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Anatomical presencing

Visualisation, model-making, and embodied interaction in a language-rich space

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For decades, research in science and technology studies and the rhetoric of science have demonstrated that representation is at the center of scientific, technical, and medical practice.[1] Yet, the conception of image-making that emerges from this body of work has challenged us to reject a simple isomorphic correspondence between an image and the thing it represents. Instead, through empirical investigations of scientific practices (both historical and contemporary practices), this research conceptualises scientific image-making, in Chad Wickman's words, as visual inscriptions necessary to 'analyse phenomena' and visual displays used to 'document and communicate' findings.[2] Some scholars (under the banner of what is called New Materialism) have criticised a focus on representation as a kind of intellectual dead-end, of which we can steer clear if we shift our focus to material objects themselves.[3] Yet, this anti-representational approach, aptly critiqued by S. Scott Graham, often assumes a kind of naïve representationalism to be the only form possible, thus ignoring both research and theory that productively complicates our notions of how image-making works.[4] The goal, I contend, should not be to reject notions of representation (linguistic or imagistic) but instead to recast those notions empirically so that our concepts match the material, discursive, and fully embodied practices of science.[5]

Analysing data from an ethnographic study of anatomy labs through the lens of rhetorical theory and embodied cognition, this chapter argues against an anti-representational position by demonstrating how scientific and medical knowledge is enacted through material interactions that depend on two forms of representational work—mental image-making and analogy-like model-making—both of which rely on forms of language-in-action, namely medical discourse and rhetorical language aimed to explain and persuade. In scientific and medical spaces, particularly laboratories and classrooms, imagination and memory are foundational to mental image-making and analogy-like model-making, both of which I understand as embodied practices of what Shaun Gallagher has termed 'affordance-based imagining'.[6] Rather than see linguistic and imagistic representation as at odds with materiality (an old regime that New Materialism will overthrow), I argue that proper attention to the materiality of embodied interaction requires a careful attention to the components of those interaction that are deeply representational.

To make this argument, I return to ethnographic data from my monograph, *Rhetoric in the Flesh: Trained Vision, Technical Expertise, and the Gross Anatomy Lab*, specifically the interviews, fieldnotes, and objects collected during year-long fieldwork in the cadaveric anatomy labs of a large medical school in the Midwestern United States.[7] Through these materials, I return to a common occurrence for which I never satisfactorily accounted in the book, namely the ways students seem to engage their memories and imaginations to 'visualise' or 'call to mind' the particular human cadavers and the more conceptual anatomical body. Reanalysing the data to account for this allows me to expand on my approach to scientific and medical demonstration that couples rhetorical theory with cognitive science, an approach that takes seriously the role of what Chaim Perelman, Alan Gross, and Lawrence Prelli, drawing from ancient rhetoric, have understood as rhetorical presencing.[8]

Rhetoric as an art of making present

From this perspective, rhetoric is not only the use of persuasive force to 'form attitudes or induce actions', as Burke famously pronounced.[9] Rhetoric is also a performative practice, a capacity of making present—to 'bring before the eyes'—that which is implied, concealed, absent, and (as Plato lamented) at times non-existent. The long and varied rhetorical tradition describes techniques for making present both reasoned evidence and performative eloquence. One key technique identified by ancient Greek and Roman rhetoricians went by the constellation of terms *hypotuposis*, *sub ocolus subiectio*, *enargeia*, *evidentia*, and vivacity, each of which described a similar phenomenon—the quality of vivid description that seeks to 'bring before the eyes' some absent or non-existent object, person, or event, in a way that moves the audience to attitude, action, and feeling.[10] According to Roman-era rhetoricians like Cicero, Quintilian, and Pseudo-Longinus, words most powerfully shape belief and action not through reasoned arguments, but through a kind of verbal vivacity that calls forth mental images, or *phantasia*, rooted in the memories and cultural knowledge we use to make sense of the world. In the eighteenth century, Joseph Addison, Adam Smith, Edmund Burke, George Campbell, and Hugh Blair theorised anew the role verbal description plays in acts of aesthetic and political imagination. Often downplaying the Roman-era insistence on mental images, these thinkers nonetheless advocated for the power of vivacity, a rhetorical presencing technique made possible by description's unique ability to create new experiences of the familiar *without* always moving us beyond our preconceived notions. In the twentieth century, Chaim Perelman and Lucie Olbrechts-Tyteca emphasised the ways presencing techniques are used in argumentation in order 'to make objects of discourse present to the mind'—bringing them to consciousness and inviting an audience to attend to and re-experience these objects (174).[11]

