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ABSTRACT

The most important contemporary development in rhetoric for the theory of argumentation is Jeanne Fahnestock's program of figural logic, the ruling insight of which is that figures epitomize arguments. Working primarily with the antimetabolic formula at the heart of Gregor Mendel's paper "Experiments in Plant Hybridization," I investigate the figural bases of the logic anchoring this foundational essay in genetics. In addition to antimetabole, the formula also depends crucially on ploche, polyptoton, onomatopoeia, antithesis, synecdoche, reification, and metaphor.

KEYWORDS: Mendel, antimetabole, figural logic, rhetoric of science

The most important contemporary development in rhetoric for argument theory is Jeanne Fahnestock's program of figural logic (1999, 2005), the cornerstone of which is that figures epitomize arguments. This claim is not controversial at all for one figure, the trope metaphor, epitomizing analogy, which has received extensive attention for six or seven decades in cognitive science, psychology, philosophy of mind, literary studies, linguistics, rhetoric—in perhaps every discipline of the humanities and social sciences in the modern academy. But metaphor, for all this press, is still only one figure in a spectrum of schemes, tropes, and related stylistic instruments that runs conservatively to sixty-four (in the *Ad Herennium*), and, less conservatively into the hundreds.[1] Drawing perceptively on argumentation scholars as diverse as Aristotle, Cicero, and Chaïm Perelman and Lucie

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Olbrechts-Tyteca, and applying her insights with precision and acuity to scientific arguments, Fahnestock has given us an incredibly rich framework for tapping into this deep reserve of the rhetorical tradition, developing what Christopher Tindale characterizes as a "truly overwhelming case for figures as arguments" (2004, 69).

In what follows, I outline the nature of rhetorical figures, adumbrate figural logic, featuring a few of Fahnestock's exemplary analyses, and probe a particular formula that brilliantly condenses Gregor Mendel's experimental design in his seminal 1866 essay "Experiments on Plant Hybrids."

RHETORICAL FIGURES

The devices and maneuvers that have accrued under the term "rhetorical figures" are many and diverse, but a four-way taxonomy puts them into reasonable order: schemes, tropes, chroma, and moves, all of them oriented in terms of what Group μ phrases as "the detected alteration of degree zero [discourse]" (1981, 37).[2]

The scheme and trope categories are among the oldest in figuration, and—construed according to the simple signifier/signified dual aspects of semiosis that dates to at least Stoic linguistics—also the most basic and the easiest to distinguish. Schemes are formal alterations, shifts away from conventional, baseline expectations in the usage of signifiers. Tropes are conceptual alterations, shifts away from conventional, baseline expectations in the usage of signifieds.

Prototypical schemes include rhyme, isocolon, and epanaphora, all on display here:

> I do not like them in a house.
> I do not like them with a mouse. (Seuss 1940)

In baseline language, identical syllables do not frequently coincide in close proximity (rhyme); prosody is not the same in proximal clauses (isocolon); and identical sequences of words are not used at the beginning of proximal clauses (epanaphora). All of these configurations certainly do occur in ordinary language, but they are relatively scattered, irregular, and usually noticed when they appear. (When inadvertent rhymes occur, for instance, my mother is fond of saying "You're a poet and don't know it.")

When these alterations occur in novel and conspicuous ways, they are often taken as evidence of design, of alteration for effect. When they occur in clusters, as in the couplet from Dr. Seuss, the evidence of design is ironclad.

Prototypical tropes include personification, metonymy and synecdoche, all in play here:

> But, look, the morn in russet mantle clad,
> Walks o'er the dew of yon high eastward hill. (Shakespeare 1983, 34)

In ordinary language, we don't normally talk about the clothes the sun is wearing or speak of it walking (personification) or refer to it by a word for the time of day in which it first appears (effect-for-cause metonymy) or screw down the focus to one element of the hill on which it "walks" (part-for-whole synecdoche). Again, all of these usage patterns occur in ordinary language—indeed, most of our words are conceptualized out of the cognitive processes sponsoring tropes (very likely *all* of our words originate in this way, with the original sponsorship long forgotten)—but the ordinary-language occurrences are usually visible only in atrophied and unassuming residues. When they occur in novel and conspicuous ways, they are noted and often taken as evidence of design, of alteration for effect. When they occur in clusters as in the passage from *Hamlet*, the evidence of design is ironclad.

The other two categories, chroma and moves, are, to understate the case, less established. But they provide useful ways of understanding the range of rhetorical devices and maneuvers that have traditionally been called figures and yet do not line up on either side of the signifier/signified boundary. Chroma are deviations of expected intention. Moves are not really deviations at all—hence, not really figures in my understanding—just specific discourse strategies identified by rhetoricians through the centuries and commingled with figurative devices.

Prototypical chroma include interrogatio ("rhetorical question") and apostrophe (faux address). Here is an elegant example of the former by one Homer:

> Do *I* know what "rhetorical" means?" (Appel and Silverman 1995)

And here is an elegant example of the latter, by the other Homer (*Iliad*, 16.21–22):

> With a wrenching groan you answered your friend, Patroclus
> O my rider. (1990, 413)

In their default ordinary-language deployment, questions are used to elicit information, either as confirmation or disconfirmation of a proposition or as a supplied constituent. But interrogatio is deployed with a different intention. It deviates from default questioning. Homer Simpson uses his question to make an assertion (that he *is* an expert in rhetoric—not, in fact, an untenable claim). His intention is not to *solicit* information but to *assert* a claim. Similarly, when we address someone, we conventionally intend to engage them in some way; minimally, we intend for them to *hear* our remarks. In an apostrophe, the rhetor speaks not to be heard by the ostensible addressee (here, Patroclus, a literary character) but to be *over*heard, by some nonaddressed listener (the audience). Homer the bard does not intend to engage Patroclus, to be heard by him—he is not even present, not even alive—but to increase the vividness of his portrayal for his listeners. Chroma rely more broadly on the context of utterance, therefore, in a way that schemes and tropes do not; in Group μ's terms, chroma are "in principle circumstantial" (1981, 131), understood as a deviation not with reference to the sign but to the context in which the sign is deployed. We need to know that, in the given circumstance, Homer Simpson is not seeking information or that Patroclus is not the true addressee of Homer the bard.

Rhetorical moves are tactical activities, often of a wider structural sort, outside the familiar linguistic domains of form, meaning, and intention. They are quite different from schemes, tropes and chroma—not figures at all, properly construed, so much as ways to identify discourse-level strategies that have historically been lumped in with figures. Prototypical moves include paralipsis, the revelation of evidence or claims under the guise of restraint, and prolepsis, the forecasting and mitigation of objections. Here is an example of each from Cicero's orations, the first from *Against Piso* (38) and the second from *For Murena* (1):

> Let's not talk about his plundering, his extortion, his thefts and demands for money; not his murders of our allies, his slaughter of his guests. I'm not saying anything about his deceit, his brutality, his crimes. (2009, 250)

> I must say a few words on my own behalf before speaking on behalf of Lucius Murena: not because I believe defending my

> sense of obligation more important than defending his well-being but so that the approval my actions receive from you may bring me greater authority to ward off the attacks of Murena's enemies on his office, reputation, and fortunes. (2009, 127)

The first is paralipsis, of course, as Cicero feigns a high-mindedness that steers clear of sordid activities—plundering, extortion, thefts, murder, deceit, brutality, and other sundry crimes—while entering all of those charges into the record surreptitiously. In the second example, prolepsis, Cicero anticipates an objection that he is self-concerned and argues that his concern is only for the moral grounding of his advocacy, which ultimately serves his client, Murena.

One can certainly see why rhetorical moves have been traditionally grouped with figures. Schemes, tropes, and chroma operate against a hypothetical degree zero language whose form draws no attention to itself, whose flat and direct denotative semantics provides the only meaning there is, and whose structure evinces the default semantics and syntactic functions of any utilized structure with which the speaker's intention matches up identically. Design and context are nowhere to be seen. If this concept matches anything, it might be Noam Chomsky's notion of linguistic competence as embodied in the "ideal speaker-listener" who lives in a "completely homogeneous speech-community" (1965, 3). For a picture of degree zero in all three of these dimensions, think of that well traveled, famously inert sentence "The cat is on the mat." Similarly, rhetorical moves operate against some hypothetical degree-zero form of argument, which proceeds building-block style, with no innuendo or prophylaxis or departure from a rigid premise-conclusion blueprint, of the sort approached by Euclid and which lies in back of many argumentation textbooks trying strenuously to avoid the taint of rhetoric. Design and context are nowhere to be seen.

