

19.4 | *Chance*

In its relation to cause, chance is essentially a negative concept. For some writers, as the quotations here reveal, that which happens by chance is that which happens without cause, such as the swerve of the atoms described by Lucretius; for other writers, it is that which, though it may somehow be caused, is not necessitated by its causes; for still others, it is an event the causes of which we do not know or cannot determine, even though such causes may exist and may even necessitate the occurrence of the event in question. In addition, there is the concept of chance that emerges in Aristotle's discussion of a coincidence, such as the accidental meeting of two persons at a place where neither expected or planned to see the other: each, according to Aristotle, was caused to go to that place by decisions, motives, or other influences operating causatively on his own behavior, but nothing caused these two lines of causation to intersect at the moment of their coincidence.

The historians, biographers, and poets are concerned with the role of chance in human affairs. On this subject, the reader is referred to relevant passages in Section 15.3 on FATE, FORTUNE, AND DESTINY. The philosophers and theologians are concerned with necessity and contingency in nature and with the difference between a world in which things occur by chance or by blind necessity and a

world governed by an intelligent deity and ordered by a benevolent providence. Spinoza, Hume, Voltaire, Darwin, J. S. Mill, and Tolstoy all deny that anything happens by chance; this, according to Hume, is consistent with our not knowing the causes of events; to ascribe something to chance, Darwin points out, is merely to confess our ignorance of the causes.

Beginning with Pascal, among the authors quoted, the consideration of chance takes a new direction—the calculus and theory of probability, the most obvious application of which is to the games we call “games of chance.” The reader will find this subject further explored in passages drawn from Laplace, Peirce, and Poincaré, and the reader will also be interested in Poincaré's contradiction of Darwin's remark that chance is nothing but a name for our ignorance of causes. With regard to probability itself, quotations from Locke and from Russell call attention to the distinction between subjective and objective probability—the one, an estimate of the reliability of our claim to know something, its credibility, or the likelihood that it is true; the other, a mathematical calculation of the betting odds on a particular future occurrence, such as making a certain number on the next roll of the dice or drawing a particular card from the pack.

1 I returned, and saw under the sun, that the race is not to the swift, nor the battle to the strong, neither yet bread to the wise, nor yet riches to men of understanding, nor yet favour to men of skill; but time and chance happeneth to them all.

Ecclesiastes 9:11

2 *Artabanus*. Chances rule men, and not men chances.

Herodotus, *History*, VII, 49

3 *Jocasta*. Why should man fear since chance is all in all for him, and he can clearly foreknow nothing? Best to live lightly, as one can, unthinkingly.

Sophocles, *Oedipus the King*, 977

4 *Pericles*. Sometimes the course of things is as arbitrary as the plans of man; indeed this is why we usually blame chance for whatever does not hap-

pen as we expected.

Thucydides, *Peloponnesian War*, I, 140

- 5 *Crito*. But you see, Socrates, that the opinion of the many must be regarded, for what is now happening shows that they can do the greatest evil to any one who has lost their good opinion.

Socrates. I only wish it were so, *Crito*; and that the many could do the greatest evil; for then they would also be able to do the greatest good—and what a fine thing this would be! But in reality they can do neither; for they cannot make a man either wise or foolish; and whatever they do is the result of chance.

Plato, *Crito*, 44B

- 6 *Athenian Stranger*. I was going to say that man never legislates, but accidents of all sorts, which legislate for us in all sorts of ways. The violence of war and the hard necessity of poverty are constantly overturning governments and changing laws. And the power of disease has often caused innovations in the state, when there have been pestilences, or when there has been a succession of bad seasons continuing during many years. Any one who sees all this, naturally rushes to the conclusion of which I was speaking, that no mortal legislates in anything, but that in human affairs chance is almost everything. And this may be said of the arts of the sailor, and the pilot, and the physician, and the general, and may seem to be well said; and yet there is another thing which may be said with equal truth of all of them.

Cleinias. What is it?

Ath. That God governs all things, and that chance and opportunity co-operate with him in the government of human affairs. There is, however, a third and less extreme view, that art should be there also; for I should say that in a storm there must surely be a great advantage in having the aid of the pilot's art. You would agree?

Cle. Yes.

Plato, *Laws*, IV, 709A

- 7 Every result of chance is from what is spontaneous, but not everything that is from what is spontaneous is from chance.

