ACTION POTENTIALS: TEXTURE, EXPERIENCE, AND LITERATURE

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Abstract

This thesis examines the idea of texture as an index of the affective capacities of things in the world, both in the history of science and in literature. I first look to the historical presence of texture in histology's investigation of the human body, considering how texture is invoked to connect structure and experience. I then move to George Eliot's *Middlemarch*, forging a connection between two textural logics in the novel, one histological and the other deconstructionist. Finally, I discuss this connection as it relates to problems of mediation in the writings of Rainer Maria Rilke.

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Obwohl wir die nächsten Bestandtheile thierischer Körper und deren chemische Zusammensetzung, sowie die meisten successiven Fakten, im Verlaufe der Organisation kennen, so können wir daraus doch noch keine Theorie derselben entwickeln; denn die Kenntniss der Erscheinungen während des Aktes der Organisation, ist noch keine Theorie, sondern bloß Geschichte derselben. Von der ältesten bis auf die neuere Zeit hat man sich abgemüht, diese Theorie zu finden; allein man hat entweder keine gefunden, oder ist auf falsche gekommen. Jenes geheimnisvolle Etwas, welches bewirkt, dass dieselbe Proteinverbindung in dem einen Falle sich zu dem, in dem anderen sich zu jenem Thiere organisiert, welches den ersten Impuls zur Organisation gibt, die einmal begonnen, unaufhaltsam fortschreitet, kennen wir wohl in seinen Erscheinungen, keineswegs aber in seinem Wesen. Wir bezeichnen es mit dem Namen einer Kraft, womit aber eben nicht mehr, als ein bloßer Name gegeben ist.

Joseph von Gerlach, *Handbuch der allgemeinen und speciellen Gewebelehre des menschlichen Körpers*, 1850.

Introduction

This is a thesis about mereology, about relations among and between parts and wholes. This is another one. Text, like all composition, works by bringing elements together and setting them in certain kinds of relations. In texts (like this one) where the aim is to mean something in particular, the task involves setting up relations in the composition of the text that mimic, enact, or produce relations that accord with that particular meaning. Any text that seeks to mean will contain mereological claims implicit in the logic it relies on to compose an explicit meaning. Texture, very broadly understood, emerges from any logic in which two things can be connected: signifier and signified, cause and effect, part to part, neuron to neuron, and so on. This thesis, for example, is interested in texture as an index of the relational logic of material objects: in a novel, in a poem, in an organism, in the brain, and in the perceptual act of perceiving any collections of parts as a whole in the first place. There will be many variations on this claim, both explicitly as the argument is extended to a set of diverse topics (histology, *Middlemarch*, and Rilke) and implicitly, insofar as it succeeds in integrating these topics, becoming a textual whole, and meaning what it says.

Texture shares a root in the Latin *texere* (to weave) with *text*, *context*, *textile* and *tissue*. A family of related meanings collect around these words, suspiciously objective and subjective, material and experiential. Texture is as much a name for a sensory or even sensual bodily experience—touching, feeling, squeezing, rubbing—as for the material composition of sensed objects. Making these two faces meet in anything more than a back-to-back fashion is the aim of this thesis. Getting around the Janus-faced quality of texture—looking inward to embodied sense

and outward to disembodied structure—entails losing the idea that texture is a gate where material and immaterial realms come into contact.

Texture, I will argue, is able to contain these apparently oppositional notions because it understands feeling as material. The qualities of material things are determined by (are immanent to) the properties of matter. Texture thus carries the possibility that embodied experience is thoroughly material—is in fact the feeling of being matter. Put more simply, texture suggests an immanent materialist account of subjective experience: life in matter can be the life of matter.

Crucial to this textural logic is the establishment of the thinking subject as material. The human body must be investigated as an assembly of interconnected material elements—as organs, tissues, and cells. Under whatever material metaphor it operates (clock, hydraulic, computer), biology systematizes in search of structures that could "correspond" to experience. We would not consider the project of anatomy complete, it seems, until we were shown a systematic description of our own bodies that matches up with what it feels like to be that system. In the first chapter of this thesis, I engage a part of that anatomical history to think about how the search for "correspondence" conflicts with the implications of its textural foundations. Looking to documents from the history of histology (the study of biological tissue) from the seventeenth, eighteenth, and nineteenth centuries, I aim to show how texture structures attempts to systematize the body, both as a way of thinking about the composition of objects from parts and as a perceptual strategy for dissection and categorization. The apparent dualism between these two sides of texture appears in histological discourse as an explicit commitment to mind-matter dualism, keeping the senses away from thought and on the side of matter. The gap across which mind and matter "correspond" is gradually shortened by new discoveries, especially that

of the cell, until the idea can finally be expressed that thought might arise from the complication of a primitive nervous system geared towards sensory response. Once thought is plausibly embodied in the tangling of a perception-action system made of independent but contiguous neurons, the sense of "being" the interrelation of parts extends from the sensory to cover the rest of subjective experience. The narrative of the first chapter stops there.

The idea of texture I am elaborating draws on two main theoretical sources. The first is work in queer theory on texture and affect (Eve Sedgwick and Renu Bora). The second is a set of philosophers (Baruch Spinoza, Henri Bergson, Gilles Deleuze) to help to think about how phenomena could exist immanently with the material world. Texture names the phenomenal qualities that accompany the kind of arbitrary local framing of the material world which an object embedded in it will always necessarily be engaged in, whether that object is a human, an atom, a star, or a sentence.

Contemporary affect theory was more or less spun out from the same two sources. I don't know enough about the landscape of affect theory to position my argument inside of it, but my sense from what I have read (some of which I draw on in the second chapter) is that something similar has been developed by theorists like Isabelle Stengers and Steven Shaviro, looking to science—especially non-biological complexity sciences—to think about the affective in human experience as just a subset of a more general affective principle having to do with matter and forces.

One important term drawn from affect theory should be defined. Throughout the thesis, especially in the first chapter, I will refer to the "affective capacities" of things, mostly human bodies. Put simply, "affective capacities" are the possibilities available to a particular

arrangement of parts in virtue of the particular arrangement of parts that it is (and therefore its texture). It is just a way of talking about how what something can do or can have done to it (its "ever-gathering accretion of force-relations") is a function of its material form (which can then be read as "a palimpsest of force-encounters") (Gregg 2).

A corollary to the textural argument made with the histological texts is the idea of general non-priority, which appears to deal with two competing kinds of explanations: reduction (the part is prior to the whole) and monism (the whole is prior to the part). In the context of histology, priority is constantly invoked to explain relations between the many intermediate scales at which life operates. The discovery of multicellularity in particular makes the problem clear: which level, the microscopic (material) or the macroscopic (embodied experience), is more real? Non-priority is simply a rejection of such metaphysical grounding relations altogether. Any explanation that explains x in terms of y has made only a relative statement until y can be shown to be prior to x. In the flat materialist ontology adopted to address texture, there is no space for priority: not of past to present, not between wholes and parts, and not between mental and material things. Texture, I am arguing, encourages us to qualities relative to the scale and frame of observation. Without priority, qualities are real, relative, and phenomenal. They are not grounded by matter or the kind of being matter has.

Bypassing priority is easier said than done. (Notice how the preceding definition explains non-priority in terms of priority, as most definitions of non-dualism reference off dualism.) The second chapter turns to George Eliot's *Middlemarch* for a worked example of the problem.

The novel is subtitled "a Study of Provincial Life." Middlemarch is a novel of texture (one of the definitive novels of texture, according to Sedgwick) because it understands that the

particular province—the frame and scale of observation—is what allows for life to be studied (Sedgwick 15). The human stories of the Victorian novel are phenomenal to a certain kind of narration and observation, and simply dissolve when the frame or scale of observation shifts. Eliot's novel is at once an exemplary nineteenth-century novel—intricately plotted, with strong characters, romance, gossip, morals, etc.—and a strangely materialistic and rationalistic account. What was recently human is always in danger of resolving to action at a different scale, worse, the inorganic activity of matter. I will focus particularly on the way that character (in the sense of constitution or temperament) is described materially and indexed by texture, so that a person's nature may be spongy, infirm, stony, or soft. These textural qualities do not stand for, but literally are the affective capacities of that organism in matter.

The occasional shifts into a material description of human life are informed by nineteenth-century science's own "study of life" and by histology in particular. The novel is set in 1830s England just before the dawning of cell theory. Lydgate, one of the novel's central figures, is a histologist searching for the "primitive tissue." Understanding Eliot's emphasis on the materiality of character together with the first chapter's arguments about histology, the use of texture can be seen to invoke the affective capacities of the person described. In this way the novel's materialism can be reconciled with its moral and familiarly human elements, as the biological and microscopic is brought to bear on what a body can learn, know, feel or do. In short, Eliot's meliorism relies on the same logic by which affect theory gets to pedagogy, since the body's materiality (texturally, its affective capacities) is the character of the person.

Nearby to this idea of texture as an index of affective capacities—what can be done to a thing, what has been done to it that it ended up this way, what it can do now—lies expression.

Middlemarch shows in a set of self-consciously textual metaphors how the materiality of the subject that expresses itself necessarily prohibits its apprehension of an objective picture. The unsettling feeling that Middlemarch can produce—what Henry James tried to dismiss as the lack of form of an "indifferent whole"—is a suggestion of the sublime terrain that lies outside of the epistemological limits of always-relative meaning. The novel meets those limits from within realist, materialist narrative.

There is something very human and very inhuman in Eliot's novel (and indeed in her larger dream of creating a new "religion of humanity"). This unresolvable subject-object movement is where I locate a connection between Eliot and Rilke. There are basic problems with trying to recover something meaningful about a material human subject while understanding what its materiality means: finitude, total subjection to external forces, determinism. Such problems can all be described in terms of mediation. Their responses to the problem differ: Eliot tries to get the text to take on the materiality of its subjects; Rilke tries to set the text into the same kind of dynamics as a material system. For all its suggestive passages and strange decisions, *Middlemarch* is principally a novel obliged to tell a story about characters. Rilke's writings, by comparison, are free to ask the relevant questions directly and let the text do what it would like. What does a dissolving subject dissolve into—or resolve towards? And what could knowledge of its destination or origin ever reveal about it?

There is in Rilke, as in Eliot, a closeness of the affective capacities of objects to expression. In an essay which I lean on for my interpretation, the poet imagines how any surface, if a phonographic needle were moved across it, would produce a sound. A potential expressivity hovers at the textural interface of all things, actualized only by the mediating action of the poet

and in the relative orders of language. In connection with this I read Rilke's text on Rodin's sculpture and the density of symbolic information contained on the surfaces of its bodies. Whether or not a text could exist a similar relation to its subject is less clear. Rilke's solution, I argue, is to make the language work according to its own inner logic (its own affective capacities) rather than to attempt to translate directly apprehended textures into the medium of language. This re-creates what is dynamic about texture without claiming direct correspondences to sense objects; these discovered dynamics can then be applied to representation.

This thesis does not claim to be discovering any special or exclusive meanings in the texts to which it attends. It is simply an experiment in reading with texture and affect. Anything that is "discovered" is discovered only relative to that project, not to the text itself. The presentation of apparently-loosely related subjects as though they form an integral, meaningful whole is a part of the experiment. Yet the relativity of any meaning-making operation is a strangely fundamental claim for texture to be able to make. How is it that it leverages its own relativity, transcending relativity only to dismiss itself, to suggest its own incompleteness marks a fundamental truth? That weird lever—where epistemology flattens out ontology—is the real interest of this thesis and perhaps its only chance at saying something.

Works Cited.

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Chapter 1. *Histology, Texture, and the Cell*

> My days are swifter than a weaver's shuttle, and are spent without hope.
> O remember that my life is wind: mine eye shall no more see good.
>
> *Job 7:6*

I. Action Potentials

Histology, the study of biological tissue, diverged from general anatomy with the invention and adoption of the microscope in the seventeenth century. From the start, microscopy was seen as a reflection of the telescope, disrupting in an analogous way a notion of the physical world that privileged the scale of ordinary human life. The two technologies developed at the same times and in the same places—primarily in Italy and the Netherlands, two nations where a Renaissance investment in linear perspective in painting accompanied the development of advanced geometrical optical sciences (Crary 19-23). As a result of the historical and technical connections between these two magnifying apparatuses, characterizations of microscopic investigation often borrow more from astronomy than anatomy (Wolpert 233). The histologist of historical narrative works by observation, surveying the microscopic field from a distance, losing days at a time squinting into eyepieces, recording movements, drawing bodies they can see but do not touch. As with astronomy, the fallibility of the intervening human mind is somehow displaced with the introduction of a visual instrument, as though the abstract geometric optics embodied in the telescope could lend credence to the perceptions and theories of its user.[1]

Although already corrupt in the astronomical scene, there one can at least point to the telescope as a guarantee that the observer has not physically interfered with the object of observation. In the case of the microscope, the opposite is true. Here, one does not need to

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[1] See Parts 6-10 in Paul Feyerabend's *Against Method*, pp. 54-105, for an argument that Galileo leveraged the telescope as part of his "propaganda" campaign. On the "incorporeal" vision of early modern geometric optics, see Crary, pp. 16-19.

carefully say that forms are discerned according to the limited set of actions the observer's body can imagine performing on the object—there is nothing imaginary about it. Histological observation is in every case prefaced by a physical contact with the textures of organic matter: in the dissection of the organism, the selection and sectioning of tissue for investigation, its fixation and staining with chemicals, considerations of light, thickness, cleanliness. The entire preparation is intensely *textural*: body-to-body, it refers to the arrangement of parts and resulting affective capacities of both observer and object. When histology takes the human body as its object, the same textures lie in some sense on both sides of the interaction. This chapter will work towards understanding what it means that these moments rely on texture for the possibility of exchange between apparently different kinds of entities (observing subject and body-object).

