

CHAPTER II

Digital Readings

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What do we stand to learn from observing that *Gravity's Rainbow* (1973) contains 15,983 instances of the letter "k"? That its longest sentence contains some 357 words but that the average sentence length is just 14.6 words?¹ The text of the novel scores a 71.5 on the Flesch-Kincaid Reading Ease test, and a 9.9 on the SMOG Index, for an average reading grade of 8.9 across eight distinct readability tests.² In a book of long words, does it help us to know that *Gravity's Rainbow's* longest word isn't a word at all, but rather the composite "swirlinggrainoftreelikefrozensmoke" (76). Average word length in the book is just 4.5 characters. There are about a hundred thousand nouns in the novel, making up not quite a full third of the text.³ Like Roger Mexico totaling up his time with Jessica Swanlake, we might wonder whether "the statistician can make these figures mean anything" (*GR* 121).

Let's refine a set of observations and start again. Though the novel has a reputation for linguistic difficulty, its word length is generally comfortably short, and the average sentence length is eminently readable by just about any standard. At the same time, *Gravity's Rainbow* is overly dense with nouns, as in the novel's longest sentence, that whopper Steven Weisenburger calls a "rubble of words."⁴ Additionally, the book is light on personal pronouns for fiction, and its points of view shift frequently, both among its many characters and among its many temporal and spatial locations. *Gravity's Rainbow* is full of what Bernard Duyhuizen describes as "time and place traps," in which temporal and geographical markers within the text do not correspond mimetically to the unfolding of narrative time.⁵ Its narrative voices are idiosyncratic, and on occasion the novel is orthographically strange, as in "swirlinggrainoftreelikefrozensmoke."

Can digital tools provide insight into some of these textual features? Using computational methods, can we visualize anew how the novel's polyphonic linguistic forms relate to narrative episodes? By estranging ourselves from the text digitally, can we gain new insight into the novel's

global structure? Its local registers? Does seeing *Gravity's Rainbow* outside linear novel-time – that is to say, without being tied to the linearity of the material book – help us to unravel the novel's labyrinthine temporalities? Reading a novel like *Gravity's Rainbow* “by the numbers” might seem particularly perverse given Pynchon’s robust skepticism about technomania, but it’s compelling, nevertheless, to consider that new ways of reading Pynchon might emerge from not *reading* Pynchon at all.⁶ In what follows, I’ll give a brief summary of what digital work has been done on Pynchon to date, proposing some goals and constraints for the present essay. Then I’ll offer a series of computationally derived graphic visualizations of *Gravity's Rainbow*, arguing that we can leverage the idiosyncrasies of the text – specifically its unstable tenses – to manipulate our visualizations. In the end, I argue that by deforming the text, in Stephen Ramsay’s sense, we can indeed uncover new ways of understanding old questions about Pynchon’s most notoriously difficult text.⁷ Specifically, my visualizations bring to light a systemic relationship between tense and theme within the novel, underscoring how past-tense narration tends to correlate with some of the novel’s weightiest historical materials. By mapping tense across *Gravity's Rainbow*, we make legible the logic behind the novel’s uneven deployment of tense. While many critics have noticed the novel’s apparent dialectic between historical awareness and something like mindfulness in the present, we can trace as well how the novel’s grammatical modes shift from a present tense focused on Slothrop’s wanderings to a past tense focused on the Nazi science that informs the book’s moral core.

What Should a Digital Reading Do?

Contemporary digital humanities is a sprawling set of methods and practices self-consciously “bound up,” as Matthew Kirschenbaum once put it, “with [technical] infrastructure in ways that are deeper and more explicit than we are generally accustomed to.”⁸ Digital humanists might produce electronic editions of texts, such as Jerome McGann’s Rossetti Archive or, more recently, Amanda Visconti’s Infinite Ulysses. They might digitize large bodies of text or particular collections, like those compiling the HathiTrust Digital Library or like the Smithsonian’s Digital Volunteers. They might aim to produce new models for literary history, the goal of Andrew Piper’s multi-institutional NovelTM initiative. Or they might explore new methods for analyzing smaller bodies of work, as in J. F. Burrows’s famous study of Jane Austen’s function words.⁹

Computational work on Pynchon has tended toward analysis of single texts, focusing on either demonstrating the precision of, say, machine-learning algorithms in categorizing critically accepted narratological analysis or on quantitative description of qualitative thematics.¹⁰ More recently, there's been interest in visualizing Pynchon's texts, in producing character networks and topic models, and in stylometric analysis of Pynchon's nonfiction.¹¹ Pynchon is also the subject of Tim Ware's Pynchon Wiki, a born-digital crowdsourcing effort to annotate all of Pynchon's novels, and Ware's project has garnered sustained critical attention as an object of digital analysis in itself.¹² That said, computational assessments of Pynchon's work remain somewhat provisional and exploratory, highlighting the usefulness (or not) of certain tools and methods but stopping short of broad claims to discovery. On the one hand, some digital readings of Pynchon suffer from a lack of context in framing what are essentially formalist stylometric observations, which means that interpretive conclusions might seem unprincipled or arbitrary.¹³ On the other hand, some methods demand a steep technological learning curve, and can be seen to emphasize mastery of technique over interpretive argument.¹⁴

An example of the former is David Letzler's observation that the word "is" appears with disproportionate frequency in *Gravity's Rainbow* relative to the fiction subset of the Brown University Standard Corpus of Present-Day American English.¹⁵ Interpreting this observation in the context of critical discourse, we might wonder if the verb's overabundance is a proxy for the novel's oft-noted emphasis on "the moment," to borrow George Levine's phrase.¹⁶ But as Letzler rightly notes, the novel is also written, for the most part, in the present tense, unlike its contemporaries in the Brown corpus, so it's hard to tell from the evidence to hand what the prevalence of "is" really means. An example of the latter is Christos Iraklis Tsatsoulis's unsupervised machine-learning experiment with *V.* (1963), which he readily admits is not for the benefit of literary scholars, except insofar as they might come to view computational methods with less suspicion. The purpose of the study, Tsatsoulis says, is to show that machine-learning techniques can distinguish the two dominant narrative threads in *V.*, or that computational techniques "converge to the already known answer."¹⁷

Hence, two common critiques of work in the digital humanities: one, that interpretive insights are too weakly supported by evidence and, two, that digital humanists privilege technological expertise at the expense of humanistic knowledge. Neither critique is wholly justified (not in general

or in the specific examples I mention). Both are instructive, however, in that they help us to define our aims in conducting something labeled a “digital reading,” especially when that reading is focused on a single text. A digital reading has to make meaningful interpretive claims without falling prey to the charge of arbitrariness. And a digital reading should go beyond demonstration of method; it should answer a research question about the text.