Chance and what results from chance are appropriate to agents that are capable of good fortune and of moral action generally. Therefore necessarily chance is in the sphere of moral actions. This is indicated by the fact that good fortune is thought to be the same, or nearly the same, as happiness, and happiness to be a kind of moral action, since it is well-doing. Hence what is not capable of moral action cannot do anything by chance. Thus an inanimate thing or a lower animal or a child cannot do anything by chance, because it is incapable of deliberate intention; nor can 'good fortune' or 'ill fortune' be ascribed to

them, except metaphorically, as Protarchus, for example, said that the stones of which altars are made are fortunate because they are held in honour, while their fellows are trodden under foot.

Aristotle, *Physics*, 197a37

- 8 Chance has no place in that which is natural, and what happens everywhere and in every case is no matter of chance.

Aristotle, *On the Heavens*, 289b26

- 9 Things come into being either by art or by nature or by luck or by spontaneity. Now art is a principle of movement in something other than the thing moved, nature is a principle in the thing itself (for man begets man), and the other causes are privations of these two.

Aristotle, *Metaphysics*, 1070a6

- 10 When bodies are borne downwards sheer through void by their own weights, at quite uncertain times and uncertain spots they push themselves a little from their course: you just and only just can call it a change of inclination. If they were not used to swerve, they would all fall down, like drops of rain, through the deep void, and no clashing would have been begotten nor blow produced among the first-beginnings: thus nature never would have produced aught.

Lucretius, *Nature of Things*, II

- 11 That the mind itself does not feel an internal necessity in all its actions and is not as it were overmastered and compelled to bear and put up with this, is caused by a minute swerving of first-beginnings at no fixed part of space and no fixed time.

Lucretius, *Nature of Things*, II

- 12 *Moeris*. Chance sways all.

Virgil, *Eclogue IX*, 5

- 13 I suspend my judgment on the question whether it is fate and unchangeable necessity or chance which governs the revolutions of human affairs. Indeed, among the wisest of the ancients and among their disciples you will find conflicting theories, many holding the conviction that heaven does not concern itself with the beginning or the end of our life, or, in short, with mankind at all; and that therefore sorrows are continually the lot of the good, happiness of the wicked; while others, on the contrary, believe that, though there is a harmony between fate and events, yet it is not dependent on wandering stars, but on primary elements, and on a combination of natural causes. Still, they leave us the capacity of choosing our life, maintaining that, the choice once made, there is a fixed sequence of events. Good and evil, again, are not what vulgar opinion accounts them; many who seem to be struggling with ad-

versity are happy; many, amid great affluence, are utterly miserable, if only the first bear their hard lot with patience, and the latter make a foolish use of their prosperity.

Tacitus, *Annals*, VI, 22

- 14 Either there is a fatal necessity and invincible order, or a kind Providence, or a confusion without a purpose and without a director. If then there is an invincible necessity, why dost thou resist? But if there is a Providence which allows itself to be propitiated, make thyself worthy of the help of the divinity. But if there is a confusion without a governor, be content that in such a tempest thou hast in thyself a certain ruling intelligence. And even if the tempest carry thee away, let it carry away the poor flesh, the poor breath, everything else; for the intelligence at least it will not carry away.

Marcus Aurelius, *Meditations*, XII, 14

- 15 To make the existence and coherent structure of this universe depend upon automatic activity and upon chance is against all good sense. Such a notion could be entertained only where there is neither intelligence nor even ordinary perception; and reason enough has been urged against it, though none is really necessary.

Plotinus, *Third Ennead*, II, 1

- 16 There is a difference between universal and particular causes. A thing can escape the order of a particular cause, but not the order of a universal cause. For nothing escapes the order of a particular cause except through the intervention and hindrance of some other particular cause; as, for instance, wood may be prevented from burning by the action of water. Since, then, all particular causes are included under the universal cause, it could not be that any effect should take place outside the range of that universal cause. So far then as an effect escapes the order of a particular cause, it is said to be casual or fortuitous in respect to that cause; but if we regard the universal cause, outside whose range no effect can happen, it is said to be foreseen. Thus, for instance, the meeting of two servants, although to them it appears a chance circumstance, has been fully foreseen by their master, who has purposely sent them to meet at the one place, in such a way that the one knows not about the other.

Aquinas, *Summa Theologica*, I, 22, 2

- 17 Certain philosophers of old denied the government of the world, saying that all things happened by chance. But such an opinion can be shown to be impossible . . . by observation of things themselves. For we observe that in nature things happen always or nearly always for the best, which would not be the case unless some sort of providence directed nature towards good as an end, which is to govern. Therefore the unfailling

order we observe in things is a sign of their being governed.