It is not a coincidence that flesh finds flesh touchable, separable, cuttable, and organized. Neither is it a correspondence. If the self-referential nature of histological perception compromises it as an objective science, the intuition that embodied experience could align with the material structure of the body implies an underlying logic in which subjective qualities are immanent to material things. The argument of this chapter is that no matter how much it announces its own dualisms, histological perception always relies on a fundamentally non-dualistic textural approach.

Before examining the history of histology in the words and drawings of its investigators in the second part of this chapter, it will be useful to build out a theoretical approach to histological perception. Like all embodied perception, histological perception is historical *because* it is physical. Body to body, it is structured both by what a human is and can do and what a human *thinks* it is and *thinks* it can do. This theoretical structure will help explain how the

histological gaze changed what it saw and how it eventually came to see something else. Rather than asking questions about progress—*why was it so easy to see tissue and fiber? why was it so hard to see the cell, and then impossible not to?*—we can take the field as a whole as a special kind of self-investigation: nominally, the search for a structure which could correspond to experience, yet proceeding by a textural technique that undermines any separation of terms between which a "correspondence" could be drawn.

The theoretical investigation will work from texture, drawing especially on the work of queer theorists Renu Bora and Eve Sedgwick (to think about texture's connection to affect) and Manuel DeLanda's materialist reading of Deleuze (to approach a non-essentialist, non-dualist view of form as something immanent to matter). The first section takes a cue from histology, which dedicates itself to the textural properties of biological matter as *tissue*, drawing on a textile metaphor for materiality. The second section reveals that texture, despite constructing this veil of tissue between mind/spirit/essence and body/world/matter, in fact relies on the embodied nature of perception. Thus, histology affirms the unity of mind and matter, as any definition of the material on textural terms is in essence phenomenological, referring to affect and feeling. The final section explores the affective dimension to texture as it relates to scale, especially relevant to the microscopical work of histology. Although there is no special scale at which texture exists, the specific texture found will vary relative to the scale at which it perceived. The possibility of microscopic explanation in histology is thus tied up with the limits of embodied knowledge in general. The goal is to use texture to build out the exact opposite possibility than that towards which histology historically employed it: not only is mind not prior to matter, but in fact any notion of priority (and any meaning in general) is relative and incomplete. Without priority,

integration and derivation no longer ascend and descend a metaphysical chain of explanation, but rather take us into spaces beside, implied by, and as real as the actual material world. What is contingent and phenomenal in our experience can then be understood as fundamental, not secondary: texture is the life of the embodied mind. The theoretical exposition of texture in this first section is designed to set up the entire thesis, not just the history of histology that follows.

Texture, Tissue, Textile.

Histology is properly the study of biological *tissue.* Both *texture* and *tissue* derive from the Latin *texere*, to weave, whence also *text*, *textile*, and *context*. *Histology* derives from the Greek *histos,* for loom, and *logos,* for word or study.[2] In the other relevant languages for this study, the same connection exits between the words for biological tissue and the verb for weaving: *Gewebe* from *weben* in German, *tejido* from *tejer* in Spanish, *tessuto* from *tessere* in Italian. Weaving has been a central metaphor for the materiality of things since antiquity, and through an association with women and women's labor, also for the human body.[3] Textiles stand for materialization, morphogenesis, the coming or bringing into form of things. The metaphor relies on two opposing interpretations.

In the first, the textile symbolizes a kind of mystery of coherence, the appearance of a solid object out of something almost invisibly thin. In this model, the textile crosses a dimensional boundary, turning from one-dimensional thread into a two dimensional object by

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[2] See entries on "texture" "tissue" and "histo-" in Hoad, T. F. *The Concise Oxford Dictionary of English Etymology*. Oxford University Press, 2003. A little more information: *texere* comes from the PIE *teks-, to weave, to fabricate. From what I have seen, *it is actually unclear whether the meaning of weaving predates the meaning of fabrication in the more general sense of making*. Luckily, my disinterest in priority relations means that it doesn't really matter which came first in time. In Romance languages, the main derivates are from *texere* and *tela* (web, net, fabric). From Greek, all the words related to *techne* (art, making, doing). In German, it's found in *Dachs* (badger, the weaver-carpenter animal), which looks like it should be related to *Dach* (and *decken*, by extension) but actually is not. (*Dach* comes from the same root as the Latin *tegere*, to roof/cover, likewise Greek *tekton,* builder).

[3] There is a lot of literature on the subject. For a sampling, see Ionna Papadopoulou-Belmehdi, "Greek Weaving or the Feminine in Antithesis"; Brittany Myburgh, "Women's (Art)Work: Re-Weaving the Textile in Ancient Greece."

pursuing a limit in the manner of a space-filling fractal curve.[4] The female weaving figure is present for the process but does not direct it; every birth is in some sense virgin birth. The textile/ tissue emerges from the exploration and evolution in a certain space of possible states by fundamentally *active* matter. In contemporary theory, this most closely describes the stances of various thinkers in New Materialism, Feminist Materialism, and Affect Theory.[5] It is also roughly the materialist position of this thesis—although unlike for some New Materialists, "agency" will not a useful word for my argument about what follows from the active properties (or "affective capacities") of matter.

The other interpretation goes further: neither the mother *nor* the child is the true cause of the child—rather, the essence lies elsewhere, in an external pattern which is more or less faithfully executed. Such faith in a pattern that is prior to form is realized by the patriarchal language of a *matter-pattern, mater-pater* family drama. When morphogenesis is understood this way, texture signals the imposition of pattern from above, as the trace of extensive structural relations to a higher authority.[6] The textile is in this mode submissive and refers to its prior (or father). It is grounded elsewhere.

It will be this second idea of texture, I argue, that early histologists use to cover the first. We might think of this as a fetishistic displacement of the real object of interest, indeed of the real itself, for it is the immanent materiality of the first that the idea of an extensively structural

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[4] See *A Thousand Plateuaus*, on space-filling curves as a model for becoming in what Deleuze and Guattari call "smooth space": "smooth, amorphous space of this kind is constituted by a *zone of indiscernibility* proper to 'becoming' (more than a line and less than a surface; less than a volume and more than a surface)" (pp. 488).

[5] See for example Jane Bennett's "A Vitalist Stopover on the Way to New Materialism" in *New Materialisms: Ontology, Agency, and Politics* for an argument about "agency" in matter, Diana Coole's "The Inertia of Matter and the Generativity of Flesh" in the same volume for an argument about the autonomy of active matter, or Manuel DeLanda's "The Actualization of the Virtual in Space" in *Intensive Science and Virtual Philosophy* for a description of morphogenesis that was influential for this chapter.

[6] To continue the biblical metaphor to the body of Christ, consider the following passage, John 19:23: "Then the soldiers, when they had crucified Jesus, took his garments, and made four parts, to every soldier a part; and also his coat: *now the coat was without seam, woven from the top throughout*" (emphasis mine). Quoted in Moffitt's "Mary as a Prophetic Seamstress" (in bibliography).

"design" works to obscure.[7] Histologists displace an embodied intuition that would unify mind and body—exactly the intuition on which texture operates, as we will see—with the careful placement of just this veil, right across the neck, like the surgical drape set between mother and child during childbirth (or a magician cutting his assistant in half). The body is thus replaced by tissue of this second type, grounding the corporeal in the realm of patterns and ideas that the mind accesses. The patient looks down and sees cloth.

The arrival of cell theory in the 1830s opens up a second ground below tissue, one that could no longer be treated as passive. The reduction receives in this way what it could only have expected: a pluralistic view of the body as a society of individual elements, leading local lives. How will the textile survive this break with the continuous? What is a fiber made up of discrete elements?

The veil disintegrates, but not all at once. In an appendix to his book on Foucault, Gilles Deleuze generalizes Foucault's analysis of a nineteenth-century historical turn in which humanity comes to feel the finitude of the "Man-form" in a two-step process. First, a discovery "breaks the series and fractures the continuums, which on the surface can no longer be developed" (*Foucault,* Deleuze 127). The emergence of cell theory puts an end to theories which imagined primitive tissues and fibers and an end to the continuity of the body itself.[8] In this phase "the forces within man enter into a relation with new forces from the outside, which are forces of finitude" (126). The cell is such a force, rupturing the infinite, abstract *matter-pattern*

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[7] Working against the characterization of matter as passive is a central part of the materialist/affect theory I engage in this thesis—it was in reaction to dualistic, typological, or idealist approaches (like those of early modern biology) that the first view was developed in the terms I have used.

[8] Already by 1830, before Schleiden and Schwann began to publish on and popularize cell theory, the existence of cells (especially in plants, where the cell wall was easily visible) was broadly accepted, especially in Germany. Tertius Lydgate, whom George Eliot has searching for the primitive tissue in exactly these years, is condemned to the wrong track not simply by a bad intuition related, it seems, to his general obstinacy and standoffishness, but also by simply being behind on the literature. Like Causabon, he would benefit from reading a little more German. More on this in the next chapter.

of eighteenth-century tissue with a new grounding in the plural and discrete.[9] The mind-matter/mind-body dualism doesn't give way immediately, for the finite term must first studied as an external object (127). Only then, Deleuze writes,

> in a second stage, does it create from this its own finitude. … It is like the advent of a new dimension, an irreducible depth. … Things, living creatures and words need only fold back on this depth as a new dimension, or fall back on these forces of finitude. There is no longer just a force of organization in life; there are also spatio-temporal programs of organization which are irreducible in themselves, and on the basis of which living beings are disseminated (127, 128).

To adapt this two-phase paradigm shift to the reorganization of histology around the cell, we can locate the first phase in the moment that lasts from the 1830s, when the cell was first "recognized" as a biological unit force (though it had been visible for centuries), until the 1890s, when the logic of cell theory was extended to the last remaining tissue: the brain. In the interstice, the cellular simply stood in for the body; now, faced with a cellular mind, the fold is necessary. The division of gray matter into distinct neurons—as opposed to the continuous fused network argued by the reticularists—marks the moment when the new cellular dimension folds back onto mankind as constraint, as a "force of finitude." It is body and mind which are folded together, through each other, to create a new and thoroughly cellular organism. The double life of the cell becomes the single life of the new human: all mind, all body. Part of what I am arguing is that this collapse was conditioned in histology by a textural approach to bodily matter.

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[9] I think there's evidence for this in Foucault's own investigation of the idea of tissue in *Birth of the Clinic*. The idea of an internal surface, and of the disease as something manifesting in the matter of the patient, but existing in its real form as an essence in a space of classification. The clinic is interested in tissue, according to Deleuze's reading of Foucault, "because it consists in unfolding the tissue covering 'two-dimensional areas' and in developing in series the symptoms whose compositions are infinite" (126). Tissue makes classifying explanation possible—it turns the body into a textile surface in which general patterns can be read, and the individual (the finite and singular) ignored. Theodor Schwann, we will see in the second half of this chapter, first conceptualized cells as unit *forces*, with the goal of making a certain kind of vitalist argument that relied on a spatialized tissue-body impossible.

With the acceptance of the neuron doctrine as a completion of the finite side of the cellular project, histological tissue falls back onto the first of the two textile models mentioned at the beginning of the section. The body is directed only by itself, finds its form immanently. Following Deleuze, we might then consider this new finite human, in which it would make no sense to distinguish mind and body, as closer to animality. It would not have two lives (mind/body, cellular/human), but would live on many scales at once, never integrating or arranging them in a hierarchy. Attention to this polyvocal play of embodied life is what motivates textural interest. It is not an accident that texture guided the long journey traced by histologists on their way back to themselves. An organism wants to touch itself, see what it feels like. Could it be that a body feels like me?

Texture and Perception.

Texture is one entry into the connection between perception and action. Queer theorist Renu Bora writes that textural perception stands beside the fiction of objective perception. Texture asks questions about the object that imply its manipulation, past and actual:

> (1) How did he get that way? (2) What do I want to do with him? (Stare? Ponder? Or reach out to touch the exciting surface?) Importantly, the questions of material, textural history (How did he get so smooth? Rubbing? Polishing? Heating? Fucking? Defecating?), and the questions of the desire to act upon this material, are answered in overlapping, inextricable ways. (Bora 95)

Eve Sedgwick, taking Bora's essay as point of departure for her book *Touching Feeling*, generalizes the formula and neuters the pronoun: how did *it* get that way; what could I do with *it* (Sedgwick 13). Histological perception of the body as texture swings between these two formulations, between body-subject (he) and body-object (it), between person and organ, tissue, or cell. To refer to *tissue,* for example, is to make an argument about morphogenesis,

embryogenesis: this is a woven object. It was made out of fibers. What's more, the textural description of biological material is a plan for further manipulation and dissection: I could rip this at the seam here, I could pull this fiber out. This part looks dense; I should cut it open to see why. Borrowing categories from Deleuze and Guattari, Bora relates textural perception to the exploration of smooth space by haptic means, a sort of reactive investigation that involves the potentials of the observer with that of their object.[10]

Histology is not an optical science that proceeds by observation alone, but rather touches everything it sees and sees by touch. In the second half of this chapter we will see how deeply histology relies on texture as a way to guess at the function and relations of biological matter. Histology's obsession with texture naturally constrains what it can observe to what the histologist can do or imagine doing. Texture, as Bora writes, is in this way fundamentally relative. "[A] kind of inevitable tactility of human agency, in performance or in labor, is crucial to any definition of what it means for something to occupy physical space" (101). The tautology here (we will recognize as material only what we can materially perceive) means for histology that the description realized by textural investigation of the body will be limited to precisely *what a body can perceive in itself, what a body feels like to itself.*

Yet the embodied subject already knows this—that is what embodied experience is. If histology claims to be on the hunt for a physical correspondence between the structure of biological organisms and the experience of being one, the omnipresence of texture as method of description betrays an unconscious disregard for such a "correspondence" from the very outset. If thinking and doing are mutually conditioned—something an honest approach to textural

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[10] We could equally invoke affective capacities. Brian Massumi has written a lot about the connection of Deleuze and Guattari's work to *affect.* See Massumi, Brian. "The Autonomy of Affect." *Cultural Critique*, no. 31 (1995): 83–109.

