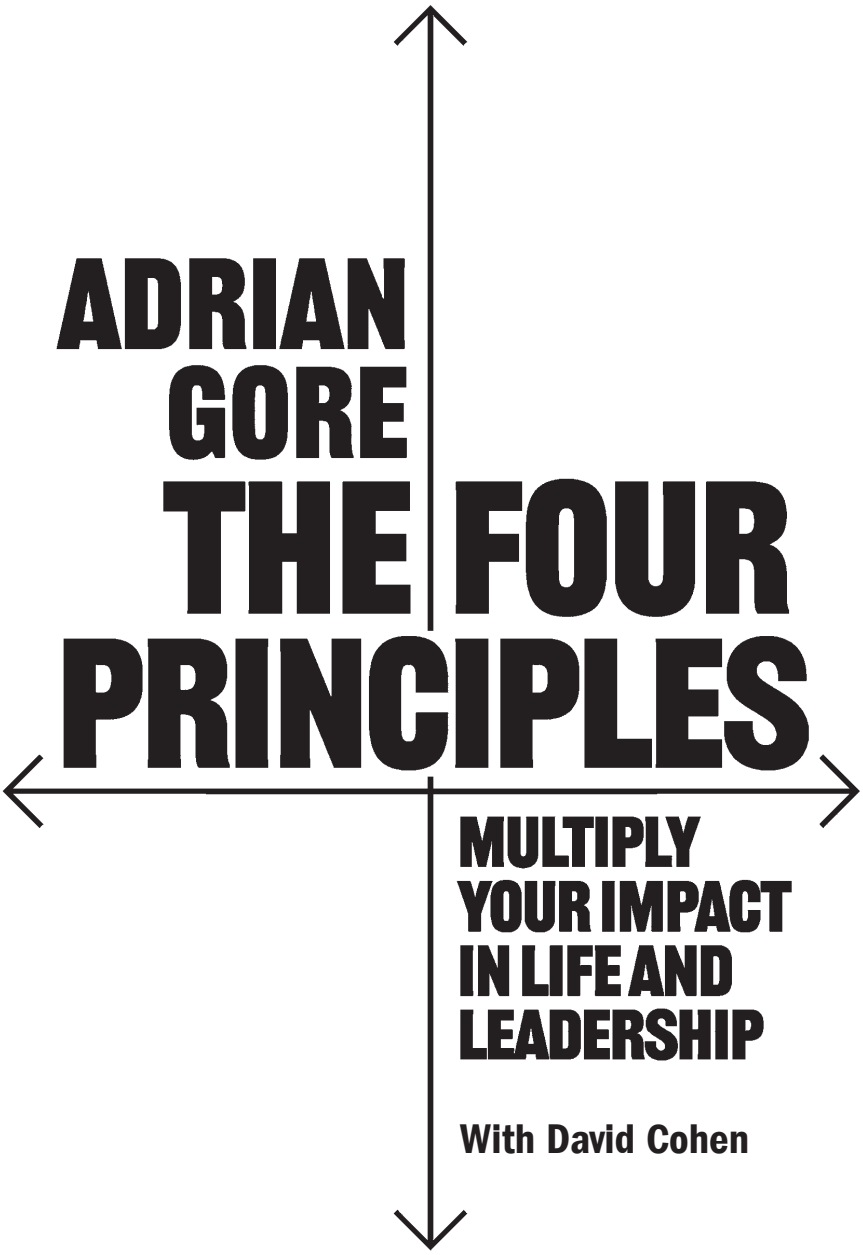

ADRIAN GORE

THE FOUR PRINCIPLES

MULTIPLY YOUR IMPACT IN LIFE AND LEADERSHIP

With David Cohen

MACMILLAN

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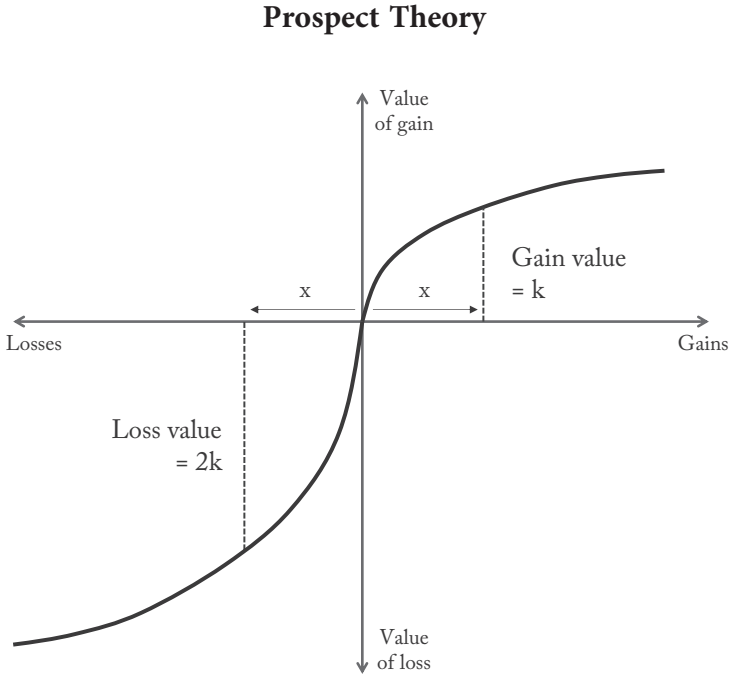
THE FIRST PRINCIPLE
DISCIPLINED OPTIMISM

