A history of the School of Cognitive Science at Hampshire College

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Preface

I started teaching at Hampshire in the fall of 1971, the second year the college was open. I retired in June 2018, 47 years later. I write as a nearly founding faculty member of the college, as a founding faculty member of the School of Cognitive Science (CS), and as the School's longest-serving member.

In the fall of 2018, shortly after I retired, I began writing this history in the hope that it might inform or inspire future faculty and students as Cognitive Science approached its 50th anniversary at Hampshire. As I began writing, a series of events unfolded that threatened the survival of the college.[1] In the aftermath about half of the college's faculty left, either permanently or for indefinite "leave." In particular all but two of 17 faculty members in Cognitive Science left the college, leaving the program with no faculty in its core areas of psychology, neuroscience, linguistics, philosophy, and computer science.[2] As of Spring 2021, in the current national environment of higher education, it is extremely unlikely that Hampshire, at the moment with less than half of its former student body, could rebuild quickly enough to re-establish Cognitive Science. Further, the faculty who remain on campus have chosen to redesign the educational program in a way that suggests that they will no longer be organized into Schools. Thus, this document has become a history of the School of Cognitive Science from its beginning to its probable end, and, I hope, a source for anyone who does research on Hampshire's history in the future.[3]

What were Hampshire's Schools?

Hampshire was founded to foster students' intellectual curiosity, independence, and initiative, to demand their active engagement with ideas, and to de-emphasize the passive memorization of textbook material and the unquestioning acquiescence to external expectations in the quest for grades. The most widely noted features of the educational program in support of these goals were the use of narrative evaluations rather than grades, the requirement that students design and defend their own programs of study (Division II), and the requirement that all students undertake a year-long independent-study project in the final year (Division III). Less remarked upon was the recognition by the founders that the educational goals for the students could not be realized if the faculty were organized into 20 or 30 narrowly-disciplinary departments, which would quickly devise hoops for students to jump through. Instead, the faculty was organized into four large groups, each of which included faculty trained in relatively nearby disciplines. These groups were called the *Schools* of *Humanities & Arts, Natural Science, Social Science,* and *Language & Communication* (later to become *Cognitive Science*).

Each School was tasked with developing a curriculum that initiated students into practicing the modes of inquiry characteristic of its disciplines and enduring issues. Faculty members co-taught across disciplines, insisted that students work through and critique journal articles, emphasized contemporary, accessible, open problems, and set assignments that were open-ended, encouraging students to generate questions and to undertake independent work. The effects on students were profound in part because faculty members themselves were liberated to initiate teaching and research at the intersections among disciplines and to orient instruction toward question formation, critique, and intellectual frontiers.

Three of Hampshire's Schools developed intellectual approaches and curricula that were strikingly innovative.[4] The School of Social Science (abbreviated SS, later renamed the School of Critical Social Inquiry, or CSI) integrated the disciplines of anthropology, sociology, political science, economics, legal studies, women's studies, Black studies, international studies, parts of psychology, and parts of history. SS was remarkably early in establishing an interdisciplinary social science curriculum, featuring frequent co-teaching, that asked students to delve into international comparisons, the history of colonialism, issues of social justice, feminism, and the complex interplay of culture and economic structure. Hampshire produced a steady stream of graduates who drew on their rich exposure to the SS curriculum in their post-graduate research and employment experience. I am not sure whether the School's curriculum had national influence on higher education, but I believe that it was years ahead of other institutions in its explorations of issues that are currently central to undergraduate instruction in the social sciences.

The School of Natural Science[5] (NS) comprised the physical and biological sciences. The School's faculty was dedicated to involving students in authentic scientific inquiry beginning in the first year and to introducing students to science, not as a set of inert facts to be memorized for an examination, but as an attitude and toolkit for generating questions, formulating hypotheses, and acquiring relevant evidence. Ann McNeal, for example, would patiently go over a few papers on muscle physiology from the research literature with the students, train them on how to use an electromyography apparatus, and then ask them to generate and test a hypothesis about muscle function, e.g. how can a human being stand erect, and not just topple over (McNeal et al., 1998). The pedagogical strategies developed by NS faculty for challenging students to actively engage with scientific concepts and to undertake their own research were nationally influential through foundation grants, publications, conference presentations, and workshop organization.

The third school with an innovative program, Cognitive Science, is the subject of this paper.

<u>The School of Cognitive Science in a national perspective</u>

In 2021 the term *cognitive science* is commonly employed in both academic and general-circulation media to refer to research on fundamental processes in the mind or brain, and to a lesser extent to research in artificial intelligence. The term was coined, however, in the mid

1970s to denote a growing emphasis across disciplines on the use of computational or information-processing concepts to build theories of mental processes or intelligent behavior.

The cognitive revolution developed within multiple disciplines from the mid-1950s through the early 1970s. Behaviorism slowly lost its grip on psychology as psychologists began to explore the influence of internal mental processes and structures. Chomsky reconceptualized structural linguistics as the study of a fundamental human biopsychological capacity. Computer scientists initiated research on artificial intelligence. Philosophers developed computational and representational theories of mind (e.g. Putnam, 1967). Montague (Montague, 1970) used techniques of formal semantics developed in mathematical logic to analyze the meanings of sentences in natural language. Conferences that drew participants from across disciplines sprang up, and interdisciplinary research, particularly in psycholinguistics, began to be published (e.g. Garrett et al., 1966).

Through a set of coincidences described below, Hampshire opened in 1970 with a group of young faculty members who were caught up in the cognitive revolution and who founded CS. As an institution and through the work of its individual faculty members and students, the School played a national role in the development of cognitive science, as a field of research and an area of undergraduate instruction. Before delving into the detailed history of CS, here are a few of the highlights of the School's history:

- CS was the first undergraduate cognitive science program in the U.S., and for many years I believe it was the only program that was a full departmental unit, rather than a cross-departmental program.
- CS was developed at Hampshire as one of four fundamental modes of academic inquiry, along with humanities & arts, natural science, and social science.
- The CS faculty wrote the first comprehensive textbook in cognitive science (Stillings et al., 1987).
- CS organized national workshops on cognitive science education in 1986, funded by the Alfred P. Sloan Foundation, and in 1993, funded by the National Science Foundation.
- In 1990 CS established one of the first, possibly the first, undergraduate EEG laboratories to conduct research on cognitive processes using event-related brain potentials (ERP). As of 2021, this laboratory appears to have outlived the School.

<u>Origins</u>

Informed by the final report of a 4-College Educational Advisory Committee (1966), Franklin Patterson (Patterson & Longsworth, 1966, p. 77) proposed that Hampshire's faculty be organized in terms of broad interdisciplinary *Schools,* rather than departments. Not surprisingly, three of the Schools would be *Humanities & Arts, Social Sciences, and Natural Sciences*. But in a striking departure from the traditional, supposedly natural and exhaustive, tripartite division of the academic world, he proposed an additional, fourth, *School of Language Studies*. The name was perhaps ill-chosen, as nearly any vernacular interpretation was bound to be completely off the mark of what was intended by Patterson and the advisory committee. By training and professional history Patterson was a professor of government and education and an academic administrator, thus his discussion of the School of Language Studies (Patterson & Longsworth, 1966, Chapter 6), while reflecting his nose for interesting ideas, is impressionistic and not deeply knowledgeable, even allowing for the year in which it was written. Nevertheless, he makes it clear that the fourth school was to be devoted to the study of the foundations of language in the broadest sense and that it was to be on equal footing with the other four Schools. In a brief chapter he sketches links among formal logic and semantics, ordinary-language philosophy, programming languages, linguistics, sociolinguistics, psycholinguistics, epistemology, philosophy of science, language and literature, and the role of technology in the dissemination and transfer of information.

Patterson's initial ideas about the School were probably influenced by two Harvard professors who were participants in a June 1966 "Academic Conference" concerning the college (Patterson & Longsworth, 1966, pp. 362–363): Jerome S. Bruner, a founding figure in modern cognitive psychology, and Morton G. White, a philosopher in the tradition of pragmatism, close colleague of W. V. O. Quine, and author of a history of 20th Century philosophy, *The Age of Analysis* (White, 1955), among other works of intellectual history. The clearest influence, however was a paper by Roger Holmes (later published as Holmes, 1969), a professor of philosophy at Mount Holyoke College and a member of the 4-College Advisory Committee. The most important source discernable in Holmes's paper (the published version of which lacks a reference list) is the work of Charles W. Morris, who sought to unify Charles Sanders Peirce's pragmatist semiotics, George Herbert Mead's symbolic interactionism, and Vienna Circle logical positivism. The broad vision of symbol systems as constitutive of humanity seems to come straight from Mead's idea that mind and self are constructed through social communication. A more specific notion of the foundational value of the logical analysis of language seems to come from logical positivism (later logical empiricism), as both Rudolf Carnap and Carl Hempel are cited.

Holmes makes the case that language and, more generally, symbol systems are at the heart of human life. The study *of* language might be expected to pay rich dividends in shaping students' attempts to *use* it to advance knowledge and influence others. In his proposal for a *School of Language* Holmes at one point captures this sentiment by noting that a more precise name would be the *School of Metalanguage* (though he rejects it on the grounds that the term is uncommon). A serious exposure to the formal structure of languages (syntax), to theories of meaning and truth (semantics and logic), to the force of language in the world (pragmatics), and to extended theories of discourse and narrative could equip students to reflect on the function of language, or symbol systems more generally, in their studies of other fields. Indeed, the success of a liberal arts education might be measured by the student's ability to step back and clarify the meanings of terms, to examine the logical structure of arguments, to understand or shape the rhetorical or affective force of a work, to strive to expand the expressive capacity of a vocabulary or style, or to understand the influence of technologies on communication.

In its specifics, however, Holmes's proposal was unworkable. Morris's semiotics program was idiosyncratic even in the 1930s, and, by the time that Holmes proposed the School of Language, logical empiricism was essentially dead, at the hands of critics such as Quine, Putnam, Popper, Kuhn, and ordinary language philosophers from the later Wittgenstein to J. L. Austin. Although Holmes mentions the potential importance of computer languages, his paper is silent on the Chomskyan revolution in linguistics, cognitive psychology, and artificial intelligence. It is possible that Holmes just hadn't followed these developments, though it is also clear from the paper that he did not wish the School to be a center of technical or quasi-graduate study but rather a source of continuing general education for all students. Patterson, and the other founding consultants and first School deans, had the latter hope for the other schools, as well, but that never came to pass. Quite the opposite, Hampshire came to be characterized by its own faculty as a kind of graduate school for undergraduates, where students were encouraged to discover and cultivate specific interests from the moment of their arrival.

During the period of roughly late-1966 through 1968, as Patterson hired Deans for the Schools and began to recruit faculty, he decided, after a process that has never been fully documented, not to open the college with a School of Language Studies. There was apparently doubt, perhaps even pushback, among some of his advisors about the departure from tradition, and it must have been unclear how to go about hiring a dean for the School. The decision was to hire faculty to be members of a *Program* that would continue to experiment with and develop the idea of a *School*. Possibly to preserve his own interest in technology and mass communication, Patterson named the program *Language and Communication (L&C)* rather than *Language Studies*. The Program in L&C was announced in the Fall 1970 course guide, but the first official course offerings were in Spring 1971.

Coincident with this decision, two young mathematical logicians, William Marsh and John J. (Jack) LeTourneau, having read and talked about *The Making of a College,* wrote to Patterson applying for faculty positions in the proposed School of Language Studies and outlining their qualifications for and ideas about it. Their letter was a stroke of luck for Patterson. With no recruiting effort he had two candidates who were looking to move on from social-justice oriented 3-year posts at HCBUs (Talladega for Marsh, and Fisk for LeTourneau), who knew the math and would carry that authority into program planning, and who had the broad knowledge of contemporary developments in linguistics, computer science, philosophy, and psychology to help recruit more faculty. Also, as recent Ph.D.s neither Marsh nor LeTourneau would expect to be named the dean of a school. They were appointed as assistant professors of mathematics in the then School of Natural Science and Mathematics and as the first faculty members of the Program in Language and Communication.

Although Patterson resigned from the presidency in Spring 1971, the Program's early faculty continued to develop the idea that L&C did indeed represent a "mode of inquiry" that could stand as an equal to the humanities and the natural and social sciences. In spring 1972 they presented a report to the full faculty proposing that the Program in L&C become a School (Members of the Program in Language and Communication, 1972). There was significant debate and opposition in the faculty, but the proposal was approved with the proviso that it be evaluated after ten years.[6] The debate partly represented an important, potentially unresolvable, dialogue concerning the best way to carve up the intellectual world, which resists division at its ever-changing cutting edges. It also reflected conventional faculty politics—if L&C became a School, it would have its own budget, administrator, and power to make appointments, thus competing for resources with the other Schools. As a School, L&C became free to compete for faculty positions and to chart its own course. It was also allowed to hire an administrative assistant, and Bill Marsh astutely recruited Ruth Hammen, who had been Patterson's secretary but had been cast adrift when he resigned and was replaced by Longsworth, who brought in his own secretary, Dorothy (Dot) Anderson.

