Contingency and History

Kim Sterelny*†

Debates on the contingency of history have largely focused on the history of life. This article targets the supposed contingency of human history. It does not defend a global claim about the overall contingency of history. Rather, it aims to identify and explain the difference between robust and fragile historical trajectories. It does so by considering a set of contrasting cases and identifying critical differences among the cases. The analysis shows that one important source of contingency is the historical emergence of command-and-control institutions; one important source of robustness is the existence of population-level processes structured by relatively stable institutions.

1. Plausible Worlds. Geoffrey Hawthorn begins his *Plausible Worlds* by imagining a Europe in which Islam had retained Spain and used it as a basis of empire. After a brief sketch of this alternative world, he even imagines how such a world might seem inevitable to its inhabitants. "'Islam is of the three great monotheisms, the one closest to modernity.' Medieval Christianity, as Ibn Weber so persuasively put it in *The Kharejite Ethic and the Spirit of Capitalism*, with its 'baroque, manipulative, patronage-ridden, quasi-animistic and disorderly vision of the world,' its belief that justice could be bought by donations and pious works, 'could never have taught its adherents to rely on faith alone and to produce and accumulate in an impersonal, orderly and systematic manner'" (Hawthorn 1991, 2). The professionals do not take such scenario-building seriously, nor does he, although the aim of his book is to defend a much more modest version of this enterprise. But why not? It seems that when we understand why something happened—say, why

Received May 2015; revised November 2015.

*To contact the author please write to: Research School of Social Sciences, Australian National University, Canberra; e-mail: kim.sterelny@anu.edu.au.

†Thanks to Joe Bulbulia, Adrian Currie, John Matthewson, Ron Planer, and the referees of this journal for helpful comments on earlier versions of this article. Thanks also to audiences at University of Sydney and Victoria University at Wellington for constructive feedback and to the Australian Research Council for their generous funding of my research into human evolutionary history.

Philosophy of Science, 83 (October 2016) pp. 521–539. 0031-8248/2016/8304-0004$10.00
Copyright 2016 by the Philosophy of Science Association. All rights reserved.

https://doi.org/10.1086/687260 Published online by Cambridge University Press

Hitler came to power—we equally understand what would have sabotaged his ascent. Causal and counterfactual analyses are intimately connected, so there should be circumstances in which scenario-building is serious theory. One answer is that historical trajectories are often contingent. They are fragile, because they are affected by events and background conditions too small to detect and measure or because they are unpredictable through influences from outside the system and through fiendishly complex interactions within the system. Gould (1989) made the idea of the contingency of history vivid through his attractive metaphor of replaying the tape of history but with a small variation or two at the starting point.[1] The replays, Gould suggested, would rapidly and strikingly diverge from the original run-through.

It turns out that there are two notions of contingency (at least) implicit in Gould's thinking about evolutionary history. One is sensitivity to fine-grained differences in initial conditions. When Gould talks of replaying the tape, with small initial differences making huge differences in the final outcome, contingency is sensitive to dependence on initial conditions. Small initial changes would result in large and ramifying changes in historical trajectories. This view of the contingency thesis is developed and defended in Ben-Menahen (1997, 2009), Sterelny and Griffiths (1999), and Inkpen and Turner 2012). However, Beatty (2006) shows that there is a second notion of contingency in Gould. A change in a system is contingent if it could not be predicted from information about the prior state of that system. One of Gould's favored examples of contingency is the extinction of the dinosaurs and the rise of the mammals. But if dinosaur extinction was the result of an asteroid impact, extinction does not show the sensitive dependence of dinosaur evolution on initial conditions. Replaying the tape of life from the Cretaceous/Tertiary boundary, but without impact, is not making a small, apparently inconsequential, change. But it is an example of an external intrusion into the biosphere; an intrusion that could not be predicted from information about the evolutionary interactions among the Cretaceous fauna. These two notions are connected. Sensitively dependent systems are also typically unpredictable. In sensitively dependent systems, a causally relevant difference in initial or background conditions can be generated by processes that are not captured by a description of that system using the theoretical and empirical vocabulary of the relevant science. If a battle is lost because the admiral in command has a stroke at the crucial moment, that disruption in command is not literally indeterministic. But its causes are not likely to be captured by an analysis of the relevant military factors before the battle.[2] Given an analysis of the military-

1. "Variations," because the contingency claim was not meant to depend on a premise about fundamental causal indeterminism.

2. In contrast to a case in which the battle is lost because the chain of command is not well specified, as often with coalitions.

https://doi.org/10.1086/687260 Published online by Cambridge University Press

political system using those conceptual tools, this will be an unpredictable, chance, disruption to the flow of command. Sensitively dependent trajectories are counterfactually sensitive to events below the descriptive resolution of the sciences that specify those trajectories. But as the dinosaur example shows, system trajectories can be unpredictable without sensitive dependence. So although the two notions of contingency are connected, they are not the same, and in this article, I will be concerned with the first of these notions, sensitive dependence.

In thinking through this notion of contingency, Jackson and Pettit (1992) have developed a helpful distinction. They introduce two explanatory strategies. An *actual sequence explanation* aims to identify the specific links in the causal chain connecting a cause to its effect. To reuse their example, an actual sequence explanation of the cracking of a flask of boiling water would identify a chain of microphysical events that lead to the breaking of a molecular bond in the surface of the glass. A *robust process explanation* specifies the resilience of that outcome.[3] The flask cracked because it was placed on a heat source. That source heated the water contents past their boiling point, and that in turn caused a crack. Robust process explanations specify both the range of alternative initial conditions across which we would still see a qualitatively similar outcome and the limits on that range. In any (or perhaps almost any) situations in which we hold the general background fixed, and in which the water was boiled vigorously, the flask cracks. Again holding the general background fixed, unless the flask is heated beyond the water's boiling point, it does not crack. What counts as a relevantly similar outcome depends on the explanatory interests of the explanation producers and consumers. If, for some reason, the exact moment and place of the crack is significant, the class of relevantly similar antecedent conditions in which we still get the effect of interest will shrink dramatically. In the limit, if every aspect of the effect is salient, it shrinks to the actual sequence.