GRAPH 1


Prospect Theory
Value
of gain
Gain value
= k
x
x
Losses
Gains
Loss value
= 2k
Value
of loss

THE SECOND PRINCIPLE
FOCUSED URGENCY

EQUATION 1

How we experience time

$$\frac{(1+1/2+1/3+\ldots+1/30)}{(1+1/2+1/3+\ldots+1/80)}$$

$$\approx 0.78$$

$$\approx 78 \text{ per cent}$$

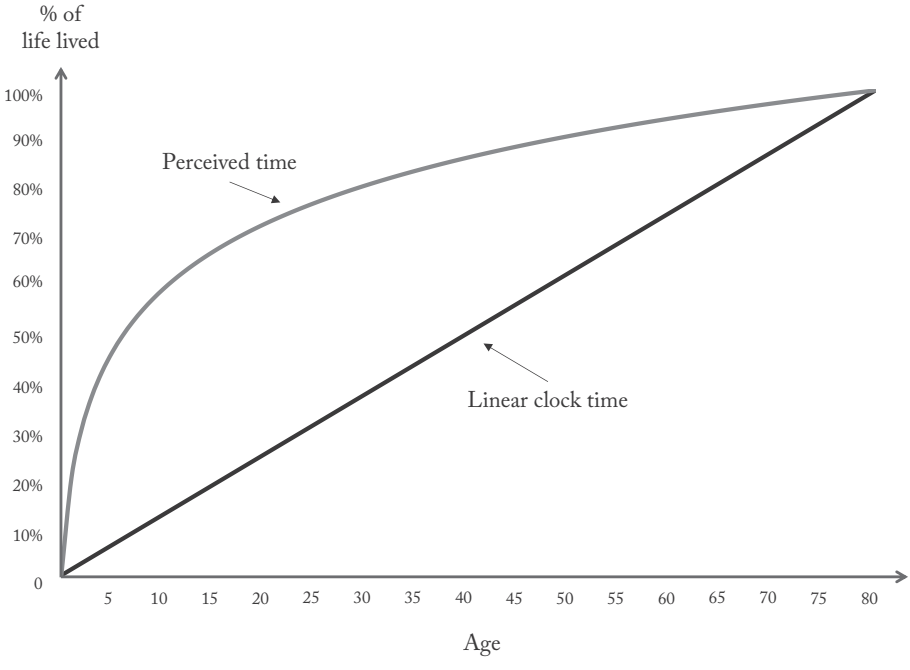
TABLE 1

What percentage of your life have you lived?

Age	Real time	Perceived time
5	6%	37%
10	13%	53%
20	25%	68%
30	38%	78%
40	50%	84%
50	63%	89%
60	75%	93%
70	88%	97%
80	100%	100%