Deforming *Gravity's Rainbow*

In *Machine Readings: Toward an Algorithmic Criticism* (2011), Stephen Ramsay argues that digital reading allows us to “employ the rigid, inexorable, uncompromising logic of algorithmic transformation as the constraint under which critical vision may flourish.”¹⁸ Following Lisa Samuels and Jerome McGann, Ramsay asks us to consider computational analysis as a sort of critical Oulipo operation, a method by which to expose “areas of the poetic and artifactual media that usually escape our scrutiny.”¹⁹ In other words, computational analysis can change our view of a text, opening creative critical possibilities. It can expose features of a text obscured within the linearity of the printed book. It can untether the eye from the codex.

In this vein, we might think to deform the text of *Gravity's Rainbow*. Specifically, I'm interested in manipulating the text along the lines suggested by David McClure when he proposes using probability density to produce something like a “diagram of the idea of a text.”²⁰ McClure's notion is appealingly uncomplicated. If you think of the length of the text as an x-axis – for *Gravity's Rainbow*, that's 328,552 words – you can then plot the occurrence of any given word along that axis.²¹ As McClure explains, this gives us a word-dispersion plot in what Matthew Jockers has called “novelesque time.”²² We then divide the x-axis into segments, count the number of occurrences in each, and end up with a series of integer values tracking occurrences of our given word from the start of the book to its end. Figure 1 shows occurrences of the word “is,” plotted as integer points, for every 1,000 words of *Gravity's Rainbow*. We can smooth our graph by turning the points into kernel density functions, as in Figure 2.²³ Now we have a fairly intelligible, “non-noisy” estimation of how the word “is” disperses across novel time in *Gravity's Rainbow*.

McClure's idea, then, is to plot a given number of words across the novelistic time of a book and to compare those plots to see which words tend to appear together and where.²⁴ We can then visualize word

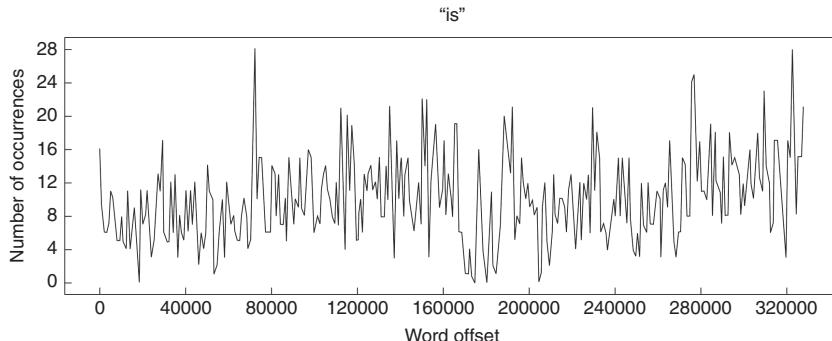


Figure 1 Occurrences—of the word “is” per every 1000 words of *Gravity’s Rainbow* plotted as integer points

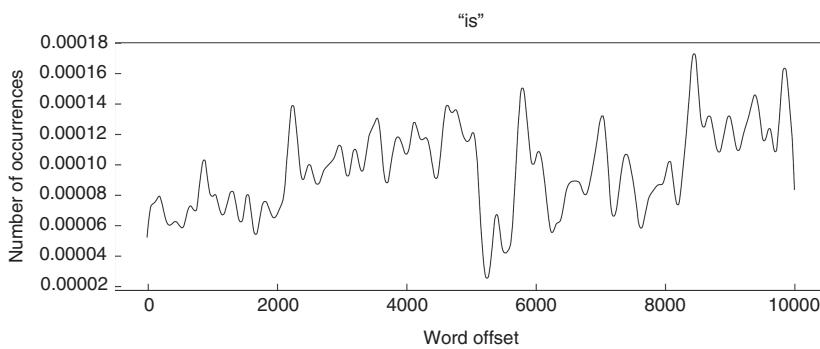


Figure 2 Kernel density estimate of “is” across *Gravity’s Rainbow*, 2000-word bandwidth

correspondences as a network graph, which gives us a way to view globally how words “hang together” in a text. It’s a remarkably straightforward implementation of word distribution that results in what McClure calls a simple “intra-document” topic model.²⁵ Figure 3 shows a network graph of the 1,000 most frequently appearing words in *Gravity’s Rainbow*, not counting high-frequency words, such as determiners, auxiliary verbs, and pronouns.²⁶ The network maps how likely words are to appear near one another across the length of the novel. Words appearing near the center of the graph are well connected. That is, they are very high frequency and are likely to appear near many other words. Words appearing at the periphery of the text occur with lower frequency – most proper nouns appear here,

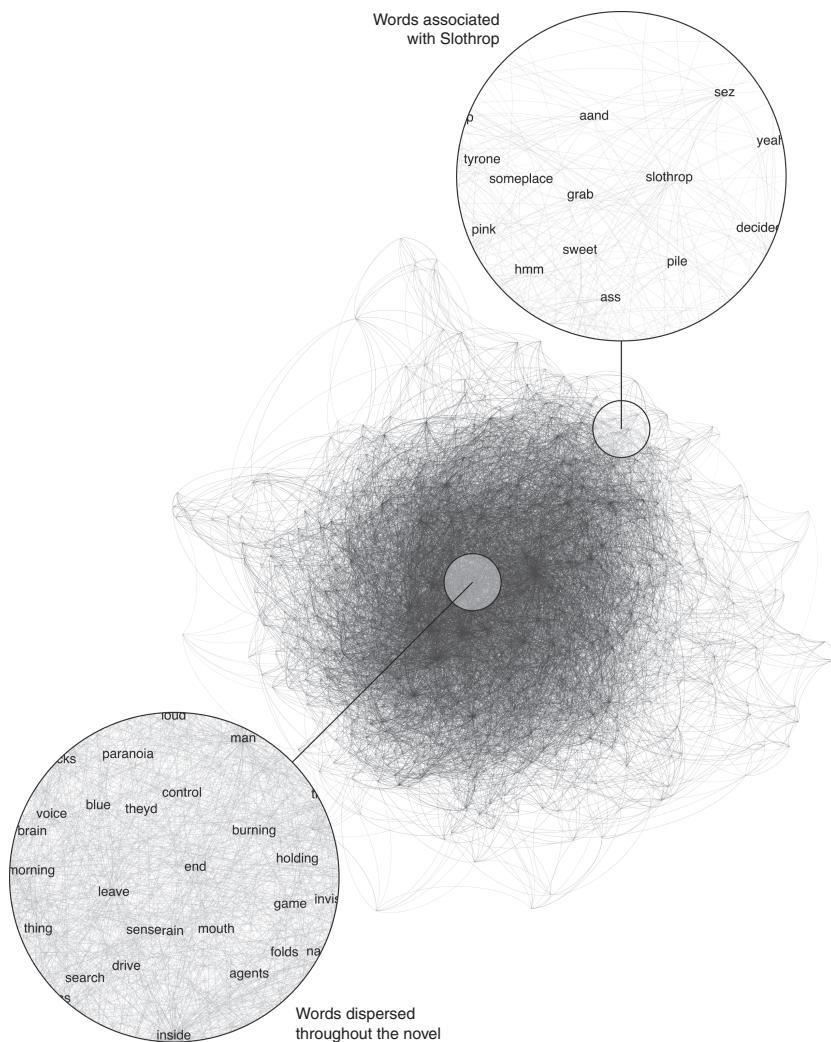


Figure 3 Textplot mapping of *Gravity's Rainbow* with details of a Slothrop word cluster and a central word cluster