Aquinas, *Summa Theologica*, I, 103, 1

- 18 It is written *I saw that under the sun the race is not to the swift, nor the battle to the strong, nor bread to the wise, nor riches to the learned, nor favour to the skilful, but time and chance in all.* But things subject to the Divine government are not ruled by chance. Therefore those things which are under the sun are not subject to the Divine government. . . . These things are said to be under the sun which are generated and corrupted according to the sun's movement. In all such things we find chance. Not that everything which occurs in such things is by chance, but that in each one there is an element of chance. And the very fact that an element of chance is found in those things proves that they are subject to government of some kind. For unless corruptible things of this kind were governed by a higher being, they would tend to nothing definite, especially those which possess no kind of knowledge. So nothing in them would happen unintentionally, which constitutes the nature of chance. Therefore to show how things happen by chance and yet according to the ordering of a higher cause, he does not say absolutely that he observes chance in all things, but *time and chance*, that is to say, that defects may be found in these things according to some order of time.

Aquinas, *Summa Theologica*, I, 103, 5

- 19 Every action of nature terminates in some one thing. Therefore it is impossible for that which is accidental to be the effect *per se* of an active natural principle. No natural cause can therefore have for its proper effect that a man intending to dig a grave finds a treasure. Now it is manifest that a heavenly body acts after the manner of a natural principle, and so its effects in this world are natural. It is therefore impossible that any active power of a heavenly body be the cause of what happens by accident here below, whether by luck or by chance.

Aquinas, *Summa Theologica*, I, 116, 1

- 20 To call out for the hand of the enemy is a rather extreme measure, yet a better one, I think, than to remain in continual fever over an accident that has no remedy. But since all the precautions that a man can take are full of uneasiness and uncertainty, it is better to prepare with fine assurance for the worst that can happen, and derive some consolation from the fact that we are not sure that it will happen.

Montaigne, *Essays*, I, 24, Various Outcomes

- 21 *King Richard.* A horse! a horse! my kingdom for a horse!
Catesby. Withdraw, my lord; I'll help you to a horse.

K. Rich. Slave, I have set my life upon a cast
And I will stand the hazard of the die:
I think there be six Richmonds in the field;
Five have I slain to-day instead of him.
A horse! a horse! my kingdom for a horse!

Shakespeare, *Richard III*, V, iv, 7

22 *Chatillon.* And all the unsettled humours of the
land,

Rash, inconsiderate, fiery voluntaries,
With ladies' faces and fierce dragons' spleens,
Have sold their fortunes at their native homes,
Bearing their birthrights proudly on their backs,
To make a hazard of new fortunes here.

Shakespeare, *King John*, II, i, 66

23 *Portia.* In terms of choice I am not solely led

By nice direction of a maiden's eyes;
Besides, the lottery of my destiny
Bars me the right of voluntary choosing:
But if my father had not scanted me
And hedged me by his wit, to yield myself
His wife who wins me by that means I told you,
Yourself, renowned Prince, then stood as fair
As any comer I have look'd on yet
For my affection.

Prince of Morocco. Even for that I thank you:
Therefore, I pray you, lead me to the caskets
To try my fortune. By this scimitar
That slew the Sophy and a Persian prince
That won three fields of Sultan Solyman,
I would outstare the sternest eyes that look,
Outbrave the heart most daring on the earth,
Pluck the young sucking cubs from the she-bear,
Yea, mock the lion when he roars for prey,
To win thee, lady. But, alas the while!
If Hercules and Lichas play at dice
Which is the better man, the greater throw
May turn by fortune from the weaker hand:
So is Alcides beaten by his page;
And so may I, blind fortune leading me,
Miss that which one unworthier may attain,
And die with grieving.

Por. You must take your chance,
And either not attempt to choose at all
Or swear before you choose, if you choose wrong
Never to speak to lady afterward
In way of marriage: therefore be advised.

Mor. Nor will not. Come, bring me unto my
chance.

Por. First, forward to the temple: after dinner
Your hazard shall be made.

Mor. Good fortune then!
To make me blest or curs'd 'st among men.

Shakespeare, *Merchant of Venice*, II, i, 13

24 *Nestor.* In the reproof of chance
Lies the true proof of men.