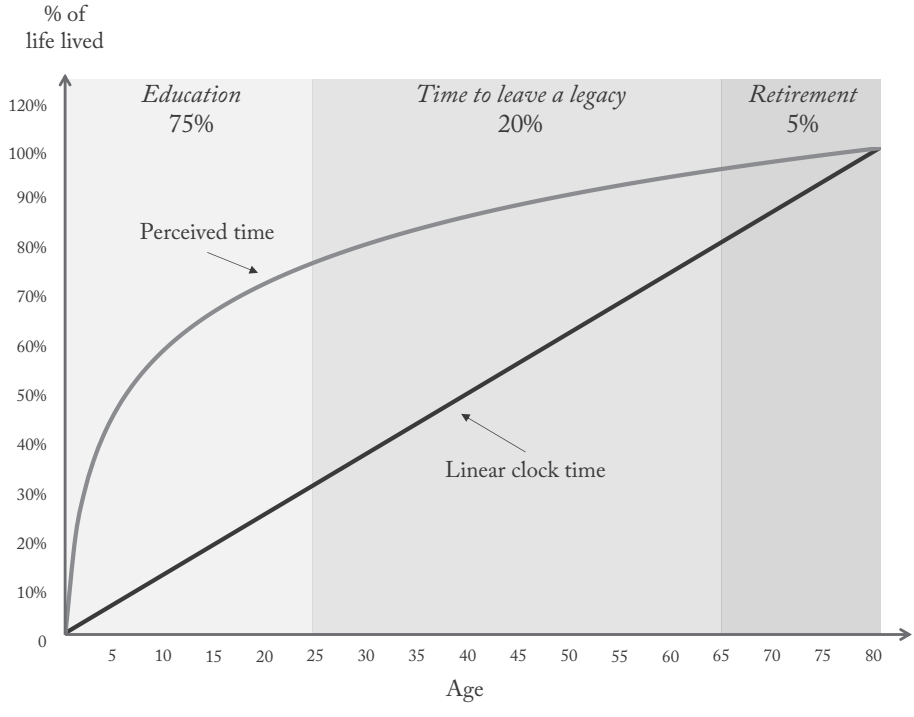
GRAPH 2

Linear Clock Time versus Perceived Time

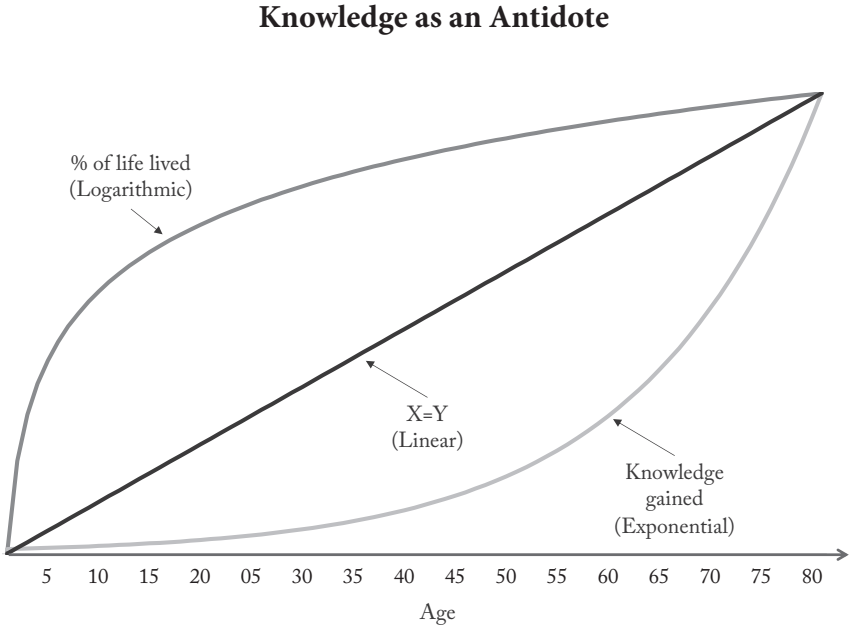


GRAPH 3

The 20 Per Cent of Time We Have to Make an Impact



GRAPH 4


Knowledge as an Antidote
% of life lived
(Logarithmic)
X=Y
(Linear)
Knowledge
gained
(Exponential)
5 10 15 20 05 30 35 40 45 50 55 60 65 70 75 80
Age