for example – and are less well connected. Words that are peculiar to individual plotlines appear near one another and tend to cluster on the periphery. Incidentally, reading the periphery of the graph counterclockwise in this orientation roughly tracks with the linear development of the text.²⁷

This plot does a good job visualizing a few key features of the text. As Martin Eve noted when he tested McClure's Textplot software on *Gravity's Rainbow*, characters who belong together cluster on the map as do words we intuitively associate with one another (e.g., "Slothrop" and "sez," or "Weissmann" and "SS").²⁸ We also get a sense from this visualization of important episodes in the novel. Slothrop rescues Katje from Grigori at Casino Hermann Goering in the upper-left quadrant, for example, accompanied by "Bloat," "Tantivy," "shirt," "beach," and "bottle." He dons his Rocketman getup in the mid-right sector, not far from "Bodine," "Säure," "dope," "cape," "helmet," "boots," and "Berlin." Broadly speaking, the top-right quadrant belongs to Slothrop, his cohorts, and his escapades. The bottom right belongs to the Nazis, the Anubis, and the rocket. The bottom left, to Pointsman, Mexico, and England. The top left to Katje, feeling, and fucking. As we move toward the interior of the map, we see more abstract words, verbs, and descriptive terms. The center of the map is dominated by a few heavily weighted words – words that appear frequently throughout the novel and that, thus, correspond strongly with many other words in the text. Some of the most highly connected of these are "back," "day," "long," "time," "face," "eyes," "inside," "night," "feel," "head," and "find," and perhaps with the exception of "back" (which Letzler argues is overrepresented in the novel generally, relative to contemporaneous fiction), this set is not terribly surprising for a novel stripped of common stop words.²⁹

In short, McClure's Textplot produces a legible visualization of *Gravity's Rainbow* that jibes with our sense of the overall contents of the book. What's novel about this kind of visualization is that it strips the text from the linear confines of the codex. Compared to textual summaries of the novel, our Textplot visualization provides a wealth of information simultaneously. It's more navigable than conventional plot maps because regions are defined by textual nearness, and unlike a print or hypertext companion (e.g., the Pynchon Wiki), it's not organized by arbitrary alphabetical or numerical indices. We've deformed the novel through a process of text-based analysis that retains something of its original thematic, conceptual, and lexical structures.

While close reading Textplot mappings might be entertaining, in isolation it's not, as McClure himself admits, interpretively rich.³⁰ It's not clear that we get different results from reading the defamiliarized text than we get from reading the novel itself. Changing the appearance of the text, however – reordering it and rendering it afresh – is only part of the deformative project as Ramsay imagines it. If we are serious in taking our inspiration from the likes of Georges Perec, we need to consider the

algorithm as a constraint.³¹ When we think of the algorithm as constraint, we are asking how we might manipulate its parameters and arguments to produce novel critical observations. By leaning into computational constraints, we begin to think critically about how we might leverage their limitations to reveal something new.

McClure introduces an important caveat with respect to method in the Textplot project, and that caveat points to a feature of the program we can exploit. Looking at a “scrambled, less differentiated” map of *Leaves of Grass* (1855), McClure wonders if by bluntly selecting the first 1,000 most frequent words in a text (minus stop words), he’s distorting his maps by failing to cull words that are not common enough to make a universal stop word list but that are too common to an individual text to clearly cluster with one conceptual topic or another.³² In other words, does the Textplot method undermine its efficacy as a topic model by failing to filter the “noise” of globally common words within a given text?

For *Gravity’s Rainbow*, these globally common words are the ones inhabiting the center of the map – words such as “back,” “day,” “long,” “time,” “face,” and “eyes,” which I’ve already suggested aren’t very interesting if we’re looking to highlight episodes, characters, and concepts. In fact, several appear frequently not just in *Gravity’s Rainbow*, but in a number of novels. In comparing our map of *Gravity’s Rainbow* with seven other fairly disparate novels – *Robinson Crusoe* (1719), *Moby Dick* (1851), *Great Expectations* (1861), *Sister Carrie* (1900), *Ulysses* (1922), *The Great Gatsby* (1925), and *The Crying of Lot 49* (1966) – we find that eight terms central to *Gravity’s Rainbow* – “back,” “day,” “long,” “time,” “face,” “eyes,” “head,” and “find” – are also central to one or more of the other novels. “Time” is central to all of them. Evenly distributed terms might not just muddy the waters of individual maps, as McClure surmises; they might also inject red-herring terms, or terms that seem thematically relevant but probably aren’t.

We can quickly test McClure’s suspicion by running the program with an empty stop-word file. When we don’t remove stop words from the text at all, our map indeed collapses around a center of “to,” “in,” “a,” “and,” “of,” and “the.” “Back,” previously the most powerful word in our network, falls down to somewhere around fortieth in the list (depending on how you measure node importance), and we lose much of the specificity of our conceptual regions, as the map flattens to an oval with two poles – one dealing broadly with Slothropian themes and the other dealing broadly with everyone else. By not removing stop words, we ensure that we’re catching terms that, as McClure puts it, “aren’t ‘typical’ of any topic.”³³

The zero stop-word plot seems to show that *Gravity's Rainbow*, like just about any narrative in English, unfolds around a core set of function words. We can use this methodological limitation to our advantage.

Not all high-frequency words are distributed equally throughout *Gravity's Rainbow*. Most notably, tense – marked in some cases by the presence of past- rather than present-tense auxiliary verbs – is unevenly distributed throughout the novel. While *Gravity's Rainbow* is for the most part narrated in the present tense, it occasionally shifts to past tense, often to provide historical background – as in the description of Dog Vanya's vivisection or Brigadier Pudding's interwar backstory (78, 77–78). Relatively nondisruptive breaks like these are fairly common, as the present-tense narrator relates facts and events that have already happened. Occasionally, though, Pynchon indulges in more sustained shifts in tense.

