

Chapter 2

On the Nature of Disciplinary Intuitions

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Opening Thoughts on Intuition and Disciplinarity

What is the nature of intuition? Quite simply, in the words of Michael Polanyi as he discussed tacit knowledge, we can know more than we can tell (2009). Let us begin with some guiding questions to facilitate the reading of this chapter. We begin from an analysis of the disciplinarity of knowledge, which appears as a sociological question: What are disciplines? Do they refer to any “real” distinctions between forms of knowledge, or are they merely determined by cartels of robed academics carving out particular niches to solidify their prestige? In an age where we can all “google it,” what use do we have for the stuffy old academic distinctions? From there, we zoom in to consider psychological and cognitive aspects. We will consider questions such as: How do we think, and have language? Are phenomena such as the development of language purely the result of sociality, or is there something else deeper? And then, finally to tie everything back together: What might some implications be for learning?

Polanyi points to the importance of considering the entire body as our means to probe and come to know truths about the universe in which we exist; in other words, we can have “muscle memory” of how to perform a repetitive task with a mechanical device, which can potentially inform the way we understand how the device works, but in such a way that is not expressible in formal language. Polanyi also claims that trying to formalize all forms of knowledge is probably futile (p. 20), and there will perhaps always be ineffable knowledge forms which permeate our conscious formalized knowledge and its process of acquisition.

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Polanyi's insightful words were written in 1966, and we have had several grand leaps in our understanding of cognition and learning since. Significantly, we have come closer to understanding the workings of the human mind, largely facilitated by the computing and artificial intelligence revolution, especially if we see these as experiments in applied cognitive research. We have also come to an increasingly sophisticated understanding of the nature–nurture debate, where we now can respond that it is both; we also know that there ought to be innate cognitive modules primed to respond intelligently to external stimuli. Importantly, this then implies that there is some form of stable reality to which we can develop dependable knowledge, for which we may obtain a sufficiently high degree of intersubjectivity, and hence, truth. As such, the disciplinarity of knowledge can (and should) be defended.

Sociological Arguments for Disciplinarity

Mark Taylor, in his *New York Times* op-ed (2009), claims, boldly, that we should “end the university as we know it”—one of his reasons being that the disciplinary boundaries currently in universities are unhelpful for contemporary problems, which are often multi- and transdisciplinary, and for which university academics cannot go very much beyond their specific areas of specialization to arrive at satisfactory solutions:

The division-of-labor model of separate departments is obsolete and must be replaced with a curriculum structured like a web or complex adaptive network. Responsible teaching and scholarship must become *cross-disciplinary and cross-cultural*. (emphasis added)

But these notions of disciplinarity are certainly not novel, and calls for greater interdisciplinarity have had a history of almost a century now (Applebee et al. 2007). Disciplinary boundaries have been imagined to be artificial, a form of preservation of institutional privilege unjustly earned, and even likened to a straitjacket for the free exchange and flow of ideas. In order to better understand the nature of disciplinary boundaries, it is helpful to begin an enquiry from a sociological position, considering the role of disciplinary boundaries as they play out in the organization and production of truth claims, before next considering ontological and epistemological aspects of knowledge, and what recent thought about the nature of knowledge and truth may imply for learning and the disciplinary organization of knowledge.

When C.P. Snow presented the Rede lecture at Cambridge in 1959, he described two cultures of intellectual communities, namely the sciences and the humanities, each with their divergent interests, research agenda, and mutual incomprehension bordering on hostility and dislike:

The non-scientists have a rooted impression that the scientists are shallowly optimistic, unaware of man's condition. On the other hand, the scientists believe that the literary

intellectuals are totally lacking in foresight, peculiarly unconcerned with their brother men, in a deep sense anti-intellectual, anxious to restrict both art and thought to the existential moment. (p. 5)

The existence of this gulf had implications for the way that society's problems were to be addressed, especially if consilience were not to be reached, and learners could not benefit from being able to see past differences. Having drawn the divisions, a natural question that came to occupy the academic interest was the idea of demarcation—what is it that makes science *science*, and how might one distinguish science from nonscience. One of the dominant responses came from Karl Popper (1959), whose idea of a test for science was that of falsifiability: a theory could be properly considered scientific if it could be falsified. For instance, the claim that all swans were white could be proven false if a single black swan could be identified.

Eventually though, falsifiability was found to be insufficient—there are no clear-cut means for deciding how something might come to be judged to be impossible to falsify (Feyerabend 1993). Falsifiability as a criterion was recognized as merely a mechanism for deferring the question of judging; in other words, the criterion for boundary demarcation was to be located elsewhere. It was the next move in the demarcation problem that led eventually to a greater public awareness of epistemological issues: How is it that we know what we know?