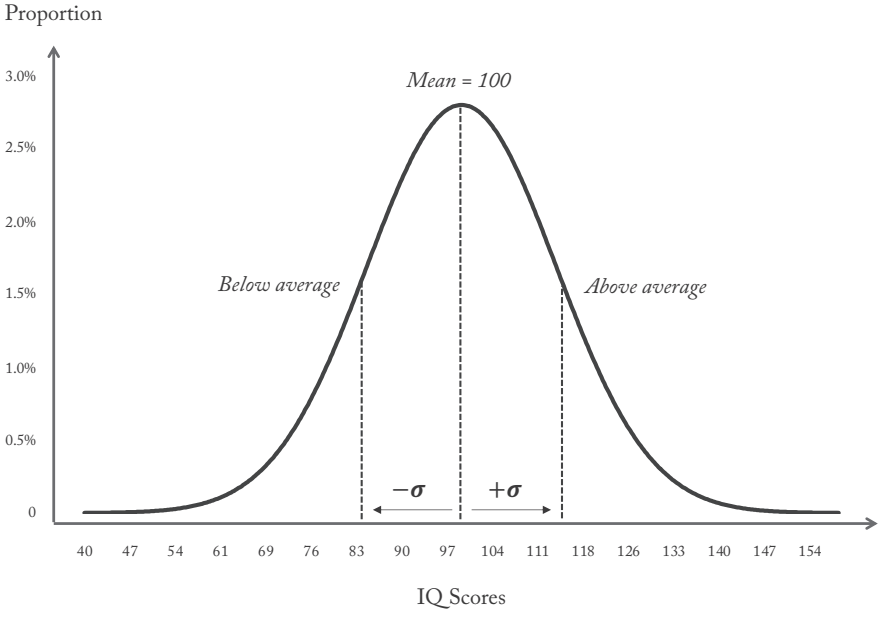
THE THIRD PRINCIPLE
DECLARED GOALS

There are no graphs for the third principle

THE FOURTH PRINCIPLE
THE PARETO TAIL

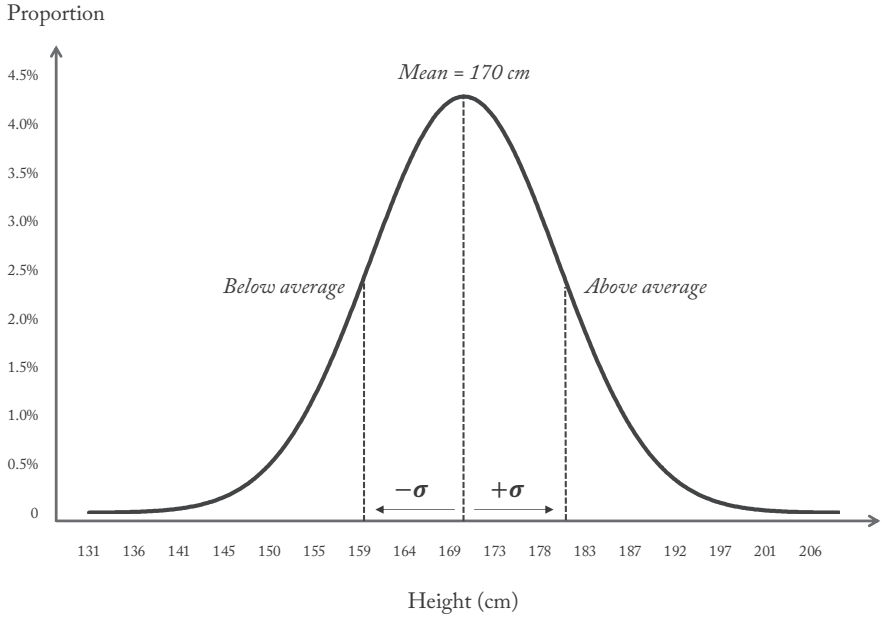
GRAPH 5

IQ as an Example of a Normal Distribution



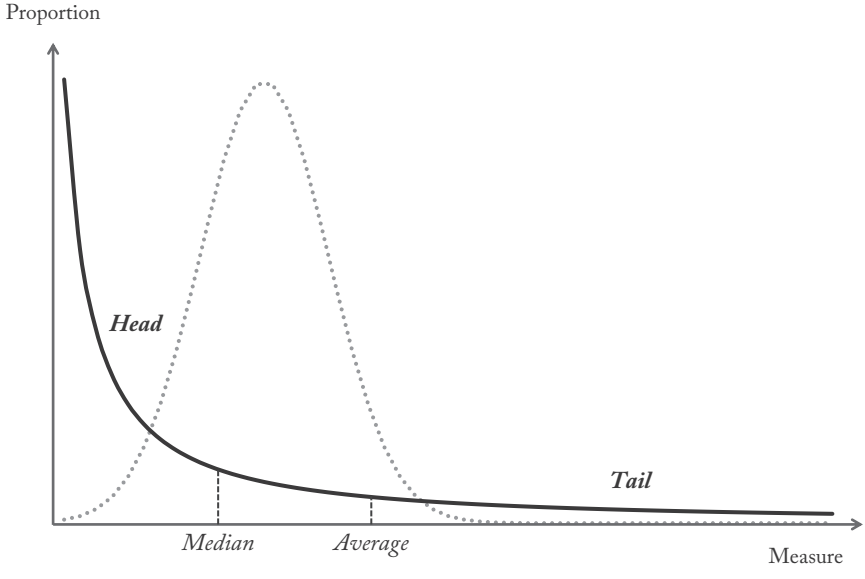
GRAPH 6

Height as an Example of a Normal Distribution



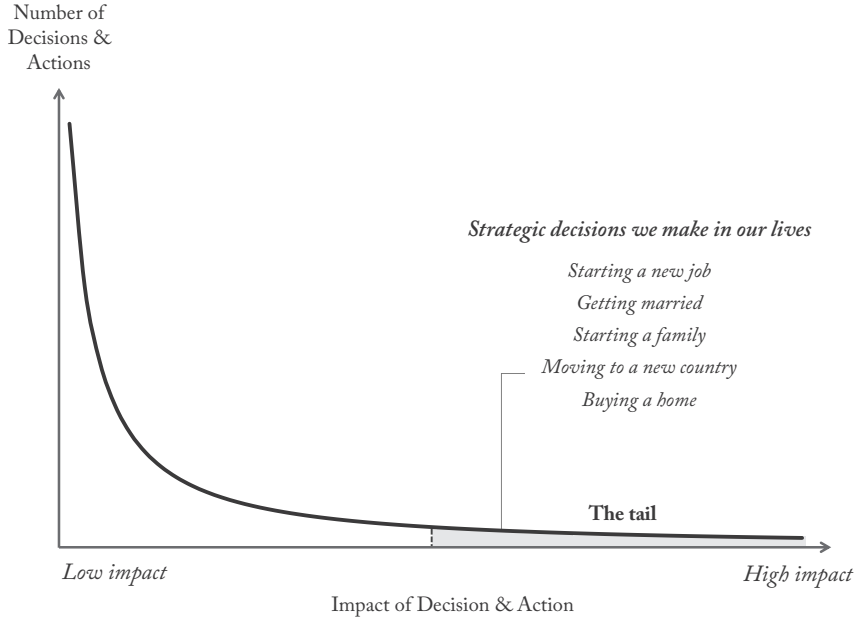
GRAPH 7

The Pareto Distribution: Power Lies in the Tail



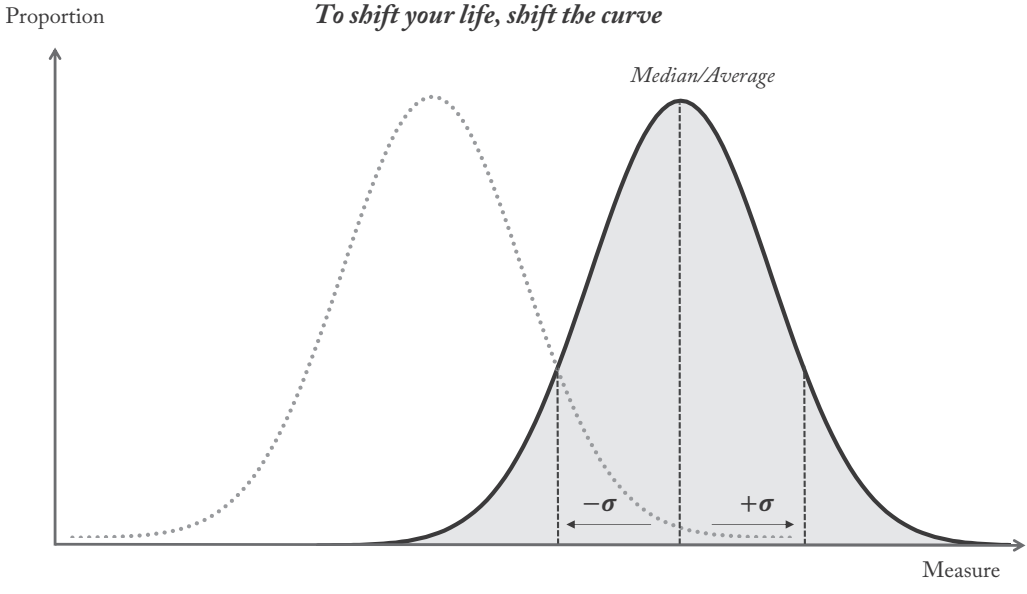
GRAPH 8

Pareto: Impact on Your Life



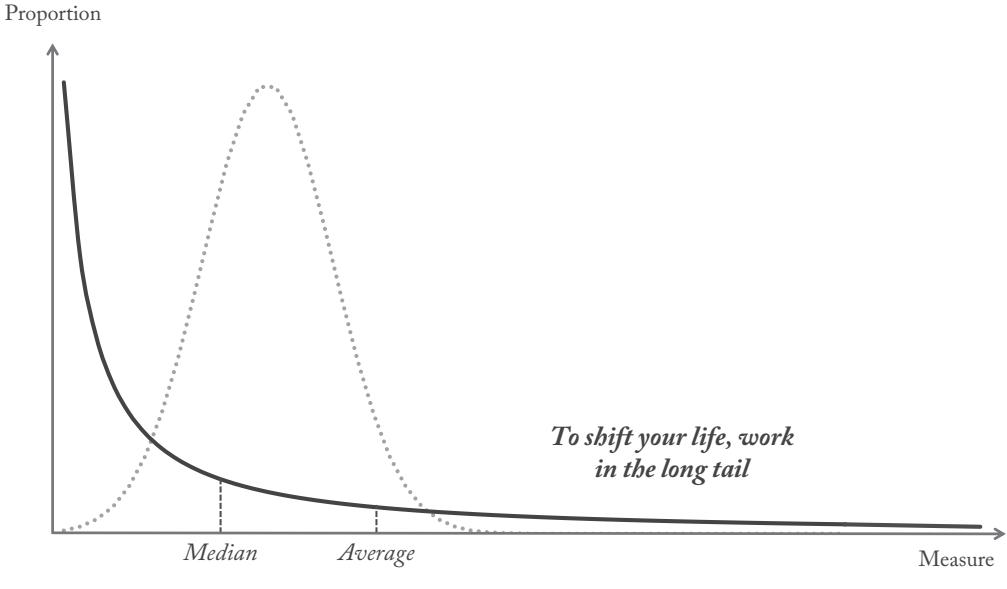
GRAPH 9

Progress in a Normal Distribution World



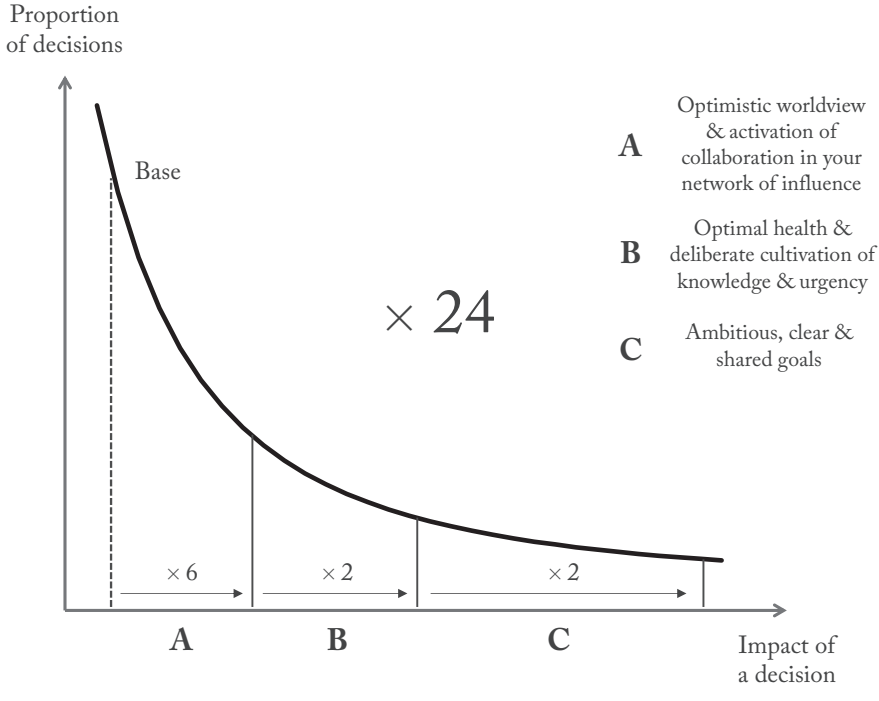
GRAPH 10

Progress in a Pareto World

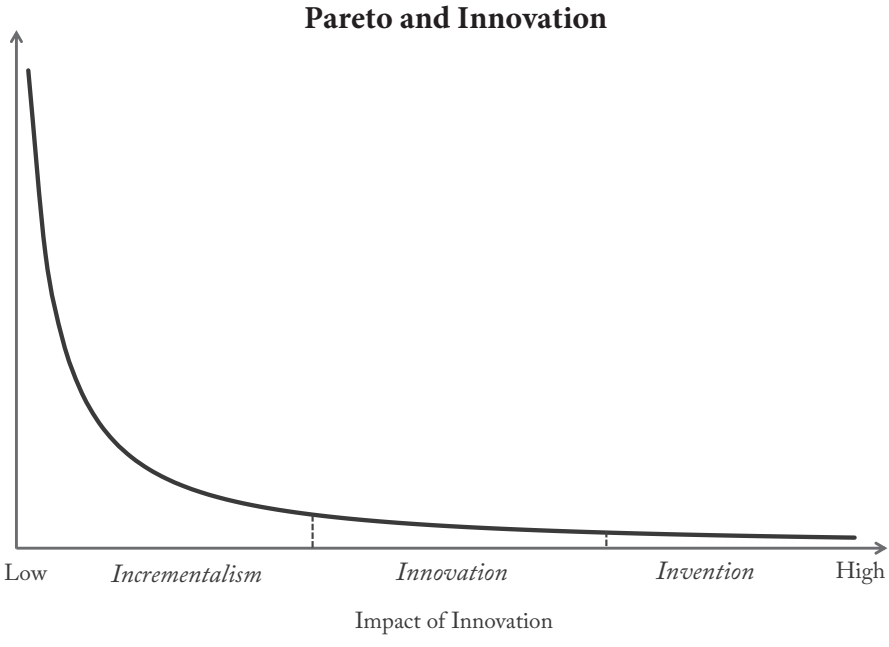


GRAPH 11

Scaled Up Impact in a Pareto World

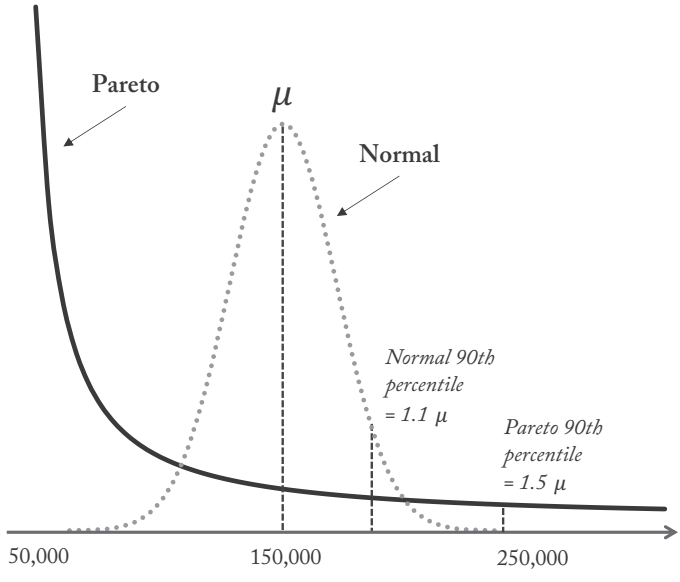


GRAPH 12


Pareto and Innovation
Low
Incrementalism
Innovation
Invention
High
Impact of Innovation

GRAPH 13

Pareto Impact versus Normal Remuneration



TECHNICAL APPENDICES

APPENDICES

