lumpers rather than splitters, answering all the questions Weisberg gives up on.

Here are my answers: Idealization is constituted by supposition. Only simplified suppositions count as idealizations. The filters are psychological and methodological. Idealizers seek tractability, memorability, and transmissibility (rather like myth makers). Negatively, they streamline to avoid the weaknesses of human beings. But they also play to strengths such as the “peak-shift” effect. This is the phenomenon that makes caricatures more effective for face recognition than realistic photographs (Rhodes 1997). Since logicians supply precise validity conditions for conditional proof and *reductio ad absurdum*, there are rules governing the rational use of idealization. In addition to explaining how idealizations get quarantined from assertoric reasoning, the rules generate surprising predictions – such as the existence of sub-idealizations corresponding to subordinate suppositions. Suppositions are topic-neutral so there is no restriction to abstractions. Since suppositional reasoning is perfectly satisfactory even by mathematical standards, there is no general need to eliminate idealization. For instance, mathematicians have no reductive program against suppositional proof. However, not all proofs are explanatory. For instance, computers tend to be addicted to *reductio ad absurdum* because it plays to their strength -- brute force. Their rambling reductios do not generate the orgasmic “Aha!” of understanding. So there is preference for direct proof – which have a stronger tendency to satisfy Gricean maxims of relevance and manner. But as with all proofs, explanation is a supererogatory service.
An idealization that succeeds as proof may fail as explanation. This distinction accounts for our ambivalence toward minimal idealizations. These strip down the causal story to just its most potent causal factors. They tend to be misleading as explanations because of the implicatures that all of the factors are represented. The economics sophomore concludes that all people are selfish because the rational pursuit of self-interest explains the bulk of social science effects.

Misconceiving Idealization as Attenuated Assertion

Weisberg characterizes idealization as “the intentional introduction of distortion into scientific theories” (2007, 639). Just as the falsehood of a lie is no accident, the falsehood of an idealization is intended. It is not a mistake or a misstatement. So says Weisberg.

In How the Laws of Physics Lie, Nancy Cartwright characterizes the idealizations as falsehoods that help make laws applicable. She takes this much as common ground with realists.

Historically, Cartwright’s claim of common ground is all too correct. Although realists acknowledge the counterfactual nature of idealizations, they tend to comply with the assumption that idealization involves assertion – albeit of some attenuated species. Ernan McMullin (1985) treats idealizations as, in effect, temporary assertions of falsehoods. After Galileo simplifies a situation to untangle various causal influences, he successively reintroduces complexities, returning to a more and more realistic situation. For instance, to attain a more accurate description of the cannonball’s descent the scientist can begin with its rate of descent in a vacuum and then consider its rates in thicker and thicker media. The lies get closer and closer to the truth. Ronald Laymon extends this theme to computer science and engineering.

McMullin’s analysis appeals to the ideal of verisimilitude. At first blush, this ideal is directly relevant because assertions aim at truth. It is self-defeating to say ‘p is false but I assert that p’. However, it is also self-defeating to say ‘p is merely close to the truth but I assert p’. So the hitch is that assertion is perfectionist; mere proximity to the truth is not close enough.

Converting to Karl Popper’s Conjectures and Refutations will not provide relief. Guessing is also perfectionist because it also aims at truth. It is self-defeating to say, “All prime numbers are odd” is merely close to the truth but I guess that all prime numbers are odd”.

Verisimilitude does permit us to rank some false assertions over other false assertions. The smaller the deviation from the truth, the easier a correction that will yield full truth. Smaller deviations from the truth tend to generate less severe consequences than larger deviations. (Thus a lie that is closer to truth is preferred over a lie that is far from the truth.) Verisimilitude is especially instructive when there is a feedback mechanism that allows us to “home in”.
However, this rationale for verisimilitude does not directly extend to suppositions. A false supposition is not an error. For suppositions do not aim at truth. There is no self-defeat in a mathematician saying “‘There is no largest prime’ is true but I hereby suppose that there is a largest prime’”.

Is there an indirect connection between verisimilitude and supposition? Suppositions are made in the service of a conclusion and the conclusion is asserted. However, the conclusion of a *reductio* purports to be a necessary truth while the conclusion of a conditional proof is a conditional. The verisimilarites of such statements are difficult to measure.

And why bother measuring? A supposition with low verisimilitude (or none at all in the case of a *reductio ad absurdum*) can support a conclusion with high verisimilitude. For some purposes (such as preparing for a future *modus ponens* inference), one might prefer suppositions that have a high degree of verisimilitude. But this would not yield a general account of suppositional proof.