"feeling" makes clear—there is no sense in treating one as prior to the other. Instead, I read the histological project as a covert search for exactly the opposite—for the liberation from that dualism. The aim is to discover (or rediscover) proof that what one's own biological life *expresses* is not spirit, but matter, in all its finite power. The destruction of the "correspondence" is not, therefore, the destruction of the human category, but its re-articulation within the world of matter, as an emergent expression of what matter can do.[11] Histology's main preoccupation—the *organization* of biological matter—can then be understood as a way to systematize and save what seems special about life: its self-effecting, self-organizing potential … its "self" in general. The historical story of this chapter ends with the discovery that nervous tissue, including the brain, is composed of individual cells. Once the circuitry of the nervous system can be understood as a complication of the space between perception and action, input and output, it no longer seems metaphorical to say that conscious experience is somehow about texture and affect.

In *Creative Evolution*, Henri Bergson provides a concise re-articulation of human exceptionalism in light of material constraints on what it can perceive:

> Now, we have considered material objects generally. Are there not some objects privileged? The bodies we perceive are, so to speak, cut out of the stuff of nature by our perception, and the scissors follow, in some way, the marking of lines along which action might be taken. But the body which is to perform this action, the body which marks out upon matter the design of its eventual actions even before they are actual, the body that has only to point its sensory organs on the flow of the real in order to make that flow crystallize into definite forms and thus to create all the other bodies—in short, the living body—is this a body as others are? (12)

For Bergson, knowledge—the ability to distinguish objects—is embodied, and the greater the sophistication of those distinctions, the greater must be the organization of the distinguishing

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[11] Here I am thinking about Deleuze and Guattari's ideas of *content* and *expression* of matter from the third chapter of ATP, "On the Geology of Morals."

body. George Eliot, who we will get to in the next chapter, founds her meliorism on the same material notion, setting the sophistication of oneself as a material thing as a moral aim.[12] Likewise for Bergson individuation is a "characteristic property" of life, though "not fully realized anywhere, even in man" (13).[13] Though Eliot's position comes before the neuron (but predicts the logic that would accompany it) and Bergson's after it,[14] both represent ways of folding the finitude of material form back onto the organism. A distinction becomes possible again: "life is a movement, materiality is the inverse movement" (Bergson 250).[15]

Even organization, which pretends to be a liftable feature, is bound through embodied perception with the strange self-interest of texture play in which the living investigates its own mysterious logic.[16] We will return at the end of the historical section to this critical role of *feedback* in the evolution of the nervous system out of a perception-action system, as life extracts regularity from the environment. Such regularity appears phenomenally, like texture, relative to *scale*.

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[12] Again, it is not a coincidence affect theory carries the same idea, often under the name of pedagogy: the possibility of "a body's becoming an ever more worldly sensitive interface … resonant affinities of body and world, being open to more life or more to life" ("An Inventory of Shimmers," *The Affect Theory Reader*, Siegworth & Gregg 12).

[13] The force of organization propels life forward, "as if it strove to constitute systems naturally isolated, naturally closed" (15). Part of the reason, Bergson writes, that complete individuation is not possible for life, is that for reproduction to be possible, the organism must come apart, bleed at the edges, and eventually separate something from itself that can live on without it. "Individuality therefore harbors its enemy at home. Its very need of perpetuating itself in time condemns it never to be complete in space" (13).

[14] Bergson was aware of Ramon y Cajal's work—in fact, I think its possible that he read Cajal's *Textura del hombre y los vertebrados*, for the argument in *Creative Evolution* on the nervous system contains similarities. Of Cajal Bergson once said that he suspects Cajal somehow *felt* the independence of neurons before he ever *saw* it (Callabed I Carracedo, Joaquim., Callabed, Joaquín. *Una mirada a Santiago Ramón y Cajal en su perfil humano y humanista*, 2019. Spain: Reial Acadèmia Europea de Doctors, 2019, 257).

[15] The full passage gives a better sense of the possibility suggested by Bergson: "In reality, life is a movement, materiality is the inverse movement, and each of these two movements is simple, the matter forming a world is an undivided flow, undivided is also the life that passes through it by shaping living beings. Of these two currents, the latter counteracts the former, but the former nevertheless obtains something from the second. From them comes a modus vivendi, which is precisely the organization" (249-250). Life defines, for Bergson, matter which has begun to effectively model the world, so that its material, affective capacities are aligned with real patterns in its environment.

[16] Bora writes: "when a surface (a rock, or your face, for example) has certain properties, we often project these properties into its interior, and by this interior I mean not just a cavity, invagination, fold, or center, but the structure, consistency, or *texxture* of its inner matter that extends liminally, asymptotically, into the surface" (101).

Texture and Scale.

Histological perception can remain textural under even the most extreme magnification because of texture's special scale-invariance. As Eve Sedgwick points out, it is by virtue of texture's connection to affect that it exists phenomenally relative to the scale of observation. "What [texture and affect] have in common," Sedgwick writes, "is that *at whatever scale they are attended to*, both are irreducibly phenomenological. To describe them primarily in terms of structure is always a qualitative misrepresentation" (21). The microscopist discovers texture does not appear at any specific scale and the same textures are not visible at all magnifications. What looks like a web of fibers at one magnification may, with a new lens, change to the brick-work of cellular lattice.

To say that texture is "irreducibly phenomenological" does not mean that it is not real. Rather, it means that texture is always relative to the scale (more generally, the frame) at which it is observed, and therefore actual only at that scale—but as real as anything that is not actively being observed. We might combine Sedgwick's notion that texture is perceptual data "whose degree of organization hovers just below the level of shape or structure," with Deleuze and Guattari's interest in the fractional dimensions of what they call *smooth space* (Sedgwick 16). One perceives texture at the level below wholes and above parts, in the "*zone of indiscernibility* proper to 'becoming' (more than a line and less than a surface; less than a volume and more than a surface)" (Deleuze and Guattari 488 and quoted in Bora 106). Texture is retrieved from the virtual by the perceiver, who supplies the limited reference frame against which it can appear, shimmering and mutual.

Once histology sees the cell, other grounds come alive. All the intermediate scales beneath the conscious are invigorated and redeemed in this fractional, smooth sense. The presence of texture at all levels of magnification in the organism now attaches to the discovery that there are life-processes occurring at every level, manifest as textures proper to that scale. They are alive exactly with respect to their dimensionality and scale—there is no excess. There is really tissue, it stretches and rips at the seams; there are really organs, they do the work local to them; there are really fibers, they contract and tear; there are really cells, they live and reproduce and die alone. Histology's relationship with the microscope encourages this intensive reconceptualization of the organism on infinite scales of operation. Just as the microtome sections a three-dimensional block of tissue into two-dimensional slices for observation, so does the microscope take the integrated life process of organism apart into discrete, infinitesimally precise scales, the re-integration of which hangs ever over the head of the histologist as a spatial or geometrical version of the problem of texture in relation to structure. If texture is a phenomenon relative to the scale of its observation—is as much an expression of that observer-dependent *scale* as of the thing observed—then how can that relativity ever be removed?[17] To what would the new thing be relative? If texture somehow, paradoxically, *got* to structure … where would we have got to then?

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[17] Bora relates this problem with texture to the general problem of observation captured by Heisenberg's principle from quantum mechanics. He writes: "the Heisenberg principle, almost identical to the problem of feedback in observation, becomes even more literally and epistemologically violent. For touch and physical pressure transform the materials one would like to know, assess, love" (99). The wave mechanics of particle motion mean that velocity, being the derivative of position, is inextricably locked to it for the purposes of measurement. The limitation is inherent to *sampling*, not to the wave itself. Maybe it is useful to imagine texture in a similar relation to structure. Then what is phenomenal in texture would be its status as an instantaneous sample of the real—a real which is also engaged in a constant development (becoming) of which texture is a sample. Digital objects (sound and photo date, for example) show different textures depending on the way they are sampled (with respect to what domain, with what sampling rate, etc.). Anyone who has noticed strange ripple-like artifacts when looking through a screen door at the right angles or a picket fence flashing by has noticed some such "illusory" textures (aliasing caused by the pixellating filter of the mesh or bars). The signal folds back on itself, potentially revealing new patterns in the signal through interference. All observation entails sampling; all cuts have a bias.

II. Cutting Looking: Sectioning the Histological Body

If phenomena come out with attention, we may have wasted time with all that abstract discussion. It would be best to get right into the matter and feel some histological text. Rather than pretend to present as continuous and complete the many digressions and divergences of its long history, I have prepared seven samples. As successive cross-sections move along a physical axis, these sections have been made chronologically, catching historical processes against the plane of the document. The history begins with early microscopical anatomy and ends with the neuron. Each "slide" presents a short passage from an important histological text alongside an illustration from the same text.

This section is meant to bring the body-textures so far under discussion into contact with the textual-textures with which the rest of the thesis will be dealing. For now, this will look like close attention to how metaphors and explanation work in a body constructed in language. *Text*, like *tissue*, is joined to *texture* not just through the common metaphor to the *textile* but in the sense that language, writing, weaving, touching, and feeling cooperate in any human attempt to live with matter. In chapters two and three I will try and read literary texts in light of this cooperation and argue that the cooperation can understood materially. Part of the goal here is thus to provide a history against which they can be positioned, Eliot at a turning point in the 1870s and Rilke just after the establishment of the neuron and the fully-cellular body.

The history of anatomical texts organizing the body is also a history of the re-organization of text itself. Before the publication of Andreas Vesalius's landmark human anatomy textbook *De humani corporis fabrica* (On the fabric of the human body) in 1543, medical texts, like most handwritten manuscripts, contained almost no illustrations (Lander 12).

Diagrams are difficult to copy faithfully by hand; text is easy. Unfortunately, as Vesalius noted, that also made them a lot less useful. Trying to identify structures from textual description while dissecting a real corpse, book here, body there, seemed to him a ridiculous inefficiency. To Vesalius, the "detestable ritual" of an anatomical dissection dramatized the distance of the book from the body (ibid 11). It took three people to get from book to body: the *lector*, the physician, who would stand by the book and read aloud, the *ostensor*, a little lower in status, who would point out with a rod where the cut should happen, and finally, the *sector*, a lowly barber, who would do the manual hand-knife work (ibid 11).

Vesalius, however, thought that physicians should get their hands dirty to understand the composition of the body. The book would have to get a little more bodily too—strangely, by the adoption of new printing techniques that obsolesced the manual production of the text. He contracted artists to make 171 woodcut illustrations, labelled and cross-referenced with precise textual description (ibid, 12). Unlike previous anatomical treatises, *De fabrica* was designed as a "visual aid" to the reader-dissector (ibid 14). More than simply providing reference diagrams, the book's schematic organization into 188 chapters tells the reader where and how to take the body apart (ibid 15). "Each chapter represents an individual section, or cut, of the sector —and, therefore, a cut deeper into (or out of) the body, or subject of the text" (ibid 15).

We might put it like this: organization imposes a causal narrative because it tells a story about priority—what comes first, what is more fundamental. Following Vesalius, the histological texts in this section organize knowledge about biological matter by inscribing certain relations among discerned parts into the relations of elements in the text. The method is textural: it seeks to explain a quality of the object by reproducing the relations it takes to compose it. The smaller

the scale of observation, the more suggestively material these qualities become and the stranger the sought-after "correspondence." The question is already here with Vesalius: which body is structuring the text—the one on the table or the one touching it, drawing it, describing? And what difference does it make? It's the same body, isn't it?

fig. 1. The cover page illustration from *de Fabrica* with Vesalius in center, performing the dissection himself, with his hand in the viscera, looking out at the viewer.

Slide 1. Helkiah Crooke*, Mikrokosmografia: A Description of the Body of Man,* 1615.

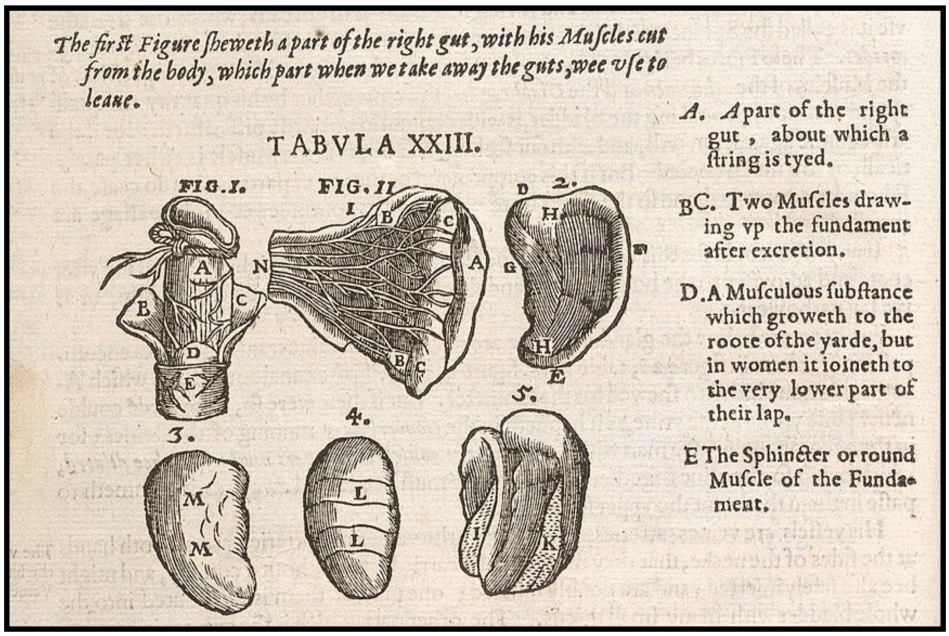

fig. 2. Drawings of the gut, labelled and numbered. At the top left, a string has been tied around the top of the gut. (Crooke 154)

> Now there is amongst Physitians, a double acceptation of Anatomy; either it signifieth the action which is done with the hande; or the habite of the minde, that is, the most perfect action of the intellect. The first is called practicall Anatomy, the latter Theoretical or contemplative: the first is gained by experience, the second by reason and discourse: the first wee attaine only by Section and Inspection, the second by the living voice of a Teacher, or by their learned writings: the first we call Historical Anatomy, the second Scientificall: the first is altogether necessary for the practise of anatomy, the second is only profitable; but yet this profit is oftentimes more beneficiall then the use it selfe of Anatomy: the first looketh into the structure of the partes, the second into the causes of the structure, and the actions and uses therefrom proceeding. (Crooke 26).

