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INTRODUCTION

Temporalities of reproduction: practices and concepts from the eighteenth to the early twenty-first century

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Reproduction is of central interest to the history of the life sciences. Yet our knowledge of the epistemological, scientific and political changes in the history of reproduction over the last two hundered years remains fragmented and limited. Existing studies usually focus on specific epochs—such as the eighteenth century, when the concept of reproduction started to circulate in the context of the emerging sciences of "the living", or the reproductive sciences and medicine of the twentieth and early twenty-first centuries.[1] Attempts to investigate scientific concepts and practices of reproduction and their social, political and cultural contexts from an interdisciplinary and *longue durée* perspective are still rare.[2] Our special issue contributes to filling this

[1] See, for example, Benninghaus (2005), Clarke (1998), Franklin (1997), Franklin and Ragoné (1998), Orland (1999), Schreiber (2007), Wilmot (2007).

[2] A research group "Generation to Reproduction" at the Department of History and Philosophy of Science at Cambridge University is currently investigating long-term shifts and transformations in the history of reproduction from antiquity to the present. A volume edited by Nick Hopwood, Rebecca

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lacuna by specifically addressing questions of time and temporality in the history of reproduction from the late eighteenth to the twenty-first century.[3]

"Reproduction" itself, along with related processes such as "procreation", "heredity" or "birth", has an essentially temporal dimension. These processes have been conceptualized according to very different notions of temporality: chronological, linear, circular or reversible time structures. Changing views of reproduction also imply very different understandings of continuity or discontinuity in the history of life sciences. Moreover, since the eighteenth century, processes of coming into existence of living beings, such as "generation", "heredity" and "reproduction", have been constantly constituted and reconstituted as a social and epistemic domain in which not only do scientific, technological and political projects intersect, but different—biological, social or political—notions of temporalities also meet. The "temporalities of reproduction" are embedded in shifting sociocultural time regimes, and are often closely related to ideas about societal change, historical variation, and notions of the "historicity" of nature and society.

Our aim here is to highlight interrelations between conceptualizations of time and of reproduction at various historical moments. Analysing specific research projects and experimental or medical practices on reproduction from the eighteenth to the twenty-first century, we ask to what extent these were linked to the emergence of new epistemological perspectives in the life sciences. We also explore interconnections between changing notions of time and reproduction and their articulations within new visions of society, gender relations and political agendas. The case studies we present address these issues in different ways depending on the specific materials and historical situations they deal with, and the authors draw on different historiographical narratives and analytical perspectives on time.

Despite these divergences, however, the authors share the basic assumption that time is not a physically or metaphysically given dimension of the world, but a social mode of orientation through which temporal dimensions are differentiated and a nexus of past, present and future is articulated. In that understanding, the analyses presented here accord with earlier groundbreaking approaches in studies either on temporal regimes in science, technology and society (e.g. Adams 1992; Adams et al. 2009; Elias 2007; Nowotny 1989) or on issues of "historicity" from general history (e.g. Hartog 2003; Hölscher 1999; Koselleck 1967, 2004). In the following, we present these reflections on the role of time in general history, history of science, and social studies of science in more detail. Our discussion focuses on three historical moments: the period around 1800, the late nineteenth century, and case studies from the twentieth and twenty-first century. This range allows us to situate the special issue's contributions within a broader historiographical and analytical context.

Footnote 2 continued
Flemming and Lauren Kassell will appear in 2015. Closely related to the history of reproduction is the history of "heredity", which has been a focus in the history of science during the last decade (see Müller-Wille 2014; Müller-Wille and Rheinberger 2007, 2012; Parnes et al. 2008; Parnes et al. 2005). For a *longue durée* perspective on the history of pregnancy, see Duden et al. (2002).

[3] This special issue results from research and debates in the research network "Economies of reproduction. Interdisciplinary research on the past and present of human reproduction, 1750–2010", funded by the German Research Foundation from 2009 to 2013.