Instrumentalists are unimpressed by the fact that realists can rummage through the history of science and find many instances of “Galilean idealization”. Instrumentalists correctly object to McMullin that often there is no “homing in” on the truth. For instance, in population biology, theories are confirmed by the fact that the leading models converge on their predictions for purely hypothetical data.

If these models, despite their different assumptions, lead to similar results, we have what we can call a robust theorem that is relatively free of the details of the model. Hence, our truth is the intersection of independent lies. (Levins, 1966, 20)

As a champion of robustness analysis, Michael Weisberg (2006) should readily agree that conditional proof can yield results that do not owe their interest merely as potential premises of an assertoric proof. A theory can be confirmed or disconfirmed by virtue of which conditionals it entails. Conditional proof has epistemic autonomy. Its results have intrinsic epistemic value in addition to the extrinsic epistemic value it has a premise in assertoric proofs.

Theoreticians can be just as minimal. Ernst Ising modeled atoms and molecules as points along a line that could be in one of two states. He wanted a simple method of studying the ferromagnetic properties of metals. Ising’s strategy was to ignore all but the most predicatively potent factors. Since the goal is simplicity rather than fidelity, it would be counter-productive to add factors in the pursuit of verisimilitude.
Idealizers commonly introduce falsehoods that they have no plans to “correct”. With a disturbing resemblance to speculative philosophers, physicists assert hypotheticals whose antecedents are impossible such as Newton’s first law (which requires an undisturbed object – impossible given Newton’s other law of universal gravitation). Or consider the resilience of Archimedes’ law of the lever, “Magnitudes are in equilibrium at distances reciprocally proportional to their weights”. Einstein’s speed limit on causal processes rules out perfectly rigid objects. But Archimedes’ laws survived this impossibility proof.

Some idealizations improve empirical adequacy beyond what any realistic interpretation affords. Scientists persist in appealing to centrifugal force and the Coriolos force when their fictional nature is common knowledge.

In addition to providing a permanent home for forces that do not exist, physicists deliberately cultivate diversity in their idealizations. When an experimenter proves a result, he tries to replicate it with very different experimental apparatus. This variety shows that result is not an artifact of one approach. Levins describes three evolutionary models that all imply that “in an uncertain environment species will evolve broad niches and tend toward polymorphism.”

But physicists go beyond the pursuit of variety and on to mutual inconsistent models – which are then simultaneously applied (Morrison 2000). The liquid drop model of the atomic nucleus is based on the analogy with a (charged) fluid drop. The shell model derives the nucleus’ properties from those of the constituent protons and neutrons. The underlying strategy cannot be that the point of departure is close to the truth.

Levins goes further, boldly preferring that the sources apply conflicting approaches:

The multiplicity of models is imposed by the contradictory demands of a complex, heterogeneous nature and a mind that can only cope with a few variables at time: by the contradictory desiderate of generality, realism, and precision: by the need to understand and also to control: even by the opposing esthetic standards which emphasize the stark simplicity and power of a general theorem as gains the richness and the diversity of living nature. These conflicts are irreconcilable. Therefore, the alternative approaches even of contending schools are part of larger mixed strategy. But the conflict is about method, not nature, for the individual models which, while they are essential for understanding reality, should not be confused with that reality itself (1966, 26).

Levins’ approach suggests that diversity should be artificially cultivated when it does not arise naturally.
Levins’ rationale for multiple modeling is also reminiscent of John Stuart Mill’s case for free speech. Instead of preventing people from lying, it is better that the dark corners of ignorance and deception be corrected by the light of many further opinions.

We lie more when under communication pressure (confidentiality constraints, insufficient time, feeble listeners). Competing theoretical desiderata (generality, accuracy, simplicity, specificity, and so on) imposes pressure on the scientist. It is impossible to satisfy this constituency. Any particular model will be forced to make trade-offs. And there is often no uniquely best trade-off. So these desiderata are best satisfied by having many models making different trade-offs.

The Lying Metaphor

Picasso’s “Art is the lie that tells the truth” is less shocking than Nancy Cartwright’s title How the Laws of Physics Lie. Scientists aim at truth and to get there by impartial, verifiable means. If we neglect the distinction between asserting and supposing, the lying metaphor will look alarmingly apt. Idealization will resemble a noble lie—a falsehood told for the sake of a higher end.