The traditional conception of rhetorical presencing made possible by *enargeia*, *evidentia*, and vivacity is not limited to the imagistic capacities of verbal language. Caroline van Eck explores how these ancient rhetorical concepts informed early modern visual arts, by demonstrating how notions of visual persuasion influenced by Roman-era notions of *evidentia* and *enargeia* shaped the ways artists and spectators alike experienced painting, sculpture, and architecture.[12] In her analysis of Robert Hooke's *Micrographia*, Jordynn Jack examines the text's visual and verbal presence-making techniques designed to bring the microscopic world before the eyes of both scientific and popular publics, by offering a kind of 'pedagogy of sight'.[13] Using qualitative research to explore contemporary medical settings, Christa Teston turns to theories of rhetorical presencing to demonstrate how medical professionals at tumor board meetings use images as evidentiary texts that make present the 'material characteristics of disease'.[14] While rhetorical scholars Gerard Hauser and Allison Prasch have used the concept

of *enargeia* to study contemporary political speech, the rhetorician of science Aimee Kendall Roundtree has reintroduced the term as a way of making sense of scientific image-making, specifically computational simulations.[15] In this chapter, I pick up on that move by turning back to the anatomy lab and the ways students use their imaginations, memories, and bodies to engage with the multimodal objects of the lab.

Visualising bodies in the anatomy lab

In *Rhetoric in the Flesh*, I argued that the anatomy lab is a space of embodied action where students, TAs, and teachers learn and teach anatomy by interacting with visual displays, physical objects, and other human bodies.[16] Through these interactions, participants enact the anatomical body of biomedical discourse, a body that is both materially represented in the lab's image-rich, multimodal objects and immaterially presented in the minds of participants. In the labs, students often use the verb 'visualise' when they discuss the supposed mental images they conjure as they interact with and recall the cadaveric bodies and physical representations of the lab. Specifically, participants characterise these as mental images that re-present and make virtually present the objects they have encountered in the lab. This characterisation is not surprising considering the strong empirical evidence that memory and imagination share 'a common cognitive basis'; that is, we do not *recall* (or call up) memories as much as *construct* them as we do any act of imagining.[17] Like a type of anatomical memory palace, these mental visualisations function as confidence-building projections that participants use to convince themselves they understand and know the anatomical structures in question. These immaterial objects are formed from two interconnected sources: (1) students' memories of their physical experiences with anatomical images, objects, and specifically bodies, and (2) students' incorporation of the language of anatomy as key to those experiences.

That is, students use anatomical terms to construct mental images of the (3D) cadavers to help them make sense of the (2D) textbook images, but only after they have learned the proper terms and concepts necessary to enact the anatomical body. Students then use these visualisations to make sense of the various physical objects of the labs, namely the visual displays of anatomical bodies. And they do this by using those images and objects (the immaterial and the material alike) as one would a map-like model—a substitutional object that analogically stands in for something else. In anatomy labs, a set of sophisticated representational practices—based on association and substitution as much as isomorphic realism—makes possible the work of the labs through a kind of body–object–world assemblage that depends on language and discourse. The *enargeic* capacity of images and language to bring objects before the mind's eye is key to this process.

For most lab participants, the purpose of the anatomy lab is to learn anatomy by allowing students to interact with and construct anatomical representations. They construct these representations physically (when they dissect the body), conceptually (when they enact or make likeness in and across images), and mentally (when supposedly calling to mind images of the body they have learned through language and interaction with the lab's physical objects). One medical student describes the process in this way:

> I think really at the end of the day [the goal is] just to get us to do it, *not just memorise anatomy*, but, sort of, to get the zen of anatomy, but also *to really understand it*, and **to** *internalise it* and *not have to stop and think* what is the next bit. But no, we have it. [We] can *viscerally visualise it*, so that if you are a surgeon, you know, if you are surgeon, or really any physician, and if someone says 'oh, it kind of hurts when I do that', then *you can*

> *think of all of the interactions that might be going on* and not have to do the constant, you know, use your mnemonics or anything like that. But instead you just really, really get it.

