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Chance and the Dissipation of our Acts' Effects

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ABSTRACT

If the future is highly sensitive to the past, then many of our acts have long-term consequences whose significance well exceeds that of their foreseeable short-term consequences. According to an influential argument by James Lenman, we should think that the future is highly sensitive to acts that affect people's identities. However, given the assumption that chancy events are ubiquitous, the effects that our acts have are likely to dissipate over a short span of time. The sets of possible futures left open by alternative acts are typically very similar in the same way that large random samples drawn from the same population are typically very similar.

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1. Introduction

The stomp of your foot, on one mouse, could start an earthquake, the effects of which could shake our earth and destinies down through Time, to their very foundations. With the death of that one caveman, a billion others yet unborn are throttled in the womb. Perhaps Rome never rises on its seven hills. Perhaps Europe is forever a dark forest, and only Asia waxes healthy and teeming. Step on a mouse and you crush the Pyramids. Step on a mouse and you leave your print, like a Grand Canyon, across Eternity ...

Or maybe [the future] can be changed only in little subtle ways. A dead mouse here makes an insect imbalance there, a population disproportion later, a bad harvest further on, a depression, mass starvation, and finally, a change in social temperament in far-flung countries. Something much more subtle, like that. Perhaps only a soft breath, a whisper, a hair, pollen on the air, such a slight, slight change that unless you looked close you wouldn't see it. Who knows? Who really can say he knows?

[Bradbury 1953: 140]

It is a common theme within science fiction that routine acts have huge and unpredictable effects on the far future. Acts that create only relatively trivial immediate changes—accidentally stepping on a butterfly or bumping into a stranger—can beget expanding ripples of changes that grow ever larger as they extend into the future.

Despite this theme's plausibility, it is difficult to assess the magnitude of the changes brought about by routine acts. The issue has received attention in the literature on consequentialism, where ethicists have worried that the massiveness of an act's unforeseeable future effects might make them overwhelmingly important to its moral status. James Lenman ([2000]; see also Elgin [2015]) has argued that we are clueless about

the overall valences of our acts' consequences. Acts that appear to create more good than bad are about as likely as not to have unpredictable massively bad consequences in the far future. Acts that appear to create more bad than good are about as likely as not to have unpredictable massively good consequences in the far future.

In the course of arguing against consequentialism, Lenman built a compelling case that the future is highly sensitive to present acts. His framing of the issues will provide the background for my alternative position.

Lenman's critics have quibbled more about the epistemic status of our acts' consequences than the scope of their effects.¹ In contrast, this paper argues that the ubiquity of chancy events would suggest that the unpredictable effects of our routine acts quickly dissipate.² If there are chancy events, then acts do not produce single futures, but rather narrow down collections of possible futures. Just as the branches of trees may bend in different ways while producing the same round leafy outline in silhouette, the effects of different acts can accumulate in specific possible futures without much altering the shapes of the collections of possible futures that those acts leave open.

Section 2 presents one version of the view that routine acts have massive future consequences. Section 3 lays out Lenman's argument for that view. Section 4 presents a contrary position, Lenman's rebuttal of that position, and a difficulty facing his rebuttal. Section 5 makes the case that, if chancy events are sufficiently common, then the sets of possible futures produced by alternative acts will resemble each other in the way that large random samples drawn from the same population typically do.

2. Sensitivity

In assessing the extent to which ordinary acts alter the shape of the future, it helps to focus on a subset of ordinary acts, identity-affecting acts, whose potential for influence is easier to reason about. If directly identity-affecting acts have massive consequences, then many routine acts that are not directly identity-affecting are sure to have massive consequences as well, by virtue of being indirectly identity-affecting.

The view that will be the focus of the rest of the paper goes as follows:

¹ Joanna Burch-Brown [2014] argued that, while individual acts might have massive and unpredictable consequences, we can know something about the typical consequences of types of acts. Tyler Cowen [2006] pointed out that we can make reasonable guesses about certain significant acts. Elinor Mason [2004], Caspar Hare [2011], and Hilary Greaves [2016] argued that we are licensed to assign subjective probabilities in a way that justifies many common-sense ethical verdicts within consequentialist frameworks. Alexander Pruss [2017] suggested that we can ignore the unknown future consequences of our acts in moral deliberation in so far as they do not favour inaction. Dale Dorsey [2012] argued that our absence of evidence about the long-term consequences of our acts allows us to treat the possibility of unforeseen consequences as we treat metaphysical scepticism.