Shakespeare, *Troilus and Cressida*, I, iii, 33

25 *Florizel.* As the unthought-on accident is guilty

To what we wildly do, so we profess
Ourselves to be the slaves of chance and flies
Of every wind that blows.

Shakespeare, *Winter's Tale*, IV, iv, 548

26 Let us . . . say, "God is, or He is not." But to
which side shall we incline? Reason can decide
nothing here. There is an infinite chaos which
separated us. A game is being played at the ex-
tremity of this infinite distance where heads or
tails will turn up. What will you wager? Accord-
ing to reason, you can do neither the one thing
nor the other; according to reason, you can de-
fend neither of the propositions.

Do not, then, reprove for error those who have
made a choice; for you know nothing about it.
"No, but I blame them for having made, not this
choice, but a choice; for again both he who choo-
ses heads and he who chooses tails are equally at
fault, they are both in the wrong. The true course
is not to wager at all."

Yes; but you must wager. It is not optional. You
are embarked. Which will you choose then? Let
us see. Since you must choose, let us see which
interests you least. You have two things to lose,
the true and the good; and two things to stake,
your reason and your will, your knowledge and
your happiness; and your nature has two things to
shun, error and misery. Your reason is no more
shocked in choosing one rather than the other,
since you must of necessity choose. This is one
point settled. But your happiness? Let us weigh
the gain and the loss in wagering that God is. Let
us estimate these two chances. If you gain, you
gain all; if you lose, you lose nothing. Wager,
then, without hesitation that He is. "That is very
fine. Yes, I must wager; but I may perhaps wager
too much." Let us see. Since there is an equal risk
of gain and of loss, if you had only to gain two
lives, instead of one, you might still wager. But if
there were three lives to gain, you would have to
play (since you are under the necessity of play-
ing), and you would be imprudent, when you are
forced to play, not to chance your life to gain
three at a game where there is an equal risk of loss
and gain. But there is an eternity of life and hap-
piness. And this being so, if there were an infinity
of chances, of which one only would be for you,
you would still be right in wagering one to win
two, and you would act stupidly, being obliged to
play, by refusing to stake one life against three at
a game in which out of an infinity of chances
there is one for you, if there were an infinity of an
infinitely happy life to gain. But there is here an
infinity of an infinitely happy life to gain, a
chance of gain against a finite number of chances
of loss, and what you stake is finite. It is all divid-
ed; wherever the infinite is and there is not an
infinity of chances of loss against that of gain,
there is no time to hesitate, you must give all. And
thus, when one is forced to play, he must renounce

reason to preserve his life, rather than risk it for infinite gain, as likely to happen as the loss of nothingness.

For it is no use to say it is uncertain if we will gain, and it is certain that we risk, and that the infinite distance between the *certainty* of what is staked and the *uncertainty* of what will be gained, equals the finite good which is certainly staked against the uncertain infinite. It is not so, as every player stakes a certainty to gain an uncertainty, and yet he stakes a finite certainty to gain a finite uncertainty, without transgressing against reason. There is not an infinite distance between the certainty staked and the uncertainty of the gain; that is untrue. In truth, there is an infinity between the certainty of gain and the certainty of loss. But the uncertainty of the gain is proportioned to the certainty of the stake according to the proportion of the chances of gain and loss. Hence it comes that, if there are as many risks on one side as on the other, the course is to play even; and then the certainty of the stake is equal to the uncertainty of the gain, so far is it from fact that there is an infinite distance between them. And so our proposition is of infinite force, when there is the finite to stake in a game where there are equal risks of gain and of loss, and the infinite to gain. This is demonstrable; and if men are capable of any truths, this is one.

"I confess it, I admit it. But, still, is there no means of seeing the faces of the cards?" Yes, Scripture and the rest, etc. "Yes, but I have my hands tied and my mouth closed; I am forced to wager, and am not free. I am not released, and am so made that I cannot believe. What, then, would you have me do?"

True. But at least learn your inability to believe, since reason brings you to this, and yet you cannot believe. Endeavour, then, to convince yourself, not by increase of proofs of God, but by the abatement of your passions. You would like to attain faith and do not know the way; you would like to cure yourself of unbelief and ask the remedy for it. Learn of those who have been bound like you, and who now stake all their possessions. These are people who know the way which you would follow, and who are cured of an ill of which you would be cured. Follow the way by which they began; by acting as if they believed, taking the holy water, having masses said, etc. Even this will naturally make you believe, and deaden your acuteness. "But this is what I am afraid of." And why? What have you to lose?