This medical student voices a common sentiment about the purpose of the lab; namely that cadaveric anatomy labs allow students to develop knowledge of the anatomical body, a kind of knowledge that ideally involves an automatic, second-nature awareness that is ready-to-hand during their future interactions with patients. Most students and teachers in the lab draw a distinction between memorising anatomy (or using mnemonic techniques to consciously set to memory anatomical structures and knowledge) and remembering anatomy (calling to mind a supposed mental image of what one experienced in the labs). In this formation, cadaveric anatomy is learned when it becomes part of their memory, when they can effortlessly construct a memory of the structure in question. When they can 'viscerally visualise it', then they know they have learned it. Cadaveric anatomy allows future physicians, in the words of an anatomy lab TA, 'to *visualise* what a person looks like without their skin'.

Obviously, cadavers play a foundational role here. They are, as one medical student described, 'the 3D visualisation' of the anatomical body. By physically interacting with cadavers—touching them—students gain a haptic knowledge through texture and depth, one that is necessary for differentiating and identifying structures like nerves, arteries, and veins. The cadaver is also a 3D physical visualisation of the conceptual anatomical body they are learning—the idealised body of structures and functions written by centuries of anatomical discourse. For most participants, the action of dissection is crucial to this image-making process. Most anatomy professors and TAs of my study felt that performing the dissections themselves allowed students to learn anatomy rather than merely memorising it. In the words of one anatomy professor, 'If you are forced to look at a picture and memorise it—[as in,] oh that is a vein, artery, or nerve—you know, that's memorisation. Whereas if you dissect it yourself, you don't memorise that, [instead] you remember doing it'.

Thus, by dissecting cadavers, students engage in an embodied process that allows them to build up these mental images through memory and imagination. One medical student's description of the benefits of performing dissection emphasises the role memorisation and visualisation play in learning:

> When you are looking at something, and you are peeling away layers, and you have such a *good visual representation of it in your own head*, and—I mean, that really helps with the three-dimensional framework. Because in the bulk, they [images in anatomical atlases] show things reflected back, and it is not the same when you are looking at it in the body. So, I think it [dissection] just *helps to build that visual representation* for everything when you actually do a dissection yourself.

This conception of the benefits of cadaveric dissection is, of course, not a complete rejection of anatomical atlases and other illustration-heavy texts, which students, TAs, and professors variously described as 'road maps' and 'blue-prints'. These 3D images are crucial but limited, as the following undergraduate student explains:

> They [visual displays like anatomical atlases] are just like a starting point for you to *visualise*, but it is really the cadavers that play the most important role because without seeing it—I mean, we are tested on a cadaver. So, you really need to be able to identify it on the cadaver, but at least with the pictures you can say at least this is how it should, or how it is generally supposed to be […] So, the pictures sort of give *a rough sketch* of what it should

look like and then you have to go to the cadavers to say 'okay yes, I now understand how this is put together. I see this now'.

These atlas images are for this student and many others akin to 'a rough sketch' of the body or the structures in question, in that they are flat, 2D pictures that are made to stand in for the more complex 3D body—the way a rough sketch of an improvised map serves a rhetorical function made possible in part because of its limited details. Yet the relationship between the 2D anatomical illustration and the 3D cadaver is not merely one of simple recognition. Students learn to enact the anatomical body onto the images of the lab by reading the cadaveric body into the images, and vice versa.

Anatomical images as analogy-like models

Anatomical atlases, especially the often-used *Netter's Atlas of Anatomy*, are image-driven genres of medical training that provide seemingly definitive examples of anatomical structures (see Figure 17.1). They are, in the words of Lorraine Daston and Peter Galison, 'systematic compilations of working objects', used to guide how expert viewers should see and depict anatomical bodies (22).[18] Save for the inclusion of labels that identify structures, anatomical atlases are presented without verbal accompaniment. These images exemplify what Gross