Early faculty[7]

In the beginning Hampshire was a new, basically unknown, college with a radical mission that could only reach potential applicants for faculty positions through brief print advertisements (which sometimes were not placed in potentially relevant disciplinary publications) and word of mouth among those interested in higher education reform, circa 1965-70. The appeal of the L&C idea is suggested by the strong intellectual credentials of the early faculty group that proposed the School. Marsh had a Ph.D. in mathematics from Dartmouth and had studied as an undergraduate and graduate student with the great mathematician and educator John Kemeny, who later became president of Dartmouth. LeTourneau had a joint Ph.D. in mathematics and in the Logic and Methodology of Science program at Berkeley. He had studied under its founders, Alfred Tarski and Leon Henkin, two giants of 20th Century logic. James Koplin, hired in 1970, received his Ph.D. at the University of Minnesota under James Jenkins, a founder of modern psycholinguistics and an early proponent of J. J. Gibson's theory of perception.[8] Robert Rardin, hired in 1970, came straight from MIT's Department of Linguistics & Philosophy, having studied with Noam Chomsky. Hired in 1971 for the second year of the college's operation, Christopher Witherspoon came from the Berkeley philosophy department, having studied with H. P. Grice and John Searle.[9] To indulge in a bit more detail in my own case, I came in 1971 from the Stanford psychology department, having studied within the department under Herbert Clark, Gordon Bower, Richard Atkinson, and Roger Shepard, and outside the department with John McCarthy (Computer Science), Patrick Suppes (Philosophy), Zenon Pylyshyn (a one-year visitor from the University of Western Ontario), and Michael Arbib (Engineering).

This early group was diverse in particular intellectual backgrounds and personality yet also united in its commitment to reforming undergraduate education and in its excitement about the convergence of multiple traditional disciplines in forging a new approach to understanding mind, meaning, and communication. Everyone was a 60s radical of one stripe or another, and everyone had been at least a little bit crazy to take a job at a new college that might fail at any moment. I am writing this as the one who was boring enough to still be around 50 years after Marsh and LeTourneau wrote their letter to Patterson.

The early intellectual mission of the School of Language & Communication

The history of L&C is complicated by the failure of one of its key proposals, which was to establish a cross-school program in mass media and public communication that would involve faculty from other schools. The proposal reflected a recognition that the sociology and political economy of mass communication, as well as the set of skills involved in media production, could not be fully incorporated into a School that was focused on what we now call cognitive science. After the School was approved it became clear within a year that the other Schools were not going to hire mass communication scholars or mass media production practitioners, forcing L&C to try to carry the program internally. The resulting duality became a lasting source of stress in the School and was one cause of events that nearly led to the School being terminated in the late 1990s. For the moment, however, discussion of the "communication" part of the early school will be postponed in order to focus on the "language" part.

Due to its origins in *The Making of a College* and its subsequent trajectory, L&C had to be the name of the new School. Although the initial faculty realized that L&C was something of a misnomer that would lead to confusion, it also knew that renaming the enterprise while trying to transition to School-hood was a political non-starter. So, L&C it was.

From the standpoint of intellectual history the focus on language is understandable. Although the idea that thought can be understood as symbolic computation goes back at least to Leibniz and Hobbes, even arguably to the medieval logicians and Aristotle, the period from the late 19th-early 20th Century, with Boole, Frege, and Russell, to about 1980 can be seen as a time when this idea took hold and led to an intellectual revolution that reached a peak around the time the School was founded. It seemed completely plausible that minds were entities that computed over structured symbolic expressions (and brains or other intelligent machines were physical implementations of symbolic representations and processes). Thought could be conceptualized as in the same general class as deductive systems in formal logic, with the expressions encoded in a "language of thought." Chomsky had demonstrated that the syntaxes of natural languages could be described as infinitely-productive formal systems (Chomsky, 1957, 1964), which required representational and computational capacities that ruled out behaviorist theories of language (Chomsky, 1959). Further, he argued that syntactic theory had to be shaped by the explanatory requirement that languages be learnable by children on the basis of environmental input, opening up an avenue of developmental research driven by a deep and detailed theory. Some researchers proposed that each reading of a sentence in a natural language was associated with an underlying logical form and that such forms would have the properties of a formal language and thus constitute a language of thought. Psycholinguistics, a fertile collaboration of linguists and psychologists, triggered an avalanche of new research on language understanding and development, and it became a model for interdisciplinary research on the nature of mind. The emphasis on symbolic structure set off further waves of new work on concepts, semantic memory, reasoning, problem solving, discourse structure, literary style, and other topics that had a language-like flavor.

Research in early artificial intelligence demonstrated that computer programs manipulating symbolic expressions could reason and solve problems. Work by Terry Winograd at MIT was showing what seemed to be striking progress toward a general system for natural-language understanding (Winograd, 1972). Turing's and Church's conception of computable functions, Turing's (mathematical) construction of a digital universal machine, and Turing's paper on computing machinery and intelligence (Turing, 1950) lent foundational support to the notion of a computational, indeed symbolic, conception of entities with minds. Turing's proof of the unsolvability of the halting problem and Gödel's incompleteness theorem raised deep issues of possible limitations on minds and a tantalizing debate about whether humans could overcome those limits.

In conceptualizing L&C as a liberal arts field the planners and early faculty put a great deal of emphasis on questions of how linguistic mental symbols, or symbolic expressions, can have meaning, can be true or false, can represent knowledge, and can reliably communicate semantic content. In their view these questions were an integral part of why L&C was foundational to intellectual life and a necessary part of every undergraduate student's education. The approach to meaning, truth, knowledge, and communication was broad, embracing formal semantics, ordinary-language philosophy, epistemology and philosophy of science, sociolinguistics, the sociology of interpersonal communication, psychological studies of concept acquisition and word learning, knowledge representations in AI systems, and the sociology of mass communication.

Looking back nationally, the late 60s and early 70s were a moment of unity and intense cross-disciplinary discussion and collaboration that reflected the small size of the early cognitive science community and, in comparison to today, a fairly compact set of ideas and research across disciplines that an individual could become familiar with and that would contribute to that person's intellectual work. The early faculty members of L&C were younger members of that community who also happened to be interested in undergraduate education.

As a Stanford graduate student applying for a job at Hampshire, I was first interviewed by Bill Marsh, who had been given a sabbatical at Berkeley for the spring term of the first year of Hampshire's operation, 1970-71, to work further on the L&C idea. We immediately struck up a conversation about Chomsky's linguistic theory, the derivational theory of complexity in psycholinguistics, the significance of Gödel's incompleteness theorem, whether formal logic could be a basis for AI, and so on. After being hired I met Chris Witherspoon, a philosophy graduate student at Berkeley who had also just been hired for L&C. In addition to our shared love of jazz we had plenty to talk about. We were both familiar with Chomsky's nativism and Jerry Fodor's early work on the foundations of cognitive science, and I had become acquainted with the ideas of one of Chris's mentors, H. P. Grice. These kinds of easy interdisciplinary conversations would have been nearly inconceivable in earlier generations, and they may be rarer today, with the sheer proliferation of work across the cognitive sciences and the resulting re-specialization.

<u>Early curriculum and the realities of School-hood</u>

For the first two or three years of its existence L&C presented an integrative lecture series taught by the entire faculty and supported by various discussion sections and mini-courses that could be selected by students.[10] The lecture series supported the Division I examination in L&C, which was required of all students (along with those in H&A, NS&M, and SS). In 1970-71 this meant completing a personalized examination on questions that the student and faculty accumulated in a file during the year. By 1971-72 (when I arrived) the faculty had switched to requiring students to propose and complete an independent study project in each School for Division I examination. Within L&C the switch to independent study projects meant that students could immediately pick a single topic and avoid at the examination level having to engage with the broad set of issues that defined the School. L&C quickly abandoned the umbrella lecture series co-taught by the faculty in favor of more conventional elective courses, although co-taught courses continued to be common in the School for many years.

Over its first ten years L&C was shaped by institutional pressures that had significant effects on its mission. Although L&C was one of four Schools, the president delegated faculty hiring to the School deans and dean of the faculty, and it rapidly became apparent that the School lacked the political power to secure a quarter of the new positions that were being created to fill out the faculty. The School never came close to the 20 full-time faculty members requested in the original School proposal. The School's curricular and hiring decisions were always shaped by powerful institutional limits on the size of its faculty, by changes in the disciplines it served, and by its need to attract students, who came to Hampshire with interests and tastes that were not arbitrarily malleable, and who were not compelled to take particular courses as part of a standard college major. By 2018, CS, and, I believe, the entire college, was poorer for no longer having a logician, a philosopher of language, a sociolinguist/cognitive anthropologist, or a second or third linguist,[11] which, of course, is not to devalue areas that were added after the 1970s, such as animal behavior, statistics, or media arts & sciences, but to note that they might have been added without the brutal trade-offs and sacrifices that were involved.

The transition from "Language" to "Cognitive Science"

Although the size and composition of the School's faculty was strongly influenced by the institutional pressures sketched above, the intellectual mission also evolved from within and in response to developments in a growing international research community. From the late 1960s though the mid-1980s the cognitive revolution advanced rapidly. The term "cognitive science" was coined in the mid 1970s. The Cognitive Science Society was founded in 1979, and the proceedings of the first meeting were published in a book that announced the concept of a new field (Norman, 1981). The term "cognitive science" clearly fit the interests of the School's faculty and its curriculum better than "language." After waiting a couple of years to make sure the term was taking hold the School changed its name to *Communications and Cognitive Science (CCS)* in 1983-84.[12]

That year faculty members in the School, who never taught from textbooks, decided collectively to try to write a textbook on cognitive science. We proposed to divide the book between chapters on how traditional disciplines contributed to cognitive science and integrative chapters on particular topics, such as language acquisition and vision. In addition to the present writer the authors were Lynne Baker-Ward (cognitive development), Mark Feinstein (linguistics), Jay Garfield (philosophy), David Rosenbaum (psychology), and Steve Weisler (linguistics). At the time L&C lacked a faculty member in artificial intelligence, but we were able to convince Edwina Rissland of the UMass computer science department to write the chapters on AI. I took on overall editorial responsibility for the project and wrote a proposal to the MIT Press. It was our extraordinary good fortune that the proposal went to Betty Stanton, who with her husband Harry, had started the Bradford Books imprint at MIT. They wanted a cognitive science textbook, and Betty was adventurous enough and free enough of the usual academic prejudices to accept a proposal from a bunch of little-known authors from a new college.

Three years later the book finally came out (Stillings et al., 1987). It is hard to think back to a time when manuscript drafts were reviewed (in this case by multiple reviewers from different disciplines) and edited (including by a meticulous professional copy editor) in hard copy that was sent by US mail, when figures were drawn in pen and ink, when there were no pdf files, and when authors might be using computers with incompatible word processors and different storage media. Although it only earned some nice pocket change for the seven authors, the book sold very well for a university press book, was translated into Japanese and Greek, and went into a second edition. The feedback that I got on the book indicated that it was widely read by graduate students and faculty members who were trying to figure out what cognitive science was.

The early-to-mid 1980s were a watershed for both the School and for the field of cognitive science. The founders of the School had placed a large bet on an interdisciplinary approach to the study of mind, and the bet had paid off in the acceleration and ascendance of the cognitive revolution over the following decade. The School's faculty had substantial experience with teaching cognitive science at the introductory level, and it now had a national audience for its ideas. During this period, as the book neared publication, I applied to and received funding from the Alfred P. Sloan Foundation for the School to hold a national workshop for teachers of undergraduate cognitive science in the summer of 1986.[13]

Evolution of the School's intellectual mission

At the time of the first edition of our book (Stillings et al., 1987) the School's early formal-systems oriented mission had matured into a more comprehensive view of a cognitively-oriented study of mind. The change reflected both the School's internal development and the progression of the cognitive revolution in the outside world. Still, a representational theory of mind that featured structured, compositional representations with potentially crisp semantics was at a peak of influence and was very much reflected in our curriculum and book. An irony is that at the moment the book was published the connectionist movement in psychology, which challenged the symbolic conception of cognitive science, had just burst onto the scene. The following twenty years would see the rise of cognitive neuroscience, the hiatus of symbolic AI and its replacement by artificial neural networks and deep learning, the rise of evolutionary psychology, and other developments. In the following sections I discuss the intellectual trajectory over time of some of the topics and issues that were important to the School and to the field.