So the robustness of a causal outcome is sensitive to how we specify that outcome, in particular, to our grain of description.[4] However, even if we have a coarse-grained specification of what counts as a relevantly similar outcome, there is no a priori guarantee that there is an informative robust process explanation to give. It is perfectly possible for the chain between cause and effect to be fragile, so very small interventions on the cause itself, or on the channel conditions between cause and effect, yield a very different outcome. This is especially likely when the effect depends on many independently acting factors, each of which is necessary. Very likely, there is no ro-

3. The terminology is actually from Sterelny (1996); their terms ("comparative" and "contrastive") were already in use but with different meanings.

4. The connection between contingency and grain of description is explored further in Inkpen and Turner (2012) and Haufe (2015).

https://doi.org/10.1086/687260 Published online by Cambridge University Press

bust process explanation of the connection between my sexual behavior 16+ years ago and the genetic makeup of my child. Very small changes in the timing and nature of sexual behavior, or of behavior between sex and conception, would have resulted in a different gametic fusion or in no conception at all. We are all triumphs of the improbable; we are all just a kiss away from being merely possible. Holding genetic makeup fixed is of course a very fine-grained specification of "the same outcome." But very likely, there is no robust process explanation of the connection between sexual behavior and my daughter's sex. So even if "having a daughter" counts as "the same outcome," very minor perturbations of the causal sequence would send a *y*-carrying gamete to the crucial rendezvous. So the availability of robust explanations is tied to both objective characteristics of the relevant causal network and our specifications of causes and outcomes within that network. Moreover, robustness is also a matter of degree. How many points of vulnerability are there in the causal chain? What is the probability of an intervention at each of those points? What must the magnitude of an intervention be, to substantially change the actual effect?[5]

2. Contingency and History. Armed with this distinction between actual sequence and robust process explanation, and the recognition that both contingency and robustness are sensitive to our grain of description, let us return to history. One of Gould's central examples is the American Civil War. The North had a much larger population, and a much larger economic and industrial base, and so Northern victory might seem to be robust: superior resources eventually tell. Even so, Gould suggests that the outcome was contingent, for the war aims of the South did not involve conquest of the North. Mere Northern war-weariness would have sufficed for its independence, and there were signs of war-weariness in 1863, with an election due in 1864, and with a credible peace candidate aiming to run. It is widely accepted that Gettysburg was a close-run battle, and so Gould suggests that a Southern victory might well have lead to a McClelland presidential victory in 1864 and an independent Confederacy. In turn, that would surely have reshaped world history in unfathomable ways in the next century. So, using Gould's views and my language, historians can and have given actual sequence explanations of the course of the war and, in particular, of the pivotal moment of Gettysburg (see, e.g., Coddington [1984], but there are many other detailed narratives of Civil War military history). But the fragility of battle means that there is no informative robust process explanation to give of the course of the battle and of the failure of the Confederacy to win independence.

5. The example above is of no scientific interest, but biologically important events can be causally fragile. For example, the origins of any specific genetic mutation probably depends on biochemical interactions that are both very specific and of low probability.

https://doi.org/10.1086/687260 Published online by Cambridge University Press

If the major episodes in human history are indeed contingent, the puzzle with which we began dissolves. We can explain historians' deep skepticism about counterfactual history. That skepticism is famously exemplified in Carr (1961). Academic historians have a deep professional distrust of attempts to say what would have happened if, say, the Persian fleet had been victorious at Salamis. As noted above, this skepticism is prima facie puzzling. For historians produce causal analyses, not chronicles, of historical trajectories. These analyses imply counterfactuals. If the discovery of gold caused a boom in the Australian population, it follows that if gold had not been discovered, the population would not have boomed (then). There are complications due to causal overdetermination,[6] but to a first approximation, there are no causal analyses without counterfactual implications. This point has been pressed very vigorously by the small minority of historians defending counterfactual history (see Hawthorn 1991; Bunzl 2004; Capoccia and Kelemen 2007; Lebow 2008, 2014; Tetlock, Lebow, and Parker 2009; Nolan 2013). Contingency makes sense of professional resistance to counterfactual history. We know that over the 3 days of Gettysburg, Lee's army attacked on both flanks before failing in its final throw of the dice with Pickett's charge. We know that had one of Lee's attacks on day 1 or day 2 succeeded, the subsequent course of the battle would have been different. But we do not know the kind and extent of that immediate difference; still less, how those immediate differences would have ramified as events unfolded. We can know that our Gettysburg—the Gettysburg we had—depended on those attacks failing, without knowing the character of the Gettysburg we would have had, if one had succeeded.[7] To the extent that a historical sequence depends in important ways on the precise character of a large number of factors, positive counterfactual projection is epistemically intractable.

Historians, notoriously, love detail. Contingency suggests that this may be more than a fetish or a costly signal of disciplinary seriousness. In a famous paper on the problem of understanding causally complex systems, Levins (1966) pointed out that no single model can be ideally general, realistic,

6. See Nolan (2013) for a guide both to the complications and also to the ways that, not withstanding those complications, casual claims are intimately linked to counterfactuals.