Helkiah Crooke seems to enjoy dissection. Taking inspiration from Vesalius, he divides and sub-divides his book into 485 sections, systematically arranged by analogy to the human body (Landers 16-17). The text organizes the body and then treats the resulting textual structure as the adoption of a natural hierarchical form, as if it was the body that had imposed an organization on the text. The body, Crooke writes, "is as it were the measure and exemplary

patterne of all corporeall things" (Crook 13). The text-book thus founds its authority to speak on material things to the extent that it adopts the edifying microcosm of the body as its model.

He has even taken anatomy apart. In the citation above, his cut follows the border of a mind-body dualism (as well as a real historical separation in disciplines between barber-surgeons and physicians). There is an anatomy of the hands, which takes things apart, and then there is an anatomy of the mind that integrates those parts to recover the whole. Even though he accepts that the manual work is "altogether necessary," understanding will always come out *prior*. The material is not sufficient to explain itself. The coy remark that effort to understand is "only profitable" means to relate the mind to *excess* and patterns beyond the material. Reaching these, the mind exceeds the body with the magic of surplus,[18] lifting the integration out of the material plane and into the realm of essences.[19]

Yet Crooke understands that the "sublunarie" body is paradoxically a prime site for seeing those patterns in action. Just as the cosmos contain lessons about physics, the body tell on the material world through its senses: "It was necessary that the body of man should be

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[18] "This alone," Crooke writes, "is incorporeall, immortall, or immutable. This may be called the receptacle, promptuary, or store-house of all the species or kinds of things" (Crooke 4). Real knowledge is that which can be exchanged.

[19] Notice the connection between this integrative logic and the idea of texture as the derivative of structure described at the end of the previous theoretical section. If material anatomy can be integrated to arrive at the essences, then the material seems to be derived from those essences. Why then does this conclusion not follow from idea of texture as a differential? The distinction is that Crooke relates parts and wholes such that the whole is *prior* to its parts. Philosopher (and monist) Jonathan Schaffer calls this *priority monism*, a view in which "metaphysical explanation dangling downward from the One" (31). Schaffer's monism doesn't rely on essences but rather the conviction that failing to capture priority relations—where parts are *grounded* by the larger scale wholes they compose—means missing something about the way the world really is (Schaffer, "Monism, or the Priority of the Whole," and "On what grounds what"). Pluralism, which the cell will later suggest to its interpreters, inverts the priority, grounding the whole in its parts. One of the goals in this section is to work through these dualisms toward Deleuze and Guattari's "magic formula": "PLURALISM = MONISM" (ATP 21). If the phenomena appearing at a given scale are proper to it alone, there would then be no metaphysical excess; no profit for Crookes to take home.

composed of such a matter as might bee capable of these sences," he writes, "but of all sences the foundation is *Touching*" (Crooke 6). Tissue belongs to this touch-forward sensorium.[20]

A diagram from the section on the "Fundament" (the end of the gastrointestinal tract) visualizes some parts of the fibrous, textile body of early-modern anatomy (fig. 2). The hatch-shading makes solidity from the arrangement of contour lines like crossing fibers; muscles peel away in sheets like torn fabric. The mass of an organ seems a lumpen ball of yarn. In the first figure a piece of string has been tied around the muscle, metaphorically acting out the constriction of the rectum, so as to better picture the function of the sphincter muscles in retaining and expelling waste. That the tensile, fibrous strength of the string seems a suitable substitution for muscular constrictive force speaks not just to the textile body but to the touching manipulation that the textile body invites in dissection. The nearness of the investigation of gastrointestinal function to an anal play of retention and expulsion[21] is almost acknowledged by Crooke, who notes that when the muscles of sphincter that "retract the fundament" are weakened, "men are constrayned to use their fingers to doe that office." The two interventions—the anatomist that ties a string around the organ to make a mock rectum and the person who uses their fingers to relax a weak sphincter—have a kinship in their intuitive treatment of the body as matter among matter. Still, it is a disquieting image: the string seems to make meat out of flesh, tied like butcher twine on intestinal casing. In all this fabric and fiber, there is a lot of binding, contraction, tightening of collars, constraynt. These are the intricacies of the human body: the

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[20] More on early modern theories of perception in which touch was primary in the second chapter. An important earlier precedent is found in Aristotle (by contrast to the Platonic path to knowledge from sight). See S. H. Rosen. "Thought and Touch: A Note on Aristotle's 'De Anima.'" *Phronesis* 6, no. 2 (1961): 127–37. For a more general history of touch in philosophy (in which Crooke is discussed), see Harvey, Elizabeth D. "The Portal of Touch." *The American Historical Review* 116, no. 2 (2011): 385–400. See also Derrida, Jacques. *On Touching-Jean-Luc Nancy*. United States: Stanford University Press, 2005.

[21] See Bora, pp. 97, on the "joys of anal management" for more on this particular site of texture.

interconnections that determine what it can do and what can be done to it. The textile body is woven out of these interconnections. Equally, the texture of the sphincter muscle (the direction its fibers run, the strength of those fibers, etc.) is what suggests that a string could simulate a rectum. Crooke's functional analysis of human anatomy relies in this way on texture as an index of the affective capacities of material objects. He would like it to be keep hand and mind separate, yet even in his own writing the hand rebels and intervenes: "men are constrayned to use their fingers."

Slide 2. Robert Hooke. *Micrographia, or some Physiological Descriptions of Minute Bodies, made by Magnifying Glasses, with Observations and Inquiries thereupon,* 1664.

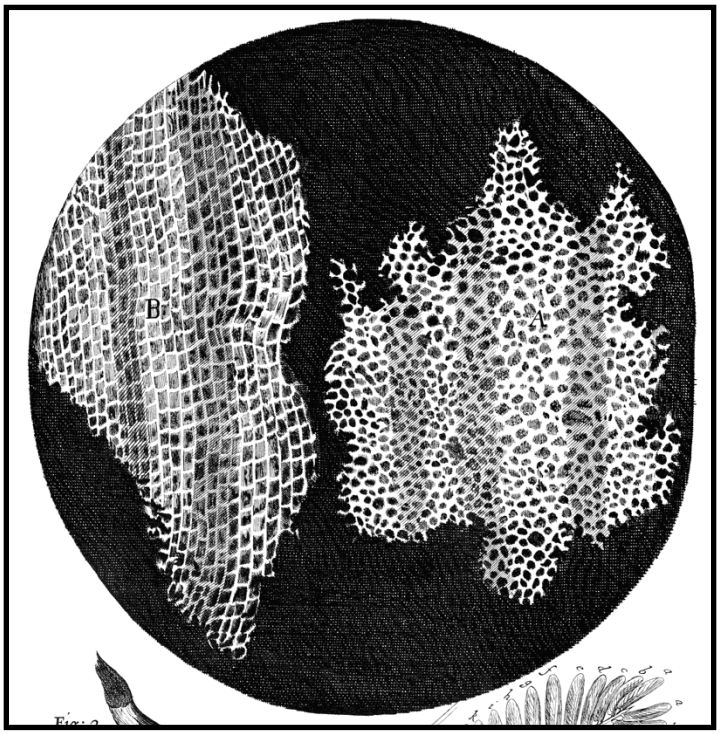

fig. 3. Illustration of the texture of cork (Hooke 114).

I took a good clear piece of Cork, and with a Pen-knife sharpen'd as keen as a Razor, I cut a piece of it off, and thereby left the surface of it exceeding smooth, … me thought I could perceive it to appear a little porous; but I could not so plainly distinguish them, as to be sure that they were pores, much less what Figure they were of: But judging from the lightness and yielding quality of the Cork, that certainly the texture could not be so curious, but that possibly, if I could use some further diligence, I might find it to be discernable with a Microscope, I with the same sharp Penknife, cut off from the former smooth surface an exceeding thin piece of it, and placing it on a black object Plate, because it was it self a white body, and casting the light on it with a deep plano convex Glass, I could exceeding plainly perceive it to be all perforated and porous, much like Honey-comb … the whole mass consists of an infinite company of small Boxes or Bladders of Air, which is a substance of a springy nature (Hooke 112-3).

Robert Hooke, an early adopter of the microscope, records here the first known sighting of the cell (Wolpert 227). His account is intensely technical, like many from early microscopy.[22] In this description of his investigation of cork, one can see how the technical details of method (the qualities of tools and the way they were used) are as important to the observed result as the quality of the material under investigation (its porosity, lightness, and buoyancy; its "springiness and swelling nature when compress'd"). The two textures interfere as two sets of affective capacities. What is worth observing here is cutting an object in sections, the preparation of thin samples for viewing under the microscope, obscures the interference it represents as the knife gets sharper and the face of the slice gets smoother. This smoothness is the fiction of textural lack (that is, the lack of a texture imposed by the observer and the revelation of the true internal texture) and the condition for seeing of textile-tissue under the microscope.

There is no extricating hand from mind. The graduated perfection of textures in Hooke's narrative—the sharpening of the knife, the geometrical perfection of the lighting glass, the smooth blackness of the plate—reflects a haptic awareness on the part of the microscopist that their handiwork is reflected in the final texture. Smoothness, as Bora writes, is a strange, self-effacing type of texture: it is "both a type of texture and texture's other," signifying "the willed erasure of its history" (Bora 99, Sedgwick 15). In histology, smoothness is the face of the cut. There's nothing sinister in the effort to take a sample that registers minimal information about the way the sample was taken. The aim is simply to reduce the confusion of information relative to

[22] It took a long time for microscopic techniques to be standardized, so results had to be accompanied by detailed accounts of their production. A by-product is the consideration of one's tools as material objects. At one point, he even puts a microscope lens under his microscope to study the smoothness of the glass: "even in the most curious wrought Glasses for *Microscopes*, and other Optical uses, I have, when the Sun has shone well on them, discover'd their surface to be variously raz'd or scratched, and to consist of an infinity of small broken surfaces, which reflect the light of very various and differing colours."

the sampling process with information from the exposed surface.[23] Hooke gives a technical account of his method for the same reason: so that the revealed texture can be read in light of what it took to reveal it.

Hooke's obsessive sharpening likely has its root in the microscopist's knowledge that a blade is never truly sharp—and that while nature produces exactitude easily, the human hand is microscopically imprecise.[24] The first three observations of *Micrographia* deal with human imprecision in the first three dimensions: the point of a needle, the edge of a razor, and a piece of cloth (point, line, plane; 0, 1, 2).[25] The needlepoint no longer appears sharp and even, but rather reveals "a multitude of holes and scratches and ruggednesses" (Hooke 1). The razor seems now twisted and rough, the wider part criss-crossed by "several great and deep scratches, or furrows," and the sharpest area looking even "rougher than the other, looking almost like a plow'd field, with many parallels, ridges, and furrows," (ibid 4). (These furrow-marks return these supposedly advanced fabrications to primitive human technologies: plows, hand-axes.) The fine piece of linen fares no better. The "plain and base" threads of flax have been woven into a "fine contexture" that *feels* silken "both to the eye and the touch, full as *fine* and as *glossie*" (ibid 5). Yet under the microscope, it becomes a "piece of coarse Matting" with more holes than substance (a "lattice-window").

It is not a coincidence that Hooke's drawing of silk mesh resembles the cell structure of his cork diagram. At the end of his section on fabrics, he speculates that the "tenacity of *bodies*"

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[23] Especially in the early days of microscopy, it was common for optical noise relating to the set-up to lead observers astray, sometimes identifying as structures of the object tricks of light (Wolpert 229).

[24] "So unaccurate is it, in all its productions, even in those which seem most neat, that if examin'd with an organ more acute then that by which they were made, the more we see of their *shape*, the less appearance will there be of their *beauty*: whereas in the works of *Nature*, the deepest Discoveries shew us the greatest Excellencies." (Hook 1)

[25] Hooke was probably consciously following Euclid with this dimensional growth. He writes of the razor that "The sharpest *Edge* hath the same kind of affinity to the sharpest *Point* in Physicks, as a *line* hath to a *point* in Mathematicks … since as we just now shew'd that a *point* appear'd a *circle*, 'tis rational a *line* should be a *parallelogram*" (Hooke 2).

is a result of a "more exact" interweaving of fibers to create a "contexture" (as opposed to the Epicurean view of "hooked" atoms). The generalization from two-dimensional textile to the composition of three-dimensional objects like cork is thus justified by a common texture or quality ("tenacity," a kind of plastic strength arising from intricacy). The greater the tenacity, the more organized, intricate, and alive the object is: in tenacity, according to Hooke, animals are superior to vegetables and vegetables to minerals. The textile is a proxy for the contexture of organic matter, with the metaphorical *pattern* in the former becoming spirit in the latter.

Texture, acting in the interstitial, inter-dimensional zone, makes possible the application of textile to organic mass. It also works in the other direction. As histology developed and microtomes replaced the steady hand and sharp pen-knife, it became possible to take thinner and thinner sections of material. The three-dimensional aspects of the object thus become less and less visible, left more to the integrating spatial memory of the microscopist. Sectioning, as Hooke's drawing of cork shows, cuts fabric-like sheets off of the material. It would be easy for a histologist to mistake their mental recomposition of the object from cross sections for its actual composition. Then a lattice would seem to be formed by the compounding of tissues.