1 The thesis of a "temporalization of nature" around 1800

As many scholars have pointed out, the term "reproduction" appeared and circulated in the second half of the eighteenth century not only in the study of nature (see Jacob 1993; Jantzen 1994; Rheinberger and Müller-Wille 2009, pp. 31–32), but also in other domains including political theory, philosophy and medicine (Jordanova 1995). The emergence of the term "reproduction" went hand in hand with a critique of established notions of generation and eternity. Proponents of epigenetic views, such as Pierre-Louis de Maupertuis, claimed that the creation of new living beings was not simply the enlargement of pre-existing germs, but a genuinely "new production" (Maupertuis [1745] 1966) that resulted from the mixture of the parental generative substances. Maupertuis emphasized that these productions succeed one another in the course of time, as opposed to being formed "all at once" at the "time of Creation" (ibid., p. 42). Similarly, Georges Louis de Buffon linked the concept of "reproduction", which he defined as "a power to produce its kind", to a vision of continuous time and organic nature—"a continuous chain of individual beings" that in his view constituted the "species" (Buffon 1749, p. 18). When the term "reproduction" surfaced in debates among naturalists and philosophers, therefore, issues of temporality were clearly at stake. However, the shift "from generation to reproduction" indicated by Roger (1997, p. 116) did not necessarily imply that a uniform concept of "reproduction" or coherent understanding of temporality was emerging from the eighteenth century onwards (see Lettow 2014). A key aim of this special issue is precisely to explore how a *range* of understandings of reproduction were formulated and coexisted from the eighteenth century. This leads us to query the thesis of a "temporalization of nature" around 1800 that has largely predominated in the twentieth-century historiography of the life sciences.

The notion of the temporalization of nature is usually attributed to Arthur Lovejoy, who in *The Great Chain of Being: The Study of the History of an Idea* (1936) claimed that until the eighteenth century "an absolutely rigid and static scheme of things" prevailed (Lovejoy 1964, p. 242). The "temporalizing" of this scheme, according to which nothing "new under the sun" can happen, was "one of the principal happenings in eighteenth-century thought" (ibid., p. 244). Authors such as Temkin (1950), Foucault (1974), Jacob (1993) or Lepenies (1976), to name but a few, also claim that until the end of the eighteenth century, a static understanding of time characterized the study of nature. They argue that premodern natural history, concerned with collecting, describing and classifying the plants and animals created by God at the beginning of the world, did not conceive of nature in terms of temporal change. Lepenies, for example, follows Foucault in describing the temporalization of nature as a process that began in 1775 and had ended by 1825 (Lepenies 1976, p. 16; see Foucault 1974, p. 221).[4] By then, Lepenies claims, "the historical point of view" had come to prevail in science (Lepenies 1976, p. 16). In a similar way, Timothy Lenoir argues that the formation and development of biology

[4] François Jacob also contributed to this picture, although in his account the transformation begins earlier, in the eighteenth century (Jacob 1993, pp. 130–152).

issued from a unified "historical way of seeing", articulated by late eighteenth century philosophers and naturalists including Immanuel Kant or Johann Friedrich Blumenbach (Lenoir 1985, p. 100; see also Lenoir 1990). According to Lenoir, these scholars introduced a specific research programme—he characterizes it as "teleo-mechanist" (Lenoir 1982, p. 12)—which was then implemented by early-nineteenth-century embryologists such as Karl Ernst von Baer and cell theorists such as Theodor Schwann.