7. For a very different analysis, see Lebow (2008). He thinks historians have the opposite bias: they think of historical trajectories as much more inevitable than they really are. But so long as the causes are known and scrutable, as they are in his picture of historical thinking, deterministic causal systems are tractable subjects for counterfactual analysis. To recycle one of Bunzl's examples, the collapse of the first Tacoma Narrows Bridge was not contingent, as it was structurally unstable in high winds, and so we can assess the truth of counterfactuals about its collapse, had its design been different. A conception of a historical trajectory's inevitable unfolding puts counterfactuals on the table, rather than taking them off.

https://doi.org/10.1086/687260 Published online by Cambridge University Press

and precise. Hawthorn notes the implication of Levins's insight for the discipline of history (Hawthorn 1991, 33–35). Historians seem to sacrifice generality for precision. But that is no sacrifice, if historical trajectories are pervasively contingent and particular, if different cases do not share a common causal structure. For then there would be no general model of (say) successful military organization to be had. However, although professional history is dominated by a focus on the particular, there are attempts to develop general models. Turchin, for example, claims to identify patterns in the formation, life history, and decline of empires. One of his supposed patterns is a "secular cycle": he argues that empires have a chronic instability cycle (of a few centuries) and that this cycle results from the Malthusian cycles of the peasantry and of the elites being out of sync. In the initial, postcrisis, population-expansion cycle of the peasantry, the peasants' bargaining position relative to the elites is at its best, and they secure a better share of the social surplus. As their population expands further (in part because of their better conditions of life), the land-to-population ratios become more favorable to landowners, with peasant incomes being squeezed as their numbers expand. Income flowing to elites triggers a Malthusian response of their own. But elite numbers tend to spike as peasant society hits a crisis-and-crash point. So elites move into a zone of increased numbers and falling total income. As a consequence, we repeatedly see reckless, intense, within-elite conflict. The model is driven by economic and demographic factors, insensitive to individual decision and to the specific political and administrative organization of empires (Turchin 2006, esp. 205–38).[8]

Turchin's "secular cycle" model establishes a plausible prima facie case that there are general patterns in human history and that there are robust process explanations of the historical trajectories that exemplify these patterns. In the next section I discuss four episodes of human history. One is very controversial, once regarded as an exemplar of a robust outcome and now perhaps an episode that was both immensely consequential and very fragile. The other three examples are relatively uncontroversial cases of robust outcomes. We will see that one common feature of robust trajectories is that they do not depend on the decisions of specific, identifiable individuals. Robustness often derives from redundancy, from population-level phenomena interacting with institutional and cultural structures that partition populations and that constrain and bias decision-making patterns within these populations.

8. Turchin explicitly sees himself in doing history in a new way and turning history into a science. He is involved in a new journal, *Cliodynamics: The Journal of Quantitative History and Cultural Evolution*, but few of the contributors to that journal are professional historians. Turchin himself is a population ecologist, and most of the others are from the social sciences.

https://doi.org/10.1086/687260 Published online by Cambridge University Press

Fragility, in contrast, derives from institutional factors that amplify the downstream consequences of the decisions of a few specific individuals, while often also making the decision making of those individuals more erratic, more whim driven.

3. The Shot Heard around the World. On June 28, 1914, Gavril Princip assassinated Franz Ferdinand (the heir to the Austro-Hungarian throne) and his wife, thus setting in motion a sequence of events leading to World War I. Uncontroversially, this was a catastrophe that reshaped the political and economic geography of Europe, and since Europe was itself a dominant force in world affairs, its impact was global rather than regional. Was a major European war early in the twentieth century—followed by a shift in the economic, military, and technical center of gravity to the United States (and Russia)—contingent? That is, would relatively minor differences in the circumstances of Ferdinand's visit to Sarajevo, or in politico-military responses to that visit, have lead to a Europe that escaped a general war?

The standard historiographies of World War I once minimized the role of contingency in the origins of the war, downplaying the importance of accidents of individual circumstance and decision. The ingredients of a structural view of the war tended to include the following factors: (i) the tripwire military organization of Europe into competing, mutually suspicious (perhaps even mutually hostile) camps and (ii) the fact that each side had, prudently, prepared for war, and those plans depended on mass armies, mobilized from reserves, and concentrated for action via rail networks. No one could afford to let potential opponents mobilize and strike first. Finally, (iii) there was a long-established, institutionally stable, German war plan of striking France down first via Belgium, before Russia could complete mobilization. This was not irrational: it was the only German hope of avoiding a long war on two fronts. So the structure of the European politico-military organization made it likely that a local conflict would become general.

Moreover, political instabilities in the region provided a steady supply of local crises, each having the potential to escalate. (*a*) Austria-Hungary (especially) and Russia were chronically vulnerable to internal unrest—a problem exacerbated by the fact that unrest in Austria-Hungary was encouraged by groups within Russia's client states in the Balkans. (*b*) Russo-Austrian-Turkish rivalries continued in the Balkans. (*c*) Chronic instability persisted in the increasingly strategic Middle East, as Turkish power declined. (*d*) Imperial rivalries in Africa and Asia generated great power friction points. (*e*) The French continued to resent the loss of Alsace and Lorraine. (*f*) The Anglo-German naval race fueled English suspicion of Germany and a gradual shift of England into military involvement with France. On this analysis, we have in hand the ingredients of an informative robust process explanation of the origins of a general European war. This explanation identifies structural fac-

https://doi.org/10.1086/687260 Published online by Cambridge University Press

tors ensuring that a regional conflict would very likely become Europe-wide and dynamic factors that generated local crises. Any of these could readily become a regional conflict. Our World War I was indeed as contingent as could be. The actual assassination was made possible only by a bizarre combination of pigheadedness, blundering incompetence, and ill luck (so much so that Fleming and Brandon [2015] use it as a paradigm of contingency). But some World War I–like event was nearly inevitable.