Thomas Kuhn (1962), in *The Structure of Scientific Revolutions* argued that scientific knowledge did not accrete in a linear fashion, but rather, there were periods of relative stability in knowledge production, while errors, inconsistencies, and the inability of the extant theory to explain phenomena became increasingly apparent. At one point, a rival theory is proposed, forming a new explanatory paradigm incommensurable to the older theory. Important to these ideas proposed, however, was Kuhn's suggestion that there were social factors that influenced the reception or otherwise of new theories. That is, in opposition to the logical positivist position that correspondence to empirical reality was the only means for assessing the veracity of truth claims, Kuhn was interpreted by many to mean that scientists' personalities, institutional reputations, and such subjective qualities as "elegance" of the theory were often more important than mere improved correspondence. Kuhn's work opened up the new field of sociological studies of scientific knowledge, seeking to find evidence for sociological means of legitimizing truth claims in scientific practice.

The problem became one of identifying nonempirical factors for the acceptance or otherwise of truth claims. Several noted contributors included Bruno Latour (1993), Sandra Harding (1991), and Luce Irigaray. Latour studied the acceptance of Pasteur's ideas on the discovery of the microbe as disease-causing agents, highlighting the uneven manner in which his ideas were accepted, and the differences in the social contexts which aided or hindered the acceptance of his theories. Harding and Irigaray have offered their respective feminist critiques. It follows that at least on a sociological level, there are adequate reasons to support a disciplinary organization of knowledge. However, the epistemological problem

we posed earlier has not been adequately addressed: Do knowledge boundaries actually cohere to anything “out there” in reality? Does it necessarily follow that just because something works sociologically, its underlying epistemic reasoning is sound?

Building an Epistemological Case for Disciplinarity

As a quick depiction of the polar extremes of the epistemological argument which influence disciplinarity: on the one pole, a logical positivist position holds that truth is only possible when there is correspondence between the claim and empirical reality, and on the other, that truth claims are made in relation to one’s position in social existence; and associated with this latter pole, an extreme skepticism of the existence, or even possibility, of truth. With the latter pole, all we have, as the postmodernists and social constructionists insist, is discourse, and power relations to determine who speaks the truth.

Social realism, the philosophy that one of the leaders of the New Sociology of Education movement—Michael F.D. Young (1971, 2008)—came to champion, can be thought of as occupying a middle position between positivism and social constructivism. Among its educational implications is that knowledge structures exist, and are not arbitrary, but instead refer to a structured reality that behaves in uniform ways and provides reliable means for adjudicating truth claims. The latter are mediated by social interactions, but in part because we have surprisingly similar mental and sensory systems, these social mechanisms for arriving at truth are not, for the most part, up to the whims of self-interested individuals; through social mechanisms like competitive cross-validation, better approximations to reality can be approached. And because these mechanisms for reducing bias and enhancing correspondence to truth exist within particular stocks of knowledge, and are often domain-specific, it is important that disciplinary structures persist, not just as warehouses of our best available knowledge, but also as demonstrative exemplars of how these social mechanisms are to applied to new and unforeseeable situations that learners may eventually encounter.

For instance, if we were to consider the truth claims of a scientist working at the European Organisation for Nuclear Research—CERN, we may decide to trust the newspaper journalist, who trusted the scientist informant, who trusted the Principal Investigator at CERN, who trusted his research collaborators, who trusted his assistants, who trusted their technicians, who trusted the manufacturers of precision tools and other equipment, ... and so on. All along this chain of trust exists numerous possibilities for the violation of trust, but, crucially, there are ways to discern such violations, we are able to tell, sooner or later, where these violations occurred, and what the more accurate versions of truth are. It is this corroboration with reality that is really the key principle here, and the reason why we can insist on the Disciplinarity of Intuitions—there really are objects in nature to which things refer to, and the distinction between the physics approach to a particular problem as opposed to a sociological one, is real and not arbitrary.

The Nature of Knowledge

The problem of philosophical skepticism is an old one, and one that has generated an entire field of epistemology (Williams 2001). The foundational problem here is how we can have knowledge, and how do we distinguish between knowledge—which we may recast as justified true beliefs—and “mere” opinion? It appears that we have not gotten very far from the Agrippan formulation of the problem; Agrippa, the ancient Greek skeptic, proposed that we only have three recourses for justification: infinite regress, circularity, and assumption. The infinite regress is the rhetorical move encountered by parents of young children who discover, for the first time, the recursive property of the magical word: “Why?” With circularity, justifications proceed until some point where one repeats what was previously mentioned; and with assumption, one refuses the infinite regress by reference to a claim that is dogmatically assumed. Williams (ibid.) argues that if the infinite regress is to be considered intolerable, we are left with either of circularity or assumption as archetypal forms of justification. These two approaches, suitably expanded, become coherentism and foundationalism respectively, and help us understand the problem of disciplinary boundaries.