But then how to avoid the taint of the lie? We have seen how McMullin excuses idealization as a temporary false assertion that will be subsequently ameliorated by falsehoods that are closer and closer to the truth. Another excuse for a lie is that it was a forced assertion. Umpires must be decisive to keep the game flowing. They cannot say, “I do not know”. This demand for speed is somewhat weaker in litigation. But decisiveness is still at a premium. This forces judges to make assertions beyond their evidence. The next step on the continuum of forced assertion is engineering. The engineer is forced to attest to the safety and effectiveness of the product and the process of construction. Least pressured, but not entirely unpressured, come the theorists. They need to complete their reasoning in a timely fashion and so must skip details.

Theorists can also be pressured by space limitations. Consider the cartographer’s slogan “All maps lie”. There is too much going on to be accurately represented. So the cartographer is forced to offer a distorted picture. Similarly, an idealizer is forced to radically simplify. Like the cartographer, he should compensate by offering a diversified portfolio of idealizations.

In Scientific Perspectivism, Ronald Giere interprets idealizers as making relativized assertions. Instead of asserting p they assert from the vantage point of a model. Models are like obligatory lenses (or the bacteriologist’s staining of specimens – or color vision itself). One can never gaze at reality directly. Absolute assertion is a myth. Frederick Nietzsche presupposes that all assertion is absolute assertion. He concludes that scientists incessantly lie. Giere avoids Nietzsche’s literal attribution of lying by perspectivism – while agreeing that interests and
convention affect scientific descriptions. Perspectivalists overlooks the fact that supposition are discharged to support assertions. That’s how suppositional reasoning differs from fantasy.

Michael Strevens regards idealizations as indirect assertions – hyperbole in which the truth is conveyed by falsehood. Mercury astronaut Gus Grissom was criticized for carrying two rolls of Mercury Dimes into space. Someone might reply, “Two rolls of dimes do not weigh anything!” This would be an indirect assertion that the weight of the dimes was negligible. To idealize away X (gravity, friction, air resistance, electrical influences), is to indirectly deny that X is significant for the purpose at hand. Idealizations are like pointers about politeness; they tell us what ought to be ignored. We can ignore small inaccuracies (because they will not accumulate). We can ignore random errors (because they cancel out). And we can ignore some biases (because the direction of the bias is against the conclusion).

However, Strevens is neglecting the distinction between what a modeler assumes and what his model actually entails. Consider one of Strevens’ own illustrations:

. . . in explaining the appearance of a rainbow, it is assumed that raindrops are perfect spheres . . . In fact, local forces will tend to deform the drops slightly. By assuming zero deformation, the model asserts that deformations within the normal range make no difference to the existence of rainbows. (Strevens 2008, 322)

The modeler may be assuming that but his model implies that a perfect sphere would trap the light in an internal reflection. Some deformation is essential to allow light to exit the drop.

Too much smoothing maroons us on a frictionless plane. We need a little grit to proceed. For instance, game theory inadvertently exaggerates the difficulties of coordination problems by idealizing away the little deviations from perfect symmetry that help create salient options. In cosmology, a little asymmetry between matter and anti-matter is needed to answer ‘Why is there now something rather than nothing?’.

A direct reading of “assuming zero deformations” and other idealizations is needed to explain how they can backfire. If the idealizers were indirectly asserting that the size of the deformation is insignificant, then an over-idealization objection would be based on misinterpretations of the indirect speech act (as when pragmatically impaired individuals overlook sarcasm and earnestly object “The opposite is true!”).

Finally, there are theories that treat idealizations as pretend assertions (Toon 2010). An idealization is akin to a story. On David Lewis’ account of fiction, the storyteller must pretend to meet the requirements of testimony.
The author purports to be telling the truth about matters he has somehow come to know about, though how he as found about them is left unsaid. That is why there is a pragmatic paradox akin to contradiction in a third person narrative that ends `... and so none were left to tell the tale’. (1983, 266)

The narrator feigns compliance with Grice’s maxim of quality.

Kendall Walton emphasizes the epistemic role of props. If any stump counts as a bear, then the discovery of a new stump constitutes the discovery of a new bear. Thus empirical discoveries can be incorporated into a game of make-believe. Scientists do resemble children when manipulating scale models.

However, supposition differs from pretend assertion in that the supposer does not pretend to meet the epistemological obligations of assertion. Suppose that the strong force were 2% stronger. Then there would be no stable hydrogen and therefore no stars and therefore none of the chemical diversity essential to life. It would be self-defeating for the physicist to feign knowledge that this supposition is true.

A second difference is that supposition is a component of a suppositional proof. A pretend assertion does not figure in this argument form.