Before leaving this incredibly brief account of figuration, I want to be very clear on two points. First, this taxonomy does not imply in any way that only schemes evince form, that only tropes have conceptual content, that only chroma exhibit intention, or that only named moves evince argumentative strategy. *Every* semiotic event has form and meaning (a signifier and a signified aspect), *every* symbolic event exhibits intention, and *every* argument evinces strategy. Moreover, some figures deviate from their standard role, venturing into more than one of these dimensions, so that categorizing them can call for a weighing up of the contributions to their

effect in each dimension. Simile, for instance, is a trope because it rests on a conceptual shift, from in-domain comparison to cross-domain comparison. On that level, it is indistinguishable from metaphor. What *does* distinguish it from metaphor is the presence of overtly comparative diction ("like" or "as" in English) and a related tethering to certain syntactic constructions. That is, the way we distinguish metaphor and simile, both tropes, is by form, the realm of schemes.

This taxonomy merely notes that when the form or the concept or the intention has additional salience, understood as a deviation from default expectations, we have distinctive, classifiable, semiotic, and communicative instruments: rhetorical figures. And the category of move—outside my taxonomy of figures—recognizes that some strategies are noteworthy enough, recurrent enough, and usually compact enough to also be labeled and that these strategies have, in some traditions of rhetoric, been affiliated with figures.

Second, this taxonomy does not presuppose some rigid separation between figural (or poetic or rhetorical) language and bland (aka literal) language.[3] There *is* no such separation. One can certainly find examples of language assembled in ways that are highly figurative (*Paradise Lost*, "Yes, we can," any rap song), and other assemblages that are highly prosaic (a business memo, an experimental report, a grocery list). As Hugh Bredin puts it, "Literal language by its nature tends to reflect what is common rather than what is unique, what is inherited rather than what is new, what is learned rather than what is discovered" (1992, 80). It exhibits a lack of design or innovation, recycling routine diction and routine arrangement for routine purposes. Fastening, as so many scholars do, on metaphor as the emblem of the figurative—in fact, using it as a synecdoche for the figurative—Bredin highlights the generative relation between figural language and bland language. "Metaphor," he says, "is language in the process of becoming. Metaphor is not the antonym of the literal, but its midwife" (1992, 80). Bland language is the effective, specialized residue of language that developed, using all the resources of figuration, for various daily communicative routines (social routines, professional routines, religious routines). But the bland/figural distinction is one of degree: some semiotic acts asymptotically approach degree-zero figuration (degree-absolute blandness) or, conversely, degree-zero blandness (degree-absolute figuration), but no living, breathing semiotic act ever actually achieves either degree.

FIGURAL LOGIC

"So what?" you ask; or, if not you, Thomas Sprat. So language is figured. So language is even *created* by figuration. In the end, we are talking only of trivial decorative devices, notable merely for their aesthetic or emotional effects, with no wholesome consequences for argumentation or for reason, which are conducted, in their purity, through the calculated exclusion of figures. Figures, indeed, will inevitably influence the flabby minded—those who can't tell cosmetics from content, decoration from argumentation—and thereby degrade rationality. These "specious Tropes and Figures," these "Ornaments of speaking," Spratt says, "are in Open defiance against Reason; professing, not to hold much correspondence with that; but with its Slaves, the Passions" (1667, 4).

But Sprat, if not you, is spectacularly wrong. My point, Fahnestock's point, is not that figures can't or don't have aesthetic and emotional effects. It is that they also have rational effects. In the best arguments, their aesthetic, emotional, and rational effects align into a vector of persuasive force. But, for the remainder of this article, I abstract away from aesthetics and affect, pretending they are irrelevant, and chart out the rational implications of figures in isolation—that is, I proceed in precisely the opposite direction from Spratt and the figure detractors. Moving in this direction, we see, for instance, that nowhere is the creative/routine relationship Bredin identifies more evident than in argumentation, in which a figure like ploche (lexical repetition) undergirds an argumentative routine like modus ponens.

Most obviously, there is a systematic correspondence between certain tropes and certain modes of reason, in which the first can be said to epitomize the second. I revisit metaphor in a slightly different light shortly, but for now we can simply register the obvious correspondence here—namely, that metaphor so clearly condenses argument by analogy that metaphors are frequently used to label such arguments (the state is a body, the mind is a computer, argument is war), and when they are not labeled by metaphors they are labeled by metaphor's first cousin, simile. Kenneth Burke (1941) characterizes metaphor as a distilled linguistic correlate of perspective, the framing of one position in the terms of another.

Similarly, though this relationship has been largely unnoticed, synecdoche epitomizes two sorts of argumentation, depending on its "direction." Synecdoche is the meronymic trope, where a part stands for the whole ("Archie has a new set of wheels," when Archie has a new car) or the whole stands for a part ("The law is here," when only one or two policemen appear).

Burke (1941) sees synecdoche as a distilled linguistic correlate of representation, which highlights how it epitomizes reasoning from example: an example is an instance taken to represent a class of instances, in a prototypical species-for-genus manner. The statements one can make about an example, and the implications one can draw from an example, serve their rational function only by generalizing to the whole class. Inductive reasoning (and therefore statistical reasoning), in short, is anchored in iterated part-whole synecdoche. If any part does not represent the generalized whole (if a black swan is observed), the conclusion is nullified.

While Burke is only interested in the part-to-whole, species-to-genus direction of synecdoche, reason works in both directions. When reasoning moves in the whole-to-part, genus-to-species synecdochic direction, we get the other classic rational framework, deduction. We can only move from "All men are mortal" to "Socrates is mortal" by way of the synecdochic assertion that "Socrates is a man," a member of the class of all men.

Metonymy, for its part, operates by association, signaling an object or concept by naming an associated object or concept ("That's a tasty dish," for the rice pilaf in the dish). Burke (1941) sees metonymy as a distilled linguistic correlate of reduction, a form of reasoning based on breaking down a concept or system into associated phenomena. Like synecdoche, with which it is frequently joined, metonymy is representational, but the representation is less immediate (the dish is not part of the pilaf, the way wheels are parts of a car). Moreover, Burke argues, above and beyond simple representation metonymy always evinces a reductionist motive. Behaviorism, for instance, to use one of Burke's favorite examples, reduces mental activity to behaviors associated with that activity. In B. F. Skinner's famous 1957 book, signaled by its title, the complex cognitive phenomenon of language is reduced to verbal behavior.[4]

To round out the so-called four master tropes, irony (the knowing subversion of primary denotation) is clearly the presiding genius of reductio ad absurdum, in which the initial "yes" to one frame of reference is inverted to a "no" by the spelling out of patently objectionable consequences. Since irony involves two contending frames of reference, Burke (1941) sees irony as the figural distillation of dialectic, which would make it the essence of reason itself. For my money, however, the figural distillate of dialectic is another trope, antithesis (the simple juxtaposition of opposites), which doesn't have the complicating nudge-nudge, wink-wink quality endemic to irony.[5]

Similar observations can be made for any number of tropes—some, like simile and reification, closely reflect aspects of reasoning we have already considered (both are forms of analogy, the first features an explicit comparison, the second a comparison of an abstract concept to a concrete object); others, like oxymoron, reflect somewhat distinct aspects (an oxymoron is a contradiction in terms, related to antithesis and reflecting paradoxical reasoning). But Fahnestock's major accomplishment is to demonstrate that *schemes* are equally important indices for the structure of reason and argument as the more high-profile clan of figures, tropes, with its superstar matriarch, metaphor. Fahnestock puts it this way, in an aggregated paraphrase of Aristotle (Fahnestock claims little originality for her views, by the way, characterizing them as "recapturing an older view"): "Certain [figures] are compelling because they map function onto form or perfectly epitomize certain patterns of thought or argument" (1999, 26). She establishes the theoretical underpinnings of this position in one of the most sophisticated readings of Aristotle in recent scholarly history, concentrating on the *Rhetoric* and the *Topics* and mapping out correspondences between topoi and figures that most rhetoricians and philosophers have overlooked for millennia. She traces this view through such rich rhetorical and argumentation treatises as Melanchthon's *Elementorum rhetorices* (1968, 30–31) and Perelman and Olbrechts-Tyteca's *New Rhetoric* (1969, 34–36). But it is in the application of this approach that she establishes its analytic power.