² Lenman [2000: 353] justified setting aside the possibility of genuine chanciness on the ground that it introduced further problems for consequentialism:

perhaps [we] must consider not two determinate possible futures but two futures that branch endlessly, assign probabilities to every branching, and seek to maximize the expected goodness ... because [this and related] possibilities make matters even more intractable for consequentialists, let us stick to the most tractable cases, in which there are just two possible futures to consider.

In so far as our interest is not consequentialism but instead the sensitivity of the future, we cannot ignore chanciness.

SENSITIVITY. Routine identity-affecting acts typically have massive socio-axiological future consequences.

Some of these terms require clarification.

Identity-affecting acts are acts that affect the identity of persons. While the meta-physical factors that determine personal identity are controversial, our present purposes permit an operationalisation in terms of ancestry and genetics. Distinct individuals cannot share both the same parents and the same DNA. Under this operationalisation, identity-affecting acts change who exists in future generations either by changing which individuals pair off as parents or by altering the genetic material that pairs of parents pass on to their offspring.

Direct identity-affecting acts include the accidental killings of would-be parents, acts of matchmaking between future parents, and any acts that change which particular sperm meet which particular ova. Indirect identity-affecting acts can include both the relatively direct (such as causing an argument that ends in murder or setting up blind dates) and the very indirect (such as kicking off long causal chains that eventuate in direct identity-affecting acts). Given the sensitivity of genetic inheritance to the specifics of procreation, it is plausible that many acts are indirectly identity-affecting.

Routine acts are ordinary acts in our present social and axiological context. They are the sorts of acts that happen regularly and are not especially notable, except occasionally to the people involved in them. They do not normally appear in the history books, and do not have specific foreseeable long-term effects.

The **consequences** of an act consist of those events that occur only because of that act. An event is a consequence of an act if it necessarily follows from the act, and only if it would not have necessarily occurred without the act. Acts that can result in multiple alternative outcomes have disjunctive or chancy events as their consequences. A chancy event is an event that can result in multiple alternative outcomes, each with an objective chance. When a fair coin is tossed, an event can occur in which the coin has a 0.5 chance of landing heads and a 0.5 chance of landing tails. If the coin had been biased, a different chancy event would have occurred even if the coin subsequently landed the same way.

It is unknown how prevalent chancy events are. Some acts may have only chancy events as consequences. Such acts merely modulate the chances of their possible outcomes. Some acts can produce single outcomes deterministically.

Perhaps no acts have chancy consequences. Objective chances are significant meta-physical commitments. In order for an individual event to be chancy, it must be genuinely possible for more than one outcome to occur. Furthermore, I will assume here that the probabilities of chancy events are not shadows cast by patterns in event results (*pace* Lewis [1980], Glynn [2010], and Emery [2015]). They must be something more like propensities [Popper 1959].³ While it remains an outstanding question whether there are any such chancy events, objective chances of this sort are popular in contemporary interpretations of physics, and it is reasonable to take them seriously [Maudlin 2007].

According to this interpretation, while causation often plays a role in settling an act's consequences, it is not sufficient. An event will not be the consequence of an act if that event was inevitable, or if the act merely rendered it more likely. If an act causes a chancy event with a particular outcome, then there is a sense in which the act has

³ The arguments that I develop might work with other interpretations of objective chance, including some Humean interpretations, but the issues are too complex to address here.

that outcome as its consequence, but this is not the sense intended here. The act is responsible only for the chance of the outcome, not for whether it actually occurs.

Events can inherit some of the chancy consequences of their own chancy consequences. An act that alters the chances with which particular events occur at one time will often also alter the chances of later events. An attack from the right might provide a general with the only chance of victory in a battle, only work if it causes that flank to collapse, and then only result in victory with a 0.5 chance. If it has a 0.5 chance of causing the flank to collapse, then it has as a consequence that there is a 0.25 chance that the battle is won.

An act has **massive** future consequences relative to a metric if its long-term consequences are much weightier than its short-term consequences as measured by that metric and weighted by their probabilities.

One person's decision to forego a coaster for a cold drink on a hot day might evenuate in the repositioning of billions of tons of dust particles but no differences to election results, political appointments, or prevalent ideologies. That act would have massive consequences in one sense: relative to a metric that treats the displacement of every particle equally, its future consequences greatly outweigh its short-term consequences. However, if all that it does is to reposition dust, then it would not be massive relative to a metric focused on political differences.

The sort of metric specified by SENSITIVITY is *socio-axiological*. A socio-axiological metric measures events according to their moral, social, cultural, or political significance. Weighty events are the sorts of events that we might expect to encounter as being mentioned in a moderately detailed world history, or that we might be particularly concerned about in our capacity as a moral agent. There are many different possible socio-axiological metrics, but their differences will not matter here.