Perception

An early issue was that the relationship between minds and worlds was mediated by sensory perception as well as by language. It was not clear, for example, how the heavily linguistic conception of the school dealt with vision. I came to Hampshire puzzled about how to reconcile Hubel & Wiesel's work on simple and complex cortical cells, which seemed to promise the possibility of a symbolic conception of vision, with the work of Stanford professor Roger Shepard, who seemed to see vision as a kind of analog simulation of the physical world. Jim Koplin, the other psychologist in the School, was an adherent of the Gibsonian school of perception, in the mold of his graduate advisor at Minnesota, James Jenkins. Although Gibson had formulated his main ideas before and independently of the cognitive revolution, he continued to insist that perception was "direct," rejecting the notion that the product of the visual system was any kind of intermediate representation of the physical world. I have fond memories of friendly but persistent arguments with Koplin about perception, in class in front of students. I wanted a computational theory of vision, but he would find reasons to reject any idea I proposed or borrowed from the nascent field of computer vision. We worried about whether our debates were a bad thing for the classroom but had a hard time stopping. Later, some students told me that they had learned a lot from listening to us, but others were probably confused and disappointed. Koplin's first Division III student, Bill Warren (who was not in the classes where Jim and I argued), went on to do graduate work with the Gibsonians Bob Shaw and Michael Turvey at the University of Connecticut and after a distinguished research career became the chair of cognitive science at Brown.

Koplin left Hampshire in the mid-1970s, and with nods to Gibson I continued to teach vision as a computational system, drawing on the expanding literature, and emphasizing that much of visual computation did seem to involve structured representations, which were likely not quasi-linguistic expressions. During that period we were influenced by Allen Hanson, the first computer scientist to join L&C and an outstanding researcher in computer vision (Hanson & Riseman, 1978).[14] David Marr's book *Vision* (David Marr, 1982) laid out a comprehensive and coherent computational theory of vision that was consistent with the original conception of L&C and that also expanded it. My chapter on vision in Stillings et al. (1987, chapter 12) was heavily influenced by Marr and gives a good picture of how we thought about and taught perception in the School at that time.

In my own teaching of vision over the next 30 years, which was unfortunately confined to introductory cognitive science courses, I continually revised a computational presentation of object recognition and occasionally used color vision as a second example. At the time of the second, and last, edition of our book (Stillings et al., 1995) I presented a connectionist recognition-by-parts model of object recognition (Hummel & Biederman, 1992; Marr & Nishihara, 1978) that illustrated a solution to the binding problem in networks. And I found a kindred soul on color vision in Steve Palmer's magisterial book on vision (Palmer, 1999), which presents the study of color vision as a model for what we hope to accomplish with the computational approach to vision.[15] The componential approach to object recognition has faded in recent years in the light of behavioral and neural evidence and advances in modeling (DiCarlo et al., 2012; Riesenhuber & Poggio, 2000), and I presented view-based approaches in my later courses.

Beginning in the 1990s research in biological vision became dissociated from research in computer vision. Researchers in the two fields were often located in different departments, faced different incentives, and developed increasingly different methodologies. Visual neuroscience researchers built models that were strongly constrained by data from behavioral studies, neuroanatomy, single-unit recording, and brain imaging, and by a desire to understand how visual systems solve ecologically-valid problems. Computer vision researchers abandoned the study of general vision, ala Marr, in favor of solving specific engineering problems. For example, one could try to develop autonomous vehicles by first developing a robust simulation of the human visual system and its motor interface and then putting it behind the wheel. Instead, in autonomous vehicles circa 2019 input to visible-light-sensitive sensors is integrated with multi-directional lidar range-finding data and real-time sub-meter GPS data referencing high-resolution pre-computed maps of the terrain, creating a "visual" system that bears little resemblance biological vision, which relies more heavily on input from two visible-light sensors. On the other hand, machine vision began to solve ecologically-valid problems that have apparently not been solved by biological evolution, such as using shadow data to see around corners (Wolchover, n.d.). Ideally, an undergraduate cognitive science program would have courses in vision that compared, contrasted, and integrated biological and AI approaches. Circa 2020 such a course probably did not exist on the national undergraduate scene. CS at Hampshire would have been a perfect place to develop such a course.

The brain

A second early issue concerned the role of studies of the brain, or neuroscience, in L&C. Clearly, the claim that minds, both biological and potentially artificial, could be understood as symbolic, information-processing, or computational systems meant that the School was not simply a neuroscience department, yet neuroscientists clearly had the ambition to ultimately explain the higher-level functional success of nervous systems, and there were concerns about the mind-brain identity theory, which preceded the coalescence of the cognitive revolution (Place, 1956; Smart, 1959). The early faculty, I think, shared with the broader nascent cognitive science community the belief that they were pursuing an approach that would not be eliminated by or reduced to straight neuroscience. The analogy with the hardware-software distinction for computers seemed persuasive. The program, or algorithm, that a computer is running (coupled with some semantic interpretation, or functional description, of its relation to or action in a world) provides an explanation of its information-processing function.[16] It captures the relevant generalizations, to use a phrase of Chomsky's. A description of the computer's electrical circuits in terms of transistors, current paths, electromagnetic field theory, and so on, is completely uninformative about this function, though critical to explaining how the function can be physically implemented. A neuroscience that stayed at this level of analysis would be similarly uninformative about the brain. Thoughtful early cognitive scientists in the 1960s, such as Allen Newell and Chomsky, were clear about this idea of explanatory levels of analysis. I remember spending a great deal of time in 1969-70 discussing it with fellow graduate students and with Zenon Pylyshyn, who was visiting Stanford at the time. Marr (1977) published a paper on levels of analysis that received widespread notice in the growing cognitive science community. Following the School's pedagogical approach at the time, my chapter 1 of Stillings et al. (1987)

attempted to lay out the three levels of analysis (the formal level, the representational or knowledge level, and the implementational level) in five pages in a way that an undergraduate might understand.

As implied above, cognitive science includes a claim that information processing systems must be physically realized, and therefore it is a version of physicalism, requiring, to the degree made possible by human ingenuity, that a computational science of the mind eventually be integrated with neuroscience. At Hampshire from the beginning we thought, first, that understanding the neural implementation of cognition was bound to be interesting, and, second, that neuroscience was a potential source of insight into, and possibly even constraints on, computational realizations of cognitive processes. In the early 1970s, however, there was not a great deal of either empirical or well-developed theoretical neuroscience to talk about in cognitive science courses. On the theoretical side we talked, for example, about single unit vs. population coding, cell assemblies, or lateral inhibition, and we also sometimes talked about how the most recent general model of high-level neural computation, Rosenblatt's perceptron theory, had been demolished in a book by Minsky and Papert (1969).[17] On the empirical side we talked, for example, about single-cell recording from visual cortex, clinical neuropsychology, or split-brain studies. David Rosenbaum's Chapter 7 and my Chapter 12 of Stillings et al. (1987) gives the flavor of how we taught neuroscience through the early 1980s.

The interplay between neuroscience and cognitive science increased rapidly after the early 1980s. The revival of artificial neural network, or connectionist, models began in the early 80s (Feldman & Ballard, 1982; Hinton & Anderson, 1981; McClelland & Rumelhart, 1981) and exploded with the publication of the backpropagation algorithm, including the proof that networks with non-linear activation functions on the units could overcome the limits on perceptrons discovered by Minsky and Papert, and demonstrations of connectionist learning models that had interesting properties (Rumelhart et al., 1986; Rumelhart & McClelland, 1986, 1987). Although the publication of the first edition of our book was coincident with the rise of connectionism, the manuscript was complete before the explosion. In my chapter 12 on vision I sketched some early, pre-1986 connectionist ideas. In chapters 3 and 12 of the second edition (Stillings et al., 1995) I introduced connectionism and some of the challenges it faced in bridging from simple models of brain-style computation to successful visual or cognitive capacities. I think it is still worth reading this discussion as a way of realizing how early the challenges were recognized and the degree to which they were still unresolved in 2020. Two students who studied with me during this early period of ferment went in opposite directions as they developed their careers. Sean Hill (87F) embraced a computational neuroscience based on detailed brain simulation (Reimann et al., 2013). Gary Marcus (86F), among other things, became a prominent critic of standard connectionist models (Marcus, 1998).

In 1989 the School was able to respond to the growing influence of neuroscience and neural-network models by hiring Chris Chase, who had worked on connectionist models of reading, was interested in teaching neuropsychology, and was familiar with event-related potential (ERP) methodology. He secured funding for and established Hampshire's ERP lab, possibly the first in the U.S. for a small college. In the following years, of course, fMRI took the world by storm, although the underlying promise had been established several years earlier with PET scanning (Posner et al., 1988 is perhaps the key seminal paper). The Journal of Cognitive Neuroscience was established in 1989, and the Cognitive Neuroscience Society (CNS) was founded in 1993. Since the mid-1990s cognitive neuroscience has become increasingly central to and influential in cognitive science by nearly any metric, including the volume of publication, funding, the reputations of departments and individual researchers, and coverage in popular media. I should note here that in a second quirk of fate, just as the first edition of our textbook missed the rise of connectionism by a couple of years, the second edition (Stillings et al., 1995), although it added connectionism, missed the rise of cognitive neuroscience.

After the departure of Chris Chase in 1997 the School was able to continue its commitment to cognitive neuroscience, first by hiring Joanna Morris, who brought strengths in psycholinguistics and cognitive neuroscience and who re-started the ERP lab, and second by hiring Jane Couperus, whose work was in developmental cognitive neuroscience and who also joined the ERP lab. Both of these appointments involved a combination of good fortune and persistent advocacy by the School, converting Morris from a visiting to a permanent position, and Couperus from a time-limited grant-funded position to permanent. In an additional quirk of fate the successful candidate for a statistics position at Hampshire was Ethan Meyers, whose research involved the analysis of high-dimensional neural data. At the end of 2018, just prior to its demise, the School had a remarkably strong faculty in cognitive and computational neuroscience.

Animal cognition and evolution

The study of animal cognition and its evolution was not high on the School's founding agenda. L&C was strongly oriented toward the study of the human mind, particularly toward capacities that were thought to be distinctively human, language being the chief example. The tendency in the early faculty, and in early cognitive science in general, to think of intelligence as a computational abstraction that could be attacked via strictly logical analysis probably also contributed to a lack of attention to evolution. Nevertheless, although the literature in the field of animal cognition as we now know it was in its infancy, early work in ethology always received some attention in the curriculum, particularly von Frisch's work on the "dance language" of the honey bee (1967), a great favorite of students, some of whom performed the dance in costume. Research on the biology and evolution of language was in a somewhat vexed state in the early years. Chomsky was decidedly skeptical about the possibility of a gradualist Darwinian account of the origins of language (Chomsky, 1968), and his doubts were underscored by critiques of claims that chimpanzees could learn sign languages (Terrace et al., 1979). On the other hand Chomsky had reconceptualized linguistics as the study of a biopsychological capacity, and his collaborator Eric Lenneberg had developed a framework for looking at the biological foundations of language from the perspective of generative grammar (Lenneberg, 1967). Researchers who worked on speech articulation and perception were also sympathetic to ethologically-oriented approaches to the evolution of language (Lieberman, 1973; Mattingly, 1972). Of course, because of the long-standing importance of research on animals, the evolution of sensory systems, particularly vision (Hubel & Wiesel, 1968; Ratliff, 1965; Walls, 1942), was always a part of the curriculum. These threads of scholarship had a rather fitful presence in the School's curriculum for its first 10 years or so.

Mark Feinstein brought a systematic curriculum in animal behavior and evolution to the School. Feinstein was hired in 1976 as a linguist who had expertise in sociolinguistics, and his early course offerings were a mix of linguistics and sociolinguistics. As a result of his own and students' interests, however, he was teaching a course in animal communication by Spring 1980. The beginning of the course description for *LC 109: Animal Communication* perfectly captures this point of transition in the School's curriculum:

> The claim that language is the exclusive property of the human species has lately come under fire. Researchers have analyzed the dances of bees, calls and songs of birds, chimp vocalizations, wolf postures, and dolphin clicks. … Whether they are anything like "language" in the human sense remains an open and exciting question.

As Feinstein developed the curriculum in animal cognition and behavior he began to collaborate with Ray Coppinger, a founding faculty member and biologist in the School of Natural Science who also taught courses in animal behavior and evolution. By the fall of 1994 this collaboration had grown to the point where Coppinger decided to switch his School affiliation to CCS. Upon Coppinger's retirement a symposium was held in his honor, and the Ray and Lorna Coppinger endowment, which supported student research, was established. His position was filled in 2006 by Sarah Partan, who became the first faculty member hired at Hampshire in a search focused specifically on animal behavior. As of 2018 animal cognition was a stable component of the CS curriculum with a strong student following. I think it is fair to say that the School incorporated this material into its curriculum much earlier than other undergraduate programs and that our treatment of it was at the cutting edge for such programs.

Although the animal cognition curriculum was in part one of many circumstantial developments at Hampshire,[18] it was also a fortunate one for the School's intellectual mission. In retrospect it is obvious that intelligent behavior is ubiquitous among animals and that a program for the study of mind should include comparative cognition, if only to glean insights from understanding the variety of biological intelligence. Further, animal intelligence is a product of evolution. It is important to understand particular cases of the evolution of intelligent behavior and to develop general theoretical accounts of possible evolutionary pathways that might drive the emergence of information-processing capacities. Evolution by natural (or perhaps artificial) selection is the most successful known mechanism for producing intelligent systems, making it crucial to understand its dynamics. In yet another happy accident for the School's curriculum, Lee Spector, who was hired for a position in artificial intelligence, moved his main interests from traditional symbolic AI to evolutionary computation, making the School a premier undergraduate program in the theory of evolution. Spector co-taught and conducted joint research with Feinstein and Coppinger in the 2000s and 2010s.