Recent scholarship has taken serious issue with the idea that war was almost inevitable. Some recent work has emphasized the highly contingent, fragile sequence of events linking the Sarajevo crisis to the outbreak of war (Clark 2013). On this view, the road from local crisis to general war had many potential stopping points: the structure of Europe's political organization did not make the transition from local conflict to general war inevitable. Other work emphasizes the specific policies and attitudes of key figures in the politico-military elite (Fischer 1968). For example, the German chief of staff, von Moltke, had the firm policy of fighting any war, if war came, as an aggressive war, rather than standing on the strategic defensive. On these views, war was far from inevitable. Moreover, even if a general conflict was a robust outcome of the European tripwire, perhaps its Europe-destroying outcome was contingent. The German attempt to knock out France in the first few weeks only just failed (Keegan 1998; although see Hastings [2015], esp. 298–342, for a more skeptical assessment of Germany's prospects of a quick victory). The German army was turned back on the Marne, and that successful counterstroke was called the "miracle on the Marne" for good reason. We cannot say what would have happened had Paris fallen in September 1914, but a short war ending with Germany established as the dominant European power is one possibility.

Most particularly, Richard Lebow has mounted an explicit case for the contingency of World War I and its consequences (Lebow 2014). He argues that (i) the assassination itself was critical in posing such a severe challenge to the Austrian prestige that its status as a recognized great power depended on a forceful response, (ii) the death of Ferdinand in itself removed a key advocate of moderation and caution from the Austro-Hungarian leadership team, and (iii) it shocked and outraged the German public enough to generate a political consensus in favor of support to Austro-Hungarian action. Without this consensus, Bethmann Hollweg would have been unwilling to risk war. Finally, (iv) the assassination affected the personal psychology of Franz Josef and Kaiser Wilhelm enough to shift them from their normal caution. Moreover, Lebow argues that had war not occurred in 1914 or soon thereafter, the steady modernization of Russia would soon have made it impossible for the German military leadership to risk a focused attack on France, leaving their eastern borders open. Military necessity would have forced on Germany a more cautious approach to international affairs. The door to war

https://doi.org/10.1086/687260 Published online by Cambridge University Press

was closing. On this view, the destruction of the European world was indeed sensitively dependent on the bizarre sequence of accidents in Sarajevo.

Suppose all of this is right. What would it show about the contingency of history more generally? Let me offer three contrasting cases to reinforce Turchin's example: cases that suggest that human historical trajectories can be robust, not sensitive to small changes in initial or intermediate conditions. I begin with the Nuer Conquest, as analyzed by Kelly (1985). In the early nineteenth century, the Nuer and the Dinka were two ethnolinguistic groups occupying much of the Sudan. The Nuer occupied a southern/central area of the Upper Nile Basin; the Dinka tended to occupy northern and western areas, although early in this process, Nuer territory was effectively embedded within, and surrounded by, Dinka territory. Although ethnically and linguistically distinct, the two groupings were closely related linguistically and culturally, and they had a similar economic base, relying on cattle, which they moved seasonally between wet season and dry season pastures, and wet season agriculture. Between roughly 1818 and 1890 (when external events intervened), the Nuer expanded their territory roughly tenfold at Dinka expense. Approximately 200,000 Dinka were killed, absorbed, or fled (apparently many were absorbed, fueling Kelly's skepticism about the idea that Nuer expansion was driven by famine).

The mechanism of expansion was through large-scale raiding. As Kelly describes them, Nuer raids were formidably dangerous and destructive. Parties of around 1,500 raiders, often divided into separate but loosely coordinated groups, would strike deep into Dinka territory (up to 80 miles), attacking numerous wet season Dinka settlements, aiming for and often achieving overwhelming numerical superiority at each settlement. The raiders stole Dinka cattle and burned crops and dwellings; they sometimes stayed for a while and often withdrew with their booty. These border zones became increasingly hazardous for Dinka. Although they could return to their territory after raids, their houses, their crops, and their cattle they could not flee with were gone. They returned to danger and to want, if not famine, and so those with other options often did not return. As each raid increased the vulnerability of those still in these zones, a pattern established of Dinka retreat and Nuer advance. The crucial question, of course, is, why did the Dinka not reply in kind or organize their defense in numbers? As Kelly develops his analysis, the key factor was a differences in bridewealth payments. Among the Nuer, brides were more expensive. These norms about marriage and bridewealth motivated territorial expansion, for the bridewealth norm increased the demand for cattle, and more cattle translated into greater territorial requirements, especially in the dry season. But the norms also built more effective links between villages; they increased the value of those connections. As a consequence, in both attack and defense, the Nuer could more readily put together multivillage coalitions, and over time, this advantage was decisive.

https://doi.org/10.1086/687260 Published online by Cambridge University Press

Kelly's analysis has been widely accepted; the book is regarded as a classic.[9] If he is roughly right, so long as we hold fixed the economic, cultural, and technical similarities of the Nuer and the Dinka, and so long as we hold fixed the crucial difference about bridewealth and its role, the Nuer conquest was not contingent. Indeed, Kelly has given an informative, robust process explanation of the Nuer expansion. One crucial point is that it is a population-based explanation. The Nuer expanded as a result of a large number of small-scale incidents. Very likely, the outcome of many of these particular encounters was contingent, although with a significant bias in favor of the Nuer. But the historical trajectory did not depend on any of these specific interactions; none were essential to the Nuer expansion. Between the Dinka and the Nuer, nothing major was at stake in any single interaction. So had the sequence of raids been somewhat different, or had the Dinka succeeded in an encounter that they in fact lost, those small-scale differences would have made no difference to the overall outcome.