The historical narrative that builds on the "temporalization of nature" has largely dominated historiography in this field. However, it has also been explicitly or implicitly criticized by various scholars. One major criticism focuses on the opposition of a premodern, static and atemporal order of nature with a modern, temporal or "historical" one. In this perspective, Arno Seifert has radically questioned the notion of an atemporal premodern knowledge of nature by demonstrating that diachronic histories of nature were in fact formulated in early modernity. He argues that eighteenth-century naturalists and philosophers reverted to these earlier diachronic histories, but interpreted them in radically new ways. Rather than setting a premodern, atemporal view of nature against a modern, temporal one, Seifert highlights the interplay between ideas of change and static visions of nature throughout the early modern period (Seifert 1983). In common with Seifert, Stefanie Stockhorst has also proposed to investigate how multiple concepts of time—linear, progress oriented, circular—overlapped during the eighteenth century (Stockhorst 2006). Other scholars have analysed Buffon's views of time and "natural history", producing a highly differentiated picture of his account of temporality (Hoquet 2010; Rheinberger 1990). In particular, Hans-Jörg Rheinberger shows that Buffon, the author of the *Histoire naturelle* (1749–1788), worked with a rather complex understanding of temporality. "The species as a unit of reproduction" in Buffon's work, Rheinberger states, is "on the one hand defined by its duration and, by preserving itself as such" over time, clearly "non-historical" (Rheinberger 1990, p. 206). On the other hand, the species "is constitutively temporal in nature, insofar as it realizes itself through the becoming and passing of individuals and thus, as a system, is based on the temporal structure of its elements: the condition for the preservation of the whole is not the *preservation* of its parts—which are, precisely, transient. Rather, the *reproduction* of temporally limited units is what makes it temporally unlimited" (ibid., p. 207; see Lettow 2014). In addition, the historians Dietrich von Engelhardt and Peter Hanns Reill have contrasted concepts of time formulated by late-eighteenth-century naturalists with those that took shape around 1800 in the context of *Naturphilosophie* (von Engelhardt 1979, 1988, 1990; Reill 2005). Reill argues that the *Naturphilosophen* differed from "Enlightened vitalists" in that whereas the vitalists had an interest in ambiguities and the multiplicity of temporal forms, the *Naturphilosophen* envisioned organic processes based on the idea of temporality as a circular process and on the nostalgia for a return to the "origin". Reill interprets this shift as a process of "detemporalization" that resonates with experiences of uncertainty and chaos in the wake of the French Revolution (Reill 2005, p. 217). He argues, too, that notions of equality between the sexes and of gender ambiguity were increasingly replaced by ideas of gender polarity and hierarchy (Reill 2005; see also Vienne 2014). Against the

background of Reill's study, the "temporalization of nature" appears as a process that involved not only multiple but also politically contested understandings of time, reproduction and gender difference.

Drawing on these critical insights, this special issue aims to contribute to reassessing the historiographical narrative that is grounded in the thesis of the temporalization of nature. It is no coincidence that several authors have chosen to base their reflections on embryology. Embryology played a crucial role in opening up new perspectives on the study of reproduction in the eighteenth and nineteenth century. In her article, Janina Wellmann examines the concept of "development" introduced around 1800 by analysing Caspar Friedrich Wolff's theory of epigenesis along with Christian Pander's and Karl Ernst von Baer's theory of germ layers. Her study reveals that in all three cases the formation and development of the embryo was conceived of not in terms of a linear and chronological time, but as an ordered and orderly alternation of repetitions and variations, movement and rest. For Wellmann, what changed around 1800 was not merely that nature was now conceptualized as temporal and changeable. Rather, the organic world was apprehended as being subject to a certain "rhythmic" structure. "Rhythm", Wellman explains, "may be a temporal structure, but unlike the continuous flux of time, it implies the restriction of the flux in favour of a rule." Proposing that rhythm became a central epistemological category around 1800, Wellmann asks how it shaped the emergence not only of biology and modern embryology, but also of other areas of knowledge and culture. In particular, she shows that envisioning the living world in rhythmical terms informed music and aesthetic theories at the turn of the eighteenth to the nineteenth century (see also Wellmann 2010).

In her contribution, Florence Vienne undertakes a close analysis of the concepts of development, history and time set out in Karl Ernst von Baer's 1827 study of the mammalian egg. She shows that Baer's research on embryogenesis aimed both to explain temporal changes and to inscribe the formation of new individual organisms into a continuous, unending organic process. For Baer, processes of becoming and passing away were only partially subject to time—and thus to history—because ultimately they were always determined by a higher, ideal and stable order. Confronting Baer's views with other explanations of embryogenesis arising in the 1820s and 1830s, Vienne further proposes a new way of reading Baer's discovery of the human ovum. In the literature, no account has hitherto been taken of the fact that Baer's discovery was also a response to the attempt by two of his contemporaries, Jean-Baptiste Dumas and Jean-Louis Prévost, to attribute embryogenesis to two different sex-specific generative substances. By highlighting divergences in Baer's and Dumas and Prévost's visions of organic formation, especially as to their view of the role of gender differences in reproduction, Vienne argues that biology emerged not from a homogeneous concept of developmental history, but out of various and even opposing views. These divergences also explain why—contrary to a well-established narrative in the history of science—the birth of biology did not entail the end of all natural history's classificatory and static thought models.