Put in these terms, for adherents of coherentism, what matters is the holistic coherence and consistency of the overall set of claims that make up the “package” of claims, even though the possibility exists that the set of claims may be entirely coherent yet entirely untrue. Coherentism largely underwrites postmodern thought; researchers surveyed earlier (Barrett 2012; Maton and Christie 2011; Wheelahan 2010) have pointed out the inadequacies thereof, especially for a theory of learning.

As for foundationalists, what matters is the location of basis claims—the self-evidentially true statements that one may use to build further truth claims, even though there is significant skepticism on the possibility of finding such claims. Seen in this light, positivism is a special case of foundationalism in that positivists claim that these self-evidentially true claims must arise from a correspondence to empirical data.

Running counter to these Agrippan forms of skepticism is Cartesian skepticism. Adherents to the latter argue against the possibility that science is in any way special (and hence would more likely advocate a dismantling of disciplinary boundaries). It did the sciences and the “traditional” disciplinary boundaries no favors to note that science and technology brought about expanded ways for humans to hate and oppress one another and bespoil the environment—if such horrors could visit the human condition due to these knowledges, there must be something inherently wrong with them. And if the boundary between science and other knowledges could be weakened, why not remove *all* “artificial” barriers to free and open interchange of ideas? The position of the contributing authors of this book would be that we do not need infallible knowledge of the world, just knowledge sufficiently reliable for our purposes. We do not need to know *for certain* that we will never find the black swan [that proves wrong the assertion that all swans are white].

To be certain, the situation is more nuanced than we present, and foundationalism is not perfect—the problem of the basis (upon which claims are built) is one that is not easily resolved. That being said, going forward we wish to choose from the Agrippan form of skepticism the mode of assumption and its associated philosophy of foundationalism in order to develop Disciplinary Intuitions.

The position we have just described corresponds to that of critical social realism (see, e.g., Moore 2007, 2009). To repeat, social realism may be described as a hybrid position: ontologically foundationalist, while epistemologically coherentist. The claim is that there exists an independent reality to which truth claims may be corroborated to, but at the same time, because we are social creatures and because our contemporary efforts to arrive at truth claims is dependent to a large extent on social organization, we often rely on social norms for assessing the veracity of truth claims. This is not to discount the numerous advances that post-modernist philosophy has provided to the intellectual discussion: for one, with increasing sociality comes the problem of political affiliation and the effect of political organizations in influencing the apparent veracity of truth claims. Nonetheless, the position we take here is that the glass is actually half full, understanding that deceit is always possible, but choosing optimism anyway.

On Intuition: How Our Senses Deceive Us, and Why This Is Actually a Good Thing

With Cartesian skepticism, we had the problem of knowledge about the external world—how is it we can come to know about it. There are very real reasons why we might want to be concerned about the degree of security we possess over our knowledge of the world. For instance, we live in a world of human proportions—we see light at a very narrow range of the electromagnetic spectrum; we are human-sized, neither atom-sized nor the size of galaxies; have limited life spans in the order of about a hundred years, neither microseconds nor millenia. What this means is that we cannot have perfect knowledge; our knowledge remains tentative and limited, and there are inferential chains that we must tolerate in order to have even workable knowledge about such phenomena as black holes, plate tectonics, abiogenesis, and the nature of our known universe. Here, it is probably wise to start asking: Do these human-scale senses possess any particular affordances which incapacitate us in particular ways? Or, as the section title suggests: Do our senses deceive us?

Because we derive so much of our information about the world through our visual sense, it is useful here to discuss an example of how this sense can be easily fooled, and what this might mean for us. Consider the following example, which depicts two views of the same learning installation conceptualized by an Art teacher in a state-funded school in Singapore, and built within a three-dimensional immersive environment by Derek Chua (a member of Lim's (2009) team). The illustrations show how—from one perspective—a given scene looks “right,” while—from another perspective—it can look quite puzzling (Fig. 2.1).