If the consequences of acts are often chancy, then ordinary acts will not make any single specific future much more likely. Instead, acts can only modulate the chance of each of a large number of different possible branches that the future could take. Even if SENSITIVITY is false, it would still be plausible that many acts make minute absolute differences to the chances of specific future branches.

The significance of SENSITIVITY in the context of objective chances can be clarified by the concept of a probability shift, which captures the degree of difference between two probability assignments relative to a single partition of propositions. The value of a shift is half the sum of the absolute differences between the probabilities of the individual propositions in each assignment. For instance, suppose that tossing a fair coin in a certain biased manner produces heads with a 60% probability and tails with a 40% probability: the manner of tossing induces a probability shift of 0.1 against a fair toss over the partition of possible facings.

In coarse-grained partitions, similar possible futures are grouped together, and so an act's chancy consequences might alter the fine details of the results without producing large probability shifts. If an act repositions tons of dust without altering the political landscape, then it induces no great probability shift relative to a political partitioning.

Therefore, if purchasing a certain brand of cereal or setting up a friend on a blind date created a probability shift of 0.001 in the partition [there will be a genocide in the 22nd century, there will be no genocide in the 22nd century], then its future effects would be massive. On the other hand, if such acts induced probability shifts of only 10^{-20} , those consequences would not be massive. The purchase of one box of

cereal is not morally or historically important, and neither is a shift of the chance of genocide on the order of 1 in 100,000,000,000,000,000.

3. Lenman's Rationale

Lenman's defence of SENSITIVITY focuses on the tendency of identity-affecting acts to ramify. Identity-affecting acts induce further identity-affecting acts, rendering their effects increasingly significant over time. He illustrates this idea with a hypothetical story [2000: 344–5]:

Imagine we are in what is now southern Germany a hundred years before the birth of Jesus. A certain bandit, Richard, quite lost to history, has raided a village and killed all its inhabitants bar one. This final survivor, a pregnant woman named Angie, he finds hiding in a house about to be burned. On a whim of compassion, he orders that her life be spared. But perhaps, by consequentialist standards, he should not have done so. For let us suppose Angie was a[n ancestor] of Adolf Hitler. The millions of Hitler's victims are thus also victims of Richard's sparing of Angie.

Given sexual reproduction and a constant or growing population, individuals will have on average at least twice as many descendants in each generation as in the previous. Conversely, individuals have twice as many ancestors in each preceding generation. Hitler has around 2^{70} ancestral relations to members of Angie's generation. Since this number so vastly exceeds the number of people alive at that time, Hitler must be related to some people in many different ways, through the conjugation of his family lines in intermediate generations. It seems likely that most people of that era with any twentieth-century descendants can count Hitler among them.

Indirect identity-affecting acts also contribute to the explosion of effects. They are sufficiently common that most people perform at least a few throughout their lives, so identity-affecting acts sway not only the identities of series of lineal descendants but also the identities of all of those individuals whose existence is in any way dependent on those descendants' behaviour.

Effects on identity translate into socio-axiological effects, assuming that different individuals will behave differently. The course of history has been shaped in some obvious ways by the behaviour of some individuals. If they had not behaved as they did, it is easy to see world history having taken a different course. How could world history have been the same without Aristotle, Muhammad, or Genghis Khan?

This rationale for SENSITIVITY can be formalised as such:

- (1) Identity-affecting acts have a massive effect on the personal composition of future generations.
 - (2) Massive differences in the personal composition of future generations make for massive socio-axiological differences in the future.
- So,
- (3) Identity-affecting acts have massive socio-axiological effects on the future.

Richard's sparing was necessary for Hitler's existence. Without Hitler, twentieth-century history would have been very different. Removing the big personalities of history is likely to alter its course. Thus, the tendency of identity-affecting acts to ramify supports SENSITIVITY.

4. The Dissipation Objection

SENSITIVITY requires the persistence of identity-affecting acts' descendant effects. If the effects of most acts become less significant with each link in the causal chain, then they will not generally lead to perceptible differences in the far future.