The more differentiated picture of the "temporalization of nature" offered by Vienne and Wellmann indicates why the shift "from generation to reproduction" was not straightforward and sudden. It is true that around 1800 very few naturalists

still adhered to pre-existence theories. However, the epigenetic views that were articulated in the first decades of the nineteenth century did not simply follow up the notions of "production" and "reproduction" introduced by Maupertuis and Buffon around 1750. For Maupertuis and Buffon, these notions had implied the existence of an organic continuity between both parental organisms and their offspring, yet most early-nineteenth-century embryologists and physiologists did not envisage a material male contribution to generation. They saw new life as resulting from basic organic entities and structures that were not sex-specific. Baer, for example, believed that new life originated in a basic organic entity distinct from the female generative substance. Moreover, the process of organic formation, like any other development in nature, did not result from organic material alone, but was largely determined by immaterial, eternal principles. For Baer, the engendering of a new being was ultimately the expression of these principles rather than a new production by two sexes. Thus, the understandings of generation that prevailed in the first half of the nineteenth century differed significantly from those of the eighteenth century and of the second half of the nineteenth century. To assume that the notion of "generation" proper to seventeenth- and eighteenth-century pre-existence theories was replaced around 1800 by today's concept of reproduction fails to account for the multiple visions of time and history that emerged between the late eighteenth and the late nineteenth century.

2 Notions of past and future in the late nineteenth century

Early-nineteenth-century views that changes at the level of individual organisms or species were largely determined by immaterial and stable "principles" or forces collapsed in the second half of the nineteenth century. Furthermore, late-nineteenth-century evolutionary theories boosted the importance of the nexus of past and future: not only did living organisms and species develop in time, but time became a historical and dynamic force that shaped the natural world (Jacob 1993, pp. 160–177). The living world was now an entity undergoing continuous, but also productive, changes. An important implication of this shift was that no immutable order determined the future of living species. Rather, their evolutionary future acquired the potential to be shaped by accidental and contingent effects. Closely linked with the formulation of evolutionary theories, new research perspectives on heredity and reproduction emerged (Gayon 1998; Müller-Wille and Rheinberger 2012). As Jonathan Hodge has shown, Charles Darwin, author of one of the first biological theories of heredity, was also deeply interested all his life in understanding the hidden mechanisms of reproduction (Hodge 1985; see also Endersby 2009).

If evolutionary theories supported new views of the temporal nexus of past and future in the mid-nineteenth century, the direction changed around 1900. At this time, the emerging field of genetics advocated a concept of temporality that explicitly disregarded issues of "history"(in the sense of past genealogies of traits) and was much more concerned with the future of a population (Rheinberger and Müller-Wille 2009). Genetic inheritance, understood as a process of recombination

of genetic elements, was often compared to the structuralist combination and recombination of chemical elements rather than to the transmission of "something" from one generation to another in the process of time. This meant a shift from a diachronic to a synchronic view. It was accompanied by the shift from a focus on the vertical (genealogical or evolutionary) line of descendants towards a focus on the horizontal (genetic) relationship within populations. As Müller-Wille (2007) and Bonneuil (2008) argue, these changes were related to the emerging norms of standardization in the context of late-nineteenth-century waves of industrialized breeding research. They interpret the changing focus in heredity research—from evolutionary variations to genetic purity and stability—as influenced by industrial values in agricultural breeding research, a process that went along with a new paradigm of temporal acceleration and a general orientation towards the future among the new geneticists (see also Thurtle 2007).

The case studies from the late nineteenth century presented by the contributors to this special issue are located in this broader historical context of shifts in evolutionary theories, heredity studies, and the emerging fields of genetics and eugenics. The authors add new insights to existing findings by considering developments in embryology, physiology and medicine that have so far received little attention from historians of science. Caroline Arni discusses the emergence of a new research interest in the "unborn child" and related questions about physiological and psychological trans-natal continuities. Antje Kampf investigates the medical concern with male germ cells around 1900. Both authors show that reproductive entities such as the sperm or the human embryo gained new meanings and became research objects in the context of new temporal regimes that affected what was understood as the historicity of the living. Arni and Kampf correlate these new research perspectives with wider social and political discourses—about contingencies, prognosis and the future of societies—that emerged in the late nineteenth century.