The clearest example is perhaps in her explication of this argument:

1. Carcasses of large prey, like elk, slaughtered by wolves will add nutrients and humus to the soil.
2. The more fertilized soil will support lush vegetation, probably attracting snowshoe hares.
3. The presence of hares will likely prove a lure for foxes and other predators.
4. The foxes will also prey on rodents like mice in the area.
5. A displaced mouse predator, like a weasel, is likely to fall prey to an owl. (1999, 109)[6]

The relevant figure here is a gradatio, a scheme in which terms are repeated on either side of a phrasal boundary, in multiple succession—in this case, we have a sequence of clauses taking us from "carcasses" to "owl" by way of four repeated terms: "carcasses" and "soil"; "soil" and "hares"; "hares" and "foxes"; "foxes" and "mice"; "mouse" and "owl."

There are other discursive ways to make this argument, of course. As Fahnestock points out, the article connected with this gradatio (Stevens 1995) develops the case in a more loosely discursive fashion ("lax" is what she calls it). But this extract *is* the argument. It epitomizes and charts the argument that wolves are necessary for the environment because their predatory activities support all the other elements in this chain (and, by implication, other similar elements) through these causal links. It plots out the syllogistic progression of the argument, providing precisely the sort of schematic account we would want our students to be able generate upon reading a piece like the Stevens article. We would want them to go somewhat further in their plotting of the gradatio than Stevens goes, of course, since their job would be epitomizing for analysis, not epitomizing for promotion. We would want them, in particular, to be more explicit about the covert bridging links, the intermediate terms like "wolves," "vegetation," and "weasel," that move the argument along but are not foregrounded in the text. Notice that should we assign such a task to our students (or perform it ourselves), however, the result would still be a gradatio, albeit with further detail, in a progression like this: if wolves, then carcasses; if carcasses, then rich soil; if rich soil, then lush vegetation; if lush vegetation, then hares; if hares, then foxes; if foxes, then increased mouse predation; if increased mouse predation, then displaced mouse predators; if displaced mouse predators, then owls. One abstract step further, we end up with a skeleton of the reasoning that would be perfectly at home in a logic text: if A, then B; if B, then C; if C, then D; still a gradatio.

Charting out a relevant argument via gradatio lets us examine its links, so we can see where the chain is strong, where it is weak, and where the structure needs to be further interrogated. As Fahnestock notes, for instance, the links in the *New York Times* piece are not all the same: "The claim that vegetation attracts hares and that hares attract foxes may depend on one kind of causal warrant; that foxes displace other predators requires a different warrant, and that a displaced predator is likely (more likely?) to fall prey to another predator needs yet a third" (1999, 109). The gradatio, by juxtaposing the steps, makes it much easier to see these kinds of covert inconsistencies in reasoning.

Furthermore, this gradatio allows us to see that in addition to manifesting a syllogistic progression, the reasoning in this passage also manifests what Burke calls a qualitative progression (Burke 1968, 124ff.), a kind of movement more familiar in traditional rhetorical analyses than in traditional argumentation analyses. That is, we see a clear "food chain of being" ladder

in the passage—soil to vegetation to herbivores to predators of herbivores to predators of predators—and the final rung on this particular ladder has a cardinal environmental virtue about it, a strigiformic charisma, because of the many campaigns around the endangerment of owl species. Gradatios regularly demonstrate this kind of ontological or moral ascent, and that helps us see that there is a central "rhetorical" aspect to the progression here, not just a "logical" aspect. The qualitative point of this particular progression is not, as we get in syllogisms qua syllogisms, to carry some property of carcasses along the chain to the owl (from the mortality of all men to the mortality of Socrates) but rather to insist on the significance of each link in the chain, so as to demonstrate the interconnectedness of everything from lowly soil on up to the charismatic owl. The qualitative progression does not lead us, step by step, up to a reverence for the owl so much as it additively increases the qualitative adherence, which back-propagates through the chain, permeates the matrix, and ratifies the ecological function of the wolf, with whom the chain begins, by its association with the owl.

In addition to the precision with which they lay bare the sort of entailment chains in arguments like this, gradatios also have, like all figures, an audience-engagement function that leverages our cognitive dispositions. Burke calls this effect "formal assent," illustrating it in *The Rhetoric of Motives* with a familiar mid-twentieth-century gradatio:

> Recall a gradatio of political import, much in the news during the "Berlin crisis" of 1948: "Who controls Berlin, controls Germany; who controls Germany controls Europe; who controls Europe controls the world." As a proposition, it may or may not be true. . . . But regardless of these doubts about it as a proposition, by the time you arrive at the second of its three stages, you feel how it is destined to develop—and on the level of purely formal assent you would collaborate to round out its symmetry by spontaneously willing its completion and perfection as an utterance. (1969, 58–59)

Readers or hearers who catch the terminological progression of a gradatio early, that is, forecast each subsequent step and ride out those steps collaboratively, investing more in each step of the progression. What Burke means by "formal assent" is a kind of agreement with the pattern that prepares the way for an agreement with the claim(s). There may be no better phrase for the way formal reasoning proceeds. In predicate calculus, all there *is* to the argument, all that can one *can* assent to, is its form.

Take one more example from Fahnestock, the scheme of brute lexical repetition, ploche. Ploche is almost an antistyle figure, since it quickly leads to monotony and/or irritation. Children discover that aspect of repetition very early and iterate words endlessly to drive each other, or their parents and teachers, to distraction. By the same token, it is the figure that makes the cognitive underpinnings of figuration most apparent, since repetition is the technique we use most often, even subvocally, to help strengthen our memory of names, phone numbers, addresses, and the like.

To illustrate the argumentative function of ploche, I quote a representative section of Fahnestock's superb discussion of Koch's postulates, a protocol developed by Robert Koch in the course of his historic discovery of the tuberculosis bacillus, which she begins by reproducing a version of those postulates as they appear in a medical textbook on viruses:

> (1) the organism must be regularly found in the lesions of the disease, (2) the organism must be isolated in pure culture (hence the need for sterile techniques), (3) inoculation of such a culture of pure organisms into the host should initiate the disease, and (4) the organism must be recovered once again from the lesions of this host.

What is stylistically notable about this version of Koch's postulates is the repetition of the word "organism" in each of the four elements. This use of ploche epitomizes perfectly the standard demanded by the postulates: that

> a consistent disease-carrying agent persist through a precise experimental route, from an infected disease-ridden host to a pure culture to a new host that manifests the disease to another isolation and identification procedure. If an organism maintains its identity through each step of this process, the way the word itself is maintained in each sentence of the postulates, then there is "proof" that it is a disease-causing agent. Ploche, then, is the figural epitome of Koch's postulates, stability of the term representing stability of the referent. (1999, 162–63)

Stability of referents is obviously important for discourse in general and argumentation in particular, because we need guarantees that we are talking and arguing about the *same* thing. Languages have treasure troves of synonyms and other forms of referential overlap that allow us the somewhat

inverse opportunity to explore variations on a theme, as well as to ward off the monotony and irritation that quickly attends brute repetition. But when precise stability of referents is at issue, as in Koch's postulates, legal documents, or algebra, ploche is our most robust resource.

Figures, like most linguistic resources, stand in sophisticated but systematic relations to one another. In particular, they often travel in clusters, for conspiracy of effects, and they can nest within each other. As our final example of figural logic, to highlight its interrelational characteristics take the most famous argument of them all:

1. All men are mortal.
2. Socrates is a man.
3. Therefore, Socrates is mortal.

We can, of course, see ploche right away. Stability of referents is essential for syllogisms; ergo, the stability of terms. But the repetition here is more specific than mere proximal word recurrence. The syntactic location of the repetition is equally critical in this example, and figuration is sensitive to location. Our syllogism utilizes epistrophe (clause-final lexical repetition in 1 and 3) and epanaphora (clause-initial lexical repetition in 2 and 3), along with polyptoton (repetition of a word in different forms with "men" and "man" in 1 and 2). The convergence of these prototypical rhetorical devices, or schemes, with this archetypal argumentation structure, the syllogism, illustrates in the clearest possible way the cognitive, rational, and argumentative functions of figures, and the profound insights of Fahnestock's figural logic program, because this convergence is not some stylistic overlay on a pure, a priori, arhetorical, quintessential core of reason. The syllogism is impossible without the figures.

