Imagining Reproduction in Science and History

Roger Pierson and

Department of Obstetrics, Gynecology & Reproductive Science, University of Saskatchewan
Royal University Hospital, 103 Hospital Drive, Saskatoon, SK S7N 0W8, Canada

Raymond Stephanson

Department of English, University of Saskatchewan, 9 Campus Drive, Saskatoon, SK S7N 5A5,
Canada

Abstract

Reproduction is at the core of many aspects of human existence. It is intrinsic in our biology and in the broad social constructs in which we all reside. The introduction to this special issue is designed to reflect on some of the differences between the humanities/arts and the sciences on the subject of Reproduction now and in the past. The intellectual/cultural distance between humanists and reproductive biologists is vast, yet communication between the Two Cultures has much to offer in guiding future research, pedagogy, and social policy. The challenges to communication include differences in methodology, professional protocols, specialization, and the increasing speed with which reproductive technology advances. The solutions require a new kind of student who can learn and adapt the approaches from both sides of the disciplinary divide to create new ways of understanding how our current and future concepts of reproduction may be informed by the past. This co-authored introduction reviews the range of interests represented in the essays and represents first steps of a dialogue between a humanist and a reproductive biologist who chart some of the possibilities on what the future of the subject might hold.

Keywords

Reproduction; Humanities; Science; History; Imaging; Transdisciplinarity

Introductory Remarks

[Note: [RP]=Roger Pierson; [RS]=Raymond Stephanson.]

In October 2007 at the University of Saskatchewan, we hosted an interdisciplinary workshop featuring eleven experts in both reproductive biology and the history of early modern sexuality and reproduction (especially for the ‘long’ eighteenth century, 1650–1800, when reproduction or “generation” came into its own as a recognizably modern subject). That meeting was largely funded by the Social Sciences and Humanities Research Council of Canada, and we gratefully acknowledge that support here. The participants came from Canada, the US, and the UK, representing departments of history, art and art history,

English, veterinary medicine, psychology, obstetrics and gynecology, and reproductive technology and sexuality. The idea was to invite these experts to present aspects of their work that could lead to discussion of how the humanities and medical sciences might collaborate in teaching such issues, or how forms of collaboration might generate new research initiatives bringing together the science, history, literature, and art of reproductive biology. As a part of this gathering, we mounted a gallery of some fifty images representing early modern and contemporary reproductive physiology. Those gallery images—along with the workshop program, list of participants, and sponsors—can be found at <http://www.usask.ca/english/jmh/>. [RS]

The collection was comprised of approximately half from historical sources and half from the most current imaging technology. The early images represented some of the earliest enlightenment visualizations of the female and male reproductive organs from the works of the great anatomists. The modern images were generated using radiography, computed tomography, ultrasonography, magnetic resonance imaging and computer-assisted enhancements of images from those sources. When we curated and assembled the gallery of images, we wanted to somehow symbolize the path that we had taken to come to the point of organizing the conference and to have the participants and gallery visitors start from the most basic visualization and understanding of the gametes and organs involved with reproduction through early visualizations of the embryo and fetus. We finished the gallery with images depicting obstetrical positions and complications of delivery. The gallery was imagined to take viewers along a visual and conceptual path with images from historic and modern medical images juxtaposed to show imaginings of early notions with the products of current microscopic and/or imaging technologies. This almost contrapuntal style was carried throughout the conference. Examples of the idea are exemplified by Leeuwenhoek's drawings of what sperm and egg might look like alongside Hartsoeker's preformationistic sketch of a sperm homunculus juxtaposed with color-enhanced electronic micrographs of a human spermatozoan penetrating the plasmalemma of an oocyte (egg). Similarly, the elegant drawings of the reproductive organs by James Drake were juxtaposed with ultrasonographic and magnetic resonance images. [RP]

Our hope was that by stimulating exchange between experts who came to similar subject matter from very different disciplinary and methodological perspectives, we might be able to open new ground for how our research and teaching could benefit from cross-disciplinary work in the humanities and medical sciences. Six of those presentations are included in this special issue of the *Journal of Medical Humanities*. Before offering our editorial remarks about this collection of essays, we begin with a few observations about the challenges of this kind of interdisciplinary dialogue. [RS]