According to the classic studies by historian Reinhart Koselleck, ideas of a *historical* time (as a dynamic force in its own right) and the notion of the "otherness of the future"[5] that radically distinguished past experiences from future expectations developed only in the second half of the eighteenth century. This eighteenth-century constitution of a concept of "historical time" is crucial to understanding the discursive entanglement of ideas of political and social "progress" with ideas of scientific and industrial progress in European societies as early as 1800. Historicizing dominant time conceptions in Western societies, François Hartog has more recently argued that the nineteenth century saw significant changes in the regimes of historicity (that is, the historically shifting ways that societies articulate the relationships between past, present and future) (Hartog 2003). He identifies as the "modern *régime* of historicity" (Hartog 2013, p. 124) the predominance of the category of the future, and distinguishes this modern future orientation on the one hand from the past orientation that prevailed until the French Revolution, and on the other from a postmodern present orientation that has gained ground since the 1980s (Hartog 2003; see also Bevernage and Lorenz 2013, pp. 7–10). Although this scheme of periodization might be doubtful if taken in too monolithic a sense, there

[5] Koselleck (1967, 2004). On the contemporary relevance of Koselleck's work, see also Jordheim (2012).

are good reasons to argue that the category of the "future" became the central organizing theme in Western societies in, especially, the late nineteenth century. In his seminal study on the history of the future, Lucian Hölscher identifies the 1890s as a decade that brought a third wave (after first waves in the 1770s and the 1830s) of future-oriented discourses in Europe, when attempts to anticipate and predict future developments became more widespread and popular than ever before.[6] By the late nineteenth century, Hölscher argues, the Enlightenment idea of human progress had differentiated into a wide spectrum of social and political movements, transporting concepts that ranged from conservative to liberal, socialist, religious, anarchist or nationalist visions of the future of societies and mankind (Hölscher 1999, pp. 129–197). Arni's and Kampf's case studies in this volume forge fascinating historiographical links between these recent historiographical approaches to regimes of historicity and the history of medicine and life sciences.

But what precisely was at stake in the ways that the past, present and future were related to each other in late-nineteenth-century physiology? This question is at the core of Arni's case study, a central figure in which is the physiologist and psychologist William T. Preyer. In the 1880s, Preyer called for the scope of embryology to expand from the mere investigation of the formation of forms into an investigation of the physiology and psychology of the unborn child. The period before birth, but also birth itself and the very first moments afterwards, were to be investigated as crucial for the future physiological and psychological development of human beings. Arni's analysis of this new research perspective on the unborn and born child enables her to demonstrate that "the present and the future of the organism were [now] related to each other in the mode of a historical connection that on the one hand accounted for the continuity of the developing organism, yet on the other raised the question of contingency". Indeed, regarding the future as not predetermined by a stable order but the result of past and present events implied that the future could be endangered by the past and by all sorts of accidental causes. The pregnant woman's state of mind or her drinking habits, for example, were now perceived as potential dangers to the child's future health. In parallel to this new concern for prenatal "accidental" pathology, Arni points out, physicians of the late nineteenth century increasingly dealt with issues of heredity and degeneration. At issue here was another kind of "historical" continuity—a continuity not at the level of one individual life, but at the level of a given society or "race".

[6] According to Hölscher, we find a rupture of this future orientation as early as World War I, with far-reaching consequences: after the war, ideas became dominant that historical time is discontinuous, and the idea of historical time as a continuous whole (or the belief in the progress of culture and civilization) were deconstructed. "For a very long period of time, the past, the present and the future seemed to follow one another and beheld together like pearls on a string. Future events became present and then past, the past was seen as the precondition of the present, just as much as the present was a precondition for the future. But over the course of the twentieth century it became more and more obvious that such concepts no longer fit modern experiences" (Hölscher 2013, p. 139). As a historiographical consequence of this experience, the "present, instead of being a transitory moment, has become the centre of historical times: Many present moments follow one another not in a coherent sequence of past, present and future, but rather as moments independent from one another, each with its own past and future" (ibid.). Hölscher's analysis can be interpreted as an argument that the postmodern condition (with its disjunctive model of time and its orientation on the present) already started in the early twentieth century.