But to show you that this leads you there, it is this which will lessen the passions, which are your stumbling-blocks. . . .

Now, what harm will befall you in taking this side? You will be faithful, honest, humble, grateful, generous, a sincere friend, truthful. Certainly you will not have those poisonous pleasures, glory and luxury; but will you not have others? I will

tell you that you will thereby gain in this life, and that, at each step you take on this road, you will see so great certainty of gain, so much nothingness in what you risk, that you will at last recognise that you have wagered for something certain and infinite, for which you have given nothing.

"Ah! This discourse transports me, charms me," etc.

If this discourse pleases you and seems impressive, know that it is made by a man who has knelt, both before and after it, in prayer to that Being, infinite and without parts, before whom he lays all he has, for you also to lay before Him all you have for your own good and for His glory, that so strength may be given to lowliness.

Pascal, *Pensées*, III, 233

27 Whatever is, is in God; but God cannot be called a contingent thing, for He exists necessarily and not contingently. Moreover, the modes of the divine nature have followed from it necessarily and not contingently, and that, too, whether it be considered absolutely, or as determined to action in a certain manner. But God is the cause of these modes, not only insofar as they simply exist, but also insofar as they are considered as determined to any action. And if they are not determined by God, it is an impossibility and not a contingency that they should determine themselves; and, on the other hand, if they are determined by God, it is an impossibility and not a contingency that they should render themselves indeterminate. Wherefore all things are determined from a necessity of the divine nature, not only to exist, but to exist and act in a certain manner, and there is nothing contingent.

Spinoza, *Ethics*, I, Prop. 29, Demonstr.

28 The highest probability amounts not to certainty, without which there can be no true knowledge.

Locke, *Concerning Human Understanding*, Bk. IV, III, 14

29 All Nature is but Art, unknown to thee;
All Chance, Direction, which thou canst not see;
All Discord, Harmony, not understood;
All partial Evil, universal Good:
And, spite of Pride, in erring Reason's spite,
One truth is clear, "Whatever is, is Right."

Pope, *Essay on Man*, Epistle I, 289

30 Though there be no such thing as *Chance* in the world; our ignorance of the real cause of any event has the same influence on the understanding, and begets a like species of belief or opinion.

There is certainly a probability, which arises from a superiority of chances on any side; and according as this superiority increases, and surpasses the opposite chances, the probability receives a proportionable encrease, and begets still a

higher degree of belief or assent to that side, in which we discover the superiority. If a die were marked with one figure or number of spots on four sides, and with another figure or number of spots on the two remaining sides, it would be more probable, that the former would turn up than the latter; though, if it had a thousand sides marked in the same manner, and only one side different, the probability would be much higher, and our belief or expectation of the event more steady and secure. This process of the thought or reasoning may seem trivial and obvious; but to those who consider it more narrowly, it may, perhaps, afford matter for curious speculation.

It seems evident, that, when the mind looks forward to discover the event, which may result from the throw of such a die, it considers the turning up of each particular side as alike probable; and this is the very nature of chance, to render all the particular events, comprehended in it, entirely equal. But finding a greater number of sides concur in the one event than in the other, the mind is carried more frequently to that event, and meets it oftener, in revolving the various possibilities or chances, on which the ultimate result depends.

Hume, *Concerning Human Understanding*, VI, 46

- 31 It is universally allowed that nothing exists without a cause of its existence, and that chance, when strictly examined, is a mere negative word, and means not any real power which has anywhere a being in nature.

Hume, *Concerning Human Understanding*, VIII, 74

- 32 All effects follow not with like certainty from their supposed causes. Some events are found, in all countries and all ages, to have been constantly conjoined together: Others are found to have been more variable, and sometimes to disappoint our expectations; so that, in our reasonings concerning matter of fact, there are all imaginable degrees of assurance, from the highest certainty to the lowest species of moral evidence.

A wise man, therefore, proportions his belief to the evidence. In such conclusions as are founded on an infallible experience, he expects the event with the last degree of assurance, and regards his past experience as a full *proof* of the future existence of that event. In other cases, he proceeds with more caution: He weighs the opposite experiments: He considers which side is supported by the greater number of experiments: to that side he inclines, with doubt and hesitation; and when at last he fixes his judgement, the evidence exceeds not what we properly call *probability*. All probability, then, supposes an opposition of experiments and observations, where the one side is found to overbalance the other, and to produce a degree of

evidence, proportioned to the superiority.