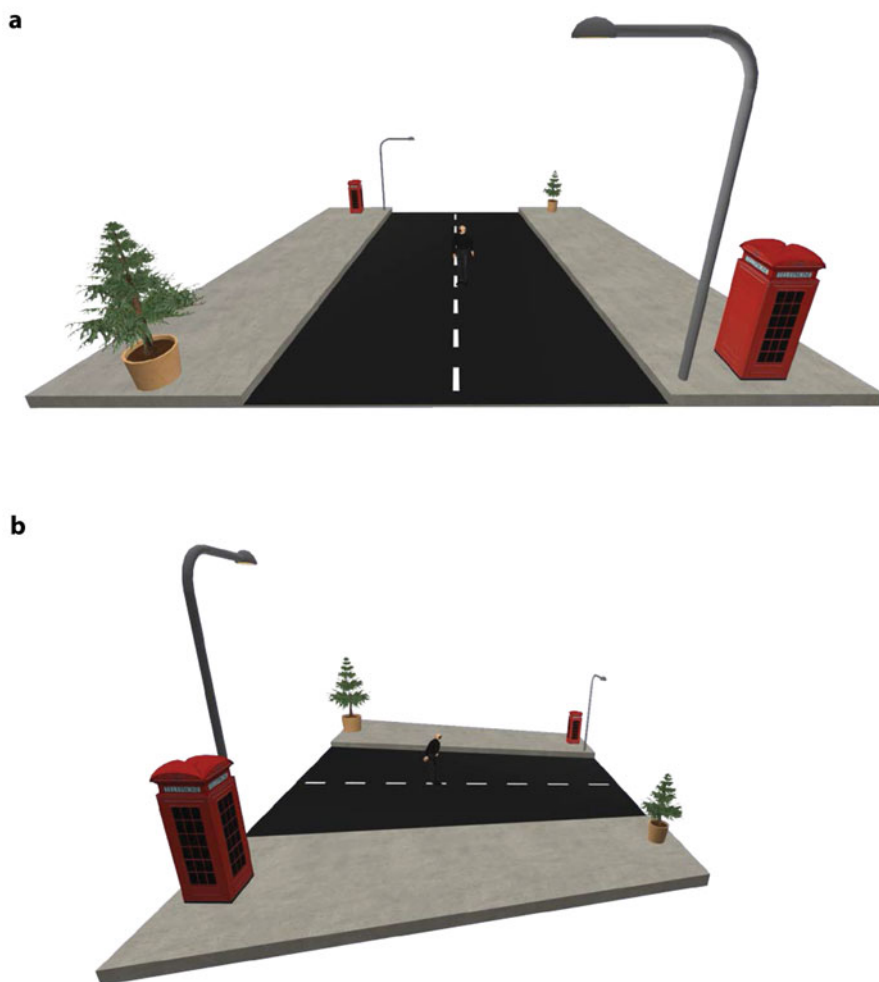


Fig. 2.1 (a) A street-scene in an immersive environment. (b) The same scene, from a different perspective

This illusion “works” because of our general familiarity with streets and urban landscapes. Illusions like these are especially convincing to claims that we cannot trust our senses; and, if relativists are correct, that truth claims are truly relative to the contexts under which these claims are made.

However, there is more to this example than meets the eye (pun intended), and this example actually leads us to our understanding of the concept of intuitions. More to the point, this example leads us to think about the mental processing required for vision; or more generally, as Pinker (1997) points out as the core problem that cognitive science and artificial intelligence researchers have struggled with for decades: What are the kinds of challenges in designing/programming a robot

that can match the abilities of a human being? The ambition here is with *understanding*; to be able to explain how it is that our minds work.

When the problem is analyzed, the problem of vision is understood to be hard indeed. Even something that we take for granted as the ability to distinguish different objects as distinct is a considerable challenge, let alone other fascinating things we can do such as recognize faces. In object detection, there needs to be an algorithm to detect edges, and this information needs to be combined with another algorithm to detect depth through binocular vision, and yet another algorithm that detects shading as all these information provides cues to the spatial location of objects. How does the human mind do these kinds of processing? From a computational and information processing perspective, it must be clear that if we can study the informational tasks needed, a highly similar, if not identical informational flow needs to happen within the mind. The terminology here needs to be careful: at this point of the discussion, we will use the word “mind,” not “brain” because the interest is in function, not anatomy. Similar to how the circulatory system is a function in which the heart plays a major part, we will not be concerned *how* the computation actually happens, but instead be interested in what the mind needs to do in order to perform the feats that it does.

The claim here is that we are able, through logical argumentation and observation of basic phenomena, to understand how our own mental functioning works—called the computational theory of mind:

The key idea is that the answer to the question “What makes a system smart?” is not the kind of stuff it is made of or the kind of energy flowing through it, but what the parts of the machine stand for and how the patterns of changes inside it are designed to mirror truth-preserving relationships (including probabilistic and fuzzy truths). (Pinker 1997, p. 77)

The investigations and analyses of the computational theory of mind have much to inform educational studies. For our purposes here, there are two important considerations of this line of work. First, almost with echoes of nineteenth-century Taylorism, when we consider mental processes, as suggested earlier, we come to the general conclusion that there ought to be specialized mental “machinery” or structures (loosely) which deal exclusively with very specific tasks, with combinatoric assembly of these subroutines as responsible for the construction of the general intelligence that we take for granted and struggle to explain in noncircular means. Second, there appears to be evidence for a certain innateness and commonality of these mechanisms across the human species.