The complex interference between research on heredity, the notion of degeneration and the rise of eugenics around 1900 is an important theme in Kampf's contribution. Kampf analyses a medical debate on paternal transmission, syphilis infection and the effects of alcohol on the embryo that lasted from the 1870s to the 1910s. What makes this debate particularly interesting is that it involved discussions of various theories of heredity as well as engendering a significant number of experimental and clinical studies on aspects of male reproduction. Kampf's and Arni's case studies, although addressing different fields of research and medicine, converge in demonstrating how the category of the future came to play a predominant role at both the epistemological and the sociopolitical level. Towards the end of the century, the investigation and control of the reproduction of both women and men in the name of the future health of society or "race" came to be perceived as a key political agenda.

3 Reconceptualizing temporality: from twentieth- to twenty-first-century life sciences

Whereas major nineteenth-century concepts in the life sciences, such as "evolution" or "development", were closely intertwined with historically specific concepts of temporality or historicity, the research objects that have predominantly shaped twentieth-century approaches in the life sciences (particularly in the field of genetics) for long periods, such as statistical correlations, the "genotype", the "molecular gene" or DNA, seem to be conceived by scientists as remarkably timeless or atemporal entities; temporal issues are thus detached from a spatial order. The impression that the life sciences had become "atemporal" by the middle of the twentieth century is intensified by looking at the field of molecular biology in the 1960s–1980s. There, the molecularization and "informatization" of life, expressed by metaphorical transcriptions such as "genetic code" and "genetic information", led scientists to see genes and DNA as primarily molecular, not developmental, objects, often neglecting cellular and temporal processes (see, for example, Kay 2000). However, Evelyn Fox Keller shows that in classical genetics, and later in molecular biology, temporality is not exactly absent: more precisely, the temporal regime of these fields is that of eternity (Keller 1995). In her view, this dimension of modern biology follows much earlier temporal concepts that belong to a preformationist order of knowledge. In addition, molecular biologists' strong focus on DNA as the essence of life (as the only persisting informational substance over the long duration of organismic history, whereas the individual bodies pass away) bears a resemblance to Christian concepts of an immortal soul (Nelkin and Lindee 1995).

A massive change in temporal concepts in the life sciences has occurred over the past few decades, with shifts that are currently often referred to as an "epigenetic turn" or even "revolution" in biology. Instead of focusing on the gene, DNA or the genome as representing life, more recent biological approaches turn back to the cell and developmental phenomena. In addition, they point to the shifts in temporality undergone by the cell since being used as a technology in itself, for example in

cloning or stem cell research. These perspectival changes in the life sciences have also been discussed in recent approaches within science and technology studies, and very often the new temporal regimes of new biotechnologies are at the centre of such analyses—for instance ideas of reversibility in recent life science, the laboratory control of cellular and organismic time (Landecker 2005, 2007), or broader sociocultural regimes of anticipation, in which recent biotechnologies are seen as being embedded (Adams et al. 2009). The historical trajectories of these recent developments are also a topic of research. In her study *Culturing Life*, Landecker (2007), for example, investigates the development of tissue culture, and the consequent possibility of making individual cells grow outside of—and separately from—the living body, since the first decade of the twentieth century. According to Landecker, this technique ultimately uses cellular plasticity for the purpose of "operationalizing biological time" (ibid., p. 11). The biological events of development have been controlled such that "they happened when the scientist needed them to happen" (ibid.), as "the time of the scientist and that of the experiment do not necessarily square with that of the organism in question" (ibid., p. 12).

Similarly to Landecker, Bettina Bock von Wülfingen traces the material contingencies of instruments and organisms in the laboratory practices over a century—for the case not of tissue culture, but of research on conception. Her specific epistemological focus is on how the choice and use of instruments interacts with temporality. Bock von Wülfingen confronts two shifts with one another. The first is the shift from observing the living cell during conception to comparing static instances in stained material, set in linear time sequence, in the 1870s. The second is the shift from the use of molecular biological methods such as haplotyping to the introduction of microarray and large-scale computing in the past 15 years. In this study, following Griesemer and Yamashita (2005) and Schmidgen (2007), time refers to the time of the phenomenon (or research object), which, not unlike Landecker's findings, may contrast with the time of the researcher and the time of investigation. By stopping time through staining and fixation techniques, spatial visibility (for example of chromosomes) can be optimized. The resulting specimen slide functions as a "time container" (Doane 2005) that can be used at any time independently from object time. While the introduction of staining helped to align researcher time and object time in the nineteenth century, the second shift relates to biobanking, cryopreservation, vitrification and high-throughput computing in reprogenomics and epigenomics, which make it possible to have living and quasi-living objects at hand for the same purpose. This helped to bring space and time back into the material phenomena and their modelling in a genetics previously less interested in time.