The epistemology of supposition is forward-looking. The supposer must be ready to answer `What will this prove?”. The epistemology of assertion is backward looking. The asserter must be able cite the basis for his claim (in readiness for the challenge `How do you know?’).

The Myth of Falsehood

The popularity of `Idealizations must be false’ is partly manifested by how often the lying metaphor is echoed. The principle figures centrally in attempts to define idealization and to differentiate idealization from other phenomena.

There is some variation in whether the falsehood is conceived as known, actual, or merely asserted. Martin R. Jones writes, “My starting point, then, is the suggestion that we should take idealization to require the assertion of a falsehood, and take abstraction to involve the omission of a truth.” (2005, 175) Notice how Jones’ distinction between idealization and abstraction mirrors the distinction between lying and misleading (in which relevant truth is omitted). The misleader deflects his conversational wrongdoing from a violation of maxim quality (“Say what is true”) to a violation of manner (“Say what is relevant”).
Andreas Huttemann uses known falsehood to distinguish idealizations from hypotheses: “A hypothesis may turn out to be wrong: an idealization is known to be wrong (if it concerns theoretical assumptions)” (2002, 178). What about cases in which the physicist is agnostic about the truth-value of his assumption? Huttemann categorizes these cases as neither idealization nor hypotheses. Consider textbook authors discussing the assumption of a quadratic potential

[it] is not made out of strong conviction in its general validity, but on grounds of analytical necessity. It leads to a simple theory – the harmonic approximation – from which precise quantitative results can be extracted. (Ashcroft and Mermin 1976, 422)

Huttemann dutifully applies his falsehood requirement: “The above-mentioned procedure is – strictly speaking – not an idealization because it is not known to be false. It is, however, not a clear case of an hypothesis either, since it is not invoked because it is assumed to be true.” (Huttemann 2002, 183)

The belief that idealizations must be false (or known to be false or believed to be false or asserted to be false) is related to the myth that the antecedents of subjunctive conditionals (“counterfactuals”) must be false. Specialists on counterfactuals reject this. For instance, under David Lewis’ possible worlds analysis of counterfactuals, a counterfactual is true if its consequent is true in the nearest possible world in which the antecedent is true. Since modal proximity is measured in terms of similarity, and anything is perfectly similar to itself, a counterfactual with a true antecedent is true if its consequent is true (Lewis 1973, 36-38).

Absence of representation as truth differs from representation of an absence of truth. The idealizer has not switched from asserting truths to asserting falsehoods. He has switched from asserting to supposing.

One heuristic for relevance is actuality. This encourages fallacious assimilation of suppositions to digressions. Since scientists are on a hair trigger to emphasize actuality (especially when drawing contrasts with religion, metaphysics, and morality), suppositions can seem out of place in scientific discourse. They tend to assume that the only point of asserting a conditional is in the hope of performing a future modus ponens or modus tollens. Thus they infer that a conditional that has an antecedent which is known to be false will be useless as an instrument of inquiry (even if it has merit as entertainment or consolation). So when they realize that they themselves assert many such conditionals in the laboratory, they experience the counterexamples as anomalies.
Veridical Suppositions
A supposition can be true even if the speaker regards it as absurd. When asked whether zero is odd or even, some people treat the question as an invitation to fantasy. They hear the question as a subjunctive conditional; ‘If zero were odd or even, which would it be?’ -- akin to ‘If women were numbers, would they be odd or even?’ Good natured conversationalists answer ‘Is zero odd or even?’ by whimsically extrapolating from principles such as ‘Odd and even numbers alternate’ and answer ‘Even’. They are surprised that mathematicians endorse their recreational reasoning as a sound argument.

Suppositions are sometimes guided by processes that are more reliable than their supposers realize. As illustrated by blind sight and subliminal perception, common sense and introspection underestimate the accuracy of perceptions made under poor conditions. A precipitous decline in reliability is exaggerated into complete unreliability. Presentations of words can be so fleeting (when displayed by a tachistoscope) that there is no conscious awareness of perception. Yet when forced to conjecture on how a word is to be completed, the subject’s “wild guesses” are fairly accurate (substantially less accurate than in full exposures but still far better than chance). Although people are usually over-confident, they are under-confident about their peripheral vision, their ability to recognize people from behind and by their gait, and their acuity in low illumination.

Idealizations always take place against a suite of background beliefs that hedge commitment to the assumption. Relative to these pessimistic but contingent concessions, the idealization should be false. When these inhibiting, background beliefs are mistaken, the idealizations can be surprisingly accurate.