Hooke understands that the macroscopic effects of "springiness," "toughness," "friability" and "brittleness" are phenomenal. The discovery of hollow cells in cork, he writes, provides the "true and intelligible reason of all the *Phænomena* of Cork," as an analysis of other materials would "render the true reason of all their *Phænomena*, … namely, what were the cause[s]" of their macroscopic qualities (114). When Hooke speaks about the discovery of causes and reasons lying in the parts of an object (its "*Schematisme* and *Texture*"), he invokes explanation by reduction, a natural direction of explanation for microscopy. To speak causally

about a quality is to make a metaphysical claim about what can explain what. What is worth noticing is how the first intuition (that phenomena/qualities/textures are derivative with respect to a material ground truth) leads to priority relations across scales (a piece of cork floats because its made of microscopic hollow boxes) and the sense that some scales are more fundamental than others. The obvious question is then: where do we fit in? Tissue suspends this problem by covering the body with the textile, a made object to which only higher parental forces (*mater-pater*) are prior.[26] Hooke's work shows how texture not only mediates conceptually between two-dimensional textile and three-dimensional body, but also physically, in the preparation of sections.

[26] Foucault describes clinical interest in tissue as the attempt to discover such an "internal surface" for the re-mapping of the elements of the body: "the isolation of tissue—a functional, two-dimensional area—in contrast with the functioning mass of the organ, constituting the paradox of an 'internal surface'" (Foucault, *Clinic*, xviii). As Foucault writes, the clinic cannot be born until histopathology spatializes the body. Then there can be "a welding of the disease onto the organism … that situates the being of the disease with its causes and effects in a three-dimensional space" (ibid). Such a move relies on the connection between texture and affect that Hooke previews with his investigation of cork cells and fabric. Tissue's construction from the textile metaphor (its general lack of priority, its status as patterned matter) structures the investigation of the body as matter from the outset. For more on Hooke's influence on the concept of body as textile/tissue, see Hisao Ishizuka, "Visualizing the Fiber-Woven Body," pp. 115-117. Although Hooke makes a step toward the cell in his description of cork, he still considers the cells to be like the openings in a weave, as though neighboring cells are sharing a wall. He misses their independence with his textile reading, taking the whole phenomenon (texture) as prior to its components (the cells).

Slide 3. Nehemiah Grew, *The Anatomy of Plants*, 1682.

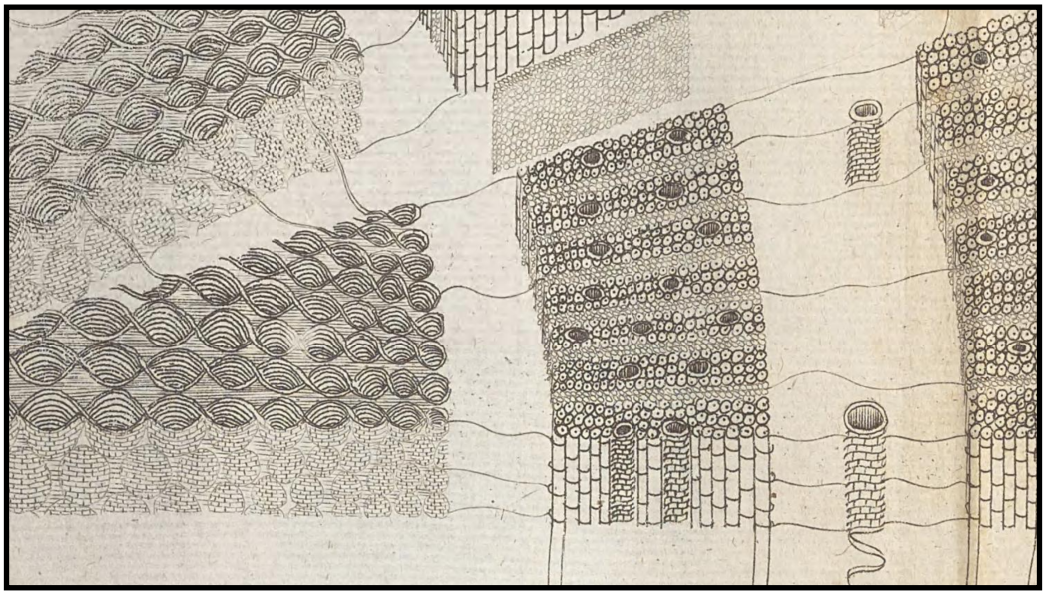

fig. 4. Detail from one of Grew's illustrations of plant tissue.

> The Contexture [of both the pithy and ligneous part of the plant], is Fibrous. Whence we understand, How the several Braces and Threds of the Vessels are made: For the Vessels running by the length of the Root, as the Warp; by the Parenchymous Fibres running cross or horizontally, as the Woof: they are thus knit and as it were stitched up together. Yet their weftage seemeth not to be simple, as in Cloath; but that many of the Parenchymous Fibres are wraped round about each Vessel; and, in the same manner, are continued from one Vessel to another; thereby knitting them altogether, more closely, into one Tubulary Thred; and those Threds, again, into one Brace: much after the manner of the Needle work called Back-Stitch or that used in Quilting of Balls (Grew 77).

Nehemiah Grew wrote at the beginning of a long moment in which the metaphor of *tissue* had so been so successfully extended to microscopic perception that histologists had begun to

theorize about and search for the primitive fibers from which this tissue was woven.[27] This provides an opportunity to think about how fiber, as part of the textile metaphor, encourages thinking about what physical connections extending between parts say about how a thing functions. The functional analysis of the fibrous body thus extends that of tissue (as in Hooke and Crooke) to a more exact investigation of the organism as a machine.

In Grew's large drawing above, the richness of surface texture along the plane of the cut extends down into a third dimension, showing the nature of the processes which meet the cross-section. With the addition of depth, Grew can show not only the fibers that run along the plane of the cut but also those intercepted by it. Nothing is left discrete—everything is in some direction composed by strands, tubes, or vessels. It is curious how much certain textures resemble brickwork—both the double-wave strands on the left and the columns on the right—considering that brickwork, or any sort of building-block metaphor for construction, would have struck closer to the cellular nature of tissue. That would however have ruled out the possibility, essential for Grew, that many fibers act as channels ("Vessels") for controlling flows.

Other contemporary microscopists had proposed other, more discrete elemental parts—the globule and the gland, for example, from van Leeuwanhoek and Malphigi respectively—but it was Grew's fiber model that won out, later dominating eighteenth century histology (Ishizuka 114-115, 117). Fiber was not simply the natural division of the textile body, but also worked with a new machinic metaphor: the hydraulic (Ibid, 115). At the same time as microscopists were seeing, for the first time, the *thickness* of what had seemed invisibly thin threads, machines

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[27] Albrech von Haller, in his 1757 book *Elementa physiologiae corporis humani*, wrote about the fiber as the ultimate elemental part of the body. "A fiber is for a physiologist what the line is for a geometer: that out of which all other figures are constructed" (Wolpert 228).

which operated by pushing fluids through tubes were becoming more and more prevalent. In the 1650s Blaise Pascal worked out an important equation describing hydraulic transmission (Pascal's Law), effectively creating the science of hydrodynamics. The vascular body applied the new systems science to organic machinery as a way to explain how parts mechanically interacted. Only a few years before Pascal's formalization, Rene Descartes published *Les Passions de l'âme* (*The Passions of the Soul*), schematizing the souls operation upon the "machine of our body" in the controlled opening and closing of valves in the pineal gland. Pressure differentials from the valve manipulation sent animal spirits "excited by the heat of the heart" circulating through the body and coordinated muscle movement (Descartes, I. 18). The soul intervenes (or supervenes) upon the material system from outside.[28] The textile body, I argued, reserves a space for priors; the Cartesian hydraulic solution elaborates a logic that locates the conscious in that space too, preserving the feeling that the mind can direct the body.

What Descartes needs from the hydraulic metaphor to establish his dualism is the notion of matter doing something *according to the properties of matter*—changes in pressure propagating through fluid in a tube due to heat energy from the heart. The soul can thus act locally and as a unity, while the hydraulic vascular system carries the burdens of matter: distribution across space, contiguity, decentralization. Starting in the 1660s, anatomists like Frederik Ruysch lent credence to Descartes' hydraulic explanation, developing new techniques to render the vascular networks of the body visible (Ishizuka 115). Ruysch's method of perfusion, for example, entailed the injection of a dark red cinnabar-based mixture into the veins of a fresh corpse, staining very delicate ramifications of the vascular system a deep vermillion (Boer). He

[28] "The whole action of the soul," Descartes writes, "consists in this: merely by willing something, it makes the little gland to which it is closely joined move" (ibid, I. 41).

preserved his samples, many of them congenitally deformed infants, in glass jars. Their faces retain a strange vital flush, the permeation of the dense capillary system of facial tissue by the red chemical. Ruysch's experiments seemed evidence for the claim implicit in Descartes' hydraulics: liveliness is an artifact of the body's machinic operation.

Although Grew's work was on plants, not human bodies, the tubes and vessels still carry the hydraulic significance of communication. The fiber is fundamental because interconnection ("Contexture") is fundamental to what an organism is. Processes "are continued from one *Vessel* to another; thereby knitting them altogether." Nature knits it into existence, giving it density and form by the progressive entanglement of its internal connections. If Grew's meticulous drawings have a *horror vacui* to them, it is because *density* is their subject. The denseness of "contexture" is a sign that a material machine is at work, since physical connections (now seen through the hydraulic metaphor) are what allow the parts of the system to influence each other. This densifying movement is also meant to perform another dimensional shift, moving from fiber to textile, as though the necessity of tubes in the machine were now grounding the observation of tissue. The language of textile production continues to dominate the metaphors of the text, only now it is the formation of the fibers under discussion, wrapping, coiling around, breaking the textile down into warp and weft. Fibers make a natural reduction from within the metaphorical space of the textile, preserving continuity (flows, threads, vascular networks) while becoming more machinic about the organic. The body becomes a container by default, a vessel, as *Faser* collects into *Gefäß* or *vaso* to *vaso*.

Slide 4. Matthias Schleiden, "Beiträge zur Phytogenesis," *Archiv für Anatomie, Physiologie und Wissenschaftliche Medicin*, 1838.

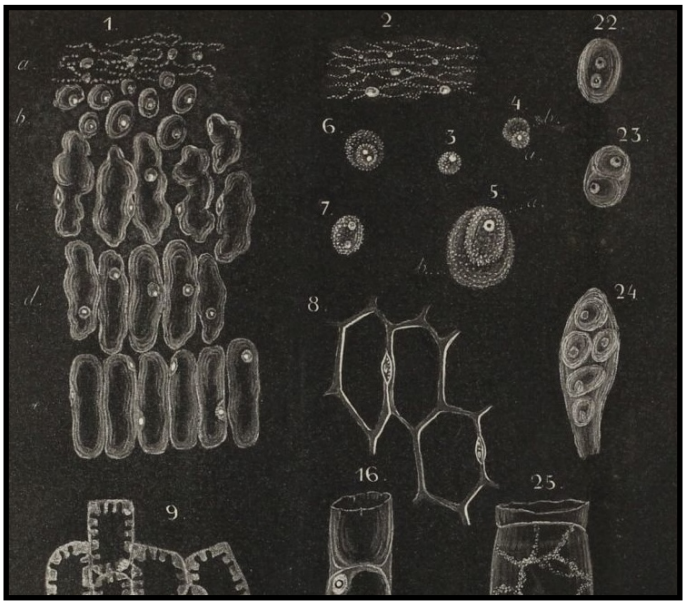

fig. 5. Illustrations from the *Beiträge*. In the top left, cell formation from substance (1) through intermediate forms (2-7) to stabile structure (8).

Jede nur etwas höher ausgebildete Pflanze ist aber ein Aggregat von völlig individualisierten, in sich abgeschlossenen Einzelwesen, eben den Zellen selbst. Jede Zelle führt nun ein zweifaches Leben: ein ganz selbständiges, nur ihrer eigenen Entwicklung angehöriges und ein andres mittelbares, in so fern sie ein integrierender Theil einer Pflanze geworden. [So, given the cellular composition of plants:] Was heisst wachsen? …

1. Die Pflanze wächst, d. h. sie bildet die ihr zukommende Anzahl von Zellen.

2. Die Pflanze entfaltet sich, indem die gebildeten Zellen sich ausdehnen und entwickeln. — Es its besonders diese für die Pflanze ganz eigenthümliche Erscheinung, die, weil sie auf der Zusammensetzung derselben aus Zellen beruht, bei den Kristallen, wie bei den Tieren in keiner auch nur entfernten Form vorkommen kann.

3. Die Wände der ausgewachsenen Zellen verdicken sich durch neuabgelagerte Schichten, ein Process, den man nach der alten Regel: *a potiori fit denominatio*, am zweckmässigsten das Verholzen der Pflanze nennen kann. (Schleiden, 137-138, 160-161).

By the time Matthias Schleiden left law to join the anatomy lab of Berlin anatomist Johannes Müller, the promise of elementary fibers had been replaced by early forms of cell theory (Vienne 634). Botanists like Schleiden got to the cell before their zoological counterparts. In plants, the cell is delineated by a semi-rigid cell wall; in animals (which need to move and bend), the only boundary is the amorphous lipid layer of the cell membrane.