Landecker's and Bock von Wülfingen's analyses are part of a larger group of studies in cultural anthropology and science and technology studies that have appeared since the end of the 1990s, focusing on temporalities in recent life sciences (e.g. Franklin 2007; Waldby 2002). The interest of scholars from these fields is often aroused by the impression that an ever closer intertwining of economics and science poses new challenges for society and the individual (Franklin 2007; Michael and Brown 2005; Nowotny et al. 2003; Nowotny and Testa 2010; Waldby 2002). Accordingly, these studies cluster in the life science fields that are most publicly

contested, such as genomics, cloning research, embryonic stem cell science or regenerative medicine.

With the focus on the cell, new bio-techniques have emerged that, according to bioscience and some science studies scholars, are capable of changing a fundamental trait of organisms, namely "organismic time" (Waldby 2002; see also Franklin 2007). Whereas irreversibility and unidirectional development typified the concepts of time used to describe the development of the organism around 1900 and in the early decades of the twentieth century (see, for example, Griesemer 2002), at the end of the twentieth century the cellular organism began to be understood as reversible (Brandt 2012, 2013; Cooper 2008; Franklin 2007, 2014; Nowotny and Testa 2010). According to Nikolas Rose, a major trait of modern biotechnology is that it enables almost all life processes to be "reverse engineered" and constructed in the laboratory (Rose 2001, p. 15). Adding to this, Catherine Waldby's economic analysis argues that "the manipulation of the time scales and trajectories of biological fragments is one of the major biotechnological strategies for the production of biovalue" (Waldby 2002, p. 314). In her view, the possibility of "capitalizing" the organism and of producing what she calls "biovalue" is grounded in biotechnologies based primarily on new possibilities of manipulating organismic time: "The biovalue produced by stem cell technologies depends on complex temporal reconfigurations, the engineering of cellular, embryonic and ultimately ontological time" (ibid.).

According to some analysts, the translation of biovalue into monetary value has involved not only laboratory techniques, but also social techniques such as promises and the production of hope (Brown et al. 2006; Cooper 2008; Sunder 2006). Melinda Cooper holds that these changes were accompanied by an orientation towards the future, in reaction to the perception of resource scarcity that dominated from the 1950s to the 1980s (Cooper 2008; see also Lafontaine 2009). In this discourse, the new cell technologies are seen as tools to overcome such limitations. The perception of limitation also relates to the promise of immortality that can be observed in reproductive and regenerative medicine (Lafontaine 2009; Waldby 2002). In a similar vein, Christina Brandt has interpreted the clone as a cultural symbol in the popular debates about science and technologies. The clone as something exempt from evolutionary history, she argues, fitted well with new tendencies to a "defuturization" of societies that took place in the 1970s (Brandt 2013, 2014): The "concept of an 'open horizon' or 'open future' was replaced by the notion of a projectable future—a future that was regarded as something that had to be (and could be) controlled with respect to technological risks, and, as a result, was now regarded as something that extends the present" (Brandt 2013, p. 78). To articulate this sense of a projectable future, Vicanne Adams, Michelle Murphy and Adele Clarke adopted the term "abduction", which means anticipating a calculable risk and warding off its danger by investing in specific measures (Adams et al. 2009).[7] Abduction "is the concept to capture the processes of tacking back and forth

[7] The term is derived from Peirce (1929), who describes constant uncertainty or fear as a favourable "weather situation for abductive lightning to strike, … it is a state of preparedness for being taken unprepared" (Peirce 1929, p. 270).

between futures, pasts and presents" (ibid., p. 251). According to these authors, anticipation, as a way of managing the future, "is not just betting on the future; it is a moral economy in which the future sets the conditions of possibility for action in the present, in which the future is inhabited in the present. Through anticipation, the future arrives as already formed in the present" (ibid., p. 249).