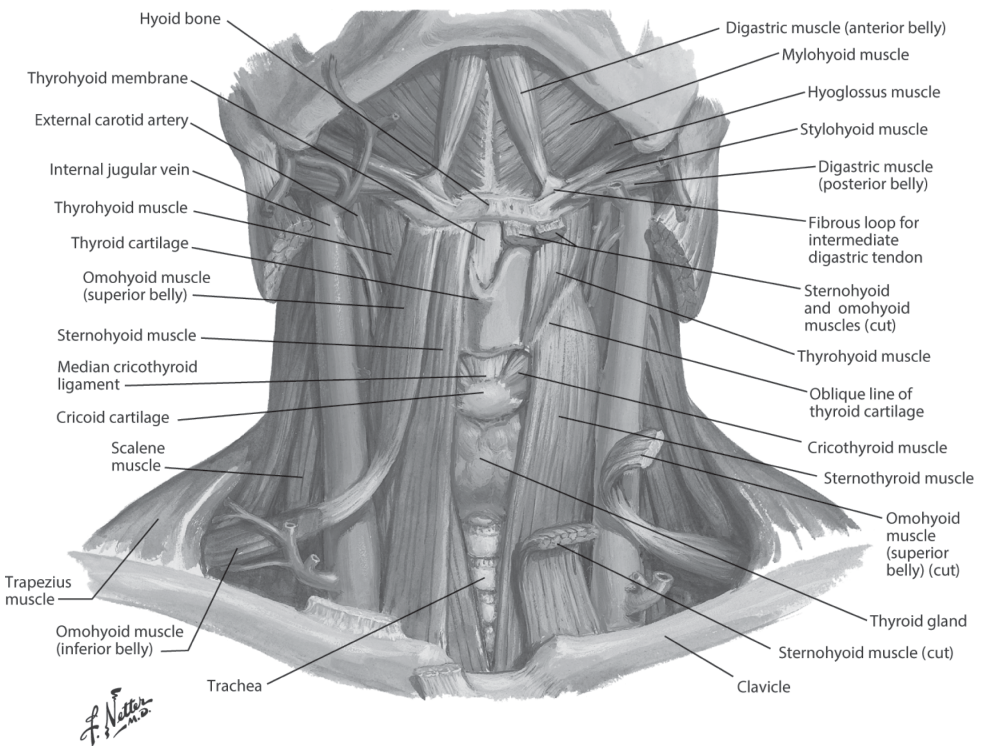

Figure 17.1 Illustration of infrahyoid and suprahyoid muscles from *Netter's Atlas of Anatomy*
Reprinted with permission from Netter Images.

and Harmon term 'representations of arrangements in space' (like maps or visual models) and representations that function as 'virtual witnesses' (like drawings and photography).[19] Anatomical atlas images, often rich in chromolithographic detail, construct knowledge in a way similar to that Kathryn Northcut has identified in her analysis of paleontology illustrations; that is, these images are 'epistemologically operative'; they represent not just what is known but also the specific features an illustrator deems worthy of depiction and thus learning.[20]

Phenomenologically and rhetorically speaking, anatomical images, particularly atlas illustrations, involve three components: what Evan Thompson would call the 'pictorial vehicle' (the physical display or object, in this case the atlas illustration on the page), the 'pictorial image' (the image or picture we perceive), and 'the pictorial object' (the referent for that image we perceive, the object out there in the world that we say is represented).[21] Representation is an image-making system that depends on these components as well as a viewer's knowledge, memory, and interpretive capacity. Bas van Fraassen argues that scientific representations are user-dependent; that is, a representation of any kind depends on a user and a situated context of use: 'There is no representation except in the sense that some things are used, made, or taken to represent things'.[22] Building on this, Mathias Frisch states that likeness or resemblance is a 'symmetric relation but representation is not'.[23] That is, representations do not require a simple symmetric or isomorphic relationship between the pictorial image and the pictorial object. While van Fraassen and others do acknowledge the role of partial resemblance between the image and the object, they insist that the features judged as significant in acts of resemblance-making are imprecise and always user-dependent. Edwin Hutchins, turning to enactivist approaches to cognition, makes a similar point about representation: 'To apprehend a material pattern as a representation of something is to engage in specific culturally perceptual processes'.[24] In other words, representation is a performative or enactive process that depends on the cultural and at times disciplinary training of users and the situated context of use.