G.E. Moore recognised the threat that SENSITIVITY posed to consequentialism, and suggested in response that the effects of most acts might dissipate, although he was hesitant about his own proposed solution [1922: 152]:

[The assumption that events in the far future are unlikely to outweigh events in the short-term] may, perhaps, be justified by some such considerations as the following. As we proceed further and further from the time at which alternative acts are open to us, the events of which either act would be part cause become increasingly dependent on those other circumstances, which are the same, whichever act we adopt. The effects of any individual act seem, after a sufficient space of time, to be found only in trifling modifications spread over a very wide area, whereas its immediate effects consist in some prominent modification of a comparatively narrow area. Since, however, most of the things which have any great importance for good or evil are things of this prominent kind, there may be a probability that after a certain time all the effects of any particular act become so nearly indifferent, that any difference between their value and that of the effects of another act, is very unlikely to outweigh an obvious difference in the value of the immediate effects.

We may formulate the basic idea in this way:

DISSIPATION. Routine identity-affecting acts typically have consequences that dissipate quickly and are therefore not massive.

Moore noticed that events tend to be dependent on many different acts, and so the responsibility of one act disperses as its effects mingle with the effects of others. He suspected that, since each event is the product of a large number of different acts, no individual act could claim much influence.

The previous argument for SENSITIVITY raises significant doubts about this rationale for DISSIPATION. It is possible for each event both to be the product of many different acts and to be highly sensitive to each. Identity-affecting acts have consequences that appear to satisfy these conditions: individuals result from the interactions of different identity-affecting acts but require each to be exactly as it is. Having written in ignorance of modern genetics, Moore might not quite have grasped the ways in which identity-affecting effects can ramify.

However, if objective chances are accepted, then DISSIPATION can be given a plausible rationale. The chancy effects of acts can revert to a probability that is dependent on broader trends. It is possible that some of the distant effects of our acts would have occurred with the same chance, had we acted differently.

Richard's sparing of Angie initiated a causal chain that eventuated in Hitler's birth. If causation is deterministic, then we can be reasonably confident that no equivalent individual would have been born, had Richard acted differently. If causation is indeterministic, then Richard's sparing of Angie might have only shifted the probabilities.

It is unclear how Richard's acts might have changed the probability of the eventual birth of someone like Hitler. Even with a long causal chain whose connections are recognisable in hindsight, the probability of each chancy twist and turn in that chain going the right way is rather small. Hitler was unlikely to result, however Richard acted. Had Richard acted differently, it is possible that another individual just like

Hitler might have come to be. We should not be confident that the chance of some similar figure would have been much more, or much less, than it actually was.

Compare this with shuffling a deck and drawing the top card. Assuming that shuffling is fair and chancy, ordering the deck in any way before shuffling does not change the chance with which any given card is subsequently drawn. If the intermediate generations between Richard and Hitler shuffle the possible twentieth-century events, then Richard's sparing of Angie might have altered the chance that Hitler himself would eventually be born (given his necessary descent from Angie), without having altered the chance of the birth of someone with precisely the qualities that allowed Hitler to do what he did.

5. Chancy Dissipation

The previous section showed that DISSIPATION ought to be taken seriously. I will now argue that it is true:

- (1) Very large sets of samples randomly drawn from a single population are very likely to have distributions of properties that very closely resemble those of the whole population.
- (2) The sets of futures left open by routine identity-affecting acts have distributions of socio-axiological properties that are as they would be if they were randomly drawn from the set of all previously open futures. (They depart from representativeness to the same degree and with the same frequency as randomly drawn samples do.)
- (3) If chancy events are ubiquitous, then, for any given act, the number of futures that it leaves open is very large.
So,
- (4) Routine identity-affecting acts are likely to leave open sets of futures with distributions of socio-axiological properties that very closely resemble the population of all previously open futures.
- (5) Routine identity-affecting acts only produce very small probability shifts on socio-axiological partitions.
- (6) Routine identity-affecting acts typically have consequences that quickly dissipate and are thus not massive.

5.1 Premise 1

The first premise states that very large sets of samples randomly drawn from a single population are very likely to have distributions of properties that very closely resemble those of the whole population. For any single way of partitioning the population and its samples, the proportion of each sample that falls into any part of the partition is likely to resemble the proportion of the whole population that falls into its corresponding part, and likely to resemble very closely the proportion for very large samples. This premise is foundational to modern statistics. It needs no further defence here.

5.2 Premise 2

Whenever we act, we foreclose some futures that were previously open. Those ways that things could have gone in which we acted otherwise become counterfactual. The remaining futures are a subset of those that were previously possible.

The second premise states that the futures left open by acts are typically distributed as if they were randomly chosen from the set of all previously possible futures with respect to their non-immediate effects.

The qualifier ‘as if’ is necessary because the sets of futures left open by a given act are not randomly selected. It might be chancy which possible futures result from an act, but the whole set of futures that are left open by the act is determined by the laws of nature and the prior state. This premise claims that we can treat the futures left open as random, for the purposes of statistical inferences.