Given the School's historical emphasis on human cognition, it is somewhat paradoxical that very little curricular space has been given to the field of human evolutionary psychology, which has grown explosively since around 1990. Although much of the field focuses on human social behavior, leading figures in the field use an explicitly computational framework (Cosmides & Tooby, 2013; Pinker, 1997). The neglect seems to stem from a combination of lack of faculty interest and a fairly widespread student distaste that arises from work in evolutionary psychology on evolved human sex differences, which does not play well in a student culture saturated with the embrace of arguments that human sexual behavior is entirely socially constructed and that biological sex itself is a continuum.

Emotion and motivation

For many years the School reflected the general orientation of cognitive science toward an understanding of the rational mind, that is, people's evident success in employing their beliefs/knowledge to satisfy their goals and employing language to encode and transmit beliefs and perform socially-coordinated actions ("speech acts"). The insufficiency of behaviorism in either the Skinnerian or Hullian formulation to handle even simple cases of human planning, reasoning, and problem solving or to account for the representational flexibility and learnability of language posed a rich set of research problems for the field, addressed, for example, by Chomsky's early work or Newell and Simon's work on human problem solving (1972). Limits to ideal rationality were considered, but either in purely formal terms, e.g. Gödel's incompleteness theorem or Rice's theorem (Hopcroft, John E. & Ullman, Jeffrey D., 1979), in heuristic terms, e.g. seminally in Simon's (1956) concept of satisficing, or the heuristics-and-biases framework of Tversky and Kahneman (1974). The question of whether human cognition is rational or optimal under some abstractly computational conception of constraints or costs continues to be an important issue in cognitive science (Anderson, 1990; Chater et al., 2006; Gigerenzer, 2008), but considerations of evolved motivational/affective systems that lead to systematic departures from normative rationality have also become increasingly important.

Although the School reflected the general orientation of cognitive science toward the rational mind in its early years, topics in motivation and affect did surface unsystematically in parts of the curriculum. For example, in the 1970s in working to find a fit between Chomsky's universalist psychobiological position on language and issues in sociolinguistics and interpersonal communication, some of us were struck by Paul Ekman and colleagues' revival of Darwin's notion of an evolutionary basis for the emotions and their facial expression in primates (Ekman et al., 1969). We invited Ekman to campus to give a talk and appear in a class. In another example, I often used Zajonc's (1968) claim that affect precedes cognition, which was couched in information-processing terms, as a critical foil in my courses. After a number of years I finally had a student, George Bonanno, who had the imagination and perseverance to translate discussions of Zajonc into a publishable experimental study (Bonanno & Stillings, 1986). Bonanno went on to a distinguished career in clinical psychology and personality theory (Bonanno et al., 2011). Although this is not the place to review the sometimes long-standing strands of theory and research that came together, motivation and affect began to be seriously integrated into cognitive science around the 1990s. I was initially affected by Ziva Kunda's (1990) influential paper on motivated reasoning and by Leda Cosmides's (1989) theory of the evolutionary basis of performance variability on the Wason selection task. In my treatment of the Wason task in the second edition of our textbook (Stillings et al., 1995) I stuck with Holyoak and Cheng's (1985) theory of pragmatic reasoning schemas, an innovative twist on traditional heuristic approaches, but I recognized that Cosmides and her collaborator John Tooby were making a compelling case for considering the importance of evolution in shaping human cognition (Tooby & Cosmides, 1992). Cognitive neuroscience probably played an important role in moving cognitive science into the affective realm, as neuroimaging studies demonstrated the involvement of cortical areas in emotional processing and provided evidence for complex circuits linking cortical and subcortical areas. Motives and emotions appear to be more than just simple multipliers or activators of "higher" cognitive processes.

The School was lucky to be able to respond to the growing influence of studies of affect and the gradual erasure of the traditional sharp distinction between affect and cognition by hiring Laura Sizer in 2001 to fill a position in the philosophy of mind. It just happened that she had done her dissertation on a computational theory of moods (Sizer, 2000), and at Hampshire she developed courses on the emotions, on happiness specifically, and even on love, sex, and death, along with other topics in philosophy of mind and language. Although analytic philosophy has been a central part of the School's program since its inception, Sizer was the first philosopher in the School to thoroughly integrate philosophy with empirical research in cognitive science.

Sizer's work was supplemented by the inclusion of new research on affective and motivational topics in courses taught by other faculty members. In my own case I was able to add material on music and the emotions to my courses on music cognition as contemporary research accumulated (Bharucha et al., 2006; Huron, 2006; Juslin & Västfjäll, 2008). Megan Curtis in the previous citation studied with Joanna Morris and me at Hampshire before going on to graduate work with Jamshed Bharucha and then to a faculty position at SUNY Purchase. As noted above I included work in evolutionary psychology and the psychology of morality in some of my courses. Finally, in the fall of 2012, coinciding with a presidential election year (Obama's 2nd term), I taught a first-year seminar on political psychology that covered empirical and theoretical research on irrational polarization and tribalism in the electorate.

<u>Core CS disciplines over time</u>

Artificial intelligence

Artificial intelligence and the theory of computation were central to the explicitly computational conception of language and mind that was the basis of School's founding curriculum. With two mathematical logicians, Marsh and LeTourneau, on the founding faculty there was a strong emphasis on the theory of computation and on its connections with model-theoretic logic (metamathematics) and with formalizations of the syntax (Chomsky, 1956, 1957) and semantics of natural languages. Marsh and LeTourneau did a great deal of work making this material accessible to beginning students, and both were gifted at distilling the essence formal proofs into lines of argument that were accessible but avoided hand waving. Marsh's 50-minute lecture on Gödel's incompleteness theorem, which used Turing machines to avoid introducing the apparatus of Gödel numbering, was a notable example for me. Marsh developed a full beginning-to-intermediate level course, called *Strings, Trees, & Languages,* which used the tree and rules for combining trees as its basic concepts, facilitating a visual, diagrammatic, development of the material. When Emmon Bach joined our faculty half time in a joint appointment with linguistics at UMass for a couple of years before moving full time to UMass,[19] he and Marsh worked on simplifying the Peters-Ritchie theorem (Peters & Ritchie, 1973), the first detailed attempt to formalize the computation-theoretic properties of transformational grammars. Their work was eventually published as Bach and Marsh (1987).

With no one on the founding faculty trained in the research,[20] AI was approached conceptually in the early curriculum, exploring the philosophical issues raised by AI, starting with Turing (1950) and extending to Weizenbaum's ELIZA (1966), and probing the promise and implications of then-contemporary research in symbolic AI, e.g. semantic memory (Quillian, 1968), game playing (Greenblatt et al., 1969; Samuel, 1959), logic-based representation (McCarthy & Hayes, 1969), scene description (Guzmán, 1968), natural language understanding (Winograd, 1972), and problem solving (Fikes & Nilsson, 1971). Our approach to this material was intensely interdisciplinary. Although we were aware that AI could be pursued as a pure engineering discipline, we thought of it as integrated with cognitive psychology and linguistics. In this we were part of at least a partial zeitgeist—Newell and Simon (Newell & Simon, 1972) pursued AI and cognitive psychology on the same track; McCarthy (McCarthy & Hayes, 1969) spoke of capturing common sense; Winograd, a student in the MIT AI lab, published his thesis (Winograd, 1972) in the journal *Cognitive Psychology*; Collins and Quillian (1969) gathered experimental data supporting the theory that human long-term memory had a semantic-network structure. We presented our approach in a lecture series taught by the entire School faculty and in a course called *Minds, Brains, & Machines.*

We were lucky to be able to hire an established AI researcher, Allen R. Hanson, in 1974. Hanson was doing well in a tenure-track job at the University of Minnesota, but he decided to move to Hampshire in order to facilitate his collaboration with Edward Riseman of the UMass computer science department. Hanson brought more advanced instruction in AI to the curriculum, as well as support for students who wanted to work on AI projects. Ironically, Hanson was not associated with any of the major symbolic AI centers (MIT, Stanford, & CMU), and he and Riseman took an engineering approach to computer vision that was not rooted in biological vision or necessarily inspired by the goal to achieve human visual capacities.

When Hanson left Hampshire to take a full-time position at UMass in 1980, the School entered a twelve year period during which we did not have a long-term faculty member in AI. One result, already noted, was that we had to recruit Edwina Rissland from UMass to write the AI chapters in our cognitive science textbook. Another result for much of this period was that our teaching of AI reverted to the earlier interdisciplinary and conceptual approach. In addition to *Minds, Brains, and Machines*, I co-taught or taught an introductory course in AI and a course based on Hofstadter's (1979) celebrated book, *Gödel, Escher, Bach. GEB* was a kind of poetic apotheosis of early cognitive science that was a near perfect fit for the founding vision of the School, with its enthusiasm for the liberal arts implications of the field and its interdisciplinary mix of logic, AI, and psychology. I enjoyed teaching elementary Lisp programming and Hofstadter's version of the incompleteness theorem. I got to display the scores and play recordings of some of my favorite music in class and to exercise my amateur knowledge of music theory in explicating musical structures.[21] One of the pleasures of teaching at a small college is the opportunity to learn and to teach beyond the boundaries of one's original training. The School's development rested fundamentally on the broad interdisciplinary appetites of the early faculty. Students at Hampshire across Schools have, I believe, benefited from exposure to the unusual breadth of mind and intellectual curiosity of many faculty members. At the same time faculty members have an obligation to be intellectually humble enough to know what they don't know and to take pains to hire people who can fill large gaps of expertise in the curriculum. As much as I and others enjoyed the somewhat guilty pleasures of teaching AI during this period, we knew we needed a faculty member with training in AI, even though we were being stymied by a very hot job market in computer science.

In 1992 we finally found Lee Spector, an AI researcher who was a great fit for the School and also liked Hampshire. Spector's job talk made effective use of the concept of "supervenience," which had also figured in the talk of a previous successful candidate. It became a running joke in the School that we would hire any candidate who used the word. In my time this theory was never further tested, but it paid off in Spector's case. He restored our ability to offer advanced instruction and research opportunities in AI. He transformed our approach to introductory instruction by developing courses, such as *Cognitive Science Fiction* and *Creative Computing*, that inspired beginning students to try their hand at AI programming. He developed a research program in evolutionary computing, securing grants for his work, becoming a journal editor, and winning awards. Evolutionary computing turned out to be synergistic with the focus on biological evolution in the School's animal-behavior curriculum, leading Spector to co-teach and engage in joint research with Mark Feinstein and Ray Coppinger.

The School was awarded a long-overdue position in computer science in 2000 and was able to recruit Jaime Davila, who brought an AI-research background in natural language processing and artificial neural networks. Having two faculty members, Spector and Davila, with AI research training in complementary fields within a supporting cognitive science curriculum, CS surely had one of the better AI curricula in a college nationally.

Computer Science

As alert as the founders of CS and of the college were in the late 1960s to the potential importance of computing technology, no one could have predicted its future importance to college curricula and infrastructure. Computer science as a discipline was established during the post-world-war-II era in research universities, and small colleges were challenged as it spread into the larger academic world. I suspect that a typical progression at a small college was that, first, a faculty member or two became interested in computing and began teaching programming courses, second, one or more computer science positions were added to the mathematics department, and third, in many institutions computer science ultimately became a separate department (sometimes as a result of friction between pure mathematics and the more practical aspects of the computer revolution, with students often preferring the latter to the former). At Hampshire, although there have always been School of Natural Science faculty members with significant interests in computer applications, the institutional responsibility for computer science fell to CS.

Theory of computation and artificial intelligence were founding themes for CS. They are quintessential liberal arts fields, given their importance to the framework for cognitive science in the critical consideration of the nature and potential of computation. They are also only subdisciplines of computer science, which is at least equally concerned with its practical aspects and applications, such as machine and system architectures, programming paradigms, efficient data structures and algorithms, networks and communication, graphics, the WWW, scientific computing, and so on. These other aspects of computer science have been a part of the CS curriculum since 1970, and their presence in the curriculum has reflected developments in computing technology and student interest. In the college's first year of operation Jack LeTourneau, a pure-math theoretician, shouldered the task of offering a computer programming course, and Larry Wolf, a precocious early student, became involved in computer science instruction and drafted the section on computer and information science in the 1972 proposal for a School of Language & Communication. Computer science instruction was more firmly established with the hiring of Allen Hanson a few years later. Over time CS offered a mix of relatively standard computer science courses and more innovative courses that integrated computer science with other disciplines or that approached computing in a way that draws students who typically avoid the conventional courses. Our ability to do this depended in part on the reliable presence of the full standard curriculum in computer science at the other four colleges in the consortium.