The Disciplinarity in Intuitions: Innate Abilities of the Mind

The evidence sources for these claims are as astounding as the claims themselves. For instance, take the case of one Phineas Gage, the railroad worker who, in an unfortunate incident while he was tamping explosives into a hole, had the tamping rod blasted through his head, from under his cheekbone and out through the top of his skull. Phineas survived the incident, and while Phineas was a pleasant,

hardworking, ambitious person before the incident, he became rude, unreliable and shiftless, even though his other mental functions were intact. His ventromedial prefrontal cortex was destroyed, a region “of the brain above the eyes now known to be involved in reasoning about other people. Together with other areas of the prefrontal lobes and the limbic system (the seat of the emotions), it anticipates the consequences of one’s actions and selects behavior consonant with one’s goals” (Pinker 2002). This case, a classic in psychology textbooks, tell us quite clearly that there are various parts of the brain involved in various segments of our cognition, and that in numerous cases of individuals who have selective damage (either by disease, accident, or congenital reasons) to different parts of the brain, different aspects of cognition are selectively lost.

Or take the case of “Mr. M,” studied by Laurent Cohen and Stanislas Dehaene (in Lakoff and Núñez 2000). Mr. M had the curious disability to tell the number between say 3 and 5, but could correctly give names to numerals. He could not do basic arithmetic, could not perform mathematical bisection (e.g., cannot tell if 45 or 8 lies between 2 and 10). However, Mr. M has his rote arithmetic knowledge intact, he is able to recall the multiplication table. As Lakoff and Núñez surmise, “he has lost every intuition about arithmetic, but he preserves rote memory. He can perform simple rote calculations, *but he does not understand them.*” (ibid., p. 24, emphasis added). Mr. M was diagnosed with lesions in the inferior parietal cortex, “located anatomically where neural connections from vision, audition, and touch come together—a location appropriate for numerical abilities, since they are common to all sensory modalities” (ibid.). Lesions here, besides disabling patients’ mathematical abilities, also generally impact patients abilities in writing, representing fingers on the hand, and distinguishing left from right, as Mr. M demonstrated. This case, again, demonstrates the specificity of the brain regions involved in particular forms of computation, and in concert with other cases, hints at the remarkable similarity of brain function across different individuals, generalizable across our entire species.

It is from evidence such as the preceding two examples that we begin to appreciate there appear to be mental structures that are innate to the human species which carry out specific tasks, in very predictable ways.

A prime example, again from the domain of mathematics, is the idea of subitizing. Subitizing is the innate ability to tell, at a glance, the number of items in a collection, and forms the foundation for such feats as efficient usage of the abacus and the ability to identify instantly numbers on dice and playing cards. Studies in the Violation of Expectations in babies as young as 4.5 months have permitted their subitizing ability to be inferred by studying fixation time: the duration which they stare at a pattern of dots. For example, a pattern of two dots is presented to a baby; she soon gets familiarized with this pattern and starts to ignore it. Without prior notice or other cues, this pattern is suddenly changed to one with three dots. Immediately the baby exhibits a longer fixation time with this new pattern, indicating that she could tell the difference between the number of dots. A fuller review may be found in Mandler and Shebo (1982).

If subitizing is deemed fairly straightforward, studies that showed infant abilities to add and subtract, or, more precisely, discern addition and subtraction, are nothing

short of remarkable. In one study (Wynn 1992), investigators placed an object within a field of view of the infant, obscured this object with a screen, visibly added an additional object behind the screen, then visibly withdrew an empty hand. When the screen was lowered, two possible scenarios were presented to the children: either two objects were revealed, or one. Measuring fixation times again, investigators found that infants stared longer when an incongruous result (one or three items) was presented. Again, with similar inference pattern, the innate ability of some animals has been determined (Lakoff and Núñez 2000).

Our mathematical abilities appear to be innate. To understand how we can come to understand abstract concepts, Lakoff and Núñez (*ibid.*) contend that we make use of conceptual metaphors; these can be thought of as a system of *inference-preserving* mappings from one conceptual domain into another. These conceptual metaphors allow us, for example, to connect operations valid for groups of objects into the principles of arithmetic operations, or conflate our experiences of traveling along defined paths to the rules for the manipulation of negative numbers, in the process preserving the rules valid for one domain into another more abstract one.¹

While discussing metaphors, it is also appropriate here to point out studies in linguistics: numerous studies have shown remarkable similarities across the different languages in use throughout the world, not in the representational form used but in the grammatical structure; this is elaborated upon in Chapter 8. Chomsky's Universal Grammar posits the innate ability of the human mind to acquire linguistic ability, and interrelatedly imply that there are grammatical properties that are common to human languages, which hint at both the regularity of the reality that confronts our senses and, more significantly, the uniformity of the human computational mechanisms required to process language. In the words of Pinker (1997):

[...] it is a significant discovery that both [Japanese and English] languages have verbs, objects, and pre- or postpositions to start with, as opposed to having the countless other conceivable kinds of apparatus that could power a communication system. And it is even more significant that unrelated languages build their phrases by assembling a head (such as a verb or preposition) and a complement (such as a noun phrase) and assigning a consistent order to the two.