Stability of referents is crucial to the syllogism; ergo, stability of term—ploche. But stability of predication is crucial as well; ergo, stability of location—epistrophe and epanaphora.[7] And a specific variation on stability of referents is equally crucial; ergo, variation on the stability of term (specifically, universal and particular, "all men" and "a man")—polyptoton. Notice that it is not especially relevant that a syllogism might be expressed in other formulations—that proposition 2, for instance, might be expressed as "the set of all men includes Socrates." When rendering a passage into its syllogistic structure for analysis, we routinely deploy epanaphora to highlight the shared propositional character among the premises and conclusion.

Apropos of the attention I soon bestow on one of Mendel's formulae, it is worth pointing out, too, that the figural dimension cannot be eliminated by moving to an abstract formalism like the predicate calculus. It is in fact *enhanced*, brought even more sharply into focus, by such a rendering:

1. (x) (Px & Qx)	1. $Px \rightarrow Qx$
2. (∃x) (Sx & Px)	2. $Sx \rightarrow Px$
3. ∴ (Sx & Qx)	3. ∴ $Sx \rightarrow Qx$

Both of the conventional ways of schematizing this syllogism depend just as crucially on epistrophe (1 and 3) and epanaphora (2 and 3), and the version on the left, with quantifiers, depends additionally on polyptoton (1 and 2), as the universal and existential quantifiers are expressed as morphological variants of the same symbol/concept.[8]

Argumentation, like all uses of language, is impossible without figuration. Fahnestock's insight is that the *types of argument* are closely tied to, and most succinctly epitomized by, *types of cognate figures*.

MENDEL'S FORMULA

To remind us all: Gregor Mendel was a nineteenth-century monk in the Augustinian abbey of St. Thomas in Brünn (now Brno, the second largest city in the Czech Republic). In the 1850s he conducted a remarkable series of experiments that pointed to a unit of heredity that would later be called "the gene." He found that by interbreeding varieties of peas with specific different physical characteristics, he could chart out the transmission of these characteristics—later called "genetic traits"—and their combinatorial tendencies. Some traits, he found, are *dominant*. Others are *recessive*. The dominant traits swamp the recessive traits, so that only one dominant hereditary unit is necessary for the trait to manifest, regardless of which parent supplied it. Recessive hereditary units, for their part, only manifest in a trait if two are present, one from each parent. So, roughly speaking, Mendel discovered the gene; Mendel discovered the dominant/recessive ratios among genes; and Mendel plotted out the mathematical relations for dominant and recessive traits, a formula that has come to be known as Mendel's law of heredity. This constellation of results is the foundation of modern genetics.

The story doesn't end here; indeed, it barely even begins here. Enter rhetoric, stage right. The good monk presented his results to the Brünn Natural History Society in 1865 and published them the following year as "Experiments in Plant Hybridization" ("Versuche über Pflanzen-Hybriden") to widespread indifference, if not incomprehension. When he read his paper to the society, as Loren Eisley tells it, "stolidly the audience had listened, . . . no one had ventured a question, not a single heartbeat had quickened. . . . Not a solitary soul had understood him" (1958, 206). Eisley perhaps overdramatizes the situation. But it does seem clear that not a solitary soul had understood him in the way he later came to be understood, when the paper shook the biological sciences forty years later. Its results were replicated by Hugo DeVries in Holland, Carl Correns in Germany, and Erich Tschermack in Austria, and were propounded vigorously by William Bateson in England. This postponed impact is a fascinating rhetorical puzzle, which I set aside for the moment.[9] Here, I would like to concentrate solely on the rhetorical kernel of Mendel's paper, zeroing in on the links between figuration and argumentation, as expressed in one quasi-mathematical formula.

The formula (fig. 1) epitomizes Mendel's experimental combinations. For any given trait pair (of seven pairs), one comes from the male source (i.e., from the pollen), one from the female (i.e., from the flower). The members of the pair for any given trait are in competition, in the sense that only one can be expressed. So, for instance, the color of the first leaves of a seedling (called the cotyledon, the "seed leaf") might be yellow or green. The yellow color trait unit could be inherited from the male or the female; the green color trait unit could be inherited from the male or the female. In this formula, the male contributions are the top sequence (A, A, a, a). The female contributions are the bottom sequence (A, a, A, a). So, the fundamental, baseline job of the formula is to show that all possible combinations were tested in the breeding experiments (green from pollen, green from flower; green from pollen, yellow from flower; yellow from pollen, green from flower; yellow from pollen, yellow from flower). At the very heart of the formula at the very heart of the paper is an antimetabole.

$$\frac{A}{A} + \frac{A}{a} + \frac{a}{A} + \frac{a}{a}$$

FIG. 1 Mendel's Formula for the Distribution of Dominant and Recessive Character Traits. From Mendel (1966 [1866], 30).

Antimetabole is a scheme of reversed lexis. Famous examples include these three:

1. And so, my fellow Americans: ask not what your country can do for you—ask what you can do for your country. (Kennedy 2004, 188)
2. Do unto others as you would have others do unto you. (Matthew 7:12)
3. I meant what I said and I said what I meant . . . /An elephant's faithful—one hundred per cent. (Seuss 1940, passim)

Before we look at the argumentative implications of the antimetabole, however, we should attend to several other figural elements of the formula, some of them entailed by antimetabole, others just happy traveling companions. And, as we follow out this analysis, I want to be as clear as possible that I am not claiming Mendel had a rhetorical manual at his elbow, looking for the appropriate figure to decorate his text or epitomize his argument.[10] The claim is much deeper than that. Reasoning depends on principles and processes that also underlie thought and language more generally and that have obvious manifestations in "style." These principles include identity, similarity, contrast, and symmetry; processes include repetition, substitution, expansion, reduction, and inversion. The figural presence in Mendel's formula is not such as to heighten its *aesthetic* salience. Rather, that figural presence heightens the formula's *functional* salience, by compressing the reasoning into a distinctive harmony of patterns.

Ploche is the most obvious figural presence in the formula. Antimetabole is a compound figure, in the sense that it contains other, simpler figures (there is no suggestion here that compound figures were at some prehistorical point assembled out of those other figures, just that, structurally, compound figures are impossible without certain component figures). Antimetabole contains ploche. In this formula, we have the repetition of A, a, –, and +.

"Of *course* there is repetition in the formula," you are thinking. "It is expressing identity of referents." But that is precisely the point of ploche, precisely why it is essential to this formula—indeed, precisely why it is indispensible for reasoning in general and reasoning that relies on variables specifically. The job of variables is to signal a certain genericness of reference, and when variables repeat, throughout equations, formulae, derivations, and so forth, they signal a more local identity of referents. The most natural way to express identity of referents is through ploche.

As Fahnestock notes, "Stability of the term represent[s] stability of the referent" (1999, 163). Mendel's A can stand for any one of seven particular dominant traits in his formula (genericness), but when there is more than one A, each instance stands for the precisely the same trait (identity). Ditto a, for the seven recessive traits in Mendel's experimental design. And, for an even more rigid reason, ditto – and +. (These symbols, that is, always refer to the identical relation or operation—axiomatically in the system of mathematics and analogously in the sort of system Mendel builds here.) The argumentative (and more generally semiotic) function of repetition is to ensure stability. Iterated variables in a symbolic notation perform this function in a more abstract and heightened way than iterated words in natural language, because variables *only* enforce stability of referents, even and especially when the actual referent is unknown or diverse. In short, ploche is absolutely fundamental to reason (or, more accurately, the principle of repetition is absolutely fundamental to reason, expressed lexically by ploche).

We need to make one more point of connection explicit: variables are words of a very restricted sort. They are pronouns. Mendel's A is serving precisely the function that "he" serves, for example, in this passage:

> He was tired and very hot, walking across the uneven, shadeless pine pram. At any time he knew he could strike the river by turning off to his left. It could not be more than a mile away. But he kept on toward the north to hit the river as far upstream as he could go in one day's walking. (Hemingway 1998, 165)

We know that the person who was tired and hot is the same person who knew where the river was with respect to the trail, who kept on, and who could walk a presumed distance in one day, just as we know that the specific trait is the same whether it comes from the pollen or the seed, whether it combines with another instance of itself or with an instance of the other trait in the pair.