The most often remarked of these is Franz Pökler's story in episode eleven of "In the Zone." Though we open the episode in the present tense – "... yes, bitch – yes, little bitch – poor helpless *bitch* you're coming can't stop yourself now" – we quickly shift to the past tense, as it becomes clear that Pökler's just been reliving the night of Ilse's conception (397, italics in original). "Only later did he try to pin down the time" (397), Pynchon writes, establishing that we've just briefly inhabited a flashback. Two paragraphs later, he situates us in Pökler's present: "He sits tonight by his driftwood fire in the cellar of the onion-topped Nikolaikirche, listening to the sea" (398). But the episode does not remain thus situated for long, descending into the "cinematic flashback" in which we learn of the dissolution of Pökler's family, his early obsession with rocketry, his work at Peenemünde and the Mittelwerke, his visits to Zwölfkinder, and his eventual discovery of Mittelbau-Dora, the subcamp of Buchenwald which funneled slave laborers to the rocket program at the Mittelwerke. Pökler's story is the most sustained example of past-tense narration in the novel, and, at just under 17,000 words, it is the longest single episode. It is also, as Inger Dalsgaard, Bernard Duyhuizen, Robert McLaughlin, Khachig Tololyn, Steven Weisenburger, and others have suggested, a center of moral gravity.³⁴ The Pökler episode figures a character's direct confrontation with his own complicity in genocide.

In our first Textplot map, in which we removed a default set of stop words from the text before generating graph coordinates, Pökler's story is visible at the bottom right of the diagram (Figure 4). While we see several concepts in the story represented here – "child," "return," "moon," "dream," "engine," "fuel," "assembly," "material," "SS," "Peenemünde," "tunnel," "Nordhausen" – we do not get a sense that the Pökler episode

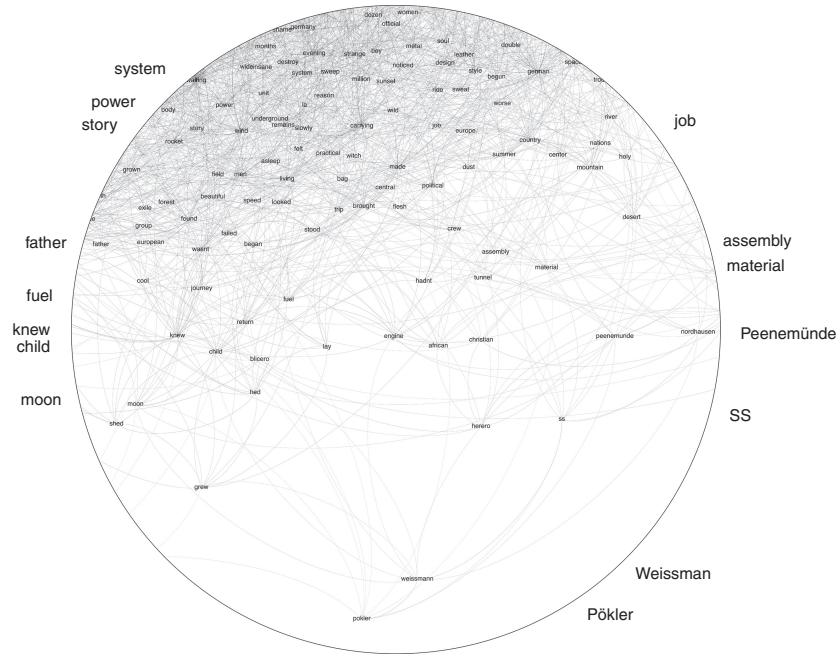


Figure 4 Detail of Pöklér region with a few key words highlighted around the periphery

particularly stands out within the broader stylistic or thematic economies of the novel. But it does stand out, and in relation to both. Narrated predominantly in the past tense (it does occasionally break into present tense), the Pökler episode inverts the narrative style of the novel. If we manipulate our algorithmic constraint such that it recognizes tense, the relation of moral weight with the past – here literally illustrated by the grammatical past tense – becomes uncontestedly clear.

We can get Textplot to recognize tense by eliminating high-frequency verbs – “have,” “be,” “is,” “was,” et cetera – from our stop-word list. In other words, we add to our mapping auxiliary verbs, verbs of being, modals, and so on. What emerges is a rough charting of tense in the novel. Figure 5 compares the basic shapes of the three plots we’ve run so far. Unlike our zero stop-word plot, this graph maintains the episodic regions we observed in the first rendering. Here, however, the area dealing with Pöklér’s story becomes more distinctly visible as a differentiated zone near the bottom of the image. The introduction of high-frequency verbs does not collapse our plot, but rather elongates it. What’s more, *Gravity’s*

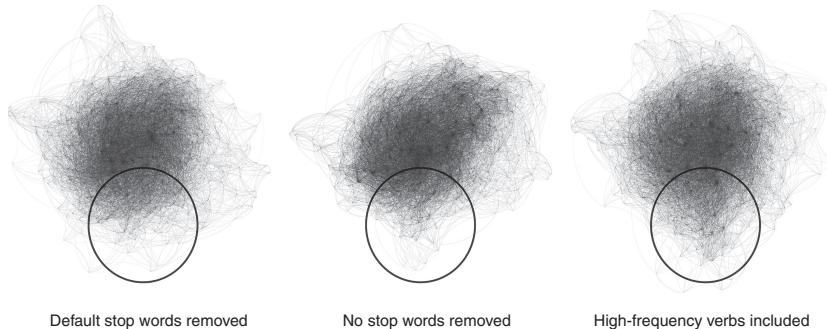


Figure 5 Three Textplot visualizations of *Gravity's Rainbow* using different stop word lists, Pöklér region highlighted

Rainbow behaves oddly in this respect. Compared to the seven novels mentioned above, it's the only one that distorts this noticeably upon the introduction of high-frequency verbs, as shown in Figure 6. This might be a useful deformation.