The standard objections to such innate theories of mind lie in the idea that the mind should remain inexplicable through mechanistic means. One might fear a mechanistic erosion of the concept of free will. We bookmark this and acknowledge that we are aware of this challenge. Ways forward exist in various forms; a leading contender being that of complexity theory whose fundamental insight is that simple mechanisms can give rise to highly unpredictable results at larger scales of interactions because of the simple laws of combinatorics and huge numbers.

When we consider the weight of the evidence, noticing similarities across the various cultures and especially when we take a “top-down reverse engineering approach” (Dennett 1998) to logically analyzing how “intelligence” may arise from

¹For example, 1 object added to another gives $2 :: 1 + 1 = 2$.

computational structures of flesh, we come to the conclusion that at least at some minimal level, there exists some degree of innateness in the numerous talents that human beings may display. The number of innate talents and the means by which these are developed are not well-known; Pinker points to about ten innate cognitive faculties that cognitive scientists have been able to identify. These include intuitive physics and intuitive biology (developed in Chapter 5), intuitive engineering (developed in Chapter 6), spatial sense (developed in Chapter 7), language (developed in Chapters 8, 9 and 10), and number sense (developed in Chapter 11). The remaining faculties have been identified as (1) intuitive psychology, (2) probabilistic sense, (3) intuitive economics, and (4) mental database and logic.

The natural question that arises from such observations of innateness would be to ask: Where do these innate modules come from? This question may be answered in two parts. First, these innate faculties appear to be essential for the optimal “operation” of the human organism; for example, our spatial sense prevented our ancestors from flinging themselves off cliffs, their relatives which were not able to instinctually differentiate between “prospect,” “refuge,” and “hazard” (Appleton 1975) would not have been around to be our ancestors. Intuitive biology would be necessary for the species to understand disease-causing agents and to avoid bodily discharges; intuitive number sense allows us to tell, at a glance, whether there was only one predator, or three, and therefore select the appropriate response.

The second explanation of how we acquire these intuitions is more interesting: it appears that the information contained in the human genome is not enough to uniquely specify all aspects of the human organism. For example, the curvature of the lens in the human eye, and the exact location within the brain of the various computing circuits dedicated to the various senses, in relation to other regions, cannot be contained with the informational content of the human genome. How then, can we develop such concepts as intuitive psychology? The solution that was discovered, spawning its own field of research called epigenetics, was that the immediate environment that the cells were in played a vitally important role in the correct expression of the appropriate segment of the gene. Through a process of feedback loops, such interactions with the environment ensures that the appropriate cell, organ, or system develops in the correct location and is “wired up” (especially in the brain) to its correct partner. For example, Pinker points out that the following specifications appear to be dependent on such environmental interactions: the distance between the lens in the eye and the retina; the curvature of the hip ball and socket joint; and the neural wiring in the brain. In the case of the hip ball and socket joint, this joint requires that the developing embryo rotate the joint through its normal range of motions; in experimental embryos where the joint is paralyzed, the joint develops into a badly misshapen form. There is reason, then, to believe that our innate mental faculties develop as a result of similar kind of environmental feedback; as infants develop, manipulating objects develops the intuitive physical sense, interactions with other children in give-and-take develops their intuitive economics, and so on.

Disciplinary Intuitions

There should now be a fairly clear indication of where we situate Disciplinary Intuitions. In the first two chapters of this book, we have been accreting evidence for the embodied or grounded nature of cognitive processes. The grounded/embodied perspective extends beyond the brain *per se* when considering cognition. As an example, children are often taught basic arithmetic by reference to their fingers as counting objects; these processes involve corporeal manipulation as essential to cognition. Our understanding of mathematics – the “language of science” – can be thought of as a metaphorical extension of corporeal experiences and processes (Lakoff and Núñez 2000).

Similarly, in terms of processing language, emotions, beliefs, and our state of consciousness, our cognitive processes need to be thought of as being reliant on the external environment. Our understanding of language metaphors is grounded in schema derived from our day-to-day experiences of a manifest reality (Lakoff 1987). For instance, when subjects were asked to read a sentence “the ranger saw the eagle in the sky,” and presented pictures of either an eagle with wings outstretched or folded, subjects were faster at identifying the eagle with outstretched wings (Zwann and Madden 2005; in Barsalou 2008; see also, Hall and Nemirovsky 2012; Wilson 2002). In other research summarized by Barsalou (2008), participants’ motor systems became active by simply reading out action-words; motor simulations triggered by words produced priming across lexical decision trials; and when reading about a sport – such as bowling (as elaborated upon in the preceding chapter) – experts were found to produce motor simulations absent in novices. A similar set of results have been summarized by Bergen and Feldman (2008): numerous empirical findings show that cognitive simulations are the basis for comprehension and processing of language and abstract thought. Rowlands (2010), for example, even posits that corporeal and object configurations are not to be thought of as representations of cognitive states (like fingers in counting), but rather that these are cognitive processes in themselves.