Polyptoton, in which the same word stem repeats with different morphology ("for every action, there is an equal and opposite reaction"), is also integral to Mendel's formula.[11] Polyptoton encodes the concept of fundamentally-same-but-notably-different: A and a are variations of the same word. Most morphological differences are affixial, though different languages use stem-changing mechanisms of various sorts (i.e., apophony), such as vowel alternations or tonal shifts. English, predominantly

affixial, also has a scattering of stem changes (as in "run/ran", "mouse/mice," "is/are," "he/him/his"). Mendel's A/a distinction is a precise visual counterpart to stem change (coincidentally no doubt, but interestingly all the same, very similar to ablaut in the verbs of Mendel's mother tongue, German).

Mendel's polyptoton depends on an alternation of the same letter, each of which corresponds to a specific abstract value, corresponding in turn to a range of seven particular binary value alternations of his trait pairs. The A's represent the dominant traits in his formula. The a's represent the recessive traits. (It is equally significant that one of them is physically more imposing than the other, since that difference codes the fact that one of the traits in the pair is more imposing genetically—we return to this aspect of the polyptoton shortly.)

Mendel's defining antimetabole and the polyptoton it contains are enmeshed very tightly in his argument, though this aspect of the polyptoton requires some additional explication. Notice that there is a specific antimetabolic polyptoton of the second and third combinations in the series (i.e., A/a and a/A). If we treat these expressions as compound words, as is perfectly reasonable, then they are inverted versions of each other.[12] They are compounds that contain the same elements, but in reverse order. This antimetabolic polyptoton is especially critical for the contemporary argument field Mendel was engaging, hybridization. Recall that the reason the orders in these compounds are different is the source of the trait—pollen or egg, male or female. There were debates about the different trait contributions of males and females to heredity—some arguments even portraying the egg as a kind of incubator, with *all* the traits coming from the male, and most portraying the trait with the greatest frequency of occurrence (what Mendel called the dominant trait) as exclusively male. Mendel demonstrated that it doesn't matter where the relevant trait in the pair comes from, male or female—the trait is expressed in exactly the same way (dominant is dominant, from male or female; recessive is recessive). The antimetabolic polyptoton of terms 2 and 3 in Mendel's formula highlights the irrelevance of trait source. The two expressions of polyptoton epitomize two different aspects of Mendel's argument. The majuscule/minuscule polyptoton epitomizes the binary-alternative relationship. The antimetabolic compound-word polyptoton epitomizes the irrelevance of trait source (one of the natural uses of antimetabole being to signal the irrelevance of order).

Onomatopoeia, the autological trope in which meaning is signaled representationally by some aspect of the form, is also present in the use of

variables in Mendel's formula. Conventional use of onomatopoeia refers to the pronunciation of a word (or sometimes a lexical sequence) in a way that acoustically evokes the meaning. The signifier *sounds* like some aspect of the signified. The phonology of words like "murmur" and "whisper" is onomatopoeic—signaling in the first case a kind of low, humming talk and a sibilant, breathy talk in the second—but it is perhaps most obvious in the animal-noise words of early speech ("bow-wow," "meow," "cock-a-doodle-doo") and nursery rhymes ("Baa-baa black sheep, have you any wool?"). Cognitive linguists have adopted the term "iconicity" from Peircean semiotics, for any linguistic situation in which the form evokes an associated concept through resemblance, of which onomatopoeia is the prototype.[13]

Mendel's A/a pair is autological because the majuscule letter represents the "greater" trait of the pair, while the minuscule letter represents the "lesser" trait. The greater size, or perhaps the "grandeur," of the majuscule grapheme signals the dominant trait of the pair; the smaller size, the relative modesty, of the minuscule signals the recessive trait. Staying with our cotyledon color example, simple ploche tells us which trait will manifest in the A/A hybrid and which trait will manifest in the a/a hybrid (these are the two homozygous hybrids). But polyptoton (constrained variation), along with the autological signal that one polyptotonic element is greater than the other, tells us which trait will manifest in the A/a and a/A combinations (these are the two heterozygous hybrids). If yellow cotyledon is dominant, green recessive, and they are, we know there will be three yellow cotyledon plants produced with these combinations (A/A, A/a, and a/A), signaled by the presence of the majuscule letter in the pairs of variable, and one green cotyledon plant (a/a), signaled by the duplication of the one variable. We get, in short, Mendel's famous 3:1 ratio.

Notice that Mendel might easily have used a notation that did not utilize onomatopoeia/autologia—going totally abstract with "p and q," or "x and y," or "m and n," for instance, or going totally mnemonic with "d and r" (for "dominirend" and "recessive"), or taking a more "concrete" and localized mnemonic route with something like "Ge and Gr" for cotyledon color (for "Gelb und Grün" ["yellow and green"]). But the A/a convention is considerably more more parsimonious. Autology allows Mendel to be *both* abstract *and* mnemonic at the same time and also allows him to utilize the convention more generally when designating different combinations of contrasting traits: he also uses B/b and C/c signifying pairs, for instance, so that he can identify clusters of traits in given plants with strings like AbC, abC, and ABC (e.g., 1966, 45). Moreover, the genericness of A/a implicates

a universal law. By making the letters applicable across all traits Mendel is visually enacting universality: *any* trait goes here.[14]

At this point, with a few figural correspondences on the table, it is worth noting how these notational features work not just within a given formula but between and among formulae. The true way to characterize Mendel's convention is not A/a, but X/x—that is, not as a specific variable alternation but as a *class* of alternations giving us B/b, C/c, D/d, . . .—and it is this *class* of alternations that utilizes ploche and polyptoton and onomatopoeia to cement identity of trait referent, trait-pair alternation, and the dominant/recessive concept among formulae. That is, these figural correspondences are not "simply stylistic" attributes of individual expressions but defining features of the argument.

Antithesis frequently attends antimetabole (illustrated by the famous Kennedy example) because of the high degree of affinity between inversion and opposition, and it is prominent in Mendel's central formula. Indeed, Fahnestock regards Mendel's deployment of antithesis as the definitive contribution of his paper. "The hallmark of Mendel's work," she notes, "is not his careful empiricism; his many predecessors in plant hybridization did far more breeding experiments than he did. It is rather his imposition of antitheses in both constructing his categories of observation and in interpreting his results" (2005, 116). Antithesis operates in Mendel's formula both in terms of the general opposition at the heart of the argument it epitomizes and in the specific expression of two oxymorons in the formula (A/a and a/A). It is crucial for Mendel that his A and his a signal not just variation but opposition. The two variables are, in the very narrow trait-pair frame of reference, antonyms. In our cotyledon color example, for instance, there are only two possibilities, yellow or green. (Compare the narrow frame of reference known as vertical direction, which has only two possibilities, coded in English by the antonyms "up" and "down.") The two cotyledon color possibilities are *manufactured* antonyms (yellow and green are only oppositional in the specific binary experimental frame Mendel sets up); other trait pairs in Mendel's experiments are more naturally oppositional (smooth/wrinkled cotyledon surface; short/long stem length); still others are somewhere in between (inflated/constricted pod shape; axial/terminal flowers). All are coded with the majuscule/minuscule letter opposition.

Oxymoron signals a paradox, most famously in the familiar one that attends discussions of the principle of noncontradiction, a and ~a. The most frequent argumentation result with the principle of noncontradiction is a zero-sum result—one alternative wins, one loses—which is precisely the

use to which Mendel puts his antitheses, epitomized especially sharply in the two oxymorons in his formula.[15] Note, too, that the oxymorons are absolutely essential for Mendel's argument. The fundamental problem for heredity before Mendel lay in the transmission of discrete traits—how, theoretically, to prevent a blending down with every generation to a slurry common denominator. Genes, prefigured by Mendel's work and illustrated most clearly in the dominant/recessive patterns, solve that problem. A must be ~a; a must be ~A. This result is most elegantly expressed by the combination of ploche, polyptoton, onomatopoeia, and oxymoron in Mendel's formula. The notion of dominant and recessive traits is largely irrelevant for the A/A and the a/a combinations—either contributing source, or some inherent character of the trait itself, or even a blending model could explain those hybrids. It is only the A/a and the a/A combinations (that is, the oxymorons), producing plants with the A trait, that instantiate the zero-sum result (A always wins; a always loses) and articulate the famous 3:1 ratio. Those two compound expressions also encode another paradox, a contradiction in *experience*, more than in terms. If you look at a plant that can be described as the result of an A/a or an a/A pollination, you see only a green cotyledon, but the yellow cotyledon trait unit, these expressions tell us, is really there as well.