You Are Here (Reading the Map)

The fact that *Gravity's Rainbow* disperses rather than collapsing or remaining stable when we introduce high-frequency verbs into its network matrix points to something important about the book's composition. There are some forty to fifty past-tense flashbacks in *Gravity's Rainbow*, depending on what you count as a proper flashback. Some jumps to the past tense are too brief to count, as in the Dog Vanya example. Others are what we might call shallow – as when Slothrop recalls finding a small girl trapped in a Morrison shelter “yesterday,” or when we learn he’s recovered his harmonica somewhere in the Harz mountains (24, 737). Or, in the somewhat vaguer, but presumably recent, flashbacks to Roger and Jessica’s flirtation: “Once they met at a teashop,” for example (120). Yet others provide deeper texture. Thus we learn about Slothrop’s girls, Pirate Prentice’s first adenoid encounter, Leni’s frustration with Franz, Pudding’s interwar years, Tchitcherine and Enzian’s shared familial past, Margherita Erdmann’s encounter with Blicero, and so on. Still another layer provides historical anchors: Laszlo Jamf and IG Farben, Walther Rathenau, Roland FeldSPATH, the engineers Närrisch, Achtfaden, and Pöklér, the testing stands at Peenemünde, the assembly tunnels at Mittelwerke, the Herero and Namaqua genocide, the camps at Mittelbau-Dora. A final

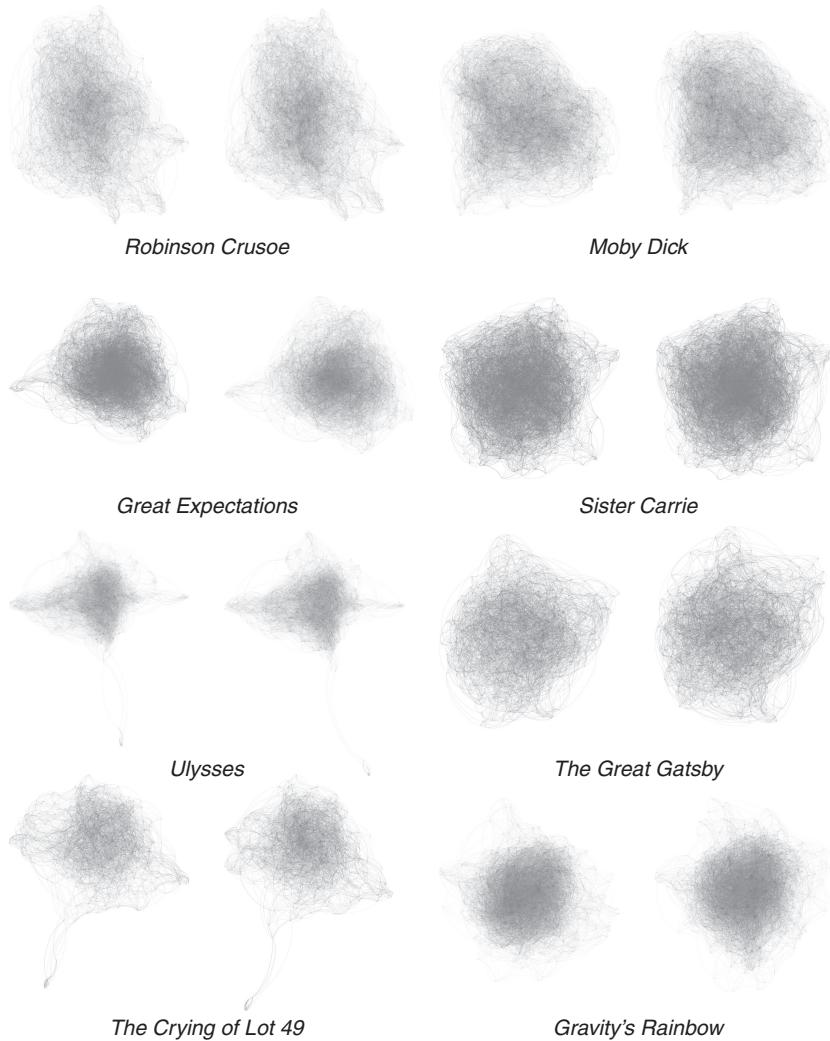


Figure 6 Eight novels visualized with Textplot, high-frequency verbs removed (left) and all verbs included (right)

type is more abstract, as in Enzian's methamphetamine-fueled rumination on the Zone as "Real Text" or Rocketman's graffitied memorialization on the "wall of a public shithouse" (520–22, 623–24). These lapses into past tense, however, are not evenly distributed through the novel. By incorporating tense

markers into a conceptual map of the text, we produce a visual record of how past-tense narration correlates with theme.

Our deformative mapping of *Gravity's Rainbow* doesn't just visualize the conceptual and thematic contents of the novel; it visualizes the novel's treatment of history and its complex handling of time. For just as we can read here character relations and narrative threads, we can also read a temporal allegory linking Slothrop's wandering present to the historical gravity of Nazi science and industry. At the top of the map, in the region of Slothrop, Seaman Bodine, and company, we find, too, a range of words focused on the grubby bodily present – “shit,” “vomit,” “ass,” “beer,” “drunk,” “vomit,” “screaming,” “giggling,” “singing,” “clutching,” “shaking,” “sucking.” This is also the location of words indicating dialogue – “sez,” “a-and,” “huh,” “uh,” “yeah,” “hey.” Moving to the top left of the map, we encounter bodily imagery having to do with sex – “fucking,” “twisting,” “bare,” “frock,” “penis,” “cock,” “hair,” “cheek,” “sheets,” “bed,” “breasts,” “skin,” “kiss,” “tongue,” “warm,” “sigh,” “breath.” Below this, words of place and time, sense and emotion – “cold,” “pale,” “clouds,” “sky,” “blast,” “bomb,” “time,” “remember,” “feel,” “love,” “day,” “night,” “bright,” “dark,” “hour.” The level of abstraction increases as we move into a region having to do with human mortality – “life,” “death,” “dead,” “mortal,” “record,” “data,” “pattern,” “structure,” “government,” “truth,” “exist,” “reason,” “believe,” “world,” “possibilities,” “process,” and finally “history,” “story,” “dream.” We are also now in the vicinity of “rocket,” and squarely in a region of past-tense verbs – “were,” “was,” “wasn’t,” “would,” “could,” “began,” “saw,” “knew,” “allowed,” “found,” “had,” “hadn’t,” “made,” “came,” and so on. Moving counterclockwise around the interior of our map has taken us from a bodily present; to bodily connection; to setting, abstract time, and history; and finally to the Pökler narrative. Which is to say, to Peenemünde, which will lead us, with Franz, to Mittelbau-Dora. From there, continuing counterclockwise, our map dissolves into the Zone.