The sets of futures are distributed as if randomly chosen, because the factors that determine which futures remain open are effectively random. A mechanism of sample selection is effectively random if it produces samples with the same *a priori* subjective probability of bias as genuinely random mechanisms do.

This absence of bias has two requirements.

First, the individuals selected by the mechanism must be as subjectively likely to display any of the properties under investigation as do randomly selected members for any distribution of properties in the population:

$$\Pr(x \text{ has } f \mid x \text{ is selected by an effectively random mechanism \& the population has distribution } d \text{ of } f)$$

=

$$\Pr(x \text{ has } f \mid x \text{ is selected by a random mechanism \& the population has distribution } d \text{ of } f)$$

Second, the probabilities of the properties of individuals selected by the mechanism must be subjectively independent. The conditional probability with which each individual displays some property, given that other selected individuals display the same property, must be the same as its bare probability conditional on any particular distribution of the property throughout the whole population. In other words, the information about the whole population must screen off any information that one sample provides about others:

$$\Pr(x \text{ has } f \mid x, y, \dots, z \text{ are selected by an effectively random mechanism \& the population has distribution } d \text{ of } f \text{ \& } y, \dots, z \text{ have distribution } e \text{ of } f)$$

=

$$\Pr(x \text{ has } f \mid x \text{ is selected by an effectively random mechanism \& the population has distribution } d \text{ of } f)$$

Pseudorandom algorithms illustrate this idea. Pseudorandom algorithms can be used to select effectively random samples by identifying properties that are probabilistically independent of the property whose statistical distribution is under investigation.

We might conduct a study by selecting a thousand numbers using a pseudorandom algorithm, and by matching those numbers to an alphabetical list of people to poll about political preferences. The thousand individuals whose numbers are generated constitute an effectively random sample for the assessment of the distribution of political sentiments, even though the pseudorandom algorithm deterministically produced the numbers that were used to select participants. Such a method would generate an effectively random sample because there are no *a priori* connections between a person’s ideology and the means that the algorithm uses to select their place in an alphabetical list. Data about the political beliefs of such individuals could tell us nothing about the

political beliefs of others, except by conveying information about the whole population. Despite not utilising true randomness, pseudorandom algorithms are equally suited to statistical inferences, because the mechanisms of sample selection that they allow are equally unlikely to introduce biases.

Both genuine and effective random samples occasionally draw too heavily from biased subpopulations. Some acts might leave open sets of futures that are unlike the population of previously possible futures. For large samples of either sort, biases should be extremely rare.

The justification for this premise is that the mechanisms that determine the futures that result from a given act, while not actually chancy, have a structure of causal mediation that makes collective biases as unlikely as in truly random samples. This is supported by three considerations.

5.2.1 Acts' Far-Future Effects Depend upon Many Coincidental Interactions

It is rare for acts to be uniquely responsible for any of their far-future effects. The course of history is directed at each moment by the confluence of many events. The effects of routine acts depend upon highly complex relations between them and their contextual backgrounds. Given the importance of coincidental alignments in these complex relations, there is no reason to expect the futures resulting from a routine act to be biased in any particular way. The arbitrariness of these alignments serves to effectively randomise the results of individual acts.

When a handful of dice are shaken in a cup and tossed upon a table, the facing and trajectory of each die at the onset of shaking contributes to the resulting positions of the settled dice, but those final positions are determined by the interactions between the dice as they tumble about the cup. Those positions depend upon extremely complex relationships between the initial trajectories that are fundamentally altered with any modest change to a single die's trajectory. The complex relationships serve to randomise the effect of slightly deviating one die.

Identity-affecting acts also interact with background conditions. Angie, if she is to contribute to the eventual birth of Hitler, needs to pair with just the right mate at just the right time to conceive the next link in the ancestral chain. The events in her vicinity are likely to influence not only her life but also the lives of everyone around her. They will affect who travels where and when, and thereby help to determine with whom she lives and works, whom she befriends, whom she marries, and, ultimately, her children's identities. Against this backdrop of interactions, slight changes to the circumstances of Richard's sparing can lead to different sets of coincidences and result in wildly different outcomes, making the future effects of Richard's act itself essentially random.