There is, predictably enough, a good deal of idealism attending professional encounters that seek to soften or remove the disciplinary boundaries and protocols that distinguish the humanities from reproductive biology. "If only we could sit down and talk to one another about what we really do, we might be able to get beyond specialized vocabularies and find some common ground." Or, "If only we could demonstrate that the present really can be explained in terms of the past, or the past in terms of present knowledge, we might be able to imagine collaboration of a new kind." Despite such hopes, the practical realities are

daunting, and given the meteoric rate of technological change in the medical sciences, the gap between the two professions may very well be increasing. Reproduction in its various manifestations—biological, historical, literary, technological, cultural, economic, political—is a huge subject, and one must ponder an obvious practical impediment to any complete fluency between medicine and the humanities: how many of us have the time and the intelligence that would allow us—in a single lifetime—to master the demanding disciplinary content and protocols of two subject-areas so far apart? There are some who have been able to accomplish this, but they are rare. The question, then, is how to improve the imperfect interaction between reproductive biologists and humanities scholars—professionals who speak different languages, who are trained to have different goals, and yet with the best of intentions seek to improve and extend their grasp of what Reproduction entails. [RS]

One of the most difficult aspects of the tremendous increase in our collective knowledge as we have come from the eighteenth century to the early part of the twenty-first is the reality that, regardless of our discipline, we are much less broadly educated than our counterparts of 300 years ago. Very few scientists or physicians working today have any sort of background in classical literature, philosophy or the humanities. Sadly, our education tends to be based in the challenges of learning the basics of the fundamental sciences such as physics, chemistry and biology. The explosion of knowledge in each has made it increasingly more difficult to master an even passing familiarity with them. We tend to opt for basic exposure to the elements required to understand the biologic systems that we will work with as we develop our own areas of specialization. New knowledge in physics, for instance, may be gleaned from review articles for small items of importance in our own field, but the rest is typically discarded. We hope that our junior colleagues and trainees may pick up on it as they develop their own areas of expertise. Nowhere in medicine or biology is this tendency more apparent than in medical imaging. As humans, our anatomy has changed very little over the past few centuries; however, the tools that we use to visualize our physical structure evolve at an ever increasing and accelerating pace. [RP]

To me there is a single clear answer: humanists must actually learn some of the basic science so familiar to the reproductive biologist, and the biologist in turn must learn to use some of the analytical tools necessary to engage the objects of humanist study. What we do not need are more of the following stereotypes: the reproductive biologist who views the Humanities primarily as the “soft” ethics component, viewing cultural history in anachronistic or romanticized ways; the humanist who views the Medical Sciences with Luddite suspicion, certain that new technologies are producing a generation of skilled medical specialists who are out of touch with important human truths or even with the contexts of their own cultural placement. These are exaggerations, of course, but they are also still prevalent views waiting to be replaced by a new generation whose formal training has required them to learn the language and praxis of both the reproductive biologist and the humanist. Cross-disciplinary programs such as this are still very hard to find in the English-speaking world, despite the now common phrase “medical humanities.” Our recent pedagogical experiments at the graduate level here at the University of Saskatchewan suggest that there is a strong interest in such training (http://rsm.usask.ca/imaging/docs/English802.6_Repro_Workshop.pdf). [RS]

In all of the sciences, information is increasing at a rate that challenges specialists to keep current in their own fields, to say nothing of allowing intelligent, diligent and motivated “others” to understand even the most basic of issues arising almost constantly in each sub-specialty area of science or medicine. Nowhere is the knowledge gap more pronounced than in reproductive biology. Somehow, we have known the basics of reproduction since the beginning of time. Sexual intercourse leads to pregnancy, and pregnancy leads to the delivery of a new generation of “us.” Obstetrics, when it works well, is a beautiful process. Delivery of a healthy infant is the source of some of our greatest joys. Complications in obstetrics embody some of our most profound apprehensions and terrors. The fundamental biologic realities of how our species propagates itself has created gender roles that have been embodied in different cultures in different ways. However, the discovery of the gametes and our understanding of how the genetic information in them combines to create a new individual have initiated an entirely new level of insights that have a profound effect on what it means to be human. We are now 31 years past the birth of the world’s first baby conceived via in vitro fertilization. In those 31 years, we have learned more about the reproductive biology of our species than we have known since the beginning of time. [RP]