The map's polarity – bawdy immediacy versus historical weight – matches our general sense of the novel's thematic hierarchies, or that, as David Leverenz has put it, “the novel's undergraduate defenses against seriousness are themselves part of a more terrible seriousness.”³⁵ What first appears as mindless play – “entropy with a vengeance,” Gore Vidal sniped irritably – finds its justification in the historical density of the rocket's psychosexual semiotics.³⁶ Decoding the mystery of Slothrop's penis is not just the doomed central quest of an unresolving narrative but also a figure for our own interpretive enterprises, for our own “pornographies of deduction” (*GR* 155) as we plumb the depths of Pynchon's historical allusions to

unravel the sense behind the scat, the systems of meaning underpinning the novel's apparent logorrhea.³⁷

Our digital analysis makes intelligible the novel's opposition of present- and past-tense grammars as key to understanding the novel's argumentative force and its interpretive procedures. As our map moves from bodily to abstract, from the penis Slothrop thought was his own to the material history of the V-2, so the novel unspools its own materials, drawing on historical documents and memoir to capture what must have been the lived texture of Peenemünde and the Mittelwerke. These particulars appear often in the past tense, as when Pökler recalls the A3 "christened not with champagne, but with flasks of liquid oxygen by the playful technicians" or how "[t]hermometers and barometers were sealed in a watertight compartment with a movie camera" (406). Details such as these are borrowed, as Weisenburger notes, from the Nazi scientist Walter Dornberger, who writes, of the first tests at Peenemünde, "[w]e baptized our missiles with liquid oxygen" and that "a watertight compartment contained a barograph, a thermograph, and a small cine-camera for photographing these two instruments during flight."³⁸ While it's not universally the case that citations of historical materials coincide with past-tense narration, the Pökler episode is especially rife with both, linguistically tied to its documentary intertexts.

In addition, the Mittelwerke itself is associated thematically with the historical past elsewhere in the novel. As Slothrop descends into the tunnels beneath the Kohnstein – the structural design of which is another "symbol belonging to the Rocket" (299) – we are treated to a Pynchonian flight of epic proportions. Part list, part reverie, part invocation, the passage traverses concrete description of the Works to the "bureaucracy of mass absence" haunting the Zone, by way of the following miniature analepsis:

Entrances to cross-tunnels slip by like tuned pipes with an airflow at their mouths . . . once upon a time lathes did screech, playful machinists had shootouts with little brass squirt cans of cutting oil . . . knuckles were bloodied against grinding wheels, pores, creases and quicks were stabbed by the fine splinters of steel . . . tubeworks of alloy and glass contracted tinkling in air that felt like the dead of winter, and amber light raced in phalanx among the small neon bulbs. Once, all this did happen. It is hard down here in the Mittelwerke to live in the present for very long. (303)

This moment in the passage is remarkable for the brilliance of its semiotic layering – the entrances like "tuned pipes" evoking, for example, the

whistling of airflow through instruments as well as the eerie whine of rocket exhaust. But it is also remarkable for its flexibility with tense. Entrances “slip” for a moment, but then “once upon a time lathes did screech,” “machinists had shootouts,” “knuckles were bloodied,” and “pores, creases and quicks were stabbed.” The narrative swerves from Slothrop’s immediate present into an unspecified past in which workers – wide-scale exploitation of concentration-camp labor in the rocket program began early in 1943 – inhabit the tunnels.³⁹ Subtly but unmistakably, Pynchon evokes in the “tinkling of air that felt like the dead of winter” the historical winter of 1943–1944, which claimed the lives of nearly 6,000 prisoners.⁴⁰ “It is hard down here in the Mittelwerke,” he says “to live in the present for very long.” Pynchon’s explicit association of the Mittelwerke with both the historical and the narratological past implies self-consciousness about the coincidence of past-tense grammatical structures and their thematic content.

In “The Counterforce,” the novel’s past tense diminishes. That is to say, when Slothrop scatters, the novel moves into a more sustained present tense (a fact underscored by the noticeable climb of “is” in Figures 1 and 2). As Kurt Mondaugen would have it, “‘Personal density’ [...] is directly proportional to temporal bandwidth. [...] [T]he narrower your sense of Now, the more tenuous you are” (*GR* 509). More precisely, as the novel moves away from Pökler’s story and from the documentary materials that underwrite it, Slothrop comes to more fully inhabit a tense in which present and past are less narratologically distinguished. The novel’s organized use of tense begins to break down. “[N]ow, in the Zone, later in the day he became a crossroad,” Pynchon writes, “after a heavy rain he doesn’t recall, Slothrop sees a very thick rainbow here, a stout rainbow cock driven down out of pubic clouds into Earth, green wet valleyed Earth, and his chest fills and he stands crying” (626). It takes some work to parse the tense of this sentence. “Now” occurs “later in the day he became,” which in turn occurred after something “he doesn’t recall,” the immediate “now” of which we are currently observing in the present tense. Delta-T, here the difference between past- and present-tense narrative, diminishes at the level of the sentence. Mondaugen’s Law, figuratively embodied in Slothrop, is literally embedded in the grammar of the novel, the “bandwidth” of which diminishes as we approach the last delta-T of the ballistic missile screaming toward the Orpheus Theatre.

Gravity’s Rainbow’s earliest reviewers remarked the narrative’s tendency to “scatter” with Slothrop. “There is no question,” wrote Jonathan Rosenbaum for *The Village Voice*,

that once Slothrop starts to disappear, the book becomes harder and harder to read. Jokes tend to stop being funny, the musical-comedy routines (a Pynchon specialty) grow tiresome, habitual flights of invention begin to seem more like compulsive word-chewing, and the twitching of the narrative from one apparently arbitrary center to another often appears itself like dispersions of random energy.⁴¹

Or, as Richard Locke put it in the *New York Times*, “the book is too long and dense; despite the cornucopia of brilliant details and grand themes, one’s dominant feelings in the last one to two hundred pages are a mounting restlessness, fatigue and frustration. The book doesn’t feel ‘together.’”⁴² Perhaps this scattering is more than an indulgent postmodern theme and more than the encyclopedic impulse run amok. The jumbling of tense in “The Counterforce” breaks down the tidy opposition of present mindlessness (or mindfulness, as the case may be) and historicity, unmooring Slothrop’s narrative from the historicized revelations that give it meaning.

Our deformed mapping of *Gravity’s Rainbow* offers a bird’s-eye view of how tense organizes some of the book’s most important themes. Episodes dealing with the present time of the novel float together at the top of the map, while episodes dealing with the novel’s historical reference points tend to hang toward the bottom, where they are loosely correlated with more frequent use of the past tense. The map also allows us to see how abstractions – concepts such as “history,” “reason,” “process,” and “structure” – fit into the narrative’s broader conceptual matrices. Abstract concepts relating to how we narrate the past cluster near the bottom of the map, again, roughly coinciding with more frequent use of past-tense verbs. We can trace instances of past-tense narration, then, through the text itself, following how Pynchon uses shifts in tense to underscore a conceptual argument often remarked in the criticism. Namely, that historical context consolidates identity and narrative itself. Past tense, unevenly distributed over *Gravity’s Rainbow*’s novelistic time, clusters around Pökler’s narrative – itself an allegory of complicity with historical atrocity – as well as with words such as “pattern,” “structure,” “truth,” and “history.” Structurally and at the level of the sentence, the novel manipulates tense as argument, setting the thematics of presence and the present tense against the thematics of historicity and third-person past-tense narration. Visualizing the novel by mapping its most important terms alongside tense markers makes legible the logic of the novel’s uneven temporal modes.