In the article cited above, Schleiden begins with an exposition of the double-ground realized by the cell. There is something duplicitous about the cell's "zweifaches Leben" (one might hear *Zweifel*). The individuality of the cell is cast selfish: it pursues its own development first and foremost, acting as a part only indirectly, "in so fern" as it wishes to contribute. One begins to worry that it is not really committed to the plant, whose growth nevertheless relies on its own—in fact, unfolds (*entfaltet*) as one half of that two-facedness. The question Schleiden is grappling with—how can the continuous, imperceptible growth of an organism occur if its parts are discrete?[29]—can therefore be read as a question about the collective nature of morphogenesis. With this question, Schleiden pushes the reduction around what structure houses the affective capacities of the organism into the discrete world of the cell.[30]

Just because the growth of something can be described as the growth of an individual, Schleiden explains, does not mean that it does not at the same time take part in a larger process or exist as a product of smaller processes. It is because the cell is clearly alive to-itself that this relativism becomes necessary. Even though the cells are "völlig individualisierten," one would

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[29] Schleiden will not be able to answer the question of growth entirely, for it will be another few decades before the process of cell division (*mitosis*) is described by Remak and *omnis cellula e cellula* accepted as the slogan for biological matter (Wolpert 231). Like Schwann, he hypothesizes that cells are generated *de novo* from concentrations of the right materials in a fluid (Schleiden 172). Actually, the fact of cell division (that every organism starts from a single cell) vindicates his distaste for the word *verwachsen*.

[30] Earlier candidates for such structures do not lose explanatory power with these progressive reductions (there are organs, tissues, fibers, etc), but rather lose their claim to "fundamentality" in certain priority schema.

miss something to consider the organism in which they take part as an inert by-product—it, too, is alive. To illustrate this point, Schleiden mocks the use by other botanists of the verb *verwachsen*, which, he claims, smuggles in the old idea that biological structures are formed by the growing together of processes with different origins (as tissue from fiber).[31] "Was würde der Zoologe dazu sagen," he asks ironically, "wollte man den Truncus als eine Verwachsung der Extremitäten ansehen" (ibid, 160). We can read this critique of *verwachsen* as a critique of *contexture* and the textile metaphor for tissue in general. The mistake consists in mistaking the legibility of a surface—the fact that it coalesces to form a perceivable texture—for information about the history of that surface. To imagine the torso as the joint production of the extremities—each stumbling upon each other and intertwining[32]—fails where it tries to insert priority into the double-grounded figure. Reading Schleiden's critique together with the description he offers of *wachsen* suggests that it might be equally wrong to think of the extremities as productions of the torso.

Of course, Schleiden was a botanist and did not yet know definitively that human life, too, was cellular. The joke about the torso and extremities, like the comment that keeps humans and crystals safe from the cell, could be read with a measure of denial. It is, after all, a child that gives the first answer to the question "was heisst wachsen" ("wenn ich so gross werde wie Vater"), framing the entire discussion of growth by both the human and non-human sense of *Bildung* (158). It is against a human-applicable idea of formation that the cellular account is

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[31] "Das Wort 'Verwachsen' hat aber seit ewigen Zeiten in Leben und Wissenschaft die Bedeutung gehabt, dass zwei oder mehrere ursprünglich und ihrer Natur nach getrennte Theile durch den Process des Wachstums entweder abnorm, oder unter gewissen Umständen gesetzmässig vereinigt werden" (Schleiden 159).

[32] If it were not grotesque enough to suggest an image of autonomous of body parts grasping and melting together into new masses of tissue, Schleiden's joke works as a pun as well, since *verwachsen* can also mean "deformed" (*Verwachsung*, "deformity"). Explaining the formation of wholes as the deformation of parts does not, for Schleiden, make a satisfying theory of morphogenesis. Rilke's famous poem "Archaïscher Torso Apollos" could be read productively alongside Schleiden's claim.

measured. The question is forced by priority: are wholes just parts coming together? or are parts just deformations of a whole?

The three-part definition of growth given oscillates between these two accounts, between pluralism and monism. In each part, the plant is conceded an active verb but the action of that verb must then be redefined by a subordinate clause in terms of cells. Plants exist, cells exist, but the verb will have to be redefined, specified in terms of the other ground: "wächst, d.h. [etc]", "entfaltet sich, indem [etc]." In the other direction (from cell to plant), the cell walls "verdicken sich," bringing about a macroscopic effect: "das Verholzen der Pflanze."

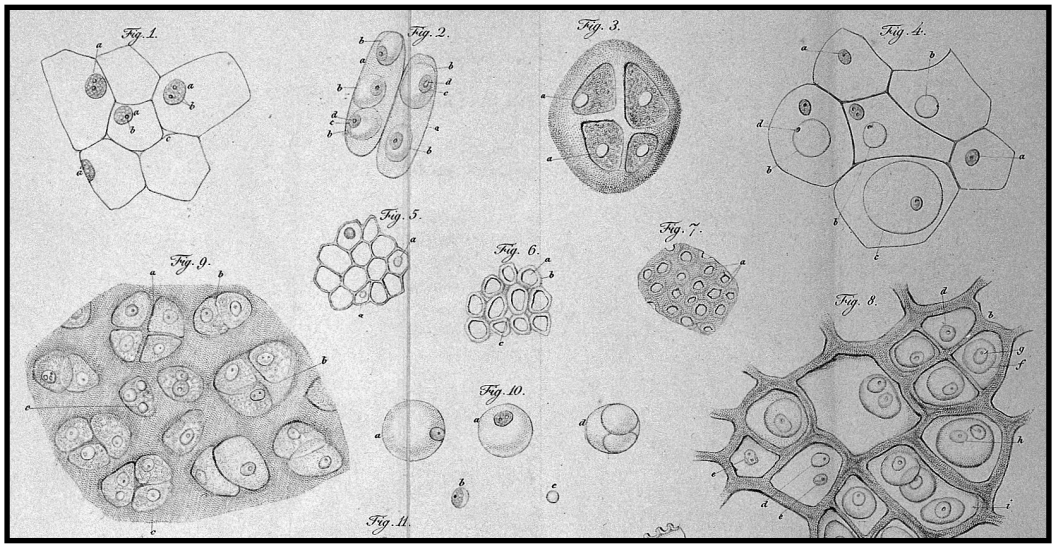
Schleiden investigates the life process of the cell as an individual in order to unify it with the life process of the organism as an individual, all around growth: *Bildung*, *Wachstum*. The two grounds, macroscopic and microscopic, share basic organic features: both are alive, both grow, develop, die.[33] Schleiden's *wachsen* describes the movement from one to the other, as an excess of dimension in the small scale (the *Verdickung* of cell walls, for instance) spills upwards into the larger scaler object, registered as a change in texture (the *Verholzen* of the plant's limb). And though names will still follow that macroscopic texture, it is only following a custom (*a potiori fit denominatio*) to enforce a priority relation with a name (*a denominationi fit potior*). Schleiden

[33] Schleiden considered individuality as a spectrum, achieved only (or nearly) in very few cases, depending upon the criterion. Annual and biennial plants (if you consider the death of the organism), unicellular organisms (if you stipulate no multi-cellular life). Like Bergson after him, he appreciated that the organism's need to perpetuate itself in time forecloses any possibility of its closure in space (*Creative Evolution*, 12-14.). There are shades to death. Schleiden writes: "Der Begriff des individuellen Leben fordert auch nothwendig als Merkmal, den schon in der Organisation selbst bedingten individuellen Tod. Wo aber ein solcher Tod nicht als endlicher Abschluss durch innere Nothwendigkeit, als innerlich im voraus bedingtes Aufhören der organisierenden Thätigkeit gegeben ist, kann auch von keinem Individuum die Rede sein" (168-169).

has noticed the names regrouping. Wholes open up; the ground gives way. He finds new sentences here: “es giebt aber keinen Baum, der Blätter hat” (170).[34]

[34] There is a cooperation between language and the dissolution of an named entity that is being thoroughly “explained.” The dissolution, as I allude to in this section, can happen because explanations are bits of language that ground x by reference to y, with the result that a good explanation leaves the explained thing with a spectral, insubstantial feeling. This idea will be relevant for the causal, materialist narrative of *Middlemarch* in the second chapter and to the diffusing and compounding movements in Rilke’s poetry in the third chapter, where two *Bäumen* appear in the analysis in even stranger sentences.

Slide 5. Theodor Schwann, *Mikroskopische Untersuchungen über die Übereinstimmung in der Struktur und dem Wachsthum der Thiere und Pflanzen*, 1839.



> Wenn man ein tierisches Gebilde den Pflanzenzellen parallel stellen will, so muß man beweisen, nicht nur daß das eine Zelle ist, sondern daß in dieser Zelle ähnliche Kräfte wirken, wie in den Pflanzenzellen oder, da dies direkt unmöglich ist, daß die Erscheinungen, wodurch sich die Tätigkeit dieser ~~Zellen~~ Kräfte äußert, nämlich Ernährung und Wachstum, auf dieselbe, oder ähnliche Weise vor sich gehe wie bei den Pflanzen. (from Schwann's drafts, quoted in Parnes 47).

In 1837 Theodor Schwann, another researcher at Müller's anatomy lab, sat down for lunch with Schleiden. They probably talked about their boss, about whom they both held reservations. In 1835, Schwann's second year at the lab, he wrote a letter to his older brother Peter, a priest, complaining about theological problems he saw in Müller's research program. Müller (inspired by Schelling) wanted to give an account of human life in which the "psychic principle," as Schwann called it, was responsible throughout the human body as a quasi-electric force (Vienne 642). Where Descartes' soul was limited mostly to the valves of the brain, Müller's

vitalism imagined the causal forces of mind operating throughout the body. Schwann thought Müller's mapping of mind onto body threatened to collapse a categorical distinction between the two. If the soul became spatialized and substantial, it would no longer be a soul. The notional separation between the two could easily collapse, or worse, reverse in priority.[35]

All this as a catholic; as a scientist, he saw no reason to imagine an abstract vital force as the causal agent in physical processes. To disprove this notion, he sought to distinguish macroscopic bodily phenomena with reducible material causes (say, pain, strength) from those without (consciousness, the life of the mind and soul). His early research in Müller's lab sought microscopic explanations for macroscopic effects: muscle contraction, digestion, fermentation (ibid 643). Paradoxically, in order to preserve the dualism that keeps matter beneath spirit, it became necessary to give an account of material phenomena from below, in some quantifiable relation to smaller causal agents.[36] Already in 1835, he was imagining in his personal notebook a comparative general anatomy ("vergleichende allgemeine Anatomie") that could unify diverse macroscopic biological phenomena by discovering common structural causes ("die wesentliche Struktur zu ermitteln") (Parnes 36).

When Schwann heard about Schleiden's research into the cell nucleus during their lunch, he thought of a corresponding structure he had seen in animal tissue (Parnes 46). The potential consequence struck him immediately: if the cell could be shown to be the elemental part of all

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[35] Schleiden also found Müller's conviction that there was some mapping that associated the spiritual and physical improbable and distasteful (Vienne 644).

[36] In February of 1835, Schwann stresses the importance of *quantifying* processes like muscle contraction "Meiner Ansicht nach muß unser Hauptstreben darauf gerichtet sein, Rechnung in die Physiologie einzuführen." (quoted in Parnes 34). The quantified body would have qualities only due to phenomenal perception, helping along Schwann's goal: "die Frage über den Sitz der Seele [...] ganz aus der Physiologie zu verbannen" (ibid 34). He theorized, for example, that muscle contractility might scale (as a quantity) relative to the ratio of light to dark parts in the "Primitivfasern" composing them (ibid 36). It is a curious irony that a quantity-quality dualism lead through the discovery of the cell to the independent neuron and the quantization of the brain. In a way, the introduction of causal *Rechnung* did do a lot to banish the question of the soul from physiology—the trouble is that the territory of banishment has since expanded to cover most of what is considered provably real.

life, then the vitalist account would be replaced by a pluralist one. This displacement succeeds by replacing a mereological priority relation with a causal one: the microscope concretizes and discretizes abstract vital force into the living cell. The body becomes an organization of *causal agents*—organs, tissues, etc., all of which have their model of causal independence in the cell.[37] A pluralist body cannot, for Schwann, also be the location of the soul, which belongs to a metaphysical movement heading in the other direction, coming down from the essential, spiritual, and unified. Schwann's encounter with finitude in the figure of the cell is thus staved off, preserving the mind-matter dualism by attaching another dualism, monism-pluralism. It is fairly Crookian: the physical and the mental have different kinds of causes, colliding in the human, whose double-nature is the meeting point of two metaphysical derivations from unity (the body rising from matter, the soul descending from the divine). Only after Schwann tissue and fiber will never again be continuous in anything more than a relative sense, as a crowd seems fluid at a distance.

In the citation above, which comes from an early draft of *Mikroskopische Untersuchungen*, Schwann notes that cell theory can be unified if cells are thought of as elementary causal units: forces, *Kräfte*, to which tissue is an incidental, contingent production. The goal is very literally to ground macroscopic phenomena (*Erscheinungen*)—tissue, texture, flash or shines of life—as collateral *expressions* of the cell-as-force: "die Erscheinungen, wodurch sich die Tätigkeit dieser ~~Zellen~~ Kräfte äußert." In German, as in English, force to turns to expression when it exceeds its origin,[38] crosses out (of) the cell (*Druck* to *Ausdruck*, pressure

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[37] See Ohad Parnes "Vom Prinzip zum Begriff," *Begriffsgeschichte der Naturwissenschaften*, pp. 27-51, for a discussion of Schwann's research notebooks and his turn toward causal agents on the way to the cell.

[38] In German the word for origin, *Ursprung*, also contains the sense of departure as an expulsion or a leap.

to expression, *Äußerung*). The cell is its forces, and those forces speak to the extent that they spill over into higher dimensions, incidentally weaving up tissues, aggregating and unfolding into complex bodies. Schwann's replacement of mereological speculation on priority (as in Crooke, Hooke) with a causal account thus discovers a way for matter to be only an expression of its own fundamental forces, harnessed by the cell. Such a material expression lets the *Stimme* push *Übereinstimming* into a *univocity* for life in matter. The organic sings its plural origin, expresses its unit force: the cell.[39] Schwann has brought the vital force inside, breathing life into what had been the passive matter of the body.[40] The cell is "alive" in order to embody a more general pluralistic principle that ascribes agency and causal priority to matter. One can read histology's interest in texture this way from the beginning: as relying on the intuition that the affective capacities of things are apprehensible from their material forms.