Taken together, the essays we have collected here sometimes hint at the frustrations which are the inevitable by-product of the gap between the Two Cultures, but overall they also reflect an optimism about what might happen in future exchanges as we gain greater knowledge and expertise about the many-sided aspects of Reproduction in history and science. Eighteenth-century studies of “generation” are, at first glance, light-years away from current techniques in ultrasonography, but as this collection suggests, there are abiding concerns and issues both then and now which point to important common ground. The past and the present do indeed speak to one another, and we hope that these essays will help to shape future possibilities for discussions of medical humanities. [RS]

In many ways, the enlightenment era provides us with an ideal reference for understanding how scientific information in reproductive biology is created or discovered and then travels from the scientific/medical elite into the mantle of “culture” and then into the working knowledge of lay people through education, literature and art. There is much that we can learn from an historic approach that we may be able to apply to our present state of knowledge and imagine how it might look in the future. We hope that by integrating the insights of what we would probably term the humanist and scientific communities, we may be able to elucidate how the tremendous volume of information about reproduction that we are generating each day may be made available and understandable to everyone who needs or desires that information. This work will have a profound impact on our global culture and on the manner in which we pass our genetic heritage from generation to generation. [RP]

The essays

Seeing reproduction

As the gallery of images makes clear, the ways in which we “see” reproduction is not entirely dependent on our technical capacity for imaging. Seeing also means how we imagine reproduction, or how we might render our visions within an aesthetic tradition or through visual protocol. And both kinds of seeing—technical imaging and the scenarios

projected by the human mind—are also located within cultural and historical parameters that condition and, in some respects, determine the meaningfulness of the visual. Three of the essays—by McTavish, Hughes, and Harvey—ask questions about *how* we see reproduction, either as the technical offerings of medical science now and in the past or as the amateur visualizations by clients seeking therapy for their infertility. [RS]

What is most striking about the gallery in its entirety (go to <http://www.usask.ca/english/jmh/>) is the extraordinary beauty of the images. The combination of artistic composition, technical clarity and information visualization in the exquisite drawings of D'Agoty, Da Vinci, Drake, and Smellie is, I believe, unparalleled in any discipline. Similarly, the selection of images reflecting the internal structures of spermatozoa using transmission electron microscopy and computerized enhancement and the progression of early human embryologic development colored using digital interference microscopy, three-dimensional ultrasonography and magnetic resonance images is astounding when viewed together. One wonders how the understanding of the underlying processes may be enhanced by the beauty of the rendering. [RP]

Lianne McTavish's "Practices of Looking and the Medical Humanities: Imagining the Unborn in France, 1550–1800" is a provocative discussion of "visuality," or the habits and histories of how we learn to give significance to what we see. Suggesting that modern medical students might well have something important to learn from art history, McTavish highlights an important aspect of imaging we may often forget to notice: "not all visual representations are meant to look like the thing they represent." In examining the ways in which seventeenth- and eighteenth-century images of the fetus are sometimes at odds with the accompanying textual directions or offer diagrammatic sketches representing ideas and concepts rather than realistic portrayal, she throws into relief the larger question of how images—then and now—portray anatomical knowledge through specific visual conventions that carry their own implications for hierarchies of medical authority and identity. Her invitation to medical students to contemplate the history and habits of their own "visuality" imagines an exchange of visual skills whereby current practitioners can analyze the ways that different imaging technologies—MRI, ultrasonography, microscopy—are both about the human body as well as schema that image ideas and interventional possibilities equally about competing medical authority and the history of medical imaging itself. The superiority of one medical image over another, she suggests, is not a simple issue of visual replication. Reproductive imagery carries a much greater workload than merely showing us the thing itself. Then, as now, "seeing" is also about status and strategy—simultaneously about rendering reality and serving the needs of other professional purposes. [RS]