The next example is less military. Hawthorn develops the idea that the retreat of the plague from western and central Europe was neither contingent nor independent of human agency.[10] In 1346, after a gap of many hundreds of years, the black death returned to Europe with brutal effect. The causal mechanisms through which it spread were not understood until late in the nineteenth century. But European administrations gradually learned that complete, relentless quarantine of infected zones could prevent the epidemic spreading. Beginning quite early, in northern Italy, elites gradually marshaled the resources (quarantine was very expensive); administrative efficiency; and centralized, coordinated decision making to impose effective quarantines. The last major European outbreak was in 1722; it continued as a major threat in the Ottoman Empire, to the east. In his analysis, Hawthorn developed a "middle range theory" of the plague and its containment.[11] This model included (i) the critical biological and ecological factors that determine its potential to spread, (ii) informational factors (the realization that quarantine needed to be complete and sustained), (iii) economic factors (control depended on resources both to physically impose quarantine and to survive the costs of disrupted trade and exchange), and (iv) institutional factors (decision making needed to be rapid, coordinated, and effectively translated into action on the ground; Hawthorn 1991, 39–80). Given this model, Hawthorn is able to

9. Although see de Wolf (1990) for a defense of population pressure as the driver.

10. It was not, e.g., the result of the replacement of the black rat by the Norwegian rat.

11. This helpful "middle range theory" framework is borrowed from Binford (2002) and his attempt to identify a middle path between grand universal theory in the human sciences and embracing particularism, seeing every episode as unique, to be understood in its own terms.

https://doi.org/10.1086/687260 Published online by Cambridge University Press

counterfactually analyze the differing responses within Europe (polities varied greatly in the effectiveness of their response) and between Europe and the adjoining lands to the east.

A final example: the European demographic transition was one of the most fundamental social changes of the nineteenth century; first in the west, then in the southern and central Europe (and later in the east). It involved a dramatic reduction in fertility and family size, largely as the result of individual decisions within marriage (rather than by delaying marriage or externally via child mortality). It began in France and England, with a similar trend appearing a little later in Belgium and Holland, in Germany and central Europe, in Italy, and later in Spain. Family size roughly halved. Families became smaller despite often pronatalist policies by church and state. It was not driven from the top by coercion or ideology.

The cause of the transition remains somewhat controversial: in England, France, and adjoining areas it began before the dramatic advances in public health, so at least originally it was not a response to the declining risk of losing one's first cohort of children. But while now controversial, the classic explanation is economic (Becker 1960). Economic changes beginning in the late eighteenth century—the first elements of industrialization—encouraged a shift away from rural life. Urban life changes the costs and benefits of children. Children are a valuable labor force for quasi-subsistence farmers, and they require little investment beyond food and minimal clothing. An urban shift suppresses their benefit. There is less of a family economy, and especially as legal barriers to child labor grew in the century, it was difficult to place them in the cash economy. To the extent that education was necessary for their entry into that economy, their expense increased. To the extent that women could access the cash economy, the opportunity costs of pregnancy and infant care increased too. On this model, country by country, the transition was the aggregate outcome of a myriad of individual decisions. As with each Nuer-Dinka interaction, each individual's family planning was contingent. Small alterations in individual circumstance and personality very likely would make a difference to family size decisions. But once again, there was a bias. Quite often, in their reproductive decision making, agents responded to economic incentives, discarding the practices of previous generations and ignoring the natalist propaganda of church and state.

Becker thus offers a robust process explanation of the demographic transition. We would see that transition if we hold fixed (i) the economic incentives for shifting to urban centers, (ii) the increased direct and indirect costs of children, and (iii) their reduced contribution to the family economy. Other factors could vary: the policies of state and church, the preexisting practices of country life, and even (presumably within limits) child mortality rates. However, had urban economies largely run on child labor, family size would not have declined. Becker's picture is probably oversimplified (Mulder 1998;

https://doi.org/10.1086/687260 Published online by Cambridge University Press

Spolaore and Wacziarg 2014). It fits England better than France and may not predict the order of the transition elsewhere in Europe. One suggestion is that it underplays the role of social transmission and, in particular, the galvanizing effect of successful early adopters of family limitation on others' practices. So various forms of social learning bias may have played an important role too. But these, too, are population-level, aggregate effects, summed over large numbers of individually contingent but probabilistically weighted decisions. As with the Nuer expansion, no single event matters. Perhaps a pattern is emerging. We escape from contingency to the extent that macrophenomena have many potential microfoundational realizations. We will see in the next section that this is only part of the explanation of why some historical trajectories are robust.

4. Mechanisms and Populations. I suggested in the last section that historical trajectories are robust when they depend only on aggregate effects of interactions in populations. For then historical trajectories are screened off from idiosyncratic individual decisions, improbable local outcomes, and outcomes that depend on tiny quirks of specific circumstances. The outcome is not counterfactually sensitive to such small variations in initial conditions and ongoing context. That is only partly right. The causal trajectories of well-designed mechanisms are often robust too, but not because mechanisms are populations of components. Engineers make mechanisms, and the historical trajectories of their operations are (typically) robust and are so by design. In a well-designed mechanism (*a*) a given component typically responds to changes only in one or a few causal ancestors; (*b*) its response is typically transparent. Causal ancestors act as switches, controlling responses in a discrete way, or as levers, changing responses in a smooth, often linear, way; (*c*) the components and their physical connections are designed to retain their core mechanical properties in the face of physical stresses at magnitudes generated at and near their normal conditions of operation. The (relative) structural simplicity of the causal map connecting components to ancestors and descendants; the physical resilience of the components; the orderliness of the causal influence of a component on its causal descendants; and, in complex mechanisms, the nested organization of microcomponents into components and subsystems into systems all combine to make causal pathways robust and counterfactual analysis tractable. Had the brakes been applied immediately, the car would have stopped before the level crossing.

So well-designed mechanisms support robust causal trajectories. Redundancy also makes robust explanation possible. Population-based trajectories are robust because populations are composed from an ensemble of relatively autonomous individuals, who often have many properties in common. So with respect to many population-level outcomes, they are interchangeable (Godfrey-Smith 2009, 147–50). The fate of a fish population under harvest-

https://doi.org/10.1086/687260 Published online by Cambridge University Press

ing pressure rarely depends on which particular fish are caught and which escape. In contrast, designed mechanisms are not ensembles of autonomous individuals but of organized, interconnected, and often quite distinct components. Typically, the behavior of the mechanism depends on the presence and placement of all of its components, although if failure is very expensive, sometimes there are backup systems. Robustness depends on the intrinsic reliability of each component; the reliability of the physical connections between the components; and of the local, modular character of the causal relations between the components. Designed mechanisms with inadvertently fragile components, or with undesigned, unanticipated causal connections to other components, are not robust and often not tractable for counterfactual analysis. In contemporary practice, this tends to be a problem with software engineering rather than hard material engineering (Calcott 2014).