If the configurations and interaction with objects outside the body are instrumental to cognition, then what about social interactions with other minds? In the preceding chapter, we considered the use of language, which must now be reconsidered as a form of externalizing cognition:

Without language, we might be much more akin to discrete Cartesian “inner” minds, in which high-level cognition relies largely on internal resources. But the advent of language has allowed us to spread this burden into the world. Language, thus construed, is not a mirror of our inner states but a complement to them. It serves as a tool whose role is to extend cognition in ways that on-board devices cannot. Indeed, it may be that the intellectual explosion in recent evolutionary time is due as much to this linguistically-enabled extension of cognition as to any independent development in our inner cognitive resources. (Clark and Chalmers 1998)

By way of drawing this chapter to a close, we refer to Intuition as innateness in the epigenetics-inspired sense that innate beliefs/understandings/instincts

are crucially dependent on interactions between the developing the individual and its environment. As for Disciplinaryity, we have explored epistemology in order to establish the nature of knowledge and knowledge boundaries. This was because in order to understand the nature of knowledge and of categories, we not only had to gain insight into reality and its representation, but also to acquire knowledge about the self, about how it is that we can even know, or, even more generally, how is it that we are conscious enough to know. Through this process of coming to know our computational machinery, we close the loop with the concept of innate modular computational elements. These modules have their form in response to the regularity of reality.

These innate cognitive modularities are our current best attempt at explanation of the nature of the human mind. If the external environment constitutes resources for cognition, and there exist innate cognitive modules primed to develop intuitive understandings of the way the world behaves, we respectfully suggest that educators seek to design learning activities and environments in order to develop and surface these otherwise tacit intuitions.

This is because these innate modules are very rudimentary, and if opportunities do not arise for them to be developed, they provide only foundational support for learning to occur. As Pinker (1997) points out:

Conspicuous by their absence are faculties suited to the stunning new understanding of the world wrought by science and technology. For many domains of knowledge, the mind could not have evolved dedicated machinery, the brain and genome show no hints of specialization, and people show no spontaneous intuitive understanding either in the crib or afterward. They include modern physics, cosmology, genetics, evolution, neuroscience, embryology, economics, and mathematics.

It's not just that we have to go to school or read books to learn these subjects. It's that we have no mental tools to grasp them intuitively. We depend on analogies that press an old mental faculty into service, or on jerry-built mental contraptions that wire together bits and pieces of other faculties. Understanding in these domains is likely to be uneven, shallow, and contaminated by primitive intuitions. And that can shape debates in the border disputes in which science and technology make contact with everyday life.

Education is interested in students' learning of these nonintuitive, noninnate knowledge forms. For example, for normally functioning children, the spoken language, an innate capacity, is far more easily acquired than the ability to read and write.

Thus informed by recent advances in the cognitive sciences, we consider Disciplinary Intuitions to be innate computational modules of mind which are in the process of being exercised and developed as the learner interacts with his or her external environment.

Given this definition, Disciplinary Intuitions has its roots in embodied cognition, social realism, and the computational theory of mind.

An embodied perspective is critical to the Disciplinary Intuitions approach because of how we understand intuitions; we see the latter as innate modules of mind – which by themselves are rudimentary and are exercised and developed (only) if and when the individual utilizes them as he or she interacts with his or her (physical (including “virtual”) and/or social) environment.

In turn, the social realist perspective is equally critical to the Disciplinary Intuitions approach because it provides an epistemological (and sociological) ground from which to argue for a disciplinary structuring of “reality” – the same disciplinarity thereof is mirrored in the typology of the innate modules of mind described in the computational theory of mind.

From the perspective of Disciplinary Intuitions, the challenge is then to design pedagogical approaches which would foster these innate capacities: for example, if the whole-language approach is understood as leaning toward an “innate” assumption of language acquisition, and the phonics approach treats language as a skill that can be acquired, Disciplinary Intuitions looks to providing principled means for deciding when it would be appropriate to use one of either method, or some combination thereof.

We have come to the conclusion that there are innate cognitive modules which are dependent on their interactions with the environment to be more developed. We also draw from the computational theory of mind, from which we gain insight into the workings of the mind. The second major insight is the disciplinary nature of our underlying reality. The major goal of this chapter then is the advocacy of more reality-based experimentation and “messing about” (Ito et al. 2013) with things, not necessarily in any directed way, in order to develop better and more nuanced ways of understanding the reality of things, and also to develop a deeper appreciation of the theoretical knowledge of the disciplines.