5.2.2 Acts' Far-Future Effects Are Filtered through Their Many Intermediaries

The possible futures left open by an act depend upon its effects, those effects' possible effects, those effects' possible effects, and so on. The causal intermediaries often have the same potency as the initial event in the chain. The intermediaries' own potential to influence the future vary arbitrarily with that of the initial act, and thereby scramble any capacity that the initial act might have had to influence the future in a specific direction. Assuming that those intermediaries bias the future in the same unpredictable way as the original act does, the futures that result will depend upon the outcomes of

intermediary events. The direction of the first step in a random walk makes little difference to the expectation of its final position.

In order for acts to induce large probability shifts in the far future, they must have a bearing that their effects neither dissolve nor reverse. Any bias introduced by an act that has a persisting chance of dissolution or reversal will probably do so at some point. The same reasons to expect ordinary acts to have unpredictable effects on the future are also reasons to think that some of their intermediate effects will upset any possible bias that they might have on subsequent events.

Suppose that there are two coins. One coin is biased so that it lands ‘heads’ 98% of the time. The other is biased so that it lands ‘tails’ 98% of the time. One coin will be tossed. If it lands in the direction of its bias, the toss will be repeated with the same coin, if it lands against the direction of its bias, the other coin will be tossed next. The process will continue for one hundred tosses. The last coin will land in the direction of the initial coin’s bias a little under 51% of the time. Starting with one coin or the other produces less than a 0.01 probability shift on the partition of possible final toss results. The long-term effects of the initial coin’s bias are dissolved by the large number of repeated intermediary chancy events, with their own power to set the future on a different course.

Routine identity-affecting acts are unlikely to have any irreversible long-term bearing. There are generally none that we can foresee, and such effects seldom clarify themselves in hindsight. Routine acts can initiate series of changes that eventuate in radically different futures, but the series will undergo so many twists and turns that the initial events must have very little power over the future results. Some acts have a clear path to affecting the future, and so might maintain their influence indefinitely. Nothing discussed so far rules out this possibility, but such acts are rare.

5.2.3 Biases that Acts Place on the Far Future Must Persist along Very Different Paths

Not only do acts’ effects on the far future require sustenance through long chains of causal intermediaries, but, given that chancy outcomes produce branching futures, they must maintain their bias within a variety of very different futures. Since each precise course of history can have only a minute probability of resulting from any act, acts need to shift the probabilities of many different possible courses in order to produce a non-negligible probability shift.

Suppose that Richard’s sparing of Angie made the rise of a twentieth-century genocidal dictator significantly more likely. For that to be the case, at every intermediate point—for example, 735, 951, and 1429 C.E.—the sparing’s many possible effects would need to be, on average, biased toward the future rise of such a figure. This might be so for some of the effects. However, given that the effects follow increasingly diverging histories, they are likely to differ greatly from one another and unlikely to share trends.

Histories depart from each other drastically as a result of happenstance. Slightly different strategies can lead battles to be won or lost, individual merchants’ plans of travel might determine where plagues spread, the whims of leaders can shift the economic, religious, and scientific environments of their countries.

In some of the alternate histories that could result from Angie’s sparing, Rome will fall and be replaced by a series of successor kingdoms, and Christianity and Islam will flourish. In others, the Sasanian empire will extend across Africa, and Manichaeism

becomes Europe's dominant religion. In some, Roman Europe will descend into a Dark Age before being rejuvenated by exchanges with its neighbours, the Mongols will unite under a capable leader and spread across the world, and Italian merchant princes will set the context for exchange between Asia, Europe, and the Americas. In others, wise leadership and a fortuitous economic climate will lead to an earlier industrial revolution in the East and trade will line the African coast with prosperous city-states. There are countless other ways that history might have gone. In many, the world would differ in ways that our history has not prepared us to imagine.

The diverse possible futures left open by Angie's sparing differ chiefly in the event with which they begin to depart from each other. The futures foreclosed by the act will differ from most of the remaining futures in terms of whether they include Angie's descendants. While she will only have descendants in those futures that begin with her sparing, Angie's many and varied possible descendants are unlikely to collectively behave in atypical ways. It is implausible that, of the incredible number of different paths that history could subsequently take, the paths that lead to genocidal dictatorships are, collectively, made modestly more likely while the paths that lead to uninterrupted peace and democracy are, collectively, made modestly less likely.

The three considerations work together to satisfy the two criteria of effective randomness. Given the importance of highly complex and largely accidental relations between a routine act and its background context, and given the varied intermediary chancy events necessary for an act to produce a particular future, we should think that the chance that the far-future has any particular feature is about the same as the chance that the feature would result from any alternative act. In light of the independent paths traced by alternative futures, the effect that an act has on the chances of any set of particular futures tells us nothing about its effect on the chances of other particular futures.