In my book, I make a similar argument about the ways that students make sense of the lab's visual displays and objects. Specifically, I introduced and classified the networks of visual and multimodal objects, in order to demonstrate how participants use and build meaning from these displays by enacting the objects' solicitations to act, or what J.J. Gibson terms perceived affordances.[25] Engaged in the interactional processes of demonstrating anatomy, participants conceive of the lab's multimodal objects as material instantiations of the anatomical body as well as opportunities to engage in skilful action. This simultaneous recognition and enactment of meaning is dependent on the way students and teachers are trained to engage the features and the material object-ness of these multimodal displays. That is, students are trained to interpret a visual display's representational or presentational content, its dimensionality, its materiality, and its perceived level of interactivity as crucial to the object's ability to stand in for or represent the anatomical body. In the anatomy lab and scientific contexts more broadly, multimodal objects carry different meanings because they allow different opportunities for action. Participants perceive these opportunities for action through skilful engagement and the expertise that shapes how they view those objects and actions.

What I did not fully appreciate, however, in my original study was the ways this enactive process of meaning-making involves a kind of model-like substitution in which students engage not just the objects of the lab but also their own memory and imagination. For Alva Noë, a picture—whether 'a photograph, a painting, [or] a drawing'—is 'a special kind of model'—a 'visual model'.[26] Depiction, then, is 'a special variety of substitution', one that is not made or enacted by the viewer's specific 'perceptual and cognitive capacities'.[27] For Noë, echoing van Fraassen, 'there is no natural or intrinsic connection between pictures and what they stand in

for'.[28] Instead, we make representational meaning by treating pictures as analogy-like models. Barbara Stafford contends that analogy, specifically analogical relationships of 'resemblance and connectedness', or 'similarity-in-difference', are foundational to Western visual culture.[29] Analogy is, in her words, 'a demonstrative or evidentiary practice' that involves recognising or enacting resemblance 'between two or more apparently dissimilar things'.[30] Noë suggests an analogical relationship when he describes pictures as model-like representatives that 'are able to go proxy for the world'.[31] While Noë acknowledges the wide variation in models, including architectural, computational, and geographical models (or maps), he nonetheless finds commonalities between all types: 'models are tools for thinking about or investigating or perceiving something other than the model itself'.[32]

We deploy models as a way of exploring a thing that the model stands in for. As such, a model functions, Noë argues, as 'a substitute, or proxy, or stand-in'.[33] Models can be objects specifically designed to stand in for something else, in the way an architectural model is a miniature version of a larger structure, or they can be an object pragmatically used as a proxy in an improvised fashion, such as the way (as Noë points out) we might use salt and pepper shakers to model geographical features when providing off-the-cuff directions during a meal.[34] Computational models, particularly computer simulations, are more complex artifacts that, as Aimee Kendall Roundtree has explained, 'go a step further than mere models'.[35] These mathematical products of 'high-level mathematical equations' are often projective, provisional, or hypothetical scenarios that 'capture a model's behavior'.[36] In less technologically sophisticated contexts, a model's properties are situational and emergent; they depend not on anything intrinsic to the object but instead are circumscribed by their possibilities of use.[37]

In other words, nearly anything can become a model or proxy for something else when a cognising agent—usually though perhaps not exclusively a human—recognises that object as affording certain possibilities for action. In our everyday interactions with people and objects all around us, models are fashioned, in a Gibsonian sense, based on the affordances of the objects in the environment. At a table, for example, I might use any proximal, lightweight, moveable objects as models to aid me in offering you directions to some real-world location or even some fictional location, for example, the major coordinates of Dante's Hell or Tolkien's Middle Earth.

Repeatedly in the anatomy lab, students describe the visual displays as analogy-like models that stand in for the cadaveric body. Remember the previous students' description of anatomical images as akin to 'a rough sketch'. Echoing and expanding that sentiment, one TA explains the ways atlas images function as model-like visualisation tools:

> I think that they [the atlas images] are seen as the standard guide for anatomy, and, you know, it is really important to study these plates [or anatomical illustrations] and compare these plates to your body, you know. Without the plate, you would have nothing to go by, so it is really the foundation for everything else. Granted things will look very different on the body, but it is something to fall back on, a common picture for everyone to *visualise*.