An early idea for innovation in the computer science curriculum was to develop a focus on computer graphics and imaging. The Five-College offerings in the area were nearly non-existent, but we thought that the capacity of computers to synthesize images could attract new students to computer science. For example, in 1985 I put an early graphics card into the homebrew microcomputer in my lab to allow the presentation of visual stimuli on monochrome CRT monitors. I made the lab available to computer science students, and in spring 1986 the late Rob Walkenstein did his Division III project on a general graphics package for visual stimulus generation and presentation. CS's graphics idea was hobbled for over ten years by the lack of a faculty slot, which was finally funded as a visiting position in 1999. During that period computer graphics had advanced at a staggering pace, e.g. moving from static to moving images and from abstract mathematical presentations or simple proof-of-concept demonstrations at academic conferences to the release in 1995 of *Toy Story,* a feature-length fully computer-animated film. In its search for a visiting faculty member CS was fortunate to find Chris Perry, a graduate of the MIT Media Lab (founded in 1985) and an early veteran of animation-industry leaders Rhythm & Hues Studios and Pixar Animation Studios. Combining a strong artistic vision with deep software engineering expertise, Perry built a strikingly successful animation program at Hampshire that produced a steady stream of accomplished graduates and a number of nationally-recognized short films. His contribution to Hampshire was quickly recognized, and the visiting designation of his position was removed.

Over time student interest in animation increasingly intersected with game design and development. Even without a dedicated faculty position Hampshire began to develop a reputation as a place to study game design, and in 2013 CS was granted a full-time position, which led to the appointment of Ira Fay. Fay arrived at Hampshire with extensive industry experience in game development and a strong conceptualization of game design. He quickly established a thriving and innovative program that drew high numbers of students and applicants.

A nostalgic interlude: Given the centrality of physical computing infrastructure to the academic program today, it is hard to conjure up the memory of a college in 1970 that had no computers, unless one counts Dean of Natural Science Everett Hafner's analog Moog synthesizer with its patch-cord connected modules. The early 1970s computer programming courses were taught using hard-copy terminals connected to a time-shared CDC-3600 computer located at UMass. In the mid-to-late 1970s Hampshire acquired its own DEC VAX 11/750 time-shared computer, with hard-copy terminals for academic use located in the library. Allen Hanson started a micro-computer laboratory, located in the library and equipped with an Altair 8800, which allowed students to get under the hood of early micro-computers and to experiment with assembly-language programming and hardware interfaces. For L&C the personal computer era began around 1978 when several faculty members purchased Apple II computers equipped with 5.25-inch floppy disk drives. David Rosenbaum and I did the first computer-controlled psychology experiments at Hampshire using Apple II computers equipped with custom hardware interface boards. Since then the evolution of computing at Hampshire has followed a familiar course of near-universal personal computer use by faculty and students, the establishment of computer classrooms with multiple workstations, the networking of campus, and the ubiquity of computer-based laboratory work. One addition to this familiar path in CS was the creation of a high-performance computer cluster in a specially-designed room in Adele Simmons Hall. The cluster received significant external grant support but also depended on the imaginative acquisition and deployment of inexpensive and used components by its founding manager and IT staff member Josiah Erikson. The cluster mainly supported work in artificial intelligence and in graphics and animation.

Locating computer science within the cognitive science program worked out remarkably well over a period of 48 years. Although Hampshire is probably the only college with this arrangement, some further reflections may be useful. As noted above AI and theory of computation[22] are two subfields of computer science that intersect significantly with cognitive science. Their study at the undergraduate level is potentially enhanced significantly when placed in the context of biological information processing and the nature of the human mind. Straight computer programming also has considerable cognitive-science related intellectual content when taught well, introducing powerful concepts, such as algorithm, function, formal syntax and semantics, recursion, symbolic computation, abstraction, representation (of lists, trees, images, etc.), search, and so on.

CS is justly proud of starting animation and game design programs well before other colleges, recruiting outstanding faculty members with strong computer science backgrounds, and building programs that rapidly gained national recognition. At the same time the maturation of high-level software tools in these areas raised, for me, questions about current fit of these areas with cognitive science. Students become proficient in the use of high-level software that facilitates their academic work but does not require knowledge of the underlying algorithms. Their creative and intellectual work involves the development of characters, narrative, visual representations, lighting, or project management. While I am enthusiastic about the interpenetration of the arts with cognitive science, having been immersed in it for years in the domain of music, it appears that most animation and game design students are more properly considered art students, who at Hampshire were very fortunate to have the guidance of mentors who do knew the details of the technology under the hood of their software tools, but who, nevertheless, were not terribly interested in engaging with the underlying technology. Most just wanted to make engaging games or narrative animated films using the very accessible software tools available. There is cognitive science to be had here, but I suspect few were interested. For example, creating abstract, non-narrative animations via direct low-level coding or machine learning is a potentially rich area at the intersection of art and computer science.[23] And there are important CS questions about the incentive structure, educational potential, and long-term psychological effects of games. In the end one might argue that placing animation and game development within a CS program enabled the hiring of faculty members who could support these interests and provided a fertile academic environment for the students who have them, while still recognizing that the majority of students will pursue more mainstream creative work.

Psychology
At Hampshire's founding, Language and Communication included cognitive psychology, while the School of Social Science covered such areas as clinical, social, and personality psychology. During the college's first two years, Jim Koplin and I actually held joint appointments in the School of Social Science and the Program in L&C (I became full time in L&C when it became a School in the third year). In this early period a huge swath of psychology was covered in Social Science by the remarkable Louise Farnham, who was trained at the Minnesota Institute of Child Development. Lou's breadth of knowledge, in clinical and developmental psychology, in personality theory, in human genetics, and in methodology and meta-theory (sparked by the tutelage of Paul Meehl at Minnesota), was a priceless resource to students and colleagues in Hampshire's early years. Robert Birney, the founding dean of Social Science, and later Vice President of Hampshire under Chuck Longsworth, was a distinguished personality theorist who also regularly taught psychology courses in the School of Social Science.[24] Michael Cole, the pioneering cultural psychologist, commuted from Rockefeller University to teach the occasional course at Hampshire. Koplin, Cole, and I were friendly dueling representatives of three somewhat-clashing revolutionary movements in psychology, Gibsonian perceptual theory, Vygotskian cultural theory, and computational/information processing theory. Co-teaching with them, straight out of graduate school (Koplin had left a tenured position at Vanderbilt, and Cole was a professor at Rockefeller), I struggled to cope with their superior classroom experience and long-rehearsed expositions of their theoretical stances. I suspect that they saw me to some degree as a naïve infiltrator from the establishment, as the computational view of cognition

was already beginning to gain the upper hand in academic psychology, but they were respectful and good friends.

In the early years psychology in L&C had three main threads. The first was psychology of language (or psycholinguistics), which fit with the School's early emphasis on language, logic, and the general human symbolic capacity (in terms of research background *psycholinguist* was probably the best subdisciplinary descriptor for both Koplin and me). The second was the development of a curriculum for an interdisciplinary approach to mind that brought together psychology, linguistics, philosophy of language and mind, mathematical logic, and computer science.[25] The third was a desire to bring a developmental perspective to cognitive science. Language development was central to Chomsky's theory of language as a human biological capacity. A satisfactory linguistic theory had to account for how languages were learnable under natural conditions by (very nearly) all children. Chomsky's critique of B. F. Skinner's behaviorist account of language acquisition in the book *Verbal Behavior* was a milestone in the cognitive revolution, and influenced a reorientation of child language research toward the study of children's productive knowledge of linguistic structure. We felt that cognitive development, in general, should be an important element of a cognitive science curriculum, and there was a cognitive developmentalist on the CS faculty from 1973 on.

Over an extended period of time, beginning in the 1980s, the division of responsibility between the Schools of Cognitive Science and Social Science for the coverage of psychology began to fray. As it developed new curricular directions Social Science gradually reduced its offerings and faculty in mainstream social, personality, and clinical psychology. This led to pressure on the psychology faculty in Cognitive Science to broaden its course offerings and to chair a much wider range of concentrations and Division III projects. The pressure became particularly acute in social psychology, essentially forcing CS to regularly hire visiting social psychologists to satisfy student demand. At the time of Hampshire's financial crisis in 2018-19 it seemed clear that there was a need to recognize that CS was responsible for what had come to be called *psychological science* in the larger academic world, that is, psychology that is anchored in systematic empirical research and rigorous hypothesis testing.[26] CS had requested a position in social psychology, giving an intellectual and curricular rationale and amply documenting the very high level of student interest. The intellectual rationale was simply that in methodology and theoretical approach contemporary social psychology is the subfield of cognitive psychology that studies social cognition, i.e. the internal representations and process involved in perceiving, thinking about, and generating actions toward others. The needed position was never to be approved or filled.

Education

In the 1980s CS secured a position in cognition and education, reflecting both Hampshire's general commitment to educational experimentation and a specific commitment within CS to bring cognitive science to bear on learning and development in formal instructional settings. The School lost the position when turnover in the position coincided with period of financial stress for the college. It was finally restored around 2000 when student interest in education had increased considerably and when Hampshire had found a way to sponsor teacher licensure in collaboration with Mount Holyoke. By 2018 a healthy cross-School program in Childhood, Youth, and Learning (CYL) had matured, with contributions from faculty in several Schools.

Linguistics

Linguistics was central to the School's founding mission: The curriculum was organized around a symbolic conception of cognition; Chomsky's development of generative grammar was one of the most important precipitants of the cognitive revolution; and the interface between linguistics and psychology (psycholinguistics) was the guiding example for the pursuit of interdisciplinary collaboration. Intersections among linguistics, logic, computation theory, and psychology were consistent themes in early team-taught lecture series in the School. Woods's theory of augmented transition network grammars (Woods, 1970) is an example of accessible research that brought together Linguistics, AI, and psychology at the time. The mature expression of the linguistics-psychology connection was the co-taught *Theory of Language* course, which beginning in the mid to late 1970s presented linguistic theory and psychology of language side-by-side in the same term. Fodor, Bever, & Garrett (1974) is a good published expression of the impulses that first motivated the course. The course explored a deep intersection between linguistics, specifically Chomskyan generative grammar, and research on the psychology of language processing and language development.

Over time, for a variety of reasons, *Theory of Language* became a pure linguistics course. An immediate cause was that linguistic and psycholinguistic research became less tightly coupled, making it harder to teach them together in depth. The psycholinguistic *theory of derivational complexity,* which hypothesized that structural rules in generative grammar were directly implemented as temporally-sequenced mental or neural computations, was not supported strongly by evidence. Experimental tests of the *psychological reality*[27] of syntactic structures or operations thus became more indirect and less fine-grained than they had been. *Theory of Language* could have been continuously retooled to reflect changes in the field, but the co-teaching effort would have been too much at a time when CS was moving toward a more comprehensive conception of cognitive science, less bound to language.

Beginning in the mid-1980s, interdisciplinary instruction involving theoretical linguistics mainly took three forms: (1) Brief introductions in cognitive science courses that provided a feeling for linguistic research and supported the coverage of psycho- or neuro-linguistic work that tested hypotheses concerning whether mind-brain processes reflected linguistic distinctions, (2) explorations of intersections with animal behavior and questions about the evolution of language, and (3) courses in formal semantics and philosophy of language. At the same time linguistics and psycholinguistics were taught in free-standing courses from the introductory to the advanced level.

To strike a self-congratulatory note, it is remarkable that CS retained its commitment to linguistics throughout its 48-year history. Small colleges, with a very few exceptions, do not have theoretical linguists on their faculties. Amherst, Mount Holyoke, and Smith have no linguistics faculty. Swarthmore and Pomona, with much larger faculties and an order of magnitude more resources than Hampshire, are the only other colleges that spring to mind that have maintained a long-term commitment to linguistics. Many talented students either came to Hampshire because it offered linguistics, or discovered the field after they arrived.

2019 was a particularly sad time for CS to go dark, as it appeared that linguistics research had emerged from an extended period of hyper-formal work that was hard to connect with the rest of cognitive science into a new interest in empirical, even experimental, work that promised resurgent connections with psychology and computer science.

Philosophy

Throughout Hampshire's history, philosophers, or faculty with substantial philosophical training, were appointed in multiple schools. CS hired philosophers of language, mind, and knowledge, as well as linguists and logicians with expertise in formal semantics. H&A/HACU hired faculty in history of philosophy and continental philosophy, as well as faculty in religious studies with varying degrees of philosophical training. SS/CSI had faculty members with varying degrees of interest and training in legal and political philosophy. In the early days of the college NS had a faculty member in history and philosophy of science. As the other Schools chose not to hire faculty trained in the Anglo-American analytic tradition in philosophy, CS was *de facto* responsible for the tradition, which is the mainstream of graduate study, yet saw its philosophy faculty reduced from three to one over the years. Adding a philosopher of language and/or an epistemologist would have enhanced the School's curriculum considerably. Students who wished to pursue graduate study in philosophy were harmed by Hampshire's drift away from analytic philosophy, but the case for one or two more analytic philosophers rested as much or more on their strengths as critical generalists in an institution that encourages students to pursue interdisciplinary interests. As Hampshire recruited faculty over the years in more and more specialized niches, the value of faculty members whose professional training was to uncover implicit assumptions, analyze argument structure, and evaluate evidence only increased.