Given that routine identity-affecting acts have no clear propensity for initiating long-term trends, and since their effects on the future are swayed by millions of contemporary and intermediary events with an equal power to shape the future in equally unpredictable ways, we should expect their consequences to form an effectively random sample of the previously possible futures.

5.3 Premise 3

The third premise states that acts leave open very large sets of possible futures. For the argument to succeed, the number of possible futures left open by an act must be large enough to secure their representativeness. Small random samples often do not reflect the populations from which they are drawn. What matters for sample representativeness is not that the samples pass some absolute threshold of size, but instead that they are large relative to the number of relevant categories in the population and to those different categories' relative frequencies. A random sample of fifty individuals from a population that is divided into hundreds of categories might not provide an accurate fine-grained representation of the distribution of the population into those categories. A random sample of five billion individuals is almost certain to produce a reasonably faithful distribution.

The third premise tacitly asserts a comparison: there are relatively few socio-axiologically distinct ways that a future can be, when compared to the total number of different ways that have some non-negligible chance of resulting from a given act.

Neither of these numbers can be estimated with any precision. My approach will be to try to produce a rough estimate of the number of possible socio-axiologically distinct ways that the future might be, and then to show that the number of different total futures left open by typical acts is staggeringly larger.

How many purely axiologically distinct futures are possible at any given time? Axiologically distinct futures differ in terms of their value. They ignore differences in the possible distributions of value in futures that are equally good overall. To simplify the issues, I will make two further assumptions. First, I will assume that what matters is the qualities of lives: it does not matter to whom those lives belong or when those lives are lived. Second, I will assume that the total future human population will include no more than a few quintillion people.

Given welfarism and a limited population, one way to get a handle on the question is to estimate a possible range of populations and to measure the maximum amount of variation in the lives that constitute those populations. Suppose that we took an individual life and rated each second of its duration on a scale from -2,000 to 2,000,⁴ and then treated the life's value as the sum of those ratings. Assuming a length of eighty years, there would be about 10^{13} possible distinct total sums of second-by-second values for a single life. Evaluating a whole population requires summing the values of its lives. For a quintillion lives, there would be about 10^{31} possible sums.

It might be inappropriate to calculate the possible range of value by summing momentary values. The order in which good or bad events occur might matter. There might also be large-scale synergies in the welfare of individuals and populations that are irreducible. However, it is unlikely that these kinds of effects will add dozens of orders of magnitude to the possible degrees of variation of the total value. Even if we say that, in addition to the variation produced by total sums, there are trillions of possible distributions of value in a life or valuable lives in a population that modulate the total, it will not radically alter the size of the range of values possibly experienced by a whole population.

It might also be wrong to restrict value to welfare. Perhaps there is value in personal achievements, natural beauty, or biodiversity that is distinct from the value contained within lives. Even if this is the case, it seems very unlikely that the additional sources of value will add more than a few dozen orders of magnitude of possible variation.

There are about 10^{67} ways of sorting a single deck of cards. If the shape of the future is very sensitive to present events, then it is plausible that different orderings of a shuffle in a given game of cards might lead to different futures. If each shuffling is a fair and chancy event, with an equal chance for each possible ordering, and if each ordering of a shuffled deck gives rise to a different future, then the total number of distinct possible futures resulting from a single shuffle of a single deck of cards would be extraordinary. Dividing the possible futures resulting from the shuffle of a single deck of cards evenly over 10^{31} different possible levels of value would leave 10^{36} distinct futures for each level.

Any pair of parents can produce about 70,000,000,000,000 different chromosomal combinations in their children (ignoring sub-chromosomal mutations). About 130,000,000 people are currently born each year. Holding parental pairings fixed, the number of genetic combinations for the newborns in a given year is roughly $10^{1,800,000,000}$. If chromosomal recombination is a fair and chancy process and each

⁴ These numbers are arbitrary and are intended only as illustrative.

result leads the future down a different path, the number of futures per possibility climbs unimaginably higher. Dividing $10^{1,800,000,000}$ futures evenly over the 10^{31} possible different degrees of value would leave $10^{1,799,999,969}$ futures for each level of value.

The discrepancy between the number of axiologically distinct futures and the total number of possible futures results in part from the stipulation that the ordering of goods is irrelevant. There are more ways of ordering a single deck of cards than there are possible degrees of value in the future, because it matters how each card is arranged but not where value is accrued. Even so, the granularity of socio-axiological properties ensures that there are many fewer socio-axiological states to be ordered. Differences of ordering can be included without erasing the discrepancy between the number of possible futures produced by an act and the number of different socio-axiological categories into which those futures may be placed.