It's appropriate, perhaps, that the novel's last foray into history in the grammatical past tense is a little lesson on the origins of countdowns, devised, we are told, by Fritz Lang as a dramatic device for the film *Die Frau im Mond*, "to heighten the suspense" (GR 753). Likewise, Pynchon's manipulation of tense in the novel works to heighten the novel's rather rarefied argument about history and presence, the systematic deployment of which we can read, ironically, in a probability mapping of correspondences among words. Another of his damned "touches" (753).

Notes

1. The longest sentence, excluding passages strung together with ellipses, is "Volksdeutsch from across the Oder [...] 'Potatoes we could have been eating, alcohol we could have been drinking. It's unbelievable'" (549–50). Depending on how you handle the dialogue embedded in the sentence, it is between 335 and 370 words long. I've counted to the first closing dialogue tag coincident with a full stop, which gives 357 words.
2. These data come from Readable.io, a search-engine–optimization application that scores text on a number of readability tests, text analytics, and composition statistics to help writers improve the accessibility of their texts to the general public. The metrics mentioned here are scaled to US grade levels, so at a ninth-grade reading level, *Gravity's Rainbow* should be easily legible to readers aged fourteen to fifteen. For comparison, when Ben Marcus sampled Jonathan Franzen's *The Corrections* (2001) for an ironic aside in his 2005 critique of "Mr. Difficult," the book scored a 12.4 on the Fog Index. Ben Marcus, "Why Experimental Fiction Threatens to Destroy Publishing, Jonathan Franzen, and Life as We Know It: A Correction," *Harper's Magazine*, October 2005, p. 47.
3. The distribution of nouns in *Gravity's Rainbow*, at approximately 29,649 per one hundred thousand words (~29%), is about 1.31 times that of most fiction (~222,000 words per million), falling much nearer to noun distribution in academic prose (~291,000 words per million) according to the corpus-based *Longman Grammar*. Douglas Biber et al., *Longman Grammar of Spoken and Written English* (Pearson, 1999), p. 235.
4. Steven Weisenburger, "In the Zone: Sovereignty and Bare Life in *Gravity's Rainbow*," *Pynchon Notes*, 56–57 (Spring–Fall 2009), p. 101.
5. Bernard Duyfhuizen, "From Potsdam to Putzi's: Can Slothrop Get There in Time? And, in Time for What?," *Pynchon Notes*, 51–52 (September 2002), p. 53.
6. Eric Bulson, "Ulysses by the Numbers," *Representations*, 127.1 (Summer 2014), pp. 1–32.
7. Stephen Ramsay, *Reading Machines: Toward an Algorithmic Criticism* (University of Illinois Press, 2011).

8. Matthew G. Kirschenbaum, "What Is Digital Humanities and What's It Doing in English Departments?," *ADE Bulletin*, 150 (2010), p. 6.
9. J. F. Burrows, *Computation into Criticism: A Study of Jane Austen's Novels and An Experiment in Method* (Clarendon, 1987).
10. Christos Iraklis Tsatsoulis, "Unsupervised Text Mining Methods for Literature Analysis: A Case Study for Thomas Pynchon's *V.*," *Orbit: A Journal of American Literature*, 1.2 (2013), pp. 1–34; Luc Herman, Robert Hogenraad, and Wim Van Mierlo, "Pynchon, Postmodernism, and Quantification: An Empirical Content Analysis of Thomas Pynchon's *Gravity's Rainbow*," *Language and Literature*, 12.1 (2003), pp. 27–41.
11. Martin Paul Eve, "Visualizing *Gravity's Rainbow*," *Martin Paul Eve*, June 7, 2015, www.martineve.com/2015/06/07/visualizing-gravitys-rainbow/; David Letzler, "A Phenomenology of the Present: Toward a Digital Understanding of *Gravity's Rainbow*," *Orbit: A Journal of American Literature*, 4.2 (2016), pp. 1–32; Katie Muth, "The Grammars of the System: Thomas Pynchon at Boeing," in Joanna Freer and Doug Haynes (eds.), "Pynchonomics," special issue, *Textual Practice* (forthcoming).
12. Ralph Schroeder and Matthijs L. den Besten, "Literary Sleuths Online: e-Research Collaboration on the Pynchon Wiki," *Information, Communication & Society*, 11.2 (January 2008), pp. 25–45; Simon Peter Rowberry, "Reassessing the *Gravity's Rainbow* Pynchon Wiki: A New Research Paradigm?," *Orbit: A Journal of American Literature*, 1.1 (2012), pp. 1–25.
13. In 2012 Stanley Fish published a series of opinion pieces against digital-humanities scholarship, reviving a much older critique of computational stylometry as essentially arbitrary with respect to interpretation. Of a great many cogent responses by digital humanists, Stephen Ramsay's reminder that arbitrariness with respect to interpretation is an occupational hazard for any literary scholar stands out in its pithiness. The arbitrariness introduced by computational methods isn't that different from the apparent arbitrariness of close reading, and "risks need to be taken in both cases," he reminds us. See Stanley Fish, "Mind Your P's and B's: The Digital Humanities and Interpretation," *New York Times*, January 23, 2012; and Stephen Ramsay, "Stanley and Me," *Stephen Ramsay*, November 8, 2012, <http://web.archive.org/web/20170517223144/http://stephenramsay.us/text/2012/11/08/stanley-and-me>. For Fish's original critique of Louis Milic, see "What Is Stylistics and Why Are They Saying Such Terrible Things About It?," in *Is There a Text in This Class?: The Authority of Interpretive Communities* (Harvard University Press, 1980), pp. 68–96.
14. Proof of method as argumentative (and institutional) end is the target of Daniel Allington, Sarah Brouillette, and David Columbia's forceful assertion in the *Los Angeles Review of Books* that digital-humanities scholarship is handmaiden to a neoliberal university that redefines "technical expertise as a form [...] of humanist knowledge." Daniel Allington, Sarah Brouillette, and David Columbia, "Neoliberal Tools (and Archives): A Political History