From the perspective of embodied cognition, it is incumbent on curriculum designers to design learning environments that cater to more than just the traditional media of communication of sight and sound. For example, while practical investigations are already part of science curricula, there is a sense in which the scriptedness that often typifies such structured investigations misses out on an essential aspect of learning. We have to get messy and deal with interpersonal relations as learners negotiate the social. This is especially so given the diversity of backgrounds from which learners come. Learners’ prior experiences with physical phenomena need to be carefully attended to, and carefully designed so that intuitions are surfaced and developed.

In summary, the central problem that Disciplinary Intuitions addresses is the acquisition of our culturally derived modern forms of knowledge in relation to the innate capacities of the human mind: What is the role of interactions between the environment and the individual in learning? This chapter has sought to provide the underlying theoretical basis for an approach to designing for learning, which we will develop and exemplify in the rest of the book.

References

- Applebee, A. N., Adler, M., & Flihan, S. (2007). Interdisciplinary curricula in middle and high school classrooms: Case studies of approaches to curriculum and instruction. *American Educational Research Journal*, 44(4), 1002–1039.
- Appleton, J. (1975). *The experience of landscape*. London: Wiley.

- Barrett, B. D. (2012). Is interdisciplinarity old news? A disciplined consideration of interdisciplinarity. *British Journal of Sociology of Education*, 33(1), 97–114.
- Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology*, 59, 617–645.
- Bergen, B., & Feldman, J. (2008). Embodied concept learning. In P. Calvo & T. Gomila (Eds.), *Handbook of cognitive science: An embodied approach* (pp. 313–332). San Diego: Elsevier.
- Clark, A., & Chalmers, D. J. (1998). The extended mind. *Analysis*, 58(1), 7–19.
- Dennett, D. (1998). *Brainchildren*. Cambridge, MA: The MIT Press.
- Feyerabend, P. (1993). *Against method*. London: Verso Books.
- Hall, R., & Nemirovsky, R. (2012). Introduction to the special issue: Modalities of body engagement in mathematical activity and learning. *Journal of the Learning Sciences*, 21(2), 207–215.
- Harding, S. (1991). *Whose science? Whose knowledge?* Ithaca: Cornell University Press.
- Ito, M., Horst, H. A., Antin, J., Finn, M., Law, A., Manion, A., Mitnick, S., Schlossberg, D., & Yardi, S. (2013). *Hanging out, messing around, geeking out: Kids living and learning with new media*. Cambridge, MA: The MIT Press.
- Kuhn, T. S. (1962). *The structure of scientific revolutions*. Chicago: University of Chicago Press.
- Lakoff, G. (1987). *Women, fire, and dangerous things*. Chicago: University of Chicago Press.
- Lakoff, G., & Núñez, R. E. (2000). *Where mathematics comes from*. New York: Basic Books.
- Latour, B. (1993). *We have never been modern* (pp. ix, 157 p). Cambridge, MA: Harvard University Press.
- Lim, K. Y. T. (2009). The six learnings of second life: A framework for designing curricular interventions in-world. *Journal of Virtual Worlds Research*, 2(1), 3–11.
- Mandler, G., & Shebo, B. J. (1982). Subitizing: An analysis of its component processes. *Journal of Experimental Psychology: General*, 111(1), 1–22.
- Maton, K., & Christie, F. (2011). *Disciplinarity: Functional linguistic and sociological perspectives*. London: Continuum.
- Moore, R. (2007). Going critical: The problem of problematizing knowledge in education studies. *Critical Studies in Education*, 48(1), 17.
- Moore, R. (2009). *Towards the sociology of truth*. London: Continuum.
- Pinker, S. (1997). *How the mind works*. New York: Penguin.
- Pinker, S. (2002). *The blank slate*. New York: Penguin.
- Polanyi, M. (2009). *The tacit dimension*. Chicago: University of Chicago Press. (Original work published 1966)
- Popper, K. R. (2002). *The logic of scientific discovery*. London: Routledge. (Original work published 1959)
- Rowlands, M. (2010). *New science of the mind: From extended mind to embodied phenomenology*. Cambridge, MA: MIT Press.
- Snow, C. P. (1959). *The two cultures and the scientific revolution*. New York: Cambridge University Press.
- Taylor, M. C. (2009, April 26). End the university as we know it. *New York Times*. Retrieved from <http://www.nytimes.com/2009/04/27/opinion/27taylor.html>.
- Wheelahan, L. (2010). *Why knowledge matters in curriculum: A social realist argument*. London: Routledge.
- Williams, M. (2001). *Problems of knowledge*. Oxford: Oxford University Press.
- Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review*, 9(4), 625–636.
- Wynn, K. (1992). Addition and subtraction by human infants. *Nature*, 358(6389), 749–750.
- Young, M. (Ed.). (1971). *Knowledge and control: New directions for the sociology of education*. London: Collier Macmillan.
- Young, M. (2008). *Bringing knowledge back in: From social constructivism to social realism in the sociology of education*. New York: Taylor & Francis.

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