The intention of these technical appendices is to illustrate the Four Principles in mathematical terms, to demonstrate how and why they work. While scientific, the appendices are not intended to be academic but draw on and connect a range of theories from statistics and behavioural economics.

The impact of our actions is a function of many things, among which opportunity, time and effort are important:

Impact = f (Opportunity, Time, Effort, Other Factors)

To increase impact, we can apply the first three Principles:

- Positivity reveals opportunities and magnifies their impact in a network.
- Our time is subjective and can effectively be expanded.
- Reframing goals scales their motivational power to drive our efforts.

Each appendix demonstrates mathematically a possible impact multiplier obtainable from the manifestation of the first three Principles:

- *Optimism:* seek out positive signals and opportunities, and build coalitions.

- *Time:* acquire health and knowledge, and foster a sense of urgency.

- *Goals:* capture the power of loss aversion to increase motivation.

These Principles can multiply and therefore build on top of one another. There is more time for an optimist to seek opportunities, to influence networks to scale them, and to use goals to magnify their effort throughout.

According to the Fourth Principle, our life decisions are distributed in such a way that just a few have enormous impact. So, the result of applying the first three Principles is not just incremental but constitutes operating far into the long tail of this distribution.

Appendix 1

A multiplier for the effect of optimism on impact can be factorized as follows:

$$\textit{Impactful pursuit and realization of opportunities} = \textit{Effect of optimism on opportunity seeking} \times \textit{Scaling effect of optimism through networks}$$

The following sections aim to quantify what a value may be for such a multiplier.

Appendix 1.1 – Prospect Theory and Loss Aversion

The S-curve of value captures the asymmetry of value with respect to losses and equivalent gains.

Prospect theory is a behavioural economic theory developed by Daniel Kahneman and Amos Tversky in 1979. Compared to classical, idealized economic theories (like expected utility theory) it describes how people make decisions involving risk and uncertainty, especially when the outcomes involve gains or losses. It entails three key concepts:

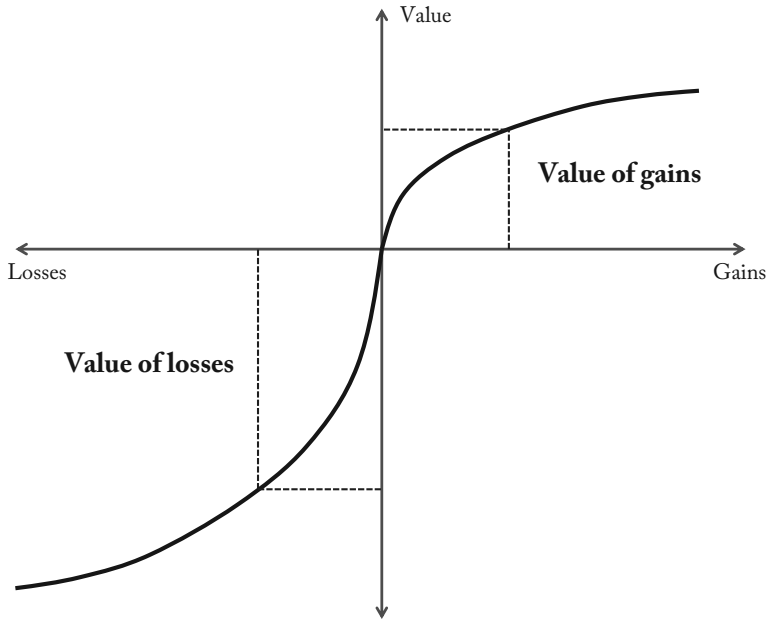
1. *Reference Dependence:* People evaluate outcomes relative to a reference point (as a change from the status quo), rather than in absolute terms.

2. *Loss Aversion:* Losses feel more painful than equivalent gains feel pleasurable. This is because of the 'endowment effect' whereby people attach more value to what they already possess.

3. *Diminishing Sensitivity:* The psychological impact of changes diminishes as you move further from the reference point.

These concepts can be represented by a value function which maps objective outcomes in terms of losses and gains, against what decision-making agents perceive as their value. They can be summarized graphically:

Kahneman & Tversky's Depiction of Loss Aversion



The graph of the value curve function illustrates the concepts of prospect theory as follows:

Observed decision-making phenomenon	Example	Loss value curve	Gain value curve
Reference dependence	If someone has $100, they will value an extra $10 not as a function of the state of having $110, but as the change of gaining $10	Represents amount of loss to the left of the origin	Represents amount of gain to the right of the origin
Loss aversion	A loss of $100 hurts more than a gain of $100	Steeper	Flatter
Diminishing sensitivity	The difference between $10 and $20 is felt more acutely than between $100 and $110	Convex	Concave

A function of this form, with parameters α, β and λ fits the features of the shape well, where x is the outcome, either a gain >0, or loss <0, and $v(x)$ represents an agent's value:

$$v(x) = \begin{cases} x^{\alpha} & \text{where } x \geq 0 \\ (-\lambda)(-x)^{\beta} & \text{where } x < 0 \end{cases}$$

Appendix 1.2 – Calculation of Loss Aversion

Losses tend to hurt twice as much as the utility derived from equivalent gains.

The degree of loss aversion implied for an agent with such a value function, is the ratio of the gradient of the loss curve to the gradient of the gain curve. The first derivative of the function with respect to x is given by:

	Loss value curve	Gain value curve
Derivative function	$v_{loss}'(x_{<0}) = \lambda\alpha(-x)^{\alpha-1}$	$v_{gain}'(x_{\geq 0}) = \alpha x^{\alpha-1}$

The slope of the loss curve divided by that of the gain curve is:

$$\frac{v_{loss}'(x_{<0})}{v_{gain}'(x_{\geq 0})} = \lambda\left(\frac{x_{<0}}{x_{\geq 0}}\right)^{\alpha-1}$$

$x_{<0}$ is a negative quantity, while $-x_{<0}$ is positive, therefore $\frac{x_{<0}}{x_{\geq 0}}$ equates to 1, and so the expression evaluates to λ. Thus, the agent's degree of loss aversion is determined by this parameter, and they will find losses hurt λ times more than equivalent gains feel good.

Kahneman and Tversky (1992) estimated a value for λ of 2.25, from empirical studies which asked surveyed populations to choose between different loss and gain scenarios.[1]

1 They also estimated α and β to both equal 0.88, parameters which respectively govern attitude to risk regarding gains (a concave curve, for risk aversion) and losses (a convex curve, for risk seeking).

A 2021 meta-study of 607 empirical results from 150 articles across economics, psychology and neuroscience, estimated the mean loss aversion coefficient to lie between 1.8 and 2.1 (Brown et al., 2024).