- of Digital Humanities,” *Los Angeles Review of Books*, May 1, 2016, lareviewofbooks.org/article/neoliberal-tools-archives-political-history-digital-humanities/.
15. Letzler, “Phenomenology,” p. 6.
 16. George Levine, “Risking the Moment: Anarchy and Possibility in Pynchon’s Fiction,” in George Levine and David Leverenz (eds.), *Mindful Pleasures: Essays on Thomas Pynchon* (Little, Brown, 1976), pp. 113–36.
 17. Tsatsoulis, “Unsupervised Text Mining,” p. 2.
 18. Ramsay, *Reading Machines*, p. 32.
 19. Lisa Samuels and Jerome McGann, “Deformance and Interpretation,” *New Literary History*, 30.1 (Winter 1999), p. 36, qtd. in Ramsay, *Reading Machines*, p. 33. Oulipo’s productive use of writing constraints to, as Georges Perec once put it, “examine the old, old patterns that were at work in all novels and poetry and all things” in order to “find new, new ways [...] to stimulate” here becomes a model for an algorithmic criticism that uses the strict logics of computation not only to reveal linguistic and semantic structures within texts but also to stimulate critical novelty. Georges Perec and Kaye Mortley, “The Doing of Fiction,” *Review of Contemporary Fiction*, 29.1 (Spring 2009), p. 96.
 20. David McClure, “(Mental) Maps of Texts,” *DM*, September 24, 2014, dclare.org/essays/mental-maps-of-texts/.
 21. Including epigraphs and numerals, but excluding punctuation.
 22. Matthew L. Jockers, *Text Analysis with R for Students of Literature* (Springer International, 2014), pp. 29–31.
 23. See Fabian Pedregosa et al., “Scikit-learn: Machine Learning in Python,” *JMLR*, 12 (2011), pp. 2825–30. Documentation specific to kernel density estimation (KDE) is available at scikit-learn.org/stable/modules/density.html.
 24. McClure uses Bray-Curtis dissimilarity to assess the extent to which two words are likely to appear near one another in the text. See J. Roger Bray and J. T. Curtis, “An Ordination of the Upland Forest Communities of Southern Wisconsin,” *Ecological Monographs*, 27.4 (October 1957), pp. 325–49.
 25. McClure, “(Mental) Maps,” n.p. McClure’s comparison to topic models is illustrative rather than strictly literal. Topic modeling in literary humanities research, generally speaking, uses machine learning to discover associated groups of words – “topics” – empirically in (often very) large corpora. Textplot, on the other hand, discovers words that are likely to occur *near one another* in a particular text. For a helpful introduction to humanities topic modeling, see the various essays on the subject in Elijah Meeks and Scott Weingart (eds.), special issue, *Journal of Digital Humanities*, 2.1 (Winter 2012).
 26. The graph is too dense to be legible in print, though the general shape will matter later. For full-resolution images, see the project repository at krmuth.github.io/plot-gr/. Textplot takes a number of parameters that can

- substantially alter the shape of output. I ran all tests cited here, with two exceptions, across 10,000 sample points at a bandwidth of 2,000 words. For shorter novels such as *The Great Gatsby* and *The Crying of Lot 49*, I ran 1,000 samples, with a smoothing bandwidth of 500 words. On setting Textplot parameters, see David McClure, “Literary MRIs (or, Tuning Textplot),” *DM*, May 20, 2015, dclure.org/logs/tuning-textplot/.
27. The orientation of the graph is arbitrary, though the word groupings are not. For comparison’s sake, I fed Textplot’s output graph data into the network-visualization application Gephi and ran iterations of a Force Atlas 2 plot to get stable representations of the data that roughly matched one another in orientation.
 28. See Eve, “Visualizing *Gravity’s Rainbow*,” n.p.
 29. Stop words are high-frequency words usually scrubbed from a data set for natural-language processing to avoid trivial results. Common stop words in English include function words like “a,” “an,” “the,” “and,” “or,” “but,” “is,” “was,” “be,” “been,” “she,” “he,” “it,” and so on. Stop-word lists can vary quite significantly from application to application. For McClure’s original stop-word list, see github.com/davidmcclure/textplot/blob/master/textplot/data/stopwords.txt.
 30. McClure is interested in large sets of texts, not in individual interpretive maneuvers. See David McClure, “Distributions of Words across Narrative Time in 27,266 Novels,” *DM*, July 8, 2017, dclure.org/labs/distributions-of-words-27k-novels/.
 31. Ironically, Perec himself imagined computer-assisted poetic analysis in a 1968 German radio play, *The Machine*, in which a series of processors “read” Goethe’s poem “Wanderers Nachleid II” by performing five “protocols” on the text. See Georges Perec, *The Machine*, trans. by Ulrich Schönherr, *Review of Contemporary Fiction*, 29.1 (Spring 2009), pp. 33–93.
 32. McClure, “(Mental) Maps,” n.p.
 33. Ibid.
 34. See Inger H. Dalsgaard, “*Gravity’s Rainbow*: ‘A Historical Novel of a Whole New Sort,’” *Pynchon Notes*, 50–51 (Spring–Fall 2002), pp. 35–50; Bernard Duyfhuizen, “A Suspension Forever at the Hinge of Doubt”: The Reader-trap of Bianca in *Gravity’s Rainbow*,” *Postmodern Culture*, 1.2 (September 1991), n.p.; Robert L. McLaughlin, “Franz Pökler’s Anti-story: Narrative and Self in *Gravity’s Rainbow*,” *Pynchon Notes*, 40–41 (Spring–Fall 1997), pp. 159–75; Khachig Tololyan, “War as Background in *Gravity’s Rainbow*,” in Charles Clerc (ed.), *Approaches to Gravity’s Rainbow* (Ohio State University Press, 1983), pp. 31–67; and Weisenburger, “In the Zone.”
 35. David Leverenz, “On Trying to Read *Gravity’s Rainbow*,” in Levine and Leverenz (eds.), *Mindful Pleasures*, p. 230.
 36. Gore Vidal, “American Plastic: The Matter of Fiction,” *New York Review of Books*, July 15, 1974, p. 38.
 37. Timothy Melley, *Empires of Conspiracy: The Culture of Paranoia in Postwar America* (Cornell University Press, 2000), p. 94.

38. Walter Dornberger, *V2*, trans. by James Cleugh and Geoffrey Halliday (Hurst and Blackett, 1954), pp. 53, 54; Steven Weisenburger, *A Gravity's Rainbow Companion: Sources and Contexts for Pynchon's Novel* (University of Georgia Press, 2011), p. 238.
39. Michael J. Neufeld, *The Rocket and the Reich: Peenemuende and the Coming of the Ballistic Missile Era* (Harvard University Press, 1995), pp. 167–95.
40. See Neufeld, *Rocket and the Reich*, pp. 209–13.
41. Jonathan Rosenbaum, “One Man’s Meat Is Another Man’s Poisson,” *Village Voice*, March 29, 1973, www.jonathanrosenbaum.net/1973/03/one-mans-meat-is-another-mans-poisson/.
42. Richard Locke, “One of the Longest, Most Difficult, Most Ambitious Novels in Years,” *New York Times*, March 11, 1973, https://archive.nytimes.com/www.nytimes.com/books/97/05/18/reviews/pynchon-rainbow.html?_r=2.