Metaphor is criterial to variables as a class and criterial specifically for the functioning of Mendel's key formula. We have already noted that identity of referents in iterations of variables depends on ploche. *Genericness* of reference, even more fundamental to variables, depends on metaphor.

The basic representational operation of mathematics, and of the kind of quasi-mathematical expressions Mendel utilizes, is analogic. That's why mathematical formulations in science are routinely characterized as *modeling* or *mapping* phenomena. Mathematical expressions put signs into abstract relationships that map (or are intended to map) concrete relationships. In Mendel's case we have traits represented as letters. What the formula claims is that the referent traits behave in reality the way we model their behavior with letters on the page. Mendel's formula says that, in his garden, he crossed plants with different characteristics in parallel to the way he combined and crossed letters on the page. He bred yellow cotyledon traits together with other yellow cotyledon traits and with green cotyledon traits, as well as green cotyledon traits with green cotyledon traits, in precisely the four exhaustive combinations expressed in the formula. There is, in short, a very tight iconicity between the formula and the experiment and, therefore, between the formula and the world. It is a narrow and

abstract iconicity, but it is unequivocal, and it is absolutely fundamental to mathematico-scientific argumentation in general, clearly demonstrable in Mendel's formula in particular.

Reification, the particular metaphorical idiom in which an abstraction is given thingness, is made concrete, may be the most consequential aspect of Mendel's formula. His variables, above and beyond the cleverness of the polyptotons and the onomatopoeia/autologia, the utility of the ploche, and the inevitability of metaphor, do their most lasting work by reifying the traits, by making them into things—in fact, into *particulate* things among a host of particulate things carrying the blueprint of the plant. By linking the traits visible among the pea plants in his garden to variables (nominals) in his formula, combining them in systematic ways, and manipulating those combinations on the page, Mendel is arguing for particulate inheritance. In a very real sense, there were no referents for the variables to index when Mendel mounted his argument, no things in the sciences of botany and hybridization that the variables could refer to. Mendel was inventing them, asserting them by the very act of assigning variables, reifying them out of descriptive qualities (colors, textures, height). The referents had to await another generation before they got an explicit name, "genes."

Synecdoche and *metonymy* are also critical for Mendel's formula, and for experimental science in general, though the dividing line between them has not been well policed traditionally. They name a cluster of indexical and other associative relationships. Cataloguing those relationships would take us too far afield. So, for present purposes, I want to focus on part-for-whole synecdoche, which is the most basic and frequent type of association linked to that trope, and on effect-for-cause metonymy.

As noted, synecdoche is criterial for inductive reasoning, since the instances (parts) one generalizes from must be taken to represent a whole class. But more specifically in Mendel's argument, the expressed inherited trait (say, yellowness of the cotyledon) is part of the whole character inheritance of the given plant, and—this was perhaps the trickiest aspect of Mendel's argument for his contemporaries—so is the *unexpressed* inherited trait. The unexpressed trait in a given plant can only be expressed in subsequent generations, under the right circumstances, but it is equally a part of the whole organism. In anachronistic but clarifying language, this line of reasoning encapsulates both the phenotype (genes expressed) and the genotype (total genetic inheritance), a reciprocally defined pair of conceptions that was foundational for the development of modern genetic theory. Returning to the formula, Mendel's variables (A and a) stand for traits, but traits understood as

parts of a whole mosaic of such traits, expressed and unexpressed, inherited equally from seed and pollen, in hereditary units of indeterminate character.

Similarly, metonymy is indispensible for Mendel's argument and perhaps for all experimental research. Mendel was arguing for something very specific, a general theory of *particulate* inheritance. Such a theory can only take shape if the expressed trait (yellow cotyledon) is the effect of a combinatory mechanism that preserves units of inheritance (later, "genes"). The variables in his formula stand for traits, but those traits connect the observation (yellow cotyledon) with a dominant/recessive particulate mechanism on a causal basis.

Before leaving the tropes, I pause to remind you that tropes compound frequently and naturally. An expression for someone who is inactive and domestic, for instance, is "couch potato": the first term, "couch," is metonymic, selecting one possible, common piece of furniture where the inactivity might manifest; the second term, "potato," is metaphoric, comparing the target person with a root vegetable. "Mouse potato," a term I've recently come across, works by swapping out "couch" for a synecdoche (representing computer activity with a part of the computer) to signal physical inactivity because of incessant computer usage. But now notice that "mouse" is, in the first order, metaphoric, as the early pointing devices were shaped a bit like mice—smallish, curved front to back, side to side, with a cord trailing out behind them. "Mouse" is a metaphoric synecdoche in the synecdoche-metaphor compound, "mouse potato." There's even some assonance in the coinage (in "couch" and "mouse") that no doubt has contributed to its creation and propagation. When I catalogue a conspiracy of figures shaping and representing the argumentation, that is, I am not on a wild, find-anything-remotely-synecdochal, deer-park hunt; rather, I am systematically uncovering the tropic and schemic actuations in Mendel's formula, exactly as one finds in natural-language lexicalization.

Antimetabole, finally, is the organizing figural pattern of the formula. Mendel's antimetabole serves two of the key functions common to that scheme, to signal comprehensiveness and commutation. Comprehensiveness is a typical use of the antimetabole, which has a natural there-and-back-again sense of domain coverage, as in this double example from the opening of a speech in the movie *Horse Feathers*: "Members of the faculty and faculty members, students of Huxley and Huxley students. Well, I guess that covers everyone" (Mankiewicz and McLeod 1932). Mendel's antimetabole carries the claim that all combinations were accounted for in his experimental design, first by iterating them (ploche being particularly important here)

and second by foregrounding the reciprocality of the combinations (A with a and a with A), which is where the antimetabole comes in. And charting the commutative principle is one of the most familiar pedagogical and mnemonic applications of antimetaboles (see Fahnestock 1999, 133–35):

$$m + n = n + m$$
$$m \times n = n \times m$$
$$m - n \neq n - m$$
$$m \div n \neq n \div m$$

Mendel's antimetabole argues that parentage doesn't matter, in exactly the sense that order doesn't matter for operations like addition and multiplication: no matter which order you mix them (dominant from male, recessive from female or dominant from female, recessive from male), the result is the same.

Note that the antimetabole is not *required* to argue for either comprehensiveness or commutativeness, but it crystalizes both properties in a way that is clearly very important to Mendel. Figure 2, an alternative formulation Mendel gives of his experimental design, is "equally" comprehensive. In achieving the logical possibility of four combinations, each source can produce two instances of each trait for possible combination with the two instances of each trait provided by the other source. Mendel also offers another formula to the same end (abbreviating the ploche slightly): A + 2Aa + a. In this variant expression, we see there is one combination in which both plants have the dominant characteristic (A), one combination in which they both have the recessive characteristic (a), and two in which they have one dominant matched with one recessive (2Aa). Mendel is not content with this formulation, however. As he works his way through a series of formulations to express the combinations he utilized, he offers yet another representation, the curious graphic in figure 3. This graphic represents the "crossing" nature of his experimental design with the central bisecting arrows, but it maintains the notational sequence of figure 2. This theme-and-variation series of ploche-laden formulas does two things in particular.

Firstly, the series does the sheer, brute, redundant work of repetition. His readers cannot overlook the constant conjoining of the variables and, hence, of the traits. His immediate readership either overlooked or underappreciated the theory of particulate inheritance that was also repeating before their eyes, but later generations did not. And this repetition of his experimental procedure, in a range of equivalent configurations, makes insistently visible the invisible, unexpressed traits: three different combinations

The egg cells: $A + A + a + a,$

The pollen cells: $A + A + a + a.$

FIG. 2 An Alternate Formula for the Distribution of Dominant and Recessive Character Traits in Mendel's Design. From Mendel (1966 [1866], 30).