Suppose that each human society differs in such ways as to produce 10^{10} distinct sets of sociological features, that there are 1,000,000 such societies on Earth, and that every society can change any of these features yearly for the next 10,000 years. Ordering effects matter to the number of possible futures at this level of granularity: switch one society's attributes with those of its neighbour, and it becomes a different possibility.

Given these assumptions, there would be $10^{100,000,000,000}$ different sociologically distinct possible futures. This is a large number. It is much larger than the number of orderings of a single deck of cards, or even the number of chromosomal pairings in a generation's worth of individuals. However, it is not so large that it cannot be swamped. If we let seven billion individuals each shuffle a single deck of cards, the number of different possible orderings among all of those decks of cards would be about $10^{469,000,000,000}$. If each of these orderings gives rise to a different possible future, the number of futures per socio-axiologically distinct possibility would reach $10^{369,000,000,000}$.

Given the discrepancy between the number of futures and the number of socio-axiologically distinct possibilities, most of these different orderings cannot lead to significantly different futures. Many orderings must lead to futures that, while differing in their fine details, share all of their granular socio-axiological features.

It might be that neither shuffling nor chromosomal sorting is a perfectly fair chancy process, and it is also possible that not all orderings or combinations lead to distinct sets of possible futures. These cases are intended to illustrate the power of chancy processes to produce massive numbers of different results. Sequences of chancy events can accumulate large numbers of possible futures, even if no individual event directly produces many distinct possibilities.

It takes a relatively small number of 50–50 chances to produce the randomness attributed to shuffling a deck or a single instance of chromosomal sorting. Assuming that there is one chancy event per person during each period of length x (minutes/days/decades) with an equal chance of diverting the future down two different courses, then, given the present population, it will take a time period lasting about fifty x to produce enough such chancy events for the future branches to swamp the $10^{100,000,000,000}$ sociologically distinct futures that were assumed for the next 10,000 years. If such events occur at a rate of one per person per minute, it would take under an hour. If the rate were one per person per month, it would still happen in about four years.

There are a number of events with some claim to chanciness, and so one such event per month is reasonable. It does not matter precisely which chancy processes generate the large number of possible futures. The chancy events need not themselves be the direct products of agency, for they will mingle with the immediate effects of acts to divert their subsequent effects down different courses. If such events are reasonably common, then it is likely that they will work in concert with each other to produce an explosion of possible futures plentiful enough to vastly outstrip the number of socio-axiologically distinct possibilities.

If our acts have chancy consequences, then a tremendous number of different futures could result from any given act. Chancy events interact in such ways as to produce many possible results. This ensures that if chancy events are ubiquitous, and if the futures left open by our acts are effectively random samples from the set of the previously possible futures, then they will most likely share nearly identical distributions of socio-axiological properties with that set.

5.4 Putting the Argument Together

SENSITIVITY requires that routine identity-affecting acts produce noticeable shifts in the probabilities of coarsely individuated futures. It is not enough that they typically boost the probabilities of a handful of socio-axiological possibilities. To induce a large probability shift on socio-axiological partitions, individual identity-affecting acts must affect the probabilities of a sizable portion of the futures that might result. These futures are likely to greatly diverge, and thus likely not to be collectively subject to any biasing trends. While some special acts surely do have such an effect, it is implausible that routine identity-affecting acts generally do.

On any way of carving up possible futures along axiological or sociological lines, there will be an unfathomably large number of distinct possible futures. However, given the ubiquity of chancy events, the number of different possible futures left open by any given act is tremendously larger. Any two large effectively random samples from the same set of possible futures will exhibit similar distributions of socio-axiological properties. If alternative acts manage to carve those futures that they leave open away from those that they foreclose in effectively random ways, then the sets of futures that result are almost sure to share nearly identical distributions of socio-axiological properties.

If different acts produce very similar distributions of possible futures, then the differences between their effects will dissipate. Routine acts have modest foreseeable short-term effects, and, although they do contribute to making some very fine-grained future possibilities more or less likely, they do not unpredictably shift the probabilities of the kinds of propositions about the far future about which we care.

6. Conclusion

Lenman presented a powerful argument for SENSITIVITY and a convincing rebuttal of Moore's rationale for DISSIPATION. DISSIPATION might still be justified. Given ubiquitous chancy events, there is a strong argument that the probability shifts induced by our acts are generally quite subtle. Our routine acts might modulate the probabilities of some distant events, but are not likely to radically alter the future.⁵

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