But of course imaging and imagining reproduction are not the special preserve of experts in reproductive biology, clinical practice, histories of medicine, art history, or sophisticated imaging suites. Edward Hughes's "Art Therapy as a Healing Tool for Sub-fertile Women" reformulates the subject of "seeing reproduction" by reminding us that non-experts, too, have a vested interest in imaging and might well have something significant to contribute. Asking how women who desire pregnancy might find relief in their self-imaging of emotional stress, Hughes's therapy draws attention to an obvious but profoundly important dimension of human experience: "Sometimes," he writes, "words just aren't rich or safe

enough” to give expression to deep emotional complexity. Guilt, fear, anger, pain, stress, depression, difficulties of communication: these are the most typical experiences accompanying the frustrations and failures of fertility, but if they cannot easily be vented or eased through language, then why not through a visual symbolism about reproduction? The collective impression generated by the artworks made by clients is that “seeing reproduction” is also heavily laden with personal meaning related to body image, family and social relationships, community status, and intense feelings (and doubts) about self worth. Imagining reproduction also includes that increasing population of heterosexual couples who have difficulty conceiving, and Hughes’s work at the McMaster University Fertility Clinic is a timely reminder that there are innovative ways to help people deal with reproductive failure. But one also wonders about the status of art more generally in reproductive biology. Will personal artistic expression also come to have a place in successful pregnancies? Will other arts such as music be used to negotiate the space between specialists and clients, or to help individuals to “see” or “hear” reproduction in their own personal ways? Will the arts play an important therapeutic role? [RS]

How do historians and scientists view medical images differently, and why? This is, in part, the subject of Karen Harvey’s “Visualizing reproduction: a cultural history of early-modern and modern medical illustrations.” Focusing attention on the gallery of images, she proposes that studying *what* an image depicts and *how* it does so might shed light on the very different agendas of the cultural historian—who approaches such imagery looking for the deep unwritten rules of a culture—and the reproductive biologist, who approaches the imagery as a means of instruction, diagnostics, and medical practice. Reviewing historical studies which have examined imagery from the earlier period, she points out how often scholars have noted the disappearance of the mother’s body in many of these engravings, or how the female subject is sometimes represented within visual contexts associated with erotica, or how severed female bodies seem to hint at some violence. But she also remarks on important differentiations that need to be made between images designed to teach practical skills (as in the case of William Smellie) and those that serve as an atlas of anatomical parts and positions (as in the case of William Hunter). She reminds us that an image containing what might seem to be a case of violence towards the maternal body must also be read against the accompanying text, which can reveal (at least in Smellie’s case) a deep level of care and concern for both mother and baby. Moreover, the images from Smellie’s and Hunter’s influential books need to be placed within an art history of medical representation, she suggests, where a combination of realism and modes of high culture achieve Hunter’s aim of producing engaging images that, in his words, “convey clearer ideas...than words can express.” As Harvey points out, while “These are dead babies in a book about saving babies,” the images are also about then-current cultural fashions governing aesthetic display. In her brief endnote about today’s imaging of reproductive biology, she notes that specialization has all but removed realism from the scene and, that while modern imaging techniques might also be informed by a cultural aesthetic, they do not serve as simple counterparts to the early modern images whose cultural freight is so much more evident. Instead, modern imaging heralds a defamiliarization of the pictorial object which is about conferring authority on the medical expert who can read it correctly. [RS]

Together, these three essays pose interesting questions about “seeing reproduction” and about the importance of one’s vantage point. An early modern art historian, an infertility specialist, an early modern cultural historian, clients seeking pregnancy: inevitably their ways of “seeing” are directed by different purposes and agendas and involve very different language and patterns of recognition. Is there value in bringing these various perceptual models together? We believe so, if only to discover that the future of reproductive study in its many contexts will be richer and more unified when the spaces between client and professional, art and medicine, history and technology, and the humanities and sciences have been reduced. [RS]

Reproduction and data

One of the most fascinating exchanges between humanists and scientists at the conference was the attempt to understand what the other side meant by evidence, data, “facts.” Truth is not so plain a matter as we might wish, and while some humanists wondered at their science colleagues’ cheerful acceptance of technology as truth, the scientists for their part wondered how reading a bunch of books could constitute hardcore evidence or offer any guarantee of truth about the past. Of course, matters are somewhat more complicated than this caricature, and it turned out that scientific debates and issues of trust about what hi-tech imaging can tell us are mightily complex and vexed issues. And on the humanities side, too, the question of how credible explanations of historical truth can be gleaned from the written record involves a demanding but often imperfect rendering of probability. In both the sciences and the humanities, the common ground is that we interpret evidence and data. At its smallest constituents, data might be incontestable and therefore a “fact”; but the more complex the system—whether biological or cultural—the more room there is for debate and contest about truth, and the more reason there is to expect that non-empirical issues such as politics, economics, morality, or private interests might color the discourse. [RS]