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[39] Reading a different early nineteenth century biologist working on morphology, Geoffrey Saint-Hilaire, Deleuze and Guattari find a similar univocity resting on plurality. They characterize his view so: "the important thing is the principle of the simultaneous unity and variety of the stratum: isomorphism of forms but no correspondence" (*ATP* 46). The breadth of plant and animal life is unified by a certain idea of morphogenesis as the immanent exploration of matter by matter: "the same formal relations or connections are then effectuated in entirely different forms and arrangements. It is still the same abstract Animal that is realized throughout the stratum, only to varying degrees, in varying modes" (ibid). The "abstract Animal" in the case of Saint-Hilaire is yet more abstract for Schwann, something like an *abstract organism*, the set of virtual potentials of which the cell is merely a vector.

[40] Schwann eventually calls the vital force metabolism—a force of change. "Die unbekannte Ursache all dieser Erscheinungen, die wir unter dem Namen metabolische Erscheinungen der Zellen zusammenfassen, wollen wir die *metabolische Kraft* nennen" (quoted in Parnes 51). The movement of the vital force into the cell can also be found in successors to Schwann, such as Joseph von Gerlach. A relevant quote from the introduction to his histology textbook prefaces the thesis.

Slide 6. Camillo Golgi, *Sulla fina anatomia degli organi centrali del sistema nervoso, 1885.*

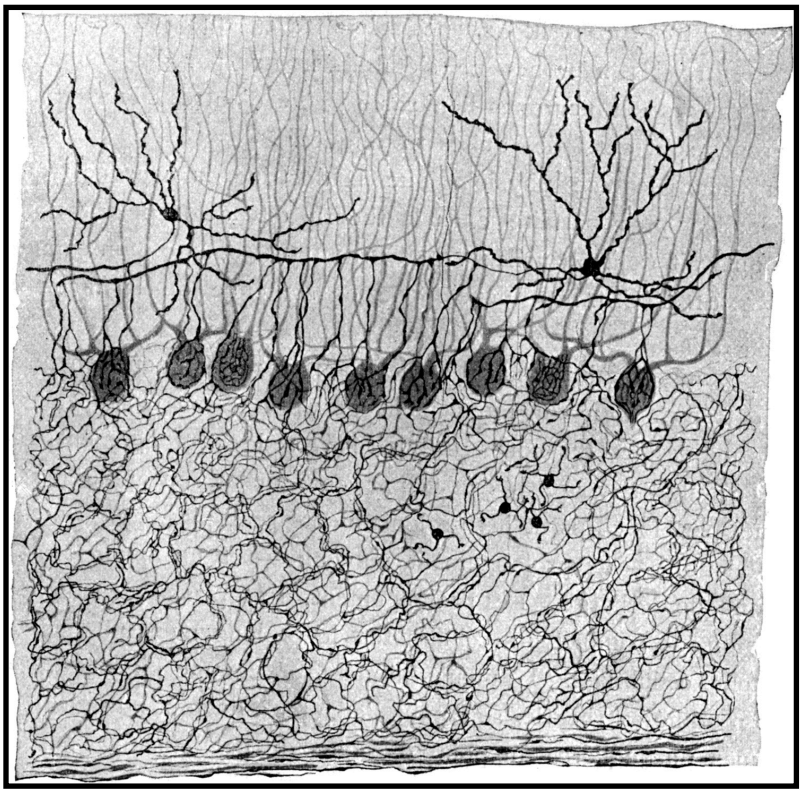

Fig. #. A drawing showing anastomoses among the axons of the cerebellar cortex (bottom half of image) (Golgi 1906).

L'elemento costitutivo fondamentale del tessuto interstiziale, tanto della sostanza bianca quanta della grigia, è sempre la cellula raggiata. … [S]econdo i metodi descritte precedentemente (lieve indurimento-macerazione), dei preparati per disgregazione, si possono isolare in grande number eleganti cellule connettive … In sifatte sezioni si possono scorgere [nerve cells] ricchissime di prolungamenti, anzi quasi completamente contornate da essi; agli orli delle sezioni poi, o nei punti ove esse raggiungono il massimo di finezza, lo stroma interstiziale si presenta anche negli strati più profondi della corteccia distintamente fibrillare (155, 164, 166).

In 1873 Camillo Golgi published a new method he had developed for staining nervous tissue (Raviola). Soft grey and white matter, extracted from a cadaver, was first placed in potassium dichromate as a fixative, hardening the fragile tissue for easier manipulation and sectioning (Golgi 184). Fixation with potassium dichromate was common and really only prepared the way for the actual staining, where tissue is impregnated with pigment through infusion (immersion in a chemical bath) or perfusion (circulation of the chemical through bodily vessels, like Ruysch's cinnabar). Different stains visualized different structures according to the nature of the chemical reactions between the stain and tissue elements. Before Golgi, the two most important histological dyes were adaptations of Meso-American textile dyes: carmine, from the cactus parasite cochineal, and hematoxylin, from the logwood tree (Raviola, Ortiz-Hidalgo). Impregnation with these dyes would stain the tissue thoroughly—too thoroughly, in fact, to be useful for dense nervous tissue (Raviola). Experimenting instead with temperamental silver nitrate, Golgi found a way to stain only a small selection with clarity. He called his process *la reazione nera*, the black reaction, for the dark silver chromate deposits that collected on the surface of nerve cells and their prolongations (Golgi 184).

Golgi's process rendered the fine structure of the neuron visible for the first time, leading eventually to its formalization as an individual cell, distinct from but contiguous to the others in its network. Golgi, however, was not the one to get there. In the passage above, he describes a nervous tissue that is not the arrangement of cells in a lattice, but rather a tissue *at the cellular level*, formed by the fusion of fine branches coming off of the nerve cell's axon cylinder. This "interstitial nervous tissue"—elsewhere he calls it a "diffuse nervous network"—was for him a single, fused organ through which communication between the nerves occurred (Raviola). Such a

"reticulum" had been proposed in less precise form by Joseph von Gerlach already in 1872 (ibid). Its proponents are the hold-outs of a theory in which continuity at the microscopic level corresponds with the apparent continuity of experience. The brain is their last refuge.

Golgi's idea of the neuron is wrong in a subtle way. As was later discovered using his own staining technique, neurons are in fact connected in such a way that they can communicate with each other. However, these connections (synapses) are chemical, not physical, and rarely communicate from axon to axon. Usually, communication goes from the axon terminals of one cell to the dendrites of the next. Between the dendrites of a cell and the axon lies the cell body itself, the soma. Signals are thus transmitted *through the cell body* in one direction, not, as Golgi thought, moving about in a tissue formed by radiations from the axons. Golgi's confusion stems in part from thinking that the dendrites (perhaps due to their resemblance to a root structure) were not part of the communication but simply brought nutrients to the cell body. Golgi's cell is a telegraph station: each cell is joined to the network only in the sense that it could send signals into it or receive them from it. It is really an outpost to thought and secondary to neural action.

The decomposition of the brain into cells poses instantiation problems for the phenomena of consciousness—or specifically, of an abiding and unified conscious experience. The reticulum solves the problem by *fusing* the network to form a whole; a unit phenomenon is housed by an irreducible material whole. Even tissue is too phenomenal, too likely to come apart into fibers or cells: the reticulum affords tissue the integral properties it wants to save in the mind.

The reticulum is a synthesis of cellular logic with the continuum of the textile-tissue body. If cells can produce aggregate life, can grow and develop, why couldn't they grow into each other literally, fusing, *verwachsen*, forming a true continuous tissue? The trick involves

passing the phenomenal continuity of multicellular life onto what is discontinuous at the microscopic scale. The reticulum relies on anastomoses between processes radiating from the axon—that is, the emanations physically join to form a single structure.[41] Anastomosis (from Greek *ἀναστομόω*, "to provide with a mouth," as a river opens onto another from a difference source) undercuts any univocal possibility for a pluralistic system like cellular tissue, since it ensures that the discrete produces an actual continuous whole and not merely the appearance of one.[42] In the drawings he made to accompany his Nobel Prize lecture, Golgi has exaggerated the anastomoses among the axons to form a wild tangle.[43] The entire bottom half of the image is dedicated to the bramble formed by these converging, deforming, fusing processes (*Verwachsungen)*. The simple cell bodies have fallen to the background, gray behind the tendrils that emanate from them and interlace, tracing shaky cycles. Lines work themselves into substance in the interstice, filling the cracks between dimensions—line to figure, cell to tissue, tissue to mind—and warding off the disassembling potential of a reduction. Reticularism takes the material mind seriously but enforces continuity of spirit as hydrodynamic flow: conspiracy. It

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[41] Golgi invokes an interesting language of emanation to enhance this improbable metaphor by which ramifying branches actually re-converge to form a whole ("un fitto intreccio") (176). In the passage above, he speaks of the "cellula raggiata." Elsewhere, the "tenuissime ramificazioni dei filamenti emananti" (177). How sources relate to their emanations—and how emanations communicate among themselves—will be relevant especially in the third chapter.

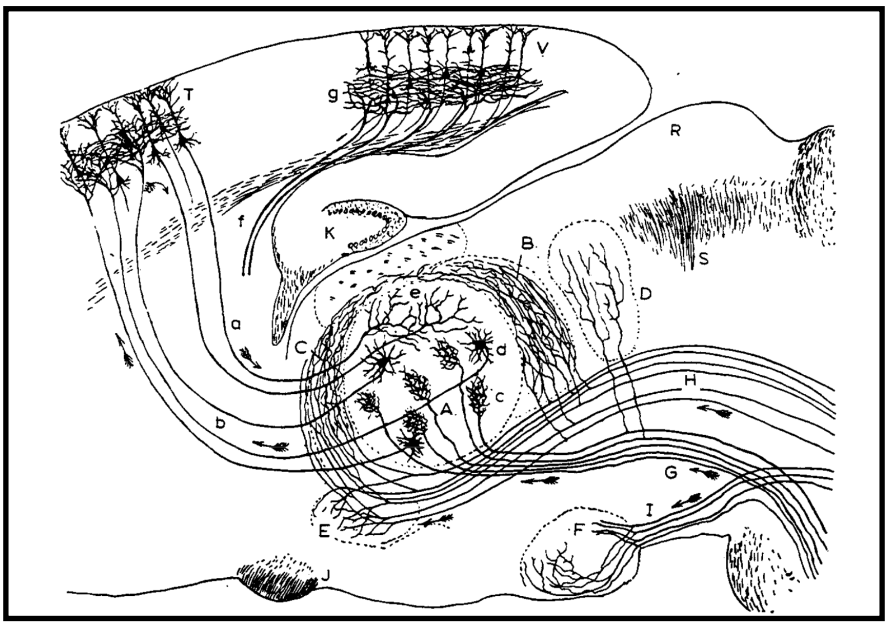
[42] In the final chapter of Finnegan's wake, Stephen (a medical student) invokes anastomosis to describe a kind of tree of life viewed from the present backwards. Then all humanity would be linked to a very distant, maternal (material) origin, to which "we are linked up with by successive anastomosis of navelcords." Elsewhere, two characters are "wedded now evermore in annastomoses by a ground plan of the placehunter" (placehunter—placenta). Anastomosis, the convergence of distinct flows, acts out in space the reverse of any accepted account of time, by which things are always diverging, differentiating, and entropy increasing. Joyce does not seem to mind the strange spatio-temporal incest of the anastomotic figure, keeping what seems past in play, making it converge again, form a denser net. Even words, separated by great distances, can meet again—as *placenta* and *place(hunter)* make an impossible recovery of a common root from Proto-Indo-European denoting the *flat*, the *planar* (and the root of *flat* and *planar* likewise). This sense in which anastomosis, the opposite of divergence, associates the distant past with a lost wholeness—and makes it the task of literature to work on this entropic dissolution—will come back in the discussion of Rilke.

[43] In Golgi's earlier, more precise drawings, the connections are fewer and the network far less visible (Raviola). These drawings were made in service of a 1906 Nobel Prize lecture in which he defended the reticular theory against its (already victorious) competitor, the neuron doctrine.

listens to its own collective breath as evidence of a unified process.[44] Golgi's position is itself an intermediary form, equally cellular and continuous—in this sense, it captures the real problem of reconciling the real qualities of embodied experience with the real cellularity operating within it. As before, texture helps to cover or collapse the gap, with the affective capacities of the organ (processing of perception, motor control, thought) instantiated by reference to the complex contexture of its parts. What is preserved with Golgi—and will finally fall away with Cajal in the next and final slide—is that the phenomenal continuity of the textile is still treated in the case of nervous tissue and the experience to which it "corresponds" as non-phenomenal, that is, as an actual structural continuity.

[44] William James concludes his essay "Does 'Consciousness' Exist" by attributing the sense of continuity in conscious experience to the continuous flow of breath (James 491). For James, this connection is spurious. When we get to Rilke in the third chapter, more ancient connections between spirit and the movements of air will return.

Slide 7. Santiago Ramon y Cajal, *Textura del sistema nervioso del hombre y de los vertebrados*, 1899.



Como hemos expuesto en otro trabajo (2), el filtro delicadísimo del órgano de Corti, así como el de los bastoncitos y conos de la retina, ha operado en el complexus de movimientos recibidos del ambiente una selección de ondulaciones, organizadas en imagen y proyectadas en haz sobre la corteza cerebral, la cual las transforma en sensaciones, ideas y voliciones. No necesita, pues, el cerebro de los vertebrados, ó el ganglio encefálico de los invertebrados, crear imágenes; se las dan hechas y perfectamente organizadas, con matices de intensidad proporcional á la energía de los estímulos, los órganos de los sentidos, cuya maravillosa arquitectura constituye la causa primordial de la actividad mental superior de los animales. En una palabra, la morfología y composición química de una célula, con ser tan importantes para la forma del trabajo psíquico, no determinan exclusi-

vamente la jerarquía de éste, que depende principalmente de la calidad de la excitación recibida del mundo exterior (Cajal 1899 6-7).