Hume, *Concerning Human Understanding*, X, 87

- 33 No more by the law of reason than by the law of nature can anything occur without a cause.

Rousseau, *Social Contract*, II, 4

- 34 Nothing was ever said with uncommon felicity but by the cooperation of chance; and therefore wit, as well as valor, must be content to share its honors with fortune.

Johnson, *Idler No. 58*

- 35 The explanation adopted by Epicurus . . . completely denies and abolishes the distinction between a technic of nature and its mere mechanism. Blind chance is accepted as the explanation, not alone of the agreement of the generated products with our conception, and, consequently, of the technic of nature, but even of the determination of the causes of this development on dynamical laws, and, consequently, of its mechanism. Hence nothing is explained, not even the illusion in our teleological judgements, so that the alleged idealism in them is left altogether unsubstantiated.

Kant, *Critique of Teleological Judgement*, 73

- 36 All events, even those which on account of their insignificance do not seem to follow the great laws of nature, are a result of it just as necessarily as the revolutions of the sun. In ignorance of the ties which unite such events to the entire system of the universe, they have been made to depend upon final causes or upon hazard, according as they occur and are repeated with regularity, or appear without regard to order; but these imaginary causes have gradually receded with the widening bounds of knowledge and disappear entirely before sound philosophy, which sees in them only the expression of our ignorance of the true causes.

Laplace, *Essay on Probabilities*, I

- 37 Consider that chance, which, with error, its brother, and folly, its aunt, and malice, its grandmother, rules in this world; which every year and every day, by blows great and small, embitters the life of every son of earth, and yours too.

Schopenhauer, *Wisdom of Life: Aphorisms*

- 38 Those who live in the midst of democratic fluctuations have always before their eyes the image of chance; and they end by liking all undertakings in which chance plays a part. They are therefore all led to engage in commerce, not only for the sake of the profit it holds out to them, but for the love of the constant excitement occasioned by that pursuit.

Tocqueville, *Democracy in America*, Vol. II, II, 19

39 When we look at the plants and bushes clothing an entangled bank, we are tempted to attribute their proportional numbers and kinds to what we call chance. But how false a view is this!

Darwin, *Origin of Species*, III

40 I have . . . sometimes spoken as if the variations—so common and multiform with organic beings under domestication, and in a lesser degree with those under nature—were due to chance. This, of course, is a wholly incorrect expression, but it serves to acknowledge plainly our ignorance of the cause of each particular variation.

Darwin, *Origin of Species*, V

41 I am aware that the conclusions arrived at in this work will be denounced by some as highly irreligious; but he who denounces them is bound to shew why it is more irreligious to explain the origin of man as a distinct species by descent from some lower form, through the laws of variation and natural selection, than to explain the birth of the individual through the laws of ordinary reproduction. The birth both of the species and of the individual are equally parts of that grand sequence of events, which our minds refuse to accept as the result of blind chance. The understanding revolts at such a conclusion, whether or not we are able to believe that every slight variation of structure,—the union of each pair in marriage,—the dissemination of each seed,—and other such events, have all been ordained for some special purpose.

Darwin, *Descent of Man*, III, 21

42 Chance is usually spoken of in direct antithesis to law; whatever (it is supposed) cannot be ascribed to any law is attributed to chance. It is, however, certain, that whatever happens is the result of some law; is an effect of causes, and could have been predicted from a knowledge of the existence of those causes, and from their laws. If I turn up a particular card, that is a consequence of its place in the pack. Its place in the pack was a consequence of the manner in which the cards were shuffled, or of the order in which they were played in the last game; which, again, were effects of prior causes. At every stage, if we had possessed an accurate knowledge of the causes in existence, it would have been abstractly possible to foretell the effect.

An event occurring by chance may be better described as a coincidence from which we have no ground to infer an uniformity: the occurrence of a phenomena, in certain circumstances, without our having reason on that account to infer that it will happen again in those circumstances. This, however, when looked closely into, implies that the enumeration of the circumstances is not complete. Whatever the fact be, since it has occurred once, we may be sure that if *all* the same circumstances

were repeated, it would occur again; and not only if all, but there is some particular portion of those circumstances on which the phenomenon is invariably consequent. With most of them, however, it is not connected in any permanent manner: its conjunction with those is said to be the effect of chance, to be merely casual. Facts casually conjoined are separately the effects of causes, and therefore of laws; but of different causes, and causes not connected by any law.