"<u>Communication</u>"

In *The Making of a College* Franklin Patterson proposed a School of Language and Communication that was a provisional meld of his notion of the importance of understanding mass communication and Roger Holmes's idea that the study of language in the broadest possible sense (perhaps better characterized as *semiotics*,[28] or the theory of signs) should be the foundation of a liberal education. To Holmes the study of mass communication was a subfield of pragmatics, which was one member of a triad that also included syntax and semantics, and which therefore included things like mathematical logic and linguistics.

Holmes's influence led Patterson to hire Bill Marsh and Jack LeTourneau, who had a cutting-edge knowledge of recent developments in the cognitive revolution and who knew what to look for in additional faculty in linguistics, psychology, and philosophy. Patterson, as president, also made sure that his vision of the study of mass communication would be represented by scholars of mass media and by practitioners of media technology. Under Holmes's vision the work and teaching of these faculty members would have been decisively shaped by expertise in theories of language, signs, and symbols. In the 1970s such faculty members were from non-existent to hard to come by (at least for a new private liberal arts college). It was prohibitive to find, say, a television content creator who was at home with current technology and also creatively conversant with, say, Nelson Goodman's theory of symbols (1968). The difficulty of finding faculty in mass communication who could cross-fertilize with a nascent cognitive science faculty was compounded with the realization that a serious program in mass communication, of the kind envisioned by Patterson, had sociological, cultural, and artistic dimensions that would require a cross-School program, with the appointment of faculty in the other Schools. As the School of L&C was approved by the faculty in 1972, it became clear that the other Schools would not support a cross-School program in mass communication. The overall result was that the School hired public-TV-documentary oriented video makers and mainstream mass communication sociologists, with the result that the "language" and "communication" parts of the School were not truly integrated. To some degree "language" and "communication" were separate departments within the School that potentially competed for resources. The potential for conflict was intensified when the video production positions in the School became vacant and were filled by postmodernist, feminist video artists. In replacing traditional documentary practitioners the hope was to acquire faculty members who had theoretical interests and who were exploring new directions in the medium. The hope was realized, but it turned out that the new faculty members had little in common intellectually with cognitive scientists. The School had been renamed Communications and Cognitive Science (CCS), and there was no good reason why its dual-program nature could not have continued indefinitely and why, with some turnover in the faculty there could have been more cross-fertilization over time.

Instead, the cognitive science and communications programs suffered a contentious divorce, resulting in the School being renamed simply Cognitive Science and two philosophy faculty members and all but one of the communications faculty members departing for other schools, and in several cases simply leaving Hampshire. The divorce resulted from a confluence of an increasing intellectual divergence between the cognitive science and communications wings of the faculty and the development of personal conflicts, even outright enmity, among School members. In the end these latter conflicts split the School along lines of friendship and loyalty rather than discipline, with the philosophers and most of the communications faculty on one side and the rest of the cognitive science group and one communications faculty member on the other.

The intellectual divergence was rooted in the embrace of "cultural studies" by a group of faculty members in the humanities and social sciences in the late 1980s and early 1990s. From 1989-90 through 1998-99 the college course guide listed a "Special" or cross-School program in Cultural Studies with a paragraph of description that included a few courses and the names of one or two faculty members who could be contacted by interested students. During this period a weekly faculty seminar was funded for a couple of years to discuss readings in cultural studies and to try to work out a direction for the program at Hampshire. During this period the communications faculty in Communications and Cognitive Science decided that they were actually doing cultural studies, and in 1997 the School was once again renamed, this time to

"Cognitive Science and Cultural Studies" (though its abbreviation remained CCS, in part to preserve email addresses, as the College was now on the internet). By the late 90s the CCS communications faculty along with a substantial group of faculty in the humanities and social sciences began advocating for a School of Cultural Studies.

Interpersonal conflicts in CCS came to a head during the same period. Most members of the communications faculty, joined by the two philosophers in CS, expressed increasing discomfort with membership in the School. They were unhappy with the way that particular reappointment and promotion decisions had been handled, with the division of budgetary and space resources, and with their perceived lack of power in the School. They released a memo to the entire faculty stating, roughly, that membership in CS was intolerable, that the School was dysfunctional, and that it should be placed in receivership. Bringing in a professional mediator with international experience in the Balkans did not resolve the conflict, confirming a well-worn image of faculty conflicts as uniquely intractable. Strangely, during this same period, a parallel set of intra-School conflicts developed in the School of Humanities and Arts (H&A), with the faculty groups in creative writing, sculpture, and theater declaring that they no longer desired to be part of H&A and wished to form their own School.

The cultural studies initiative and the strife within CCS and H&A all came to a head in the academic year 1997-98. Another mediator was called in to work with the entire faculty, to no avail. There was no clear proposal for how to reorganize the Schools in a way that created a School of Cultural Studies, except for a belief on the part of cultural studies proponents and feminist studies faculty that, whatever the final arrangement, the School of Cognitive Science and Cultural Studies would be disbanded, and the cognitive science faculty would be dispersed among other Schools, where, presumably, they could be replaced over time by faculty in other fields. A meeting to decide the organization of the faculty was, remarkably, called at this juncture. The CCS communications faculty were asking for a new home; the disgruntled H&A faculty were arguing for their own School, to be called the School of Interdisciplinary Arts; the cognitive science faculty stated that, while they were willing to lose cultural studies faculty, they wished to remain a School; and there was no proposal to combine good chunks of the Schools of Social Science and of Humanities and Arts into a School of Cultural Studies. The compromise[29] was that the faculty voted to reorganize into 5 Schools: Natural Science, Social Science, Humanities and Arts,[30] Interdisciplinary Arts (IA), and Cognitive Science (CS), with all but one of the CCS communications faculty and the philosophers re-assigned to H&A.[31] CS and IA were designated as "experimental" Schools to be evaluated by a visiting committee in 5 years.[32] CS was indeed evaluated in five years, very favorably. This was the second time the School was evaluated, and at the time, for the second time, it was the only School at Hampshire that had ever been subjected to outside evaluation. At the insistence of CS deans the other Schools were also then subjected to regular outside evaluations.

<u>Just Cognitive Science</u>

In the Fall of 1999 the name of the School became simply Cognitive Science. The twenty years from the fall of 1998 through the 2017-18 were a period of stability and success for the School.

Its curriculum and faculty were popular with students, and its course enrollments and Divisional supervision numbers per faculty member were consistently clustered at the top of the faculty. The School's curriculum expanded to include cognitive neuroscience, cognition and education, computer animation, game design, and statistics. Labs in electrophysiology, animal behavior, computer animation, and artificial intelligence attracted dedicated groups of students. CS faculty were leading participants in new cross-School programs in Childhood, Youth, and Learning and in Culture, Brain, and Development. Members of the School published at a good clip and brought in outside grants for research, conferences, or curriculum development in artificial intelligence, cognition and education, cognitive neuroscience, animal behavior, brain and culture, and scientific beliefs in Muslim countries. The School also succeeded in hiring and retaining more women and people of color, some of whom became leaders in the School. When I retired in the summer of 2018 CS was a thriving community that was providing educational experiences of the highest quality to students. Its members had no idea that they were operating in the shadow of a looming financial crisis that would shatter the School during the following year.

Reflections

Communication

Given the difficult history of the study of communication within the School, it is ironic that today it would be relatively easy to find faculty candidates who have a cognitive science mindset and are interested in information/belief flow in society or in cognition and the arts. A scholar whose focus is on the social network phenomena engendered by internet technology would be an obvious choice, though there are numerous options.

Cognitive science and language

As sketched early in this paper, the intellectual mission of the School shifted over time from an initial focus on language and symbolic systems to a more general focus on mind, adaptive behavior, and the neural substrates of human cognitive capacities. The shift reflected changes in the field at large and to some degree the faculty's judgments about topics that were attracting students. Also, Hampshire's continuous financial challenges made it difficult for CS to add positions, or even to retain positions that had become vacant, forcing trade-offs among subfields.

With the guidance provided by Franklin Patterson and Roger Holmes and the leadership of Bill Marsh and Jack LeTourneau, the School of L&C began with a focus on language, logic, and computation and a faculty that came straight from contemporary philosophy of language, linguistics, mathematical logic, and psycholinguistics. Intellectual pressure to expand the School's purview beyond the symbolic were present from the beginning, however. Philosophy of mind fairly quickly overtook philosophy of language as the specialty within philosophy that was most crucial to cognitive science. The centrality of generative grammar began to recede as its psychological claims became more abstract and as other areas of cognitive science matured. Although psycholinguistics had been the leading edge of the cognitive revolution in psychology, other areas, such as perception, memory, reasoning, and problem solving, rapidly caught up.

Symbolic natural language processing and classical logical reasoning also became less central to artificial intelligence.[33] Over time faculty interests and the School's hiring came to reflect these changes. At the same time the School lost positions in linguistics, logic/semantics, and philosophy at random moments of institutional financial crisis or shifts in the balance of power among factions of the college's faculty.

Although the School had an extraordinary 20 years as simply Cognitive Science, it was not given the faculty, in spite of strong student interest, to fully restore a robust curriculum in studies of meaning and truth, of linguistic structure, of speech act theory, discourse, and communication, and of the relations among language, thought, and behavior. Just prior to Hampshire's near collapse Daniel Altshuler, a new faculty member in linguistics and semantics, was working with great success to revive these areas of study, which still deserve a strong place in an undergraduate cognitive science curriculum. Sadly this work ended with the collapse of CS and his own departure for a position at Oxford.

Cognitive Science as an undergraduate concentration at Hampshire
At Hampshire all students developed independent concentrations, called *Division II,* with the guidance of a personal two-person faculty committee, made up of a "chair" and a "member." Rather than "declaring" a major and registering with the appropriate department, Hampshire students negotiated individualized concentration "contracts" with their Division II committees, outlining courses, independent projects, and internships to be completed during the second and third years. Thus, Hampshire had no prescribed majors, and there was no major in cognitive science that specified a set of required and elective courses. A concentrator in cognitive science was defined as a student whose Division II chair was a faculty member in the School of Cognitive Science.

The strong faculty community and rich course curriculum in CS offered students an environment in which they could find faculty mentors to help them forge CS-infused undergraduate concentrations of great variety. Faculty members sought to help students develop courses of study that grew from their interests and that had the breadth of a college major combined with enough focus to support an undergraduate thesis project (*Division III).* Supporting students' ambitions for postgraduate study was also often a factor. The result might have been a general cognitive science concentration with a focus on philosophy of mind and enough standard philosophy courses to satisfy admission requirements for graduate school in philosophy, or a cognitive neuroscience concentration with a focus on neurolinguistics that satisfies premedical requirements. Some concentrations were close to what would have been psychology or computer science majors at other colleges, followed by laboratory studies in psychology or AI programming projects for Division III, and applications to graduate school. Others took full advantage of Hampshire's freedom to explore, such as concentrations that combined cognitive science with music, dance, fine arts, or children's literature. In Division III a dance student completed both a study of movement therapy for Huntington's patients and an original work of choreography, while a music student wrote both original piano pieces and a thesis applying theories of music perception to rhythmic traditions in different cultures.

The trade-offs between breadth and depth that are present in any college major were amplified in an environment where students were encouraged to pursue their own interests and to cross traditional disciplinary lines in their pursuits. Some students ended up with programs of study that resembled double majors, or major-minor combinations, at other colleges. For some of these students, just looking at the list of courses and other activities might not reveal the underlying intellectual journey, even unity, that would emerge from reading the student's contract, retrospective essay completed at the end of the third year, and ultimate thesis project. Other students trimmed breadth to allow time to drill deeper and deeper into a single topic or research area. Their concentrations sometimes looked like programs of graduate study rather than college majors, and they often involved graduate courses and work in laboratories at the University of Massachusetts, which was part of the Five-College Consortium and just a bus ride away. This type of student, along with Hampshire's universal thesis requirement, contributed to Hampshire's reputation as a graduate school for undergraduates.

Cognitive science and general education

Hampshire was quite probably the only institution of higher education in the world that posited cognitive science as a major division of knowledge, on a par with the humanities, natural sciences, and social sciences, and made it part of a general education requirement (Division I at Hampshire). That assertion was certainly bold at the time, but from the standpoint of academic and public intellectual life today it would seem reasonable, though still radical, if one takes a broad view of cognitive science as encompassing large swaths of psychology, neuroscience, computer science, philosophy, linguistics, communication studies, behavioral economics, human evolution, and animal behavior. More on that at the end of this history.