It was particularly interesting that the humanists shared a collective background of having read the same “classic” tracts, treatises and literature and were able to comment upon those works from their own disciplinary perspectives. Only one of the scientific participants had read approximately half of the material that arose in discussion and had no disciplinary perspective on any of it. The material was simply not judged to be germane to scientific discourse. In contrast, the backgrounds shared by the science-based participants were limited to the basics of fundamental science common to all disciplines in the biosciences. The professional specialization following the basic education had taken each participant into areas where the sense of common ground had long since faded. [RP]

Unfortunately, this collection of essays does not include such a discussion from the reproductive biology side, but Allison Muri’s “Imagining Reproduction: The Politics of Reproduction, Technology and the Woman Machine” offers a searching account of the position-laden bias in some humanities research on the history of reproduction from the early modern period. Some feminist explanations of the shift from the older term “generation” to “reproduction” have posited a historical move from a more natural and disorganized female context (midwife) to a more rational and mechanized male context (man-midwife, obstetrician, forceps), with the mother increasingly viewed as a baby-making

machine and the fetus as product. With the increased mechanization of a male-driven technology, reproduction abandoned natural processes and instead valued mechanical efficiency above all else, with the result that “generation”—associated with a feminized Nature—was replaced in the late eighteenth century by the newer “reproduction,” a word now carrying the values of the industrial revolution and the technological obsessions of the male medical practitioner. Examining earlier feminist histories from the 1980s whose work has had significant influence on subsequent feminist scholars, Muri suggests that such interpretations are perhaps predictable outcomes of an earlier feminist model inclined to oppose male structures, but that such politics have not necessarily produced accurate accounts of the historical data. According to Muri, “these narratives of masculine mechanization and instrumentalization, machine-mothers, and product-progeny” sometimes rely on an anachronistic understanding of the implications of key terms as they were used in the eighteenth century to describe bodies, conception, birthing, or medical practice—words such as “mechanical,” “production,” “produce,” and “reproduce.” Examining an array of textual evidence from the mid-seventeenth to the end of the eighteenth centuries, Muri argues that, in fact, “reproduction” was used well before the end of the eighteenth century, and that many of the key terms explained by some feminist scholars as negative signs of an emerging male technology or a “woman machine” were in fact much more complex in their usage, often implying a rather different set of meanings than what these historians sought to find. In assessing the politics in some of this scholarship, Muri asks us to reconsider the original data and to challenge what have been accepted by many scholars as self-evident truths about the history of reproduction. [RS]

Yet, from a reproductive science perspective, it is only the Y chromosome that makes members of our species male or female. And, for some reason, the Y chromosome carries no vital genes as approximately half of the members of our species do not carry it. We do know that the number of genes encoded on the Y chromosome has decreased dramatically over the past few millennia, and the current scientific postulate is that it may disappear completely over the millennia to come. Similarly, the language regarding the changes that have occurred in our production of food animals as our population has increased have begun to creep into our lexicon about human reproduction. Produce and reproduce are very close in origin. Indeed, in vitro fertilization, genetic selection, and cloning technologies were developed as means of passing genetic traits considered “desirable” through the generations more rapidly than previously possible. Humans desiring more control over their own reproductive processes and the qualities expressed in their offspring now approach fertility clinics and disease screening clinics to avail themselves of the fruits of modern technology. These observations leave us to wonder about the integration of culture, gender roles and the future of human reproduction. [RP]

There is an important implication that comes out of Muri’s essay, one that draws attention to similarities between the humanities and sciences. Not unlike current developments in reproductive biological knowledge and technology, the humanities too debate and ‘experiment’ with data which, over the longer haul, are finally standardized as fact (or agreed-upon explanation) by the most compelling and credible account of the evidence, forcing other scholars to submit to the new paradigm or put up something better. And, what is received truth by one generation of experts might well be replaced by the new technology

or new account of historical evidence brought into play by the next generation. But the rate of change is different in each case. For the humanist, the question might be, “What will studies of the history of reproduction be like ten or twenty years from now?” For the medical practitioner and researcher, the question might be, “How will rapid technological change over the next two or three years disrupt some of our most basic assumptions about what reproduction entails?” [RS]