It is incorrect, then, to say that any phenomenon is produced by chance; but we may say that two or more phenomena are conjoined by chance, that they co-exist or succeed one another only by chance; meaning that they are in no way related through causation; that they are neither cause and effect, nor effects of the same cause, nor effects of causes between which there subsists any law of co-existence, nor even effects of the same collocation of primeval causes.

Mill, *System of Logic*, Bk. III, XVII, 2

43 If we assume as the historians do that great men lead humanity to the attainment of certain ends—the greatness of Russia or of France, the balance of power in Europe, the diffusion of the ideas of the Revolution, general progress, or anything else—then it is impossible to explain the facts of history without introducing the conceptions of *chance* and *genius*. . . .

Why did it happen in this and not in some other way? Because it happened so! “*Chance* created the situation; *genius* utilized it,” says history.

But what is *chance*? What is *genius*? The words *chance* and *genius* do not denote any really existing thing and therefore cannot be defined. Those words only denote a certain stage of understanding of phenomena. I do not know why a certain event occurs; I think that I cannot know it; so I do not try to know it and I talk about *chance*. I see a force producing effects beyond the scope of ordinary human agencies; I do not understand why this occurs and I talk of *genius*. . . .

Only by renouncing our claim to discern a purpose immediately intelligible to us, and admitting the ultimate purpose to be beyond our ken, may we discern the sequence of experiences in the lives of historic characters and perceive the cause of the effect they produce (incommensurable with ordinary human capabilities), and then the words *chance* and *genius* become superfluous.

Tolstoy, *War and Peace*, I Epilogue, II

44 The inference from the premise, A, to the conclusion, B, depends, as we have seen, on the guiding principle that if a fact of the class A is true, a fact of the class B is true. The probability consists of the fraction whose numerator is the number of times in which both A and B are true, and whose denominator is the total number of times in which A is true, whether B is so or not. Instead of speak-

ing of this as the probability of the inference, there is not the slightest objection to calling it the probability that if A happens, B happens. But to speak of the probability of the event B, without naming the condition, really has no meaning at all. It is true that when it is perfectly obvious what condition is meant, the ellipsis may be permitted. But we should avoid contracting the habit of using language in this way (universal as the habit is), because it gives rise to a vague way of thinking, as if the action of causation might either determine an event to happen or determine it not to happen, or leave it more or less free to happen or not, so as to give rise to an *inherent* chance in regard to its occurrence. It is quite clear to me that some of the worst and most persistent errors in the use of the doctrine of chances have arisen from this vicious mode of expression.

C. S. Peirce, *The Red and the Black*

45 The idea of probability essentially belongs to a kind of inference which is repeated indefinitely. An individual inference must be either true or false, and can show no effect of probability; and, therefore, in reference to a single case considered in itself, probability can have no meaning. Yet if a man had to choose between drawing a card from a pack containing twenty-five red cards and a black one, or from a pack containing twenty-five black cards and a red one, and if the drawing of a red card were destined to transport him to eternal felicity, and that of a black one to consign him to everlasting woe, it would be folly to deny that he ought to prefer the pack containing the larger portion of red cards, although, from the nature of the risk, it could not be repeated. It is not easy to reconcile this with our analysis of the conception of chance. But suppose he should choose the red pack, and should draw the wrong card, what consolation would he have? He might say that he had acted in accordance with reason, but that would only show that his reason was absolutely worthless. And if he should choose the right card, how could he regard it as anything but a happy accident? He could not say that if he had drawn from the other pack, he might have drawn the wrong one, because a hypothetical proposition such as, "if A, then B," means nothing with reference to a single case. Truth consists in the existence of a real fact corresponding to the true proposition. Corresponding to the proposition, "if A, then B," there may be the fact that *whenever* such an event as A happens such an event as B happens. But in the case supposed, which has no parallel as far as this man is concerned, there would be no real fact whose existence could give any truth to the statement that, if he had drawn from the other pack, he might have drawn a black card.

C. S. Peirce, *The Red and the Black*

46 It is an indubitable result of the theory of proba-

bilities that every gambler, if he continues long enough, must ultimately be ruined.

C. S. Peirce, *The Red and the Black*

47 All human affairs rest upon probabilities, and the same thing is true everywhere. If man were immortal he could be perfectly sure of seeing the day when everything in which he had trusted should betray his trust, and, in short, of coming eventually to hopeless misery. He would break down, at last, as every good fortune, as every dynasty, as every civilization does. In place of this we have death.