Analysing prenatal care in contemporary Germany, Eva Sänger's contribution draws on this work and details the temporal meanings of anticipation and prevention with regard to medical and everyday practices. Based on participant observation of ultrasound examinations in obstetricians' offices, her study traces how ultrasound scanning enables specific anticipatory modes of pregnancy management, and shows how different notions of temporality structure a highly risk-oriented prenatal care. Firstly, Sänger reconstructs how the attribution of risk around foetal growth in prenatal check-ups is based on the fragmentation of procreative time. She shows how measurable time units correlate with the normative standards of biometrics, which are checked at several moments during pregnancy. Procreative time refers to the time that the embryo needs to grow to a certain stage. It is therefore linked to a gestational age. That may differ from embryo to embryo at the same moment of measurement on a linear, but fragmented, time axis along which the pregnancy is monitored. Secondly, Sänger reveals how different time standards are involved in locating pregnancy in calendrical time. These time standards, she argues, depend on the medical apparatuses and procedures as well as on different cultural understandings of the temporal length of a pregnancy. Although it plays a major role in the enactment of anticipation and risk prevention, then, gestational time clearly has a "volatile dimension". Thirdly, Sänger shows how notions of foetal time and of everyday-life times are negotiated between obstetricians and pregnant women in the process of determining the due date. While obstetricians hold on to objectified, medical notions of time, the perception and organization of time by the pregnant women is, to a large extent, structured by gendered norms of familial time management.

4 Conclusion: towards a *longue durée* history of reproduction

As this volume shows, worries about the future development of the child, based in the prenatal or even conceptive environment, are in no way recent phenomena arising from visualization technology alone. The epistemology involved in the practice of ultrasound scanning recalls Arni's description of the historical shift in the late nineteenth century: the period after birth becomes connected with the prenatal period through "perinatal continuity". In Arni's view, this connection reignited the older question of the historicity of the living in terms of ontogenesis and phylogenesis alike. Like Kampf's contribution on the effects of syphilis and alcohol in reproduction as a sociopolitical issue of the decades around 1900, Sänger's article discusses reproductive time as precarious time, which is specifically important for preventive efforts in the anticipatory modes of obstetrical care. Arni's paper on trans-natal continuity as a new physiological and psychogenetic problem in the nineteenth century, Kampf's study of the investigation of male harm that turned

into harm mediated by the mother around 1900, and Sänger's analysis of today's pregnancy management all relate the present of the mother and the future of the child to societal structures and needs. Though they work on different historical time spans ranging from the early nineteenth century to the present, these three studies show how the idea of "acting now" in the name of the future became an imperative so firmly installed in the clinical care of reproductive times today.

As Fernand Braudel argued in his 1958 plea for a history of the *longue durée*, focusing on developments that cover long periods of time does not mean assuming a linear concept of time and history (Braudel and Colin 1987). On the contrary, historical shifts, ruptures and singular constellations—in short: change—can only be understood when contrasted with what remains stable and unchanged. "History", in this sense, comes close to what Hans-Jörg Rheinberger has called "historiality" (Rheinberger 1994, 1997, pp. 176–186) in an attempt to highlight the multiplicity of internal times within a certain research dispositif and to avoid the connotations of linear time that the notion of "history" has carried for so long. The focus on a multiplicity of temporalities is crucial for both the analysis of diachronic developments and the analysis of the synchronic entanglements of different regimes of temporalities in a given historical situation. The case studies presented in this issue analyse various epistemological, biological, political and cultural modes of temporalities of reproduction as well as their manifold interactions in the history of life sciences. By examining a variety of concepts, objects and practices from three centuries, the authors address the ways in which research on reproduction has constituted historically specific concepts of "organismic temporalities". They ask how such reproductive entities as germ cells, the embryo, the "prenatal" (specifically), or cells, genes and the organism (more generally) have been conceptualized in terms of their temporal dimension, and how these developments have been supported by historically specific concepts of political, social or cultural temporalities, and shifting ideas of the "historicity" of both life and society.

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