Unexpected Support from Ideals
Some of these background beliefs are general. After physicists discovered that stimuli were continuous, they characterized normal perception as systematically misleading because the senses lump phenomena into categories. For instance, it is impossible to paint a realistic looking rainbow without grouping the colors in bands. Consequently, the physicists apologized for this distortion in their illustrations of rainbows. They believed the categories were conventional and that anthropologists would discover cultural variation in color perception.

After Berlin and Kay (1969) presented surprising evidence that the categories were culturally universal, psychologists reconsidered what is really entailed by the physical continuity of the light spectrum. Many began to regard the pictures of the rainbows as accurate.
The physicists were influenced by the idea that colors are secondary qualities. The perceiver makes a contribution to color reality – not a distortion. The ideal becomes real.

Consider speech perception. According to the motor theory, we perceive spoken words by identifying the vocal tract gestures that originate them. When you listen to me talk, you empathically match what you heard with how you would try to produce my sounds. Since your matching repertoire comes in discrete categories, you reconstruct the sounds as discrete even if they are continuous. For instance, since you can only articulate ba’s and pa’s, you hear only ba's and pa ’s, nothing in between (despite the sounds varying along the voicing continuum). So you exaggerate the similarities within a category and exaggerate the differences between categories.

When you listen to sounds as speech, you figure out how you would have produced those sounds. Since you are picking from discrete options, the precise menu sharpens rough vocalizations. The ideal shapes what is heard.

Metaphysicians have postulated many types of ideals that would make idealization reliable. Plato buttressed our suppositions with a realm of forms. James Brown (1991) modernizes this infrastructure to accommodate thought experiments in physics. Brian Ellis (2009) contends that idealizations work because nature is organized into a hierarchy of natural kinds. They distill essences.

Many idealizers have doubts about such ideals and so curb their expectations. If their doubts turn out to be ill-founded, then the doubters will be pleasantly surprised by how frequently their idealizations are veridical.

Background Beliefs about Depiction
A physicist’s beliefs about how pictures are composed will influence whether he regards them as distortions. This background will interact with the physicist’s foreground beliefs about the phenomena in question.

In 1537, Walter Ryff published Geometrical Gunnery. His front piece depicts a town under artillery fire (Dijksterhuis 1961, 271). The trajectories of the cannonballs are indistinguishable from ellipses.

But turn the page. The reader discovers that Ryff regards the illustration as a simplification. He is a neo-Aristotelian. Ryff believes that the actual path is tripartite: During the first stage of flight, the ball travels straight because of the impetus of the exploding gunpowder. The second stage of flight is circular because the ebbing forced motion competes with the natural motion of the ball. Third, after the impetus is exhausted, the ball travels wholly naturally -- straight down toward the center of the earth.
Ryff regards the elliptical paths of the artist’s cannonballs as aesthetic concessions. The eye prefers a gentle curve to a sharp angle and the artist rounds out the trajectory accordingly.

The fact that Ryff’s elliptical idealization is correct does not, in itself, disarm the threat posed by idealization. Given that Ryff aims to describe the true path of projectiles, we are still left wondering why he illustrates with a path that he believes to be a false path.

The veridical nature of the idealization helps by shifting the question to a more tractable one: Given that Ryff aims to describe the true path of projectiles, why does he illustrate with a supposed path. The question gets easier by transcending distractions: why do describers ever resort to supposing?

At an operational level, the answer can be found in the well-established practice of conditional proof and reductio ad absurdum. Their relevance can be amplified by noting that idealization occurs in logic and mathematics. At an etiological level, David Barnett (2010) gives a rational reconstruction of how the practice of supposition would grow out of language community that initially lacked the practice.

Sub-Idealizations
Suppositional proofs may contain embedded suppositions (so we should expect sub-idealizations).

After Johannes Kepler became convinced that the orbits of the planets are not circular, he concluded that the planets are not under the total control of the sun. Each planet has a degree of self-locomotion – and so must have a soul. On the basis of some preliminary curve fitting and perhaps under the influence of creation myths in which eggs figure so prominently, Kepler conjectured that each planet’s orbit has the shape of an egg.

The egg is difficult to describe mathematically because of its asymmetry; it is tapered at one end. Ellipses are tapered symmetrically at both ends. Kepler knew that Archimedes had already worked out the areas of ellipse sectors. So Kepler used an ellipse to approximate the egg. Eventually Kepler realized that if he put the sun at one focus of the ellipse, the data fit. So although the ellipse was not a veridical idealization of its target (the egg), it was a veridical idealization of its target’s target (the orbit of Mars).