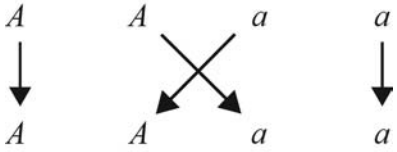

FIG. 3 Another Alternate Formula for the Distribution of Dominant and Recessive Character Traits in Mendel's Design. From Mendel (1966 [1866], 30).

in his design may all yield the A-coded outcome, but the a-coding units are always present in the offspring plant. We may only see a green cotyledon when we look at one out of four plants, but the formula tells us that the green-coding hereditary unit is somewhere in those other three plants too.

Still, figure 3 is a way station for Mendel. The antimetabole (fig. 1) is the defining configuration for him. Immediately following figure 3, Mendel writes that "the result of the fertilization may be made clear by putting the signs for the conjoined egg and pollen cells in the form of fractions, those for the pollen cells above and those for the egg cells below the line" (1966, 30).[16] Immediately, in the language of derivational inevitability ("we then have . . ."), he serves up the quintessential formulation of his experimental design, the antimetabole, figure 1.

This section of his paper seems to show Mendel arguing himself into the antimetabole or preparing the ground for his audience to accept the antimetabole—perhaps both—as the optimal expression, the epitome of the fused factors of exhaustive representation and independence of source with which to express his combinatorial procedure, along with its results, in a proof for a general theory of particulate inheritance. In short, we see the epitome of Mendel's reasoning and of Mendel's argumentation in the antimetabolic formula at the heart of Mendel's paper.

CONCLUSION

This article outlines Jeanne Fahnestock's program of figural logic and then charts the figural mechanisms of one formula in Mendel's "Experiments on Plant Hybrids" as an extended example of that program. At the heart

of Mendel's seminal paper, epitomizing the argument, I have shown, is an antimetabole. Its chief functions are to encapsulate his revolutionary experimental design and its implications, conveying specifically comprehensiveness (every combination has been tested in the binary trait space) and commutativeness (every combination, regardless of the source of the trait, male or female, is the same as any other combination). This encapsulation, in turn, certifies the experimental results.

But figures rarely travel alone. Some figures entail certain other figures, some have natural affinities for certain other figures, and some just co-occur from a convergence of motives. Mendel's antimetabolic formula includes a number of other figures from all of these categories.

Chief among these attendant figures is ploche, which, I have argued, is criterial both to antimetabole (so criterial that antimetabole might be defined as inverted ploche) and to the use of variables in mathematical and quasi-mathematical notations (so criterial that any other method to ensure identity of referent would introduce unnecessary complexity and ambiguity). For Mendel, ploche works especially to convey the stability of the factors (the traits), as well as of the combinatorial operations, and to relentlessly iterate the reified hereditary units at the center of his framework.

Polyptoton, variations upon the same lexical stem, is also central to Mendel's argument because the two traits (e.g., yellow and green) must be tightly bound as mutually exclusive alternatives for his argument to go through; that is, they must be expressed in the same domain (cotyledon color). Variation of the same grapheme (A and a) captures this relationship. Polyptoton is not entailed by the antimetabole (as ploche is); rather, polyptoton serves a parallel function in Mendel's argument and naturally accommodates antimetabole.

Onomatopoeia (or, in any case, autology) efficiently conveys for Mendel, in simultaneously abstract and mnemonic ways, the categories of dominant and recessive traits. The iconicity of the majuscule/minuscule alternation nicely reflects the dominant/recessive alternation of trait expression within the same referent space. Again, there is no necessity from the antimetabole, nor from Mendel's design, for this iconicity. But the stylistic implications of the big/little pairing are automatically (almost subliminally) apparent and, especially in concert with ploche, reinforce the experimental significance of dominance and recessiveness as properties of the traits (or, more precisely, as properties of the particulate inheritance mechanism responsible for the expression of those traits).

Antithesis is absolutely crucial to Mendel's argument, because A and a function in his design as indices for traits in binary opposition within their domain (cotyledon color, pea topography, and so on). Either one or the

other must be expressed—not both, not neither, not a blend. The fact that the primary "declensions" of Roman alphabet graphemes only run to two (majuscule and minuscule) adds a particularly apt overlay of iconicity on the structure of the trait domains.

Metaphor, I have argued, is required for variables to operate, because something from one material sphere, a mark, represents something from another material or conceptual sphere, and the manipulations of the mark (in combinations, juxtapositions, oppositions, deletions, and so on) model the arrangements and manipulations of material things or concepts; in Mendel's case, letters stand for traits brought into controlled combination with each other.

I have argued that reification was essential for Mendel's argument to achieve its full power. By representing the traits as concrete objects, assigning them variables, combining and manipulating those variables, and tying them to the appearance of physical plants, he created inheritance units. In combination with ploche, not just in the formulae, but recurrently throughout the essay, threaded through his argumentation, linked to his experiments, he makes the units more and more real—or, at least he did so for a later generation, in the early twentieth century.

Finally, I have also argued that synecdoche and metonymy attended Mendel's antimetabolic formula in an especially revealing way, revealing about the reach of the formula itself, revealing about the figural dimensions of argumentation generally and of scientific reasoning particularly. The variables in Mendel's formula stand for, and instantiate, traits. But the reified traits are important not just for their raw occurrence in the plants. They are important as (synecdochic) parts of a whole mosaic of expressed and unexpressed inheritance units, in a way incredibly suggestive of the genotype/phenotype distinction that became fundamental to genetics. Further, the traits to which the variables point connect the observational end of the experiment with dominant/recessive traits and the particulate inheritance mechanism. That is, they link the data with the theory in a necessarily causal (metonymic) relationship.

Why then, one might ask, was Mendel's paper, with its exquisitely figured central formula, not successful? How did all this persuasive machinery fail to propel Mendel's arguments to the pinnacle of biological science? That's not quite the right question, of course, since the paper *was* spectacularly successful. It *did* propel Mendel's arguments to the pinnacle of biological science, where it has remained, a locus classicus, ever since. And its figural logic has surely contributed to that success. But why was it not *immediately* successful? What took so long?

Many scholars have attempted to explain that lack of a single quickening heartbeat in the reception of an argument that subsequently proved to be among the most revolutionary in the history of science, giving Darwin's theory of evolution a key explanatory base and laying the table for a burgeoning slate of sciences and technologies that defined much of the epistemological and virtually all of bioindustrial activity in the late twentieth century and that continues to do so in the early twenty-first century. The most frequent explanation for why its importance was so dramatically overlooked is the mathematical style of argumentation Mendel deployed, which the botanists and hybridists of the nineteenth century did not find compelling. But the opacity of his figural logic for that first audience, intermingled with his notation, may also hold some of the explanation.

The apparent inability of contemporary hybridists to see the reification, the imaginative creation of an inheritance unit, especially suggests a tentative explanation for the profoundly muted initial welcome given to Mendel's arguments. The synecdochic and metonymic dimensions, too, seem to have been wholly missed by the hybridists, laying in wait for an audience that was more tuned to these representational and reductive implications. The hybridists apparently heard or read right past the synecdoche, failing to see the importance of the experimental design in large. The way they saw Mendel, he was talking only about plants, and not many of them, just a few pea varieties, rather than about general laws of particulate hereditary transmission, expressed in the 3:1 ratio. Mendel's sample was certainly representative of particulate inheritance for him, but it did not seem to generalize very far for the hybridists. For them, his paper may have just looked like a recipe to ensure yellow or green cotyledons, puffy or constricted pea pods, smooth or wrinkled seed topography. The early twentieth century biologists, however, were far more receptive to this kind of sample-based, theoretically informed, causal reasoning.

My goal, however, has not been to probe the suasive failures and deferred successes of Mendel's epochal argument, nor to probe its inventive development—though I regard both of those routes as highly profitable paths in which to take figural logic. Rather, I have taken the preliminary course of surveying the basic mechanics of that argument, to show that the logic of Mendel's case, as epitomized in the amalgamated schemes and tropes at the heart of "Experiments on Plant Hybrids," is inextricably figural.

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NOTES

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1. There is no precise bound, because new figures come into circulation and old ones fall out and because the demarcation between figures and other speech patterns is highly permeable, but the excellent website Forest of Rhetoric: Silva rhetoricae (rhetoric.byu.edu) lists well over four hundred.