Biological systems are often mechanism-population hybrids. Diagrams of cells, for example, make them seem as if they are biological versions of designed mechanisms—organized, differentiated, with physically rugged components, each of which plays a critical role that depends on its location and shape. Where would the cell be if the nuclear membrane failed? That impression is partly right. The structural, mechanistic components are causally resilient (at the relevant physical and energetic scales). Given the typical forces of intracellular interaction, the structural partitions of eukaryotic cells—the cell wall, the nucleus, the organelles, the DNA molecules—do not readily rupture or distort. But other aspects of cell function are population based. For example, the DNA-RNA-amino acid transcription and translation process depends on the fact that these intracellular compartments contain large populations of the relevant molecules in flux. These move repeatedly across binding and amino acid chain construction sites. If the appropriate tRNA molecule, jostled at the wrong moment, does not happen to dock at the ribosome binding site this instant, another will be along the next instant. So cell behavior is quite predictable and robust, through a hybrid of physically resilient components and population-based redundancy.

Historical trajectories through human social worlds can also depend on, and be robust in virtue of, hybrid structures. Relatively persistent collective facts—norms, customs, habits, institutions—serve the same stabilizing and organizational role that physically robust membranes play in cells. The emergence of a recognizably human social life depended on these stabilizing social structures. For the outcome of one agent's actions typically depends on what others do. Customs, norms, and the like help make the actions of others predictable enough to make decision making tractable (see Ross [2005] for an insightful account of the interaction between social stabilization and individual psychology). The outcome of the Nuer-Dinka conflict depended on population-level processes: the summed effects of many individual decisions. But it also depended on these institutional stabilizers: the dry season

https://doi.org/10.1086/687260 Published online by Cambridge University Press

pastoralism, wet season grain economy; the kinship system; the two different bridewealth systems. Likewise, the other plausible examples of robust trajectories depend on the interplay between population-level effects and institutional stabilizers. Thus, Becker's model of the demographic transition depends on the institutional features of city life that reduce the role of the family economy. Once there are general, community-wide practices, individuals have incentives to conform: to ease coordination problems; to reduce transaction costs in otherwise cooperative social interactions; and, in some case, to avoid social penalties. Many societies do not reward eccentricity. Social practices are not, of course, absolutely stable. But in prestate societies, they are stable in the face of perturbations from a single individual's decision. So if we imagine agents making different decisions in the course of a raid and response, we can legitimately suppose in the counterfactual scenario that these institutional factors will be effective.

5. The Fragility of Command. Another form of institution, however, explains the quite contingent nature of many historical trajectories of recorded human history. The emergence of large-scale society has bought with it command-and-control institutions (Flannery and Marcus 2012, esp. pt. 3), and these are a source of contingency for two reasons. They make population-level trajectories sensitive to the actions of a few, and they make that few more likely to behave in erratic, unpredictable, hair-trigger ways. In hierarchically organized institutions, with top-down command-and-control structures, control flows from small numbers at the apex of the pyramid through ever-larger numbers lower in the hierarchy. That organization makes the lives of myriad individuals causally sensitive to the decisions of those few (in the limit, one) at or near the top of the hierarchy. Such organizational charts are unlike the mechanisms discussed in the last section. The causal histories of well-designed physical mechanisms are robust, as (*a*) each component acts on only a few others, (*b*) the behavior of each component is orderly and predictable (small differences in input or operating conditions result in small differences in behavior), and (*c*) the links between components are scrutable and well behaved. None of this is true of hierarchical command-and-control institutions, although it can be approximately true of those in the middle and lower levels of hierarchical, bureaucratic systems. Typically, there are some customary and institutional constraints on the decisions and actions of those high in the hierarchy. Meade, the US general in command at Gettysburg, could not literally have any order obeyed. I have no idea what would have happened if he had ordered his entire army to strip naked and dance around bonfires at midnight, but obedience was not within the space of probable outcomes. The constraints on his immediate subordinates were tighter still. Even so, he had great freedom of action within the constraints of his role (otherwise, it would not matter who commanded armies), and his direct subordi-

https://doi.org/10.1086/687260 Published online by Cambridge University Press

nates had considerable freedom. And his decisions ramified, affecting the downstream actions of just about everyone in his army (and hence in Lee's army, as well). Moreover, small differences in his actions might well have lead to enormous differences in outcomes: for example, differences in the timing of his orders and their audience. Of course, the strength of these institutional and customary constraints on those occupying senior positions in command-and-control hierarchies varies from case to case. The stronger the constraints, the less the specific character of the occupant of the role matters and the more the flow of control depends on office rather than occupant. But the character of the occupant is typically causally important.

So the causal map of command-and-control systems is neither modular nor smooth. Moreover, in Gettysburg-like interactions, world-changing decisions are made in decidedly suboptimal situations; situations close to the limits of component failure. Crucial components are likely to behave in erratic ways and are likely to be counterfactually sensitive to small variations in the environment of decision (cold coffee, a disturbed night's sleep). The decision contexts are suboptimal not just in the game theoretic sense that agents act in contexts of imperfect information but in situations of physical and psychological stress and exhaustion. In discussing command decisions in the Normandy campaign, Bunzl suggests that we can, actually and counterfactually, model command decisions through game theory, treating commanders as rational agents maximizing under risk (2004). I am skeptical. German command decisions were driven from the top by wishful thinking, leading to their catastrophe in the Falaise pocket. Rational actor models are most powerful when they sum over the activities of many agents, swamping the effects of individual idiosyncrasy (Sterelny 2012). In the cases under discussion, we expect idiosyncrasy, as the components are operating outside their design specs.