Division I requirements at Hampshire were revised numerous times from 1970 to 2018. During 1970-71 after some moments of uncertainty the faculty settled on a requirement that students complete an independent project in each of the Schools. After several years of experience it was clear that students found the requirement difficult to fulfill and faculty found it burdensome to oversee. A long series of reforms was initiated, which began with an option to substitute course completion for some of the projects and ended with pure course completion under a menu system that defined courses in terms of subject areas rather than Schools. In the final system the *Mind, Brain, & Information* category was satisfied nearly exclusively by courses in the School of CS. Over a period of 48 years, then, Hampshire's general-education requirement came to be very similar to those of most other institutions that retained such requirements: entering students were required to take one course from each of several broad subject-matter areas, such as sciences, humanities, or social sciences. The choices within and across the subject areas in such systems are varied enough that students' exposure to the canvas of intellectual life tends to be rather haphazard and pointillistic, perhaps particularly at Hampshire where there were few survey courses and many courses on fairly narrow topics. The requirements serve mainly to ensure that students explore some possible interests a bit before declaring a major or concentration. The final version of Hampshire's requirement ensured that most first-year students would take at least one course in CS.[34]

Hampshire's planners and early faculty had hoped that students would receive an integrative exposure to the broad interdisciplinary territory of each School, lasting into Division II. Over Hampshire's first fifty years there were intermittent attempts in all of the Schools to offer team-taught courses at different levels of instruction that sought to bring a range of questions, perspectives, and methods together in a way that would engage students. These efforts were always intellectually exciting, but they failed to take hold over time. I certainly wish that CS had had the resources to experiment continuously with co-taught integrative courses over its entire history. For many years co-teaching helped the CS faculty build its community and define its conception of cognitive science. Co-taught courses tended to be introductory, aimed at first and second-year students. In early years the entire faculty co-taught a lecture series with seminar-style sections that covered the entire range of its subject matter and disciplines. In a number of iterations an introduction to cognitive science was co-taught, or taught by an individual faculty member, often under some variation of a *Minds, Brains, & Machines* title. This was a low-intermediate course that was open to first-year students. As a co-taught course it served both to develop and to practice teaching from our textbook in the Hampshire environment. In the 2000s Mark Feinstein and I revived this course as *Minds, Brains, & Machines: The Fifty Key Ideas.* We never did settle on what the fifty key ideas were, and when I taught the course alone late in my career, I occasionally announced that there was no list of 50 ideas and gave a final assignment asking students to describe 50 ideas that they were taking from the course. In the 2010s for first-year students Laura Sizer developed the co-taught course *Other Minds*. She and stable of undergraduate teaching assistants oversaw a lecture series in which CS faculty members spoke on topics such as children's minds, AI minds, animal minds, and, in my contribution, the possibility that one's own mind is an other mind. More advanced integrative courses were unfortunately less frequent. *Theory of Language,* mentioned above was a notable example but was not sustained over the years.

There were several reasons for lack of steady commitment to co-taught and team-taught courses. Within Hampshire's system of individualized concentrations and easy enrollment across the five colleges, co-taught courses too advanced for first-year students turned out to be quite resource intensive. Such courses counted as a full course for each of the faculty members but rarely drew more students than solo-taught courses. The instructors were perceived as doing less work than those teaching alone, the total course enrollment of the School was reduced, and the course offerings of a School looked less diverse, potentially making it more likely that students would look for courses at the other colleges. There was pressure from the Dean of Faculty and Registrar to limit co-teaching across the college. As cognitive science research matured over the years, it became easier for faculty members in CS to accede to this pressure because they often had adequate integrative competence in and around their specialties. For example, by the 1990s a philosopher of mind, such as Laura Sizer, knew more than enough about research in cognitive psychology and neuroscience to teach upper-level philosophy of mind from a strong cognitive science perspective (although Sizer did co-teach a course on consciousness with a psychologist in the early 2000s). The deeper truth was that developing and teaching upper-level co-taught courses required considerable work and creativity over and above what faculty members normally do to keep their regular courses up to date, or even to develop new variations. And, because of Hampshire's deeply-individualized concentration system, the resulting cognitive-science-intensive courses were unlikely to appeal to large numbers of students, who tended to seek out courses that were more specific to their interests. That said, such courses did have a decent constituency among cognitive science concentrators, and I sometimes regret not pushing through and regularly offering a couple of such courses per year.

In fall 2020, fighting for institutional survival, the college instituted a new academic program that eliminated the Division I distribution areas and the Schools in favor of four "themes," which had possible but not necessary or intrinsic cognitive science content: *Environments & Change; In/Justice; Media & Technology;* and *Time & Narrative.* In what could be seen as a rededication to Hampshire's founding intentions, instruction and "learning communities" organized around the themes were intended to be "transdisciplinary." It is easy enough to imagine interpreting any of these themes in cognitive science terms in interaction with other approaches, but that is/was unlikely to happen, as by the summer of 2020 all but one of the core cognitive science faculty had left the college for permanent or visiting positions elsewhere. Generally, it is unclear what general education at Hampshire will entail in the future. What does seem clear is that initiating students into cognitive science as a mode of inquiry, or way of looking at the world, is not terribly likely to be central to the college's mission.

Cognitive science as a way of organizing faculty

A key innovation at Hampshire was organizing the faculty into broad interdisciplinary units rather than conventional departments. Although CS encountered rough patches with its original mandate to include communications studies, the creation of a faculty unit in the core cognitive sciences, with a dean, a budget, and appointment powers, was a tremendous success for the college and for the faculty and students of the School. CS's success was due in part to its anticipation of and participation in the cognitive revolution, but it was also made possible through the School's strong community, which built an innovative curriculum and provided an intellectually inspiring home for hundreds of students. Faculty members in traditional small-college departments are often constrained by the blinders of their disciplinary missions. CS expanded people's vision in highly productive directions, encouraging innovation and collaboration. Over the years I consulted a number of times with faculty groups who were interested in forming cognitive science programs or establishing cognitive science departments. Invariably, people were eager to escape the intellectual suffocation of traditional departments. CS faculty members enjoyed a highly unusual freedom to develop their research and teaching efforts in new directions with the collaboration of colleagues and often also of adventurous advanced students.

<u>A future for cognitive science at Hampshire</u>?

If Hampshire survives and is able to rebuild to something approaching its former size, there is a possibility that some form of institutionalized cognitive science program could be revived. Whether it would have the appointment, reappointment review, and budget management powers necessary to retain its integrity is another question. By the 21st Century cognitive science was one of the few innovations that still distinguished Hampshire, and, in fact, a significant fraction of Hampshire's reputation and success in attracting outstanding students rested on the strength and visibility of its cognitive science program. That fraction would be hard to replace. And it is hard not to dream about what might have been, had CS been able to continue to build its faculty, or what could be, if Hampshire re-committed to CS. I close with a vision:

Reconceptualizing cognitive science today as a central field of undergraduate study
The CS faculty's continuous rethinking of the nature of cognitive science was held back by the lack of institutional power to move effectively toward attaining the full resources of a School at Hampshire, which would have doubled its faculty. We came to see cognitive science as the integrative study of mind, information, computation, and communication through a merger of methods originally associated with psychology, linguistics, philosophy, biology, computational science, mathematics, and other fields, confirming our original view that its reach and significance is comparable to the traditional branches of inquiry. When I imagine a fully-staffed School on an equal footing with Schools of Humanities, Natural Science, and Social Science, I see several overlapping, interpenetrating clusters of inquiry:

- <u>Mind, brain, behavior, learning, evolution</u>. What is the nature of mind? What are the varieties and subsystems of intelligent behavior and mental activity in biological organisms? How did they evolve? How do nervous systems make them possible? How do they develop over the lifespan of an individual? How do sensory systems, motor coordination systems, memory systems, and learning and problem-solving capacities work? What are the consequences of minds being located in individuals and physical bodies? What is consciousness? What is the role of culture in human cognition? How do sensory and motor systems potentiate the arts? Some of the relevant specialties here come from psychology, neuroscience, evolutionary biology, philosophy of mind, and anthropology.
- <u>Language, meaning, truth, logic, discourse, communication</u>. In what ways is a productive, structured, representational medium required for a flexible intelligence and what forms could it take? How does language work to represent meaning and express truths or beliefs; how does it support reasoning and the construction of connected passages; how does it allow two users to understand one another, or not; how can it be learned through mere exposure, by children, for example; In what sense does it represent a/the world; how does it function as an aesthetic medium? What does it mean for a statement to be true? What are the limits of translation? Faculty members teaching in this area might come from linguistics, formal semantics/logic, philosophy of language, psychology, or literary theory.
- <u>Computation, information, artificial intelligence</u>. We think of computation as involving the representation, storage, transformation, and transmission of information. Theories of computation can be used to understand much of cognition and adaptive behavior in biological organisms and to implement new computational, even intelligent, systems that we design. What is computation? What are its varieties? What is information and in what ways can it be represented? What can't be computed, and what is hard to compute? How can we characterize the conditions under which the formal, internal states of a system become functional, adaptive, or meaningful relative to the system's

environment? What are the possible approaches to AI and how should it be integrated with human intelligence, and human life? What are the frontiers of information technology generally? The core discipline here is computer science, particularly the subfields of computation theory and AI. Mathematics, logic, and philosophy of mind are also crucial disciplines.

- Interacting minds: Multi-agent worlds. The consideration of minds in interaction is perhaps not commonly considered to be a core area of cognitive science, and it has seen less interdisciplinary integration than one would hope, as the threads one might like to see drawn together are somewhat disparate. The intellectual line between cognitive and social psychology is so blurry as to be nonexistent, for example, and the School of CS was moving toward an appointment in social psychology as Hampshire entered its financial crisis. A bit of reflection suggests that it is a historical accident that game theory has not played a larger role in cognitive science over time, although its influence is growing as evolutionary studies of animal behavior and evolutionary psychology gain influence in cognitive science.[35] The role of culture in human cognition and considerations of distributed, or group, cognition are gaining renewed attention and influence. New analytic techniques and data sources are driving innovative studies of patterns of connectivity and information flow in social networks. Evolutionary biology, cognitive anthropology, social psychology, microeconomics, and game theory/mathematics are contributing disciplines here.
- (Ir)rationality. Cognitive science has become the best setting for the broad-ranging, fundamental study of the nature of knowledge, truth, belief, reasoning, decision making and other epistemological issues, bringing together quests for and models of ideal rationality with the realities of the limitations or ambiguities of any given representational scheme, of space/time/data constraints on computation and learning, of potentially sub-optimal evolutionary hill-climbing, of the complexities of probabilistic reasoning, and of clashing incentives in social or competitive environments. Epistemology, philosophy of science, statistics, machine-learning theory, evolutionary psychology, cognitive psychology, game theory (again), and behavioral economics are important fields here, and they are already in fertile interaction.[36] I take some small pride in having helped pushed through a statistics appointment within the School shortly before the financial crisis and finding a candidate with cognitive science credentials.

Though I have lost the chance to work further on the actuality, I still dream of a cognitive science program that holds 20-25% of the faculty positions in a college and offers a curriculum making a proportionate contribution to a liberal arts education. As it stood, the School of CS was perhaps the most innovative feature of Hampshire's faculty organization and curriculum. Built to its originally intended scale it would be a truly radical reimagination of the liberal arts landscape.

One question is what is lost when we introduce a fourth major division of knowledge into the traditional triad of humanities, sciences, and social sciences. Roughly, the answer is that no disciplines are lost. Rather, their connections to the intellectual landscape are rearranged in an interesting way. A fully-realized CS could have psychologists, biologists, philosophers, computer scientists, mathematicians, linguists, communication theorists, anthropologists, economists, and artists on its faculty. A requisite proportion of the student body would end up working with its faculty. In fact, the CS of 2018, even without some of the areas listed above, was easily drawing a proportion of the student body well above its representation in the faculty. Concentrations in CS would continue to lead to graduate careers in psychology, neuroscience, evolutionary biology, animal behavior, philosophy, computer science, statistics or applied data analysis, linguistics, anthropology, and other fields. Additional career paths include medical school, law school, software development, digital content creation, data analysis, K-12 teaching, and social service jobs related to psychology and neuroscience.

An expanded CS would allow the School to fully support work on the nature of language, knowledge, and social dynamics and to integrate that work with its traditional strengths in the study of mind, brain, and computation. It would provide the resources for a fuller exploration of the many contemporary topics associated with cognitive science, including AI ethics, neuroethics, digital security/privacy, the organization and regulation of social media and internet communications, educational applications of cognitive psychology and technology, neurobehavioral medicine, the psychology of implicit racism, the cognitive implications of bilingualism, optimal communication concerning climate change, and many more areas.

A final personal note

In 2021, at the age of 77, I doubt that I will get the chance to help realize the vision above, but I very much hope that someone somewhere will get the chance in the future. I am grateful for the chance I had to help found CS at Hampshire and to help take it as far as it could go. I loved working at the college—the freedom to develop curriculum and to work with students without arbitrary constraints, the opportunity to play a small role in the cognitive revolution, the collaboration and friendship with intellectually stimulating colleagues who also liked a good time, and the often satisfying, sometimes wrenching, experience as a departmental administrator, working to build a college that, as of this writing, is hanging by the proverbial thread. I was lucky to have a career that combined the many pleasures of being a small-college faculty member with the challenge of starting a new college and a new kind of department. I am deeply sad for my former colleagues whose careers were interrupted by Hampshire's 2018 financial crisis, and at this writing I hope that those who wish to will be able to return.