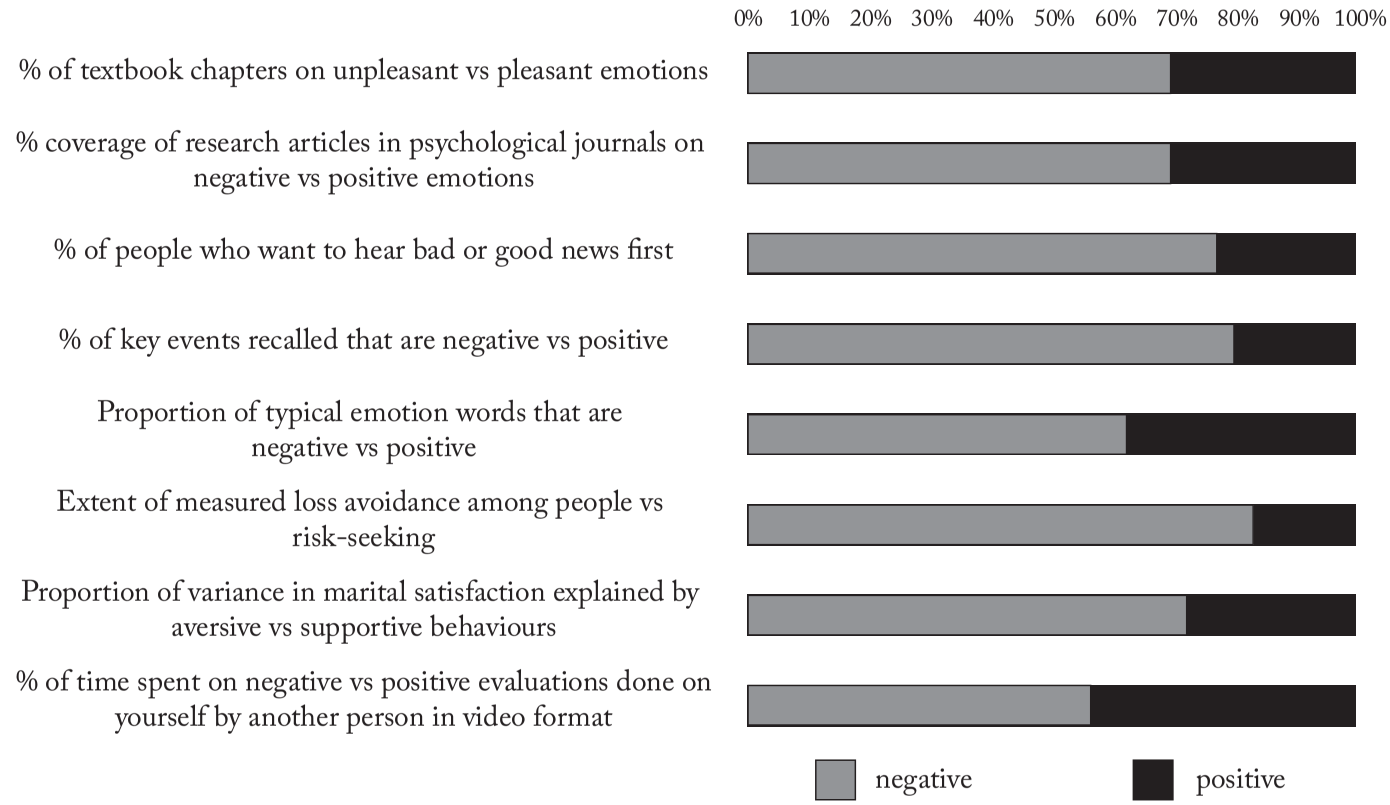
Appendix 1.3 – Negativity Bias

Negative attitudes are twice as prevalent and resistant to change as positive attitudes.

The principle of loss aversion, that losses loom larger than gains, can be generalized to domains other than the monetary. Deteriorations in relationship harmony, social approval, state of health and harm to self-esteem can all be felt as losses (assuming a consistent way of measuring these states). The hypotheses would be that hurtful actions can undo the effects of many kind acts, that one piece of criticism has a greater effect than several of praise, and the impact of stress and loneliness has a greater effect than the presence of the opposites. The evolutionary mechanisms would be the survival benefits of detecting threats to our health or maintaining our place in a supportive social community. In effect, we are conditioned to learn faster from punishment than from reward. This would be evidenced in greater salience, that is, we detect the negative more promptly than we take notice of the typical norm of the equivalent positive situation. It would also reflect in greater diagnosticity of the negative, that is, negativity is more informative in that it readily flags a threat, say of an anti-social act, by comparing it to the expectation of pro-social behaviour in general.

There is evidence in support of these hypotheses. An important meta-study by Baumeister (2001) consolidated many examples from various studies of the extent of negative biases, some of them with quantitative results. These are summarized in the graph below

Summary of Quantitative Results from Baumeister Meta-study



where the metrics of each study have been grouped into themes like prevalence of underlying psychological features, how people process information, what language emphasizes, et cetera. Each bar expresses the percentage split between negative and positive results on each metric.

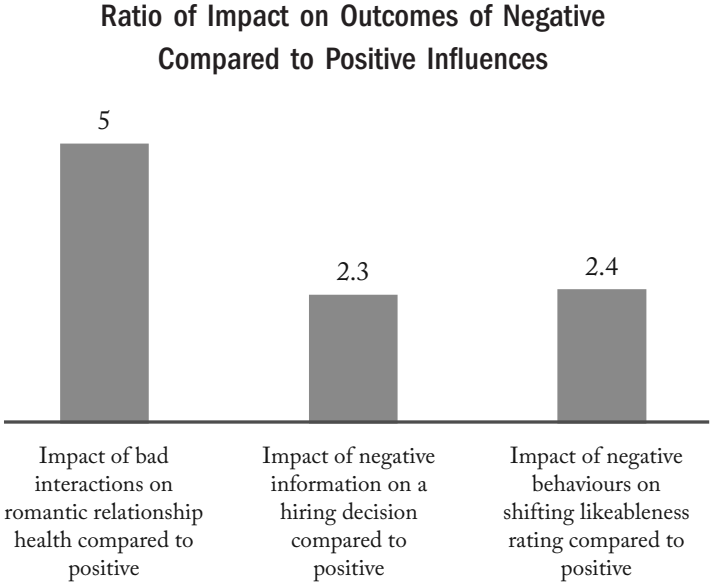
Among the studies the negative proportions outweigh the positive by a factor of between 1.3 and 4.9, with a crude average of over two, indicating that the overall bias is near-universal and differs mainly in its magnitude rather than its presence.[1]

As well as being shown, as above, in terms of static attitudes to issues, the bias is also strongly seen in situations into which new information arrives. Other studies collected by Baumeister measured how much harder it can be to shift or offset an existing belief for the better with positive information, than it is