Military decision, admittedly, is an extreme context. Not all decision is as stressed and time pressured as those decisions. But in hierarchical, command-and-control contexts, many of the mechanisms that make decision making more reliable and predictable—shared interests supporting honest communication, robust and public assessment of alternative options, division of informational labor—are excluded or weakened. We are not intrinsically rational agents, with stable preference structures and a stable grip of options and their cost-benefit profile. To the extent that we approximate such agents, we do so only as a result of social scaffolding and material culture (see, e.g., Satz and Ferejohn 1984; Ross 2006; Menary 2010; Zawidzki 2013; Sterelny 2015). So hierarchical political institutions randomize history, both by amplifying the effects of the decisions of particular key individuals in the group and by making those decisions more erratic. Aberrant decisions by one individual in a traditional foraging culture make no difference. Not so, aberrant decisions by a Pharaoh. Moreover, the upbringing and environment of a Pha-

https://doi.org/10.1086/687260 Published online by Cambridge University Press

raoh up-regulates erratic decision making; no one tells a pharaoh not to be a dickhead.

The upshot, then, is that history made history contingent (or more contingent), through the historical emergence of hierarchical command-and-control systems.[12] These systems make historical trajectories sensitive to the decisions of a few individuals and to the accidents that place specific individuals, with their idiosyncrasies, in pivotal roles. Moreover, in those cases in which the customary, normative, and institutional constraints on leadership are weak, these command-and-control systems accentuate the tendency for decision making to be erratic and unstable (and hence unpredictable), since these decisions are sensitively dependent on the momentary whims of the great and powerful. Of course, even in hierarchical societies, many social processes depend on the interaction of population-level processes with stable institutional factors, as the demographic transition and Turchin's analysis of imperial cycles illustrate. Contingency affects mostly, or most directly, the explicit targets of command-and-control decision making. Politics is the engine of contingency.

The picture developed here suggests that we should expect military, political, and diplomatic historians to be most allergic to counterfactual scenario building and social and economic historians to be least allergic to it. For they can sensibly undertake the project of building middle range theories of their target domain and sensibly assume that historical trajectories in their domains rarely depend on the decisions or attributes of specific individuals. One research tradition that has begun this project of building middle range theory in a serious way is the cultural evolution community, especially the work on cultural group selection. Consider, for example, the recent work connecting the emergence of large-scale societies with the emergence of "Big God" religions (Norenzayan et al. 2016). The project is to explain the stability of cooperation given the limits of secular, institutional mechanisms of incentivizing cooperation and deterring defection. Whatever the fate of the idea that ideological, organized, moralizing religion played an essential role in establishing respect for the social contract in large-scale societies, it is legitimate to aim at a robust process explanation of the emergence of large-scale societies. For there is a general pattern. Some, but not all, sedentary agricultural societies transitioned from informal, culturally homogenous, small-world societies to large, institutionalized, state-based, multiethnic societies (Morris 2015, 44–92). The pattern is repeated, with independent origins. It did not depend on a single, perhaps very improbable, event. In this respect, the origin of a large social world contrasts with, say, the origins of

12. Ben-Menahen (2009) and Inkpen and Turner (2012) also point out that historical processes can themselves alter the sensitive dependence of later outcomes on intermediate conditions.

https://doi.org/10.1086/687260 Published online by Cambridge University Press

modern science. Since that was unique, we have no prior reason to expect, or rule out, a robust process explanation of its origin.[13]

Let me conclude by summarizing the main ideas of this article. It begins by connecting historical contingency to historians' skepticism about counterfactual history and by contrasting two styles of explanation: robust process versus actual sequence explanations. If historical trajectories are contingent, the idea goes, they can be given only actual sequence explanations. Moreover, the professional output of historians often seems to be the production of actual sequence explanations: detailed, link-by-link specifications of causal networks. That said, this feature of professional historians' work might reflect their professional interests, not just the objective character of the causal history of an event. For the availability of a robust explanation depends as well on how coarsely or finely we characterize our explanatory project. No one doubts the contingency of the fact that World War II began in September 1939. So the article then takes up the prospects for robust explanations of historical trajectories by outlining a series of major episodes in human history and by showing that at least some of these can be given robust process explanations. The article then moves to diagnosis: Why are some but not all trajectories robust? The answer suggested in this article focuses on the interaction between individual agent decision making and stable cultural and institutional factors. Human history is the sum of the history of agents interacting and deciding, in their physical and social environment. Sometimes, and most obviously in command-and-control institutional settings, the cultural and institutional context amplifies the effects of the decisions of just a few of those agents, making their decisions and actions immensely consequential to the lives of many others, then and later. To the extent that that is true, for this is a matter of degree, historical trajectories are contingent. Moreover, even where they exist and are efficient, hierarchical command-and-control systems have limited scope. In contrast to such command-and-control systems, institutional and cultural factors sometimes result in trajectories that depend on the summed decisions of many agents; these population-based causal trajectories tend to be robust.