Students learn to visualise the common views of the body that atlases make possible by interacting with them while interacting with the bodies. In other words, they use these model-like atlases (maps!) to help them navigate cadaveric bodies whenever they are dissecting or seeking to locate some anatomical structure. When students leave the labs, these atlas images function as visualisation tools that allow them to remember what they have previously

experienced in the cadaver. Thus, through memory and imagination, or what Shaun Gallagher has termed 'reactivated presenting', participants bring before the eyes a version of the anatomical body that is made to correspond to these common atlas pictures.[38]

One dental student explains the process in this way:

> People would be lost without their *Netters* [*Netter's Atlas of Anatomy*]. I think that sometimes they are… are absolutely core. But I think sometimes, they need to be supplemented with photo atlases in the lab [atlases containing photographs of cadavers]. So, they [atlases] are not great on their own, but I think, I do find myself on the tests looking back to lab and *thinking back to my Netter and trying to pull up the photo in my brain*, so that I can see what goes to what and where things run.

Because the resemblance between *Netter's* painter-like illustrations and the actual cadavers can be difficult to achieve, students are encouraged to use a host of displays and objects as stand-ins that provide different perceptual affordances. Using these other images as representations for bodies involves two processes. First, in a model-like process of substitution, students use the atlas image as a way of seeing into the body through comparison of what is present and what is absent. Students use physical objects that are made representationally meaningful through their embodied and skilful interactions with them. Those practices of interaction, which depend on knowing and using anatomical language, are vital to making the likeness and resemblance possible. Second, students describe mentally constructing these images by remembering the viewpoint or perspective the images provided. They are using their memory and imagination to engage in what Gallagher has termed 'affordance-based imagining'.[39] Imagination, specifically memory-based imagination, 'involves embodied action' such as using 'props, artifacts, [and] instruments'.[40] Those embodied interactions with the environment bring images to mind, so to speak, because they allow us to 'manipulate concepts, thoughts, images'.[41]

Sometimes these imaginings, or visualisations, involve embodied interactions that create a host of proxy objects that stand in for or represent the anatomical body. Take for example, this dental student's description of using gestures as memorisation and visualisation aids:

> We were talking earlier about hand *gestures* and stuff, like I think a lot of us, when we are talking about things. [Holds out hand in front of her.] We are saying, 'this is an artery, and it's branching off'. I think it's really helpful to [use] your hands too, because then you get, like for your body then you can say this side or that side, so that when you're studying, you can picture the way you think about it by the way you hold your hands out or not, that makes any sense.

As J. Scott Weedon has identified, gesture can function as a presencing technique for 'bringing forth' an absent object that directs attention and frames activity.[42] Here the student uses a hand gesture as a model-like substitute which, through memory and imagination, allows her later (away from the lab) to orient herself and situate the supposed pictures in her mind in ways that let her remember and see the body. But what exactly are these students remembering or imagining? Is it the cadaveric body or the body as presented in atlases? The answer to this differs according to the situation. The contents of their visualisations are dependent on the context-specific activities in which they engage and their rhetorical rationale for constructing these mental images in the first place. For example, students in the lab might recall images from *Netter's Atlas of Anatomy* in order to navigate a chaotic cadaveric body in front of them.

At home, however, students might remember the actual cadaver bodies of the lab in order to help them see *Netter's* aestheticised, stylised images in a more realistic light.

Putting words to images

Importantly, language, specifically anatomical discourse, plays a key role in this complex orchestration of real and virtual objects.

> I mean that is how they learn, being in there [the lab] and seeing all the structures, *they can then put that in their mind, so they can put it on paper* [during the exam]. Whereas I knew people in my class who hated being in lab because for some of them if they could write it out on a paper, then they could translate it to 3D, which I cannot do. I can sort of do it. I guess I can, well I put *words into images*.

In the words of this TA, students must view the representational objects in order to put them 'in their mind', so that they can put that body into words during the exams. Yet the act of putting bodies into words is a reciprocal, co-constituting endeavor—words into images and images into words. This interdependence of words and images can be seen with the students who write out detailed descriptions of structures based on location and landmark. These verbal descriptions are not imagistic depictions of the look of a structure (its descriptive value) but instead the structure's relationship to neighboring structures (its relational value).[43]

During talk-aloud cadaveric demonstrations, students are required to put the cadaveric body on the table into words, as classmates take turns verbally identifying, presenting, and often narrating structures of the cadaver in front of them. As one TA remarked: 'We definitely encourage them [students] to talk through things, to talk through the veins, the arteries, and nerves. To imagine them, to trace them, to look at them, to draw them when you get home'. Here taking the object on the table and putting it into words—using the proper anatomical term and describing or narrating its location and pathways—allows students to recall the image of the body when they recite those words later outside the lab. Another TA discusses this process in more detail by explaining the benefits of making students perform these talk-aloud demonstrations:

> In the lab, I think that students—you can learn about these things in a class, you can read about these things, but then you can actually go in and go to the cadaver and actually find the structures, you know, actually see the relationships. I think that people can talk about something and there is room for error, they can talk and say, oh yeah this runs next to this and this is close to this, but when you actually have to go in and show somebody that, then it is a whole different story. It is a whole new level of understanding. *You put things in words, and then picture those words, and then put it all in action in the body, where you can kind of discover it* […] I think they learn a lot in the lab by seeing the words and hearing the words come out of their own mouths, you know, the terminology.

Students use anatomical terms and concepts as well as techniques of description and narration to make sense of, memorise, and visualise the anatomical body. However, this interplay of the visual and the verbal is markedly different from the ways an atlas image uses images and words to depict anatomical structures. Seeking to put forward a theory of visual-verbal interaction that possesses 'genuine heuristic potential', Gross and Harmon incorporate an enhanced version of Paivio's Dual-Coding Theory, which posits that verbal and visual information is

processed and stored in different parts of the brain.[44] In Paivio's work, which presupposed a stimulus-response model of cognition that more recent predictive processing approaches have critiqued, the combination of visual and verbal elements was believed to enhance learning and memory.[45] While visual-verbal interaction may lead to greater comprehension and recall, not all forms of visual-verbal interaction occur simultaneously on the screen or text. In many scientific contexts, participants learn and deliberate by talking through images or imagining mental models of concepts, both of which require making present virtual objects in material ways and vice versa.

Words, images, objects—all of these are made meaningful through the embodied practices of the gross lab that requires one to interact with all of these at once. Seeing the body in the images on display is not merely a process of pattern recognition, it is an enactive process of making, in which one uses the discourses of the lab and their anatomical knowledge to create likeness by way of a process that feels like detection. These images, on which likeness is enacted, are model-like substitutions that stand in for the cadaveric body. For the participants in the lab, this process is made possible by human memory and imagination. Using anatomical discourses and their memory of what they encounter, students construct mental images or visualisations of the anatomical body which are based on, but not always synonymous with, the bodies they have seen. These acts of imagining are affordance-based in that students engage in them and construct them because of the opportunities for action the objects of the lab make possible. Whether they are present in the lab or studying at home, students are always imagining bodies—bringing bodies to mind that are not physically present.

Conclusion

In the gross lab, a set of sophisticated representational practices—based on association and substitution more than isomorphic realism—are made possible through a kind of body–object–world assemblage that depends on language and objects and imagination. Learning in the sciences, in medicine, in technical fields, and in all disciplines involves embodied practices that allow participants to see into the objects of their profession according to the logics of that profession. And particular kinds of memory and imagination are necessary components of that process of trained vision. For centuries, rhetorical theory characterised a similar process as foundational to persuasion—the ability of words and images to bring to mind objects, persons, and events by recreating some part of our original experience of the thing. My goal in this chapter has been to demonstrate how scientific, medical, and technical representation is made possible through rhetorical presencing and embodied cognition.

Rhetoricians of science have cautioned against an uncritical acceptance of neuroscientific theories of mind—particularly scholarship that fails to acknowledge these theories as constructed artifacts that are often deployed to validate the inevitability of certain ideals about human nature.[46] Nevertheless, rhetorical scholarship that attends cautiously to research in cognitive science has the potential to offer a more comprehensive account of a number of scientific practices that involve both rhetoric and cognition. The presence-making practices of science, for example, depend on the rhetorical practices of embodied minds engaged in material practices in language-rich spaces. It is the notion of rhetoric as a presencing technique for the demonstration of argument, the visualisation of images, and the performance of affect that allows rhetoric to be a tool for, on the one hand, scientific discourses and genres and, on the other, literary and aesthetic texts. This conception of rhetoric—as displays of argument, evidence, and affect intended to move an audience—can provide insights into how humans make scientific meaning

through our interactions between language, image, and object. Representation, in science and beyond, is only made possible through those interactions, which are material and immaterial simultaneously.

Notes

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