2. This taxonomy, I hasten to add, is mine, partially articulated in Chien and Harris 2010. It is not, in particular, Fahnestock's, who does not commit to a taxonomy, who questions the value of *any* taxonomy of figures, and who specifically rejects the long-standing criterion that I adapt for my taxonomy, deviation. The closest Fahnestock comes to a taxonomic commitment does, however, have heartening similarities to mine. She loosely endorses the utility of a scheme/trope/figure-of-thought classification, affiliating figures of thought with speech acts and related interactional gestures, that is, with intention, which I affiliate with chroma (1999, 10ff.). There really is no way around some notion of deviation, from my perspective, for understanding figures. Language works in terms of patterns and expectations about those patterns, and figures capitalize on those expectations, however hard it might be to catalogue such expectations (which necessarily vary to some degree with speaker, register, genre, dialect and with every individual and collective that uses language). I note, in connection, that even prosaic "literal" processing is described in construction grammar in terms of "distortion." For instance, in "Give me some pillow," the noun "pillow," normally a count noun, is processed easily as a mass noun because that distortion has been "coerced" out of it by the morphosyntactic frame, "Give me some . . ." See Michaelis 2005 for this example and much related data of distortion and coercion.

3. I prefer "bland" to "literal" in this context, because "literal" is too narrow, referencing only the semantic domain, signaling a supposed absence of tropes (conceptual deviations) and ignoring the fact that schemic and chromic patterns occur both in contexts of prosaic flatness ("bland language"), the domain of unremarkable formal patterns and default utterance-intention match-ups, and in contexts of heightened salience ("figural language"), where they would mark deviations from those expected formal and intentional patterns).

4. While I promised to leave affect out, it may be worth reneging on that promise briefly to point out here that associations merge the sympathies (or antipathies) and allegiances (or repudiations) of one referent with another, so that arguments capitalizing on forced associations (a kind of manufactured metonymy) are frequently seen as fallacious, as

in the guilt-by-association fallacy, or the *ad verecundiam*, where a claim tries to gain luster through association with a celebrity or other irrelevant authority.

5. In fact, please allow me to take this claim one controversial step further: irony is not a trope. Irony is a chroma. Irony is one of those figures I mentioned whose deviations occur in multiple dimensions, so that its classification is somewhat less pure, requiring a weighing up of the contributions made to their effect by the salient shifts in those respective dimensions. But I argue that the determining factor for irony is not semantic subversion, which is only truly opposite in the crudest ironic figures, like sarcasm, but the intention. Irony implicates *repudiation* (which is an intentional posture, not a semantic factor) of flat denotation far more than it implicates *inversion* or *reversal* or *opposition* of that denotation. In repudiation, affirmation of the meaning is inverted (the "yes" becomes a "no"), but not always the meaning itself. Booth's first criterion of irony is that it is "*intended*, deliberately created by human beings to be heard or read and understood"; the second criterion is that the intention is patently "*covert*, intended to be reconstructed with meanings different from those on the surface" (1974, 5–6; emphasis his). We do not have the time or the space (or the mandate) to trace the long history of irony here, but I will note that Quintilian regarded irony as both a trope and a figure of thought (which corresponds loosely to my chroma) in different construals (9.2). If I were to choose a fourth master trope to take the place of irony in the familiar grouping, it would be antithesis, because opposition is a fundamental cognitive disposition, as are similarity (metaphor), representation (synecdoche), and association (metonymy).

6. This text is extracted from a diagram on the front page of the science section of the *New York Times*, promoting an article inside by William Stevens (1995). I have put the text into a vertical list for ease of review (Fahnestock, for her part, puts it into a continuous paragraph). Fahnestock also reproduces the diagram (1999, 110). The original text captioning the diagram is "In a hypothetical example given by Dr. Mech, a wolf kills a moose. The remains slowly disintegrate and add minerals and humus to the soil, making the area more fertile. Lush vegetation grows, which attracts snowshoe hares, which in turn draw foxes and other small predators, which coincidentally eliminate many of the mice that live nearby. A weasel that used to hunt the mice moves to another area and in so doing is killed by an owl. The chain could be extended indefinitely" (1995, C1). See also Tindale 2004, 72–73, which offers an insightful discussion of Fahnestock's use of this example.

7. Epanaphora is likewise critical in the textbook's account of Koch's postulates, and for the same reason. Stability of predication is as important as stability of referents, so three of the four postulates begin with "the organism must be," followed by a descriptive predicate. Notice, by the way, the hierarchical relation between ephaphora and ploche: you can't have clause-initial lexical repetition without lexical repetition. Any case of epanaphora is necessarily a case of ploche (indeed, multiple cases of ploche).

8. I realize, by the way, how anglocentric this discussion of syllogisms is. For languages that put a lower premium on the syntactic function of word order, for instance,

the function of locational figures like epistrophe and epanaphora—that is, of coding argument structure—might be carried out by a morphological figure, such as homoteleuton (the repetition of case markings). But the predicate calculus is not fact simply analytic: some operations in predicate calculus, like union, are indifferent with respect to order, and it is the binding function of the variables, operating like agreement morphemes in natural languages, that perform the necessary "syntactic" function; the repeating variables, that is, precisely parallel repeating affixes and equally exemplify homoteleuton. In one case, stability of function is coded by stability of order; in the other, stability of function is coded by stability of affix. Clearly, there is much cross-linguistic work to be done in figuration generally and figural logic specifically.

9. See Wynn 2007 and 2012 for a superb account of why the paper's importance was missed in the mid-nineteenth century. The other side of the coin is why it became so celebrated in the early twentieth century rather than simply remaining obscure. Part of the answer has to do with Bateson's evangelical support, but part of it surely also has to do with the structure of the original reasoning and with *kairos*; in particular, with the certainty that it was easier for the twentieth century scientists to "hear" Mendel's quasi-mathematical argumentation. David Lock (1992, 95–98) argues that the initial obscurity of the paper was largely ethotic and that it subsequently emerged out of that obscurity owing to the development of a new ethotic context. Mendel was too modest, Lock argues, using a tone suitable for "normal science"; his early twentieth-century advocates (DeVries and especially Bateson) were more appropriately insistent, using tones suited to "revolutionary science."

10. Mendel would certainly have known many of the figures discussed here, of course, from his gymnasium education, which still centered on Latin in the nineteenth century and prominently featured rhetoric, grammar, and poetics. But it remains unlikely that he would have been conscious of the parallels between those figures and the mathematics on which he based his formulae and far less likely yet that he would have "designed" his formulae with figuration in mind.

11. Polyptoton is not an uncommon traveling companion of antimetabole, incidentally, especially in case-marking languages. Here's an example from English: "Does College Make You Liberal—or Do Liberals Make Colleges?" (Mooney 2012).

12. Compound-word antimetaboles are rare but certainly attested, as in the title of the following article: "'Jewgreek and Greekjew': The Concept of the Trace in Derrida and Lévinas" (MacDonald 1991).

13. Mendel's A/a autological notation is visual and orthographic rather than sonic and oral, and I have no particular stake in whether we want to call it onomatopoeic or just autological or come up with some new term. But "onomatopoeia" etymologically only references the "creation" ("poiein") of a "name" ("onomatos"), not sound or even iconicity, and I have not been able to find a more appropriate label for this clearly figural move in the rhetorical literature. If figuration labels were logical, and if I thought I had any chance

of affecting a long-standing usage, I would propose onomatopoeia as a type of autological trope, containing at least the two subclasses: phonotopeia (sound iconicity) and graphotopeia (letter iconicity).

14. I thank James Wynn for much help with this article overall but especially for pointing me toward this line of thought in personal communication.

15. One would naturally expect the two identity expressions—which we might treat as reduplicated compound words, like "aye-aye," "bye-bye," and "goody-goody"—to correlate with an identical result. A/A *should* result in the A trait (or, instantiated, yellow/yellow should result in a yellow cotyledon); a/a *should* result in the a trait (green/green should result in a green cotyledon). It is the A/a and a/A compound, polyptotonic oxymorons, that demonstrate the power of Mendel's results (both resulting in the expression of the dominant trait, A).

16. "Das Ergebniss der Befruchtung lässt sich dadurch anschaulich machen, dass die Bezeichnungen für die verbundenen Keim- und Pollenzellen in Bruchform angesetzt werden, und zwar für die Pollenzellen über, für die Keimzellen unter dem Striche. Man erhält in dem vorliegenden Falle" (Mendel 1866, 30).

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