13. The flow and uptake of innovation may be another source of contingency. The Egyptians discovered steam power, but nothing came of it (Morris 2015, 93). Mesoamerican civilizations did not discover the wheel. Were there world-transforming technical opportunities not taken? Perhaps so, if innovation and uptake depend on rare, easily disrupted conjugations of individual insight and social support. Investigating the contingency of innovation is well beyond the scope of this article.

https://doi.org/10.1086/687260 Published online by Cambridge University Press

REFERENCES

Beatty, John. 2006. "Replaying Life's Tape." *Journal of Philosophy* 103 (7): 336–62.
Becker, Gary. 1960. *An Economic Analysis of Fertility: Demographic and Economic Change in Developed Countries*. Princeton, NJ: Princeton University Press.
Ben-Menahen, Yemima. 1997. "Historical Contingency." *Ratio* 10:99–107.
———. 2009. "Historical Necessity and Contingency." In *A Companion to the Philosophy of History and Historiography*, ed Aviever Tucker, 120–30. Oxford: Blackwell.
Binford, Lewis. 2002. *In Pursuit of the Past: Decoding the Archaeological Record*. Los Angles: University of California Press.
Bunzl, Martin. 2004. "Counterfactual History: A User's Guide." *American Historical Review* 109:845–58.
Calcott, Brett. 2014. "Evolvability and Engineering." *Biology and Philosophy* 29:293–313.
Capoccia, Giovanni, and R. Daniel Kelemen. 2007. "The Study of Critical Junctures: Theory, Narrative, and Counterfactuals in Historical Institutionalism." *World Politics* 59:341–69.
Carr, Edward Hallett. 1961. *What Is History?* New York: Vintage.
Clark, Chris. 2013. *The Sleepwalkers: How Europe Went to War in 1914*. London: Penguin.
Coddington, Edward. 1984. *The Gettysburg Campaign*. New York: Scribner.
de Wolf, Jan. 1990. "Ecology and Conquest: Critical Notes on Kelly's Model of Nuer Expansion." *Ethnology* 29:341–63.
Fischer, Fritz. 1968. *Germany's Aims in the First World War*. New York: Norton.
Flannery, Kent, and Joyce Marcus. 2012. *The Creation of Inequality*. Cambridge, MA: Harvard University Press.
Fleming, Leonore, and Robert Brandon. 2015. "Why Flying Dogs Are Rare: A General Theory of Luck in Evolutionary Transitions." *Studies in History and Philosophy of Biological and Biomedical Sciences* 49:24–31.
Godfrey-Smith, Peter. 2009. *Darwinian Populations and Natural Selection*. Oxford: Oxford University Press.
Gould, Stephen Jay. 1989. *Wonderful Life: The Burgess Shale and the Nature of History*. New York: Norton.
Hastings, Max. 2015. *Catastrophe 1914: Europe Goes to War*. London: Collins.
Haufe, Chris. 2015. "Gould's Laws." *Philosophy of Science* 82 (1): 1–20.
Hawthorn, Geoffrey. 1991. *Plausible Worlds: Possibility and Understanding in History and the Social Sciences*. Cambridge: Cambridge University Press.
Inkpen, Robert, and Derek Turner. 2012. "The Topography of Historical Contingency." *Journal of the Philosophy of History* 6:1–19.
Jackson, Frank, and Philip Pettit. 1992. "In Defence of Explanatory Ecumenicalism." *Economics and Philosophy* 8:1–21.
Keegan, John. 1998. *The First World War*. London: Hutchinson.
Kelly, Robert C. 1985. *The Nuer Conquest: The Structure and Development of an Expansionist System*. Ann Arbor: University of Michigan Press.
Lebow, Richard Ned. 2008. "Learning from Contingency: The Case of World War I." *International Journal* 63 (2): 447–59.
———. 2014. *Archduke Franz Ferdinand Lives! A World without World War I*. London: Macmillan.
Levins, Richard. 1966. "The Strategy of Model Building in Population Biology." *American Scientist* 54:421–31.
Menary, Richard, ed. 2010. *The Extended Mind*. Cambridge, MA: MIT Press.
Morris, Ian. 2015. *Foragers, Farmers and Fossil Fuels: How Human Values Evolve*. Princeton, NJ: Princeton University Press.
Mulder, Monica B. 1998. "The Demographic Transition: Are We Any Closer to an Evolutionary Explanation?" *Trends in Ecology and Evolution* 13:266–70.
Nolan, Daniel. 2013. "Why Historians (and Everyone Else) Should Care about Counterfactuals." *Philosophical Studies* 163:317–35.
Norenzayan, Ara, Azim Shariff, Edward Slingerland, Will Gervais, Rita McNamara, and Joseph Henrich. 2016. "The Cultural Evolution of Prosocial Religions." *Behavioral and Brain Science* 39, forthcoming.

https://doi.org/10.1086/687260 Published online by Cambridge University Press

Ross, Don. 2005. *Economic Theory and Cognitive Science: Microexplanation*. Cambridge, MA: MIT Press.
———. 2006. "The Economic and Evolutionary Basis of Selves." *Cognitive Systems Research* 7:246–58.
Satz, Debora, and John Ferejohn. 1984. "Rational Choice and Social Theory." *Journal of Philosophy* 102:71–87.
Spolaore, Enrico, and Romain Wacziarg. 2014. "Fertility and Modernity." Technical Report, Department of Economics, Tufts University.
Sterelny, Kim. 1996. "Explanatory Pluralism in Evolutionary Biology." *Biology and Philosophy* 11:193–214.
———. 2012. "From Fitness to Utility." In *Evolution, Co-operation and Rationality*, ed Ken Binmore and Samir Okasha, 246–73. Cambridge: Cambridge University Press.
———. 2015. "Content, Control and Display: The Natural Origins of Content." *Philosophia* 43 (3): 549–64.
Sterelny, Kim, and Paul Griffiths. 1999. *Sex and Death: An Introduction to Philosophy of Biology*. Chicago: University of Chicago Press.
Tetlock, Philip, Richard Ned Lebow, and Geoffrey Parker, eds. 2009. *Unmaking the West:* "*What-If*" *Scenarios That Rewrite World History*. Ann Arbor: University of Michigan Press.
Turchin, Peter. 2006. *War and Peace and War*. New York: Pi.
Zawidzki, Tad. 2013. *Mindshaping*. Cambridge, MA: MIT Press.

https://doi.org/10.1086/687260 Published online by Cambridge University Press