Sometimes a match with the target’s target is not regarded as a fortunate hit. When we estimate the size of errors, our aim is to model the mismodeling, not the phenomenon itself. If the model of the model of F gives us correct values for F, then we have mismodeled the model of F. A veridical idealization would yield a model of F that matched the errors we observed.
Our second order efforts at modeling modeling can themselves be the subject of modeling. Thus there can be an open-ended hierarchy of idealizations without a collapse into first order modeling.

Veridical Approximations
What makes an idealization an idealization is its intent, not its effect. Approximations may fortuitously yield exactly correct outputs for some inputs.

In mathematical contexts, veridical idealizations are necessarily correct. Consider a student who knows that the area of a rectangle is the product of its length and width. When he confronts a parallelogram, he is not sure how to calculate its area. It is plausible that the parallelogram’s area will increase if one side is made indefinitely longer. He expects any such addition is small. So the student treats each parallelogram as if it were a rectangle, unsure of how much error will be introduced by the departure from 90-degree angles. Later he learns that all of his calculations are exactly correct.

Students accustomed to handheld calculators often think translation of fractions into decimal notation involves a loss of information. When confined to decimal notation, they regard $1/3 = .333\ldots$ as only approximately true. When they multiply the right-hand side by three, they think that the product, $.999\ldots$, does not quite equal 1. But in fact $1 = .999\ldots$ is exactly true (if it were untrue, there would be a real number between the two numbers).

Understanding without Belief
To understand the behavior of pendulums, Galileo eventually was led to experiments with inclined planes that liberated the pendulum bob from its tether. These experiments down U shaped ramps led to experiments with ramps that were more and more obtuse. To reduce friction and air resistance, Galileo constructed progressively artificial laboratory situations.

Eventually Galileo was driven to thought experiments. In the final case, the ramp is laid out flat, along a frictionless, infinite plane within a vacuum. This thought experiment suggested that the ball would move forever in a straight line. Galileo accepted the eternity but regarded the straight line as misleading (as “a bug rather than a feature” in engineering jargon). In the Dialogues, Galileo reasons that if an object moved perpetually in a straight line, it would leave the universe. In view of this absurdity, Galileo continued to subscribe to the Greek doctrine that the circle is the natural form of motion. This conservatism prevented him from discovering Newton’s first law of motion. Galileo did not believe the conclusion of his idealization.
Thought experimenters frequently do modus tollens when they should have done modus ponens. They conduct a sound conditional proof but then incorporate this into a “reductio ad absurdum” by treating the consequent as an absurdity. (The absurdity of a literal reductio is a contradiction, so the loose talk of a reductio ad absurdum is hyperbole – an emphatic modus tollens.)

One of Aristotle’s reasons for rejecting the vacuum is that bodies of different weight would fall with equal velocity. This thought experiment gave Aristotle knowledge of the conditional produced by the subordinate proof.

Siméon Poisson in 1818 correctly deduced that if light were composed of waves, then interference should produce a white spot at the center of a “shadow” of a perfectly round object cast by a point source. This conditional proof was scientific progress because it advanced understanding of the consequences of the wave theory. Poisson naturally assumed that the progress went further – that he had set up an easy modus tollens that would furthermore refute the wave theory. Thus he was shocked when Dominique Arago executed the experiment and the absurd white spot materialized.

Understanding suffices for some scientific progress. Therefore, some thought experiments succeed even when they fail to provide knowledge (or even belief). Consequently, there is sometimes a point to conducting a thought experiment even if you know your audience will never believe you. Perhaps this explains why thought experimenters persist with audiences that are skeptical about their value.

Supposition and Lying

Anti-realists concede that idealizations are not really lies. They trace the difference to an absence of an intent to deceive.

This is the wrong explanation. Some suppositions are intended to deceive. In push polling, one asks the respondent a “what if” question that insinuates the truth of the antecedent. Propagandists insincerely propound suppositional proofs. When Vice President Cheney defended torture with ticking time bomb thought experiments, he was criticized for conveying the impression that the idealized circumstances were representative. Some scientists also conduct idealizations that they know to be misleading or fallacious. In Against Method, Paul Feyerabend argued that Galileo’s idealizations were propaganda.

Pictures cannot be lies because they are not discursive. Suppositions are discursive but are not the right kind of discourse. All lies are assertions. No supposition is an assertion. And all idealizations are suppositions.
References
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