As a child in the northern Spanish peasant town of Petilla de Aragon, Santiago Ramon y Cajal drew in secret on scrap paper, mixing his own pigments by dissolving wall paint or ink from printed material in water. Smooth surfaces attracted him. He liked to see a mark develop into an image; he had a mania, he later confessed, for staining (Cajal 2006 VI). His father, a barber-surgeon who taught himself to read, discovered a capacity for perfect textual recall, and was now on his way to becoming a doctor, did what he could to keep his son away from the arts. Once, he showed a drawing he had made to a painter in a nearby town and got a brutal verdict back: “Ni esto es apóstol, ni la figura tiene proporciones, ni los paños son propios... ni el chico será jamás un artista!” (RDMV VI). Santiago’s father forbade any further painting and sent him off to study medicine.

Eventually, Cajal learned his proportions. For three years, Cajal worked alongside his father at the dissection table, “desmontando pieza a pieza la enrevesada maquinaria de músculos, nervios y vasos.” They went about it in Vesalian style, following along in an anatomical textbook (“para no extraviarnos en la selva inextricable de vasos y nervios") while preparing their own. Cajal made the diagrams while his father took on the dissection (ibid).

Cajal’s uncanny ability with images—as a child he loved to copy maps—soon brought him to histology. After learning a modified version of Golgi’s staining technique, he began his own researches into the structure of nervous tissue. Unsatisfied with the penetration of the stain into the tissue, he worked with nervous tissue from much earlier stages of development in which the fatty layer surrounding the axon and resisting the stain (the myelin sheath) had not yet grown

in. This younger, often embryonic tissue received the stain more consistently and deeply. Instead of the diffuse nervous tissue woven from axo-axonal connections described by Golgi, Cajal saw axons terminating freely in these early brains. Where they did attach to other cells, the attachment was more commonly on dendrites, not other axons (De Carlos). With this discovery he began a lifelong attack on reticularism. The neuron doctrine, as it came to be known, proposed that the signal moves along the entire neuron, from the dendrite through the cell body and along the axon to the axon terminals, where it is then passed to the dendrites of the cells on which those axons terminate. Unlike reticularism, "neuronism" keeps nerve cells distinct and contiguous, forming a network with cells as junctions.

Cajal's "ontogenetic method"—studying neurons in earlier stages of development—shows the influence that Darwinian natural selection had on his understanding of the nervous system.[45] Natural selection allowed Cajal to imagine the nervous system developing gradually to better respond to external stimulus—that is, as a complication of a perception-action system that would have initially been the direct linkage of sensory to motor neurons. His account is given most concisely in the first chapter of his textbook *Textura del sistema nervioso del hombre y de los vertebrados* and quoted above. In it, Cajal describes the brain's evolution from a very primitive nervous system of localized, peripheral reflexes. We will not have to do much work to perform a textural-affective reading here, as Cajal's account has conscious experience—those "fenomenos tan admirables como la sensación, el pensamiento y la voluntad"—residing in (and emerging from) the elaboration of a perception-action system with textural perception as its limit

[45] Of course, the ontogenetic method is not properly Darwinian, since it does not involve studying the historical development of the brain so much as its morphogenetic history, relying on the recapitulationist argument that "ontogeny recapitulates phylogeny." In the argument that is next described from the *Textura*, a similarly quasi-Darwinian argument is given in which the stage of development of the nervous system in a given species is used to place these species in a history of development. For more on Cajal's teleological ideas about the evolution of the nervous system, see the next footnote.

and origin (Cajal 1). Experience is literally built inside of textural perception, as the embodied experience of one's own affective potentials. It will also let us say something more interesting about texture as it relates to human embodied experience: texture bounds human experience, flattening into one term its simple origin and most complex products. The former is tactility, peripheral response, contact sense perceptions. The latter is the complex weave of nervous tissue that results from developing machinery to discover more complex patterns in the first (specifically, the reconstruction of an extensive environment). Texture bridges the two, forgoing correspondence.

The story of the nervous system, as Cajal tells it,[46] begins with the senses of immediate peripheral contact ("táctilo y thermal"). Simple organisms without proper nervous systems can respond to these local stimuli by linking sensory and motor neurons directly. All reflex at this level is local, irritable, nervous. As one moves to organisms with more complex responses to stimuli, there appear intermediary neurons (*neuronas de asociación*) that extend and complicate the chain of reflex action ("la cadena del acto reflejo se complica … por la intervención de anillos intermedios," 5). Now a local stimulus could be responded to with a muscle on the other side of the organism, or with the entire body, depending on the level of excitation. The complication of the nervous system thus requires also the division of labor in the organism, since specialization and coordination would be useless without each other (ibid 2). To achieve a high division of labor, organisms must become multicellular colonies (*colonias*) (ibid 2). Cajal notes

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[46] Cajal's account is self-consciously teleological with the human nervous system at its end. (The first sentence of the textbook calls the nervous system the "último término de la evolución…la máquina más complicada…de más nobles actividades" (Cajal 1).) In a certain sense this is justified by the tautological logic of natural selection. Indeed, he states directly that he understands the "goal" of the nervous system to be the increased efficiency of action taken in response to stimulus. The brain—for Cajal, the crown jewel of the nervous system—arose toward this simple end: to get classify inputs and respond to them efficiently. Cajal draws his teleological notion of evolution from Eduard Pflügers "Die teleologische Mechanik der lebendigen Natur."

the strange consequence, with which Schwann and Schleiden also grappled, that any organism with seemingly sophisticated and unified behavior in fact owes this trait to the division of labor among its parts (ibid 2).[47]

Now Cajal takes an information-theoretic turn. At this primitive point, he writes, the tactile and thermal sense perception done on the outer boundary of the organism on its immediate surroundings was simply not sophisticated enough to encourage the development of complex neural circuitry. These haptic senses, directly in contact with what they perceive, play in a smooth space that defies stratification and classification: "incierta, difusa, sin relaciones precisas de extensión y forma" (ibid 7). Stimuli were simply *intensities* that either exceeded certain thresholds (action potentials in the nerve cells) or did not. The cutaneous nervous system, even with intermediate groups of neurons, had so far only learned to read the immediate external milieu of the organism intensively.

The development of new sense organs (eyes, nose, and ears), however, meant that suddenly a new kind of information was modeled, richer for classification than what had come before. These new impressions were "previamente organizadas, verdaderas imágenes del mundo exterior con relaciones fijas de espacio y tiempo" (ibid 6). The new organs of extensive perception—"verdaderos *aparatos numeradores*, es decir, que son colectores específicos de movimientos ondulatorios"—developed *out of* intensive sense perception, as the increasingly complex circuitry learned how to reconstruct extensive knowledge (to treat local disturbances as *waves* emanating from other sources) (ibid 6). The "maravillosa arquitectura" of these new sense

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[47] "The variety of parts ensures cooperation, since specialization requires losing the ability to survive independently: "cada célula diferenciada y entregada á un particular oficio, no se basta á sí misma" (Cajal 2). The nervous system makes unity possible, since it is the literal interlinkage of parts, the communication network that allows for the organism to be a system at all: "en cuanto este sistema aparece, la unidad del ser viviente se acentúa" (1).

organs “constituye la causa primordial de la actividad mental superior de los animales” (ibid 7). This is an information-theoretic argument about the origins of consciousness (though the language didn’t exist to make it as such yet): Cajal claims that the nervous system took on some of the complexity of the extensive information it was learning to reconstruct. It brings the truth inside—notice the dignity of “verdaderos aparatos” built to deal with “verdaderas imágenes.” Notice two things: first, that “truth” is equated with extensive information, with the *image*, and with the apprehension of an external objective world, and second, that the organism’s development advances only as it learns to produce extensive knowledge from what is immediately, intensively available to it. This argument describes the epistemological limits of subjectivity as a consequence of the subject’s material form, but suggests that the subject, engaged in the constant work of trying to reconstruct the object from limited and local information, is itself a product of the constraints matter places on matter. Everything happens at the site of the body. This is what Bergson meant by the special status of highly organized and organizing bodies: they seem to be drawing their own organization from the environment—or else having it imparted on them. If this particularly valuable kind of information has come to structure the body and therefore experience (confer an architecture, as Cajal says), the question is: what is the structure of that information?

The story as Cajal tells it misses the element of *feedback*, treating the development of the nervous system as progress in modeling the qualities of the inorganic world. We can refine the narrative: life did not learn to sense the world abstractly, but rather populated the world and learned to sense *its own presence*. The goal of the nervous system, as defined by Cajal, is to

perfect the ability of the organism to defend and feed itself.[48] There is not so much to eat or defend against that is not alive.[49] The movements of other creatures, they way they deflect light, emit sounds, smells, send waves in water or air—this is the information worth sensing with extensive sense perception. It is worth learning to treat what one feels at the periphery as waves from other sources. It's worth it because it's true, but it doesn't become true until an organism's external milieu is saturated with other sources, is teeming with life. All those other bodies emanating the fact of their presence create something worth sensing and modeling: fields formed by signals, origins, and reflections.

The condition for the development of extensive sense perception would then be the presence of life in the world. Evolution works on feedback: organisms populate and modify the world to which they are adapting, thus adapting to a world they help define. Feedback between evolving organisms and the world they are evolving to model is not an incidental feature: it is how and why life develops in the direction it does.[50]

Cajal is right to relate the organization of the nervous system to the organization of its input information rather than to the morphological or chemical properties of individual cells. With this move he rescues those who took refuge from pluralism in reticularism without sacrificing the independence of the cell. He allows both directions of cause to cooperate: the cells have an independent local life, but the organization of these cells in the aggregate has taken in

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[48] "En cuanto este sistema aparece, la unidad del ser viviente se acentúa, sus recursos para procurarse el alimento y sus defensas de los ataques del mundo exterior se multiplican, adquiriendo también mayor precisión, eficacia y congruencia" (Cajal 1).

[49] At least that requires specialized extensive sense perceptions. Environmental features worth sensing (concentrations of minerals or heat) are less localized and discrete with respect to the organism.

[50] Some argue that this is really what life is, in that its ability to affect its own development. Stuart Kauffman uses a version of this fact to make the argument that life escapes standard physical laws by defining its own phase space. It's development would then be irreducible (that is, incalculable by anything less than the full process in the world). See Kauffman, Stuart. 2020. "Answering Schrödinger's "What Is Life?" *Entropy* 22, no. 8: 815., in response to Schrödinger's *What is life?* where similar questions are asked. Michael Polanyi, another philosopher of science, makes a different argument about the irreducibility of life processes in relation to their boundary conditions in Michael Polanyi, Life's Irreducible Structure, *Science 160*, 1308-1312 (1968).

structure from outside. Evolution allows the double-ground of internal and external causes (cell, organism, species, world), external constraining what internally-caused expressions are useful, and internal constraining what useful expressions are possible. Life extracts from the environment a regularity which it, by proliferation, supplies.[51]

Adjusting Cajal's information-theoretic narrative to include feedback between the evolution of organic forms and the world they are evolving to model, the notion that "organization" was in any one place *first* can at last be left behind. Order in the material world does not start anywhere—priority here would only be the temporal precedence of "previamente organizada" information. It is cleaner to consider all of this as matter's inexorable exploration of the space defined by the implications of its properties. Life appears in this space of implications like a hypothetical, a runaway rule, bootstrapping itself up on its own growing complexity.

To conclude, let's make it clear how texture fits in. In Cajal's picture of the nervous system, the texture of the body (the connections of its parts that form the particular weave of nervous tissue) is able to take on both valences (structure and experience) which this chapter set out to bring together. It does so by understanding the experience of the conscious subject as the complication of a simple perception-action processing system. In doing so it predicts contemporary affect theory's conception of a subject whose experience is determined by the

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[51] Evolution is one mechanism by which collective adaptive systems utilize feedback, allowing the parts to adapt to features of the whole. As Jessica Flack points out in "Coarse-graining as a downward causation mechanism," the fact that parts can only have limited information about the whole system they contribute to is how the computation works (Flack, Jessica C. "Coarse-Graining as a Downward Causation Mechanism." *Philosophical Transactions of the Royal Society* 375, no. 2109 (November 13, 2017)). Component agents are forced to "course-grain," to compress information and learn its regularities so that it can be estimated. Perception is used to approximate the macro state of the system; this approximation informs how individuals behave, influencing the state of the macro-system (very slightly as the individual, entirely as a the collective). The macro state is predictable and regular because it is a statistical aggregate of the actions of many microscopic agents—downward causation works on phenomena that appear with scale. Flack's argument relates to those made from physics in the previous footnote, but invokes computation to think about what is happening in-between perception and action, in the space the brain grew out of, and in the collective space where phenomena like cities, languages, and culture are made and make themselves. See also:Ross, Lauren N., and Dani S. Bassett. "Causation in Neuroscience: Keeping Mechanism Meaningful" *Nature Reviews Neuroscience* 25, no. 2 (February 2024): 81–90.

affective capacities of its material form. Conscious, subjective experience arises in that space of intervenience, among the tangled intermediary neurons. The phenomenal character of that experience (Cajal names feeling, thought, and will) can then be seen simply as the life of that intervening matter. For Cajal, that intervening space where the subject lives is developed specifically by learning to "read" textures (intensive sense perceptions) *ex*tensively as traces of a world that extends around and envelops the subject. This method (by which the intensive is read for signs of other things) at once gives the subject the idea of an objective world and forecloses anything but relative access to it. Symbolic representation carries this problem: it only becomes efficient by substituting. The next chapter on *Middlemarch* will go deeper into the constitutive role matter plays in human subjectivity and how we, as finite material things, are stuck with relative meanings, feelings, and textural readings. That contingency is fundamental. We are constrained to use our fingers.

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