But what, without death, would happen to every man, with death must happen to some man. At the same time, death makes the number of our risks, of our inferences, finite, and so makes their mean result uncertain. The very idea of probability and of reasoning rests on the assumption that this number is indefinitely great.

C. S. Peirce, *The Red and the Black*

48 No victor believes in chance.

Nietzsche, *Gay Science*, 258

49 You probably feel that when religious faith expresses itself . . . in the language of the gaming table, it is put to its last trumps. Surely Pascal's own personal belief in masses and holy water had far other springs; and this celebrated page of his is but an argument for others, a last desperate snatch at a weapon against the hardness of the unbelieving heart. We feel that a faith in masses and holy water adopted wilfully after such a mechanical calculation would lack the inner soul of faith's reality; and if we were ourselves in the place of the Deity, we should probably take particular pleasure in cutting off believers of this pattern from their infinite reward. It is evident that unless there be some pre-existing tendency to believe in masses and holy water, the option offered to the will by Pascal is not a living option. Certainly no Turk ever took to masses and holy water on its account; and even to us Protestants these means of salvation seem such foregone impossibilities that Pascal's logic, invoked for them specifically, leaves us unmoved. As well might the Mahdi write to us, saying, "I am the Expected One whom God has created in his effulgence. You shall be infinitely happy if you confess me; otherwise you shall be cut off from the light of the sun. Weigh, then, your infinite gain if I am genuine against your finite sacrifice if I am not!" His logic would be that of Pascal; but he would vainly use it on us, for the hypothesis he offers us is dead. No tendency to act on it exists in us to any degree.

William James, *Will to Believe*

50 It must well be that chance is something other than the name we give our ignorance, that among phenomena whose causes are unknown to us we

must distinguish fortuitous phenomena about which the calculus of probabilities will provisionally give information, from those which are not fortuitous and of which we can say nothing so long as we shall not have determined the laws governing them. For the fortuitous phenomena themselves, it is clear that the information given us by the calculus of probabilities will not cease to be true upon the day when these phenomena shall be better known.

The director of a life insurance company does not know when each of the insured will die, but he relies upon the calculus of probabilities and on the law of great numbers, and he is not deceived, since he distributes dividends to his stockholders. These dividends would not vanish if a very penetrating and very indiscrete physician should, after the policies were signed, reveal to the director the life chances of the insured. This doctor would dissipate the ignorance of the director, but he would

have no influence on the dividends, which evidently are not an outcome of this ignorance.

Poincaré, *Science and Method*, I, 4

- 51 The greatest bit of chance is the birth of a great man. It is only by chance that meeting of two germinal cells, of different sex, containing precisely, each on its side, the mysterious elements whose mutual reaction must produce the genius. One will agree that these elements must be rare and that their meeting is still more rare. How slight a thing it would have required to deflect from its route the carrying spermatozoon. It would have sufficed to deflect it a tenth of a millimeter and Napoleon would not have been born and the destinies of a continent would have been changed. No example can better make us understand the veritable characteristics of chance.

Poincaré, *Science and Method*, I, 4

19.5 | Motion and Change

At the beginning of Western thought, two pre-Socratic philosophers, Heraclitus and Parmenides, went to the opposite extremes of asserting, on the one hand, that everything is always in flux and never for a moment remains unchanged, and, on the other, that permanence or immutability reigns everywhere and that our experience of motion or change is a deceptive illusion. While they are not quoted here, the views of Heraclitus and Parmenides are commented on by later thinkers who regard motion and rest, or change and permanence, as correlatives, neither of which can be understood without the other.

The philosophical consideration of motion and change attempts to discover its principles (that without which motion or change cannot occur); proposes a classification of the kinds of change, such as local motion, change of quality, or alteration,

change in quantity, or increase and decrease, and what was called “substantial change,” or coming to be and passing away; speculates about whether change or motion ever began and will ever stop or is everlasting, without beginning or end; and asks whether endless motion involves an unmoved mover as its cause.

The modern scientific study of motion—the motion of bodies from place to place—begins with Galileo, and introduces such distinctions as that between natural and violent motion, uniform and variable motion, and such concepts as velocity, acceleration, momentum, and inertia. Employing these concepts, the new sciences of kinematics and dynamics are applied by Newton to the motion of celestial as well as terrestrial bodies. In addition to formulating the principle of inertia as one of his three laws of motion, Newton introduces the concept of gravity,