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[1] In the fall of 2019 Hampshire had a new President and a serious shortfall in the first-year class. Like many highly tuition-dependent colleges, Hampshire had been having difficulty for several years in attracting enough applicants to fill its incoming classes without discounting tuition to the point at which revenue was insufficient to meet expenses. In January of 2019 the President made a shocking and unanticipated announcement that the college could not survive without a "strategic partner" and that a Fall 2019 entering class might not be accepted. In rapid succession the trustees voted not to accept a Fall 2019 class, the community revolted, the President and chair of the board resigned, the trustees changed course and voted to pursue Hampshire's independence, and an interim President was appointed, beginning the Herculean task of fundraising for survival and holding off what appeared to be an imminent imposition of accreditation probation by the New England Commission of Higher Education (NECHE). Over the summer of 2019 the board of trustees managed to reconstitute itself and hire a new President, who continued to fundraise, to put the college's financial projections on a realistic footing, and to buy time from NECHE. The college remained open without a first-year class for 2019-20. As of the end of the 2019-20 academic year, complicated by the spring 2020 novel corona-virus pandemic, the college re-established its admissions office and pursued a fall 2020 class with moderate success. As of this writing, in the Spring 2021, the fate of the college is undecided, but it is clear that Cognitive Science, as a School or as some other entity, will likely not survive. Cognitive Science no longer has a dean, a staff, control over its budget and appointments, or, for that matter, any visible advocates, or even presence, within the college.

[2] Of the CS faculty members mentioned in this paper, only Sarah Partan, Professor of Animal Behavior, remains at Hampshire. All others have retired, resigned to take positions elsewhere, or are on indefinite leaves of absence that do not guarantee re-employment at the college.

[3] Although this is a personal piece, I have tried to stick with institutional and intellectual history and not to pack it with anecdote. Many of the facts have been checked against documents, but more thorough archival research might reveal some errors.

[4] I do not include the School of Humanities and Arts here, because in my view, after some early successes, the School was never able to integrate the humanities and arts in the way its founders intended. The School grew rapidly and fragmented into several quasi-arts departments and a loosely-organized humanities group. Animosities among the subgroups resulted in the late 1990s in the School splitting into two. Nevertheless, exciting teaching, research, and art making did occur, much of which was sparked by Hampshire's emphasis on breaking traditional boundaries and encouraging student initiative. The film and photography program became nationally renowned, for example.

[5] The School of Natural Science was originally named Natural Science & Mathematics. Mathematics was dropped from the name under the recognition that mathematicians might be appointed in the other Schools, particularly in Cognitive Science.

[6] Until regular outside reviews of the Schools were initiated in the 2000s L&C/Cognitive Science was the only School that had been subject to outside review.

[7] This section does not discuss several administrators who were associated with, and taught occasional courses in, the Program in L&C: Richard Lyon, Dean of the College, an intellectual historian who specialized in Santayana's life and ideas; Robert Taylor, Director of the Library; Stephen Mitchell, manager of several non-academic offices, who had a Ph.D. in Language Studies; and Richard Muller, Director of Information Technology in the library, later to become Professor of Communications. Of these, only Muller had a lasting impact on the School.

[8] Koplin and I were jointly appointed to the School of Social Science and to the Program in L&C. When L&C became a School I requested that my appointment be converted to full time in L&C, and I was released from SS. Koplin retained his joint appointment until he left the college in the late 70s. Rardin and Witherspoon were appointed directly to the Program in L&C with no additional School affiliation.

[9] Sadly, Koplin, Rardin, and Witherspoon are all deceased. Koplin is memorialized here: https://jimkoplin.com/

[10] From its beginning Hampshire accepted one entering class per year. This meant that the curriculum was heavily tilted toward beginning students during the first several years. The faculty responded to the stabilization of the student body with a planning lag, which prolonged the emphasis on early curriculum.

[11] In 2018-19 the linguistics faculty consisted of Daniel Altshuler and Mark Feinstein, who devoted at least half of his time to animal behavior and bioacoustics.

[12] I remember one faculty member in NS speaking at the faculty meeting that had to approve the change saying, "There's no such thing as cognitive science." Like a good contrarian Hampshire faculty member he wasn't impressed that there was a national society and that MIT was publishing books in the field, but the motion passed. After that, Schools, including CS, changed their names several times without a vote of the full faculty.

[13] I was also funded by the NSF to organize a national workshop on undergraduate cognitive science education in Washington, D.C. in 1993.

[14] Hanson worked closely with Edward Riseman at UMass, and after a couple of years at Hampshire was recruited onto the UMass computer science faculty, where he remained for the rest of his career.

[15] In the 1970s, perhaps into the early 80s, color vision was a topic in various seminars and lecture series, including a cross-school co-taught course "Color and Light Circus." In the mid-70s Edwin Land's retinex theory of color constancy captivated some students. My memory is that at one or more points Land and/or his co-researcher John McCann lectured and gave demonstrations in the main lecture hall. An early student of mine and others, Brooks Harris, worked on replicating and extending their demonstrations, attaching rheostats to Kodak carousel projectors. The Retinex model was wrong in detail (Brainard et al., 2006) but early in its computational spirit.

[16] It is perhaps worth noting here that this point holds for general purpose programmable computers, for more special purpose computers running "firmware," for "hardwired" controllers, and for programs that evolve or learn through time in response their input/output histories.

[17] Michael Arbib, with whom I had studied briefly at Stanford, had taken a position at UMass and gave a lecture series at Hampshire, "Cybernetics and the Brain," in the college's opening term, Fall 1970, before I arrived. Bill

Marsh, and "staff," ran the associated seminars. Arbib, coming from a cybernetics background, had already been working on the application of automata theory to understanding brains (Arbib, 1964), and as a mathematician he no doubt knew that Minsky and Papert's work on perceptrons had a fairly narrow application.

[18] Hampshire was notable for its lack of systematic curriculum planning. Decentralized change and drift in the curriculum were amplified by fairly frequent cases in which faculty members made major changes in what they taught and by swings in the college's fortune that led to losses in positions that were never restored. Animal behavior in CS was fortuitous in the sense that Mark Feinstein chose to develop an animal behavior curriculum after being hired to fill a position that was designated for sociolinguistics, and in the sense that Ray Coppinger elected to switch his School affiliation in a way that extended and deepened the curriculum.

[19] Accounts of Bach's career tend to fail to mention his brief appointment at Hampshire. Bill Marsh notes this oversight in his comment on Barbara Partee's obituary for Bach in the Language Log: http://languagelog.ldc.upenn.edu/nll/?p=16230. In addition to being a major figure in syntax and semantics, as well as in linguistic field research, Bach was very well known for the work he put into clarifying, explaining, and disseminating difficult technical ideas. Because of that he was a good fit for Hampshire.

[20] I had taken or audited AI courses taught by John McCarthy and Roger Schank while in graduate school at Stanford. I was reasonably fluent in the LISP programming language and was familiar with McCarthy's logic-based approach to AI and with Schank's conceptual dependency theory, but I was studying AI to understand connections with cognitive psychology and never got involved in AI research.

[21] *GEB* was pronounced musically illiterate by the Berkeley musicologist Joseph Kerman in at least Kerman (1981) and possibly in additional writings that I haven't tracked down for this paper. We spent some time on this in class. The charge is particularly relevant to the kind of romantic overreach typified by Hofstadter but also characteristic of committed small-college teachers.

[22] Theory of computation is the mathematical study of what can be computed, what can't be, and how hard it is to compute what is, technically, computable (in any actual world the resources and time involved in a computation matter). Theoretical work depends on having an abstract model of computers that strips away technological detail. The findings are relevant to biological information processing (perception, language, reasoning, etc), even in the case that one wishes to argue that somehow brains can overcome the limitations that have been delineated in theory of computation. Interestingly, a foundational finding in the field is the Chomsky hierarchy, discovered when Chomsky considered the properties that a computational system would require in order to be able to generate the infinite set of grammatical sentences in a natural language.

[23] I see an analogy here with computer music, which I know better than animation, going back to my friendship in the 1960s at Stanford with the late David Wessel, a fellow grad student in cognitive psychology and jazz musician, who went on to positions at IRCAM in Paris and UC Berkeley, directing the Center for New Music and Audio Technologies (CNMAT). Around 2000 I spent some time at summer workshops at CCRMA at Stanford, learning digital audio and hanging around with a mix of creative programmers and avant-garde musicians, prior to teaching a couple of courses that encouraged students to play with the relatively low-level tools in the MAX sound programming environment. On the one hand one can develop digital music software in a way that facilitates and conservatively extends traditional composition and performance, designing new virtual instruments, simulating acoustic spaces, automating notation, prompting voice leadings, and so on. On the other one can confront the open sea of psychological and creative questions raised by the unlimited potential of digital audio and software and try to work in an interdisciplinary collaborative space, making new music and asking new questions about the human response to sound, from psychoacoustics to the roots of musical aesthetics and emotion. An analogous contrast seems to be possible for computer graphics and animation.

[24] Bob Birney left a full professorship at Amherst College in 1969 to become Hampshire's first Dean of Social Science. In the classroom he was a master of the Socratic method, patiently and gently challenging students to clarify their positions. With his colleague at Lehigh, Richard Teevan, he pioneered the undergraduate engagement with primary literature through multiple contributions to the publisher Van Nostrand's series of readers on *Enduring Problems in Psychology*. My own introduction to the problem of color vision came in a seminar at Amherst College with Birney, for which one of the books was a central reading (Teevan & Birney, 1961).

[25] The computational view of mind emerged as the framework that knit together the disciplines in the emerging field of cognitive science at large, and to a large extent in the CS faculty. However, it should be noted that Jim Koplin, as a Gibsonian, did not embrace the computational view. Prior to, and well into, the cognitive revolution, Gibson held that perception was "direct," and he rejected any hypothesized intervening representation or

semantically-interpretable transformation. Those who continued to develop his ideas attempted to extend this views beyond perception. Gibson, and the Gibsonians, through Koplin, exerted an influence on my own thinking. Foremost, they were a reminder that one's theoretical framework, in my case the computational, may be fundamentally in error.

[26] The term *psychological science* came to prominence when a group of academic psychologists broke from the American Psychological Association (APA) out of dissatisfaction with the APA's increasing focus on the profession of clinical psychology. They founded a new organization dedicated to empirical research and evidence-based policy, the APS (originally standing for the American Psychological Society, then altered to Association for Psychological Science).

[27] "Psychological reality" was perhaps an ill-chosen phrase. Evidence from observations of speech and grammaticality judgments for a particular syntactic structure is clearly evidence for psychological reality. Where else but in speakers' minds/brains would the structure be represented. Experimental psycholinguistics typically seeks evidence that hypothesized structures affect language understanding or production in real time.

[28] In, perhaps large, parts of contemporary academia *semiotics* has come to refer to the work of continental post-structuralist or post-modernist theorists such as Barthes or Derrida. Here the reference is to its broader application, which includes Charles Sanders Peirce and his intellectual descendants.

[29] It turned out that a significant number of faculty members were uncomfortable with terminating a School simply because some of its members were disliked by another faction of the faculty.

[30] Beginning in Fall 1999 the School of Humanities and Arts was renamed Humanities, Arts, and Cultural Studies. Cultural Studies was no longer listed as a special cross-school program, and there was no further effort to create an interdisciplinary curriculum that integrated the humanities and social sciences. There was also no systematic effort to rework the humanities curriculum. The addition of Cultural Studies to H&A's name simply signified that the School's faculty and curriculum were not constrained by the subject matter or modes of analysis of the traditional humanities and arts. This general opening up seems to reflect the national fate of cultural studies, which seems not to have been strongly institutionalized in spite of widespread, important, though diffuse, influences on the humanities, anthropology, and sociology.

[31] Cognitive Science ultimately recovered one of the philosophy positions but lost the other one.

[32] The Fall 1998 catalog listed the "Experimental School of Cognitive Science." By Fall 1999 the scarlet letter was removed, and the School was listed simply as "Cognitive Science."

[33] Symbolic AI, i.e. AI that relied on rule-based manipulation of structured symbolic expressions collapsed during the 1990s. Approaches based on the ability of machine-learning algorithms or artificial neural networks to extract patterns from large data sets became progressively more dominant in the first 20 years of the 21st Century.

[34] Students were required to take a course in four of five distribution areas. *Mind, Brain, & Information* was one of the areas.

[35] My own interest in what would come to be called cognitive science began with an undergraduate interest in game theory.

[36] In 1990 Mark Feinstein and I developed an intermediate-level course called *The Construction of Knowledge,* which attempted to integrate material from epistemology and philosophy of science, decision theory, Bayesian reasoning, work on heuristics and biases in cognitive psychology, and social contructionist theory. Sadly, we did not have the time to continue to develop the course after a couple of iterations, but I believe that we were on to something about the potential of cognitive science as a vehicle to explore this territory.