Reproduction and the people

The knowledge traffic between specialist and Joe/Joan Public will always be an important consideration in any attempt to understand what “reproduction” means in a general population. How do people come to have understanding about reproductive biology? How is medical knowledge received or deployed by a population at large? What are the practical implications of misinformation and myth in the public mind? How can a general population of non-experts be involved in creating medical knowledge? What do medical practitioners have to learn from Joe and Joan Public? Questions such as these are especially important today where public policy makers must somehow deal with the deeply complex ethical and social ramifications of new reproductive technologies. But similar questions reach back in history, as well, where older pseudo-knowledge systems typically permeated newer cutting-edge science, with the result that the collective imagination of a population could affect medical practice. The essays by Smith and Nisker explore that very interesting middle ground between client and practitioner, citizen and policy maker, popular knowledge and medical specialization. [RS]

Lisa Smith’s “Imagining Women’s Fertility before Technology” targets one aspect of reproduction—menstruation—and sifts through seventeenth- and early eighteenth-century French women’s remedy collections, medical consultation letters, and medical treatises to demonstrate the extent to which older humoral theories about the body continued to inform perceptions about reproduction even though newer approaches to generation were available. The ancient humoral model of the body imagined a balance among the four humors (blood, phlegm, black bile, yellow bile) and the four qualities (hot, cold, wet, dry). The retention and discharge of fluids were the key visible symptoms of health, and very often a stoppage or excessive discharge were read by patient and doctor alike as signs of more than one bodily disorder. Menstruation was a particularly striking instance of the tenacity of the older humoral model, which viewed a cessation of the menses as not being automatically associated with pregnancy but just as easily as a sign of lung ailments or liver disorders. In the economy of bodily fluids, a plethora of blood could be relieved mechanically by blood-letting or naturally by the body itself, either through hemorrhoids or menstruation, but the logic of such a system placed hemorrhoidal and menstrual bleeding on a common ground with a common cause. Fertility was not linked in any necessary way to menstruation, but rather was to be found on the exterior of women’s bodies where specific tokens of good health or humoral balance were believed to be predictive of fecundity. Medical doctors, too, could be purveyors of the older concept and its rhetoric, despite the new empirical knowledge making quick headway through northwestern Europe at this time. Then as now, there is a lag between new knowledge and its deployment, not just for non experts but also

for medical practitioners who occupy a lesser position on the hierarchy of specialized knowledges. [RS]

Jeff Nisker's "Theatre and Research in the Reproductive Sciences" offers a personal essay on his experiences writing and using drama to bring to the general public complex ethical questions about preimplantation genetic diagnosis and other complex policy issues. Recognizing the limits of medical "reason" and technology to explain to non-experts the issues and challenges of reproductive science, Nisker turned to the powerful impact of narrative and story-telling as vehicles for empathetic understanding and the communication of difficult technological options and their policy implications. Could theatre "combine to provide audience members with understandings of research findings," and, could audiences then provide valuable feedback about the scientific and social issues in reproduction and genetics? Nisker's innovative approach puts Joe and Joan Public—potential clients, patients, tax payers, citizens—back into the picture of medical specialization where crucially important political decisions about policy will have to be made. Two questions arise: Will the arts play a unique and important role in bridging some of the gaps between specialists and non specialists when it comes to the vital task of developing public policy? Will experts in reproductive biology need to do a better job of carrying information to the public so that it is adequately informed? [RS]

In different ways, both essays frame a central problem: how can the two subjects—the all-important reproductive bodies of ordinary people and the social implications of highly sophisticated reproductive procedures—be given a chance to communicate? [RS]

Moreover, a broader question arises as reproductive biology information is increasingly available in the popular press and from internet sources. It is, "how does the scientific/medical elite ensure that the lay public has access to current, accurate information?" Similarly, whose role is it to insure access to that information? It appears that developing new information on human reproduction and the application of that information in clinical settings is driven by an increasingly aware and affluent society. I have been a member of local, national and international ethics in human reproduction committees for over 20 years. Almost constantly, there is a demand for the application of some new discovery/technology gleaned from a popular press (mis)interpretation of a scientific report. The affluence of our population and their increasing ability to travel have made global shopping for reproductive technology and individuals with the technical skills and cultural ethos to use them a mainstay of at least two ethical discussions. They are firstly, whom do we entrust with the knowledge and secondly, how is its application controlled? The answers, I am sure, will not arise from a single disciplinary approach to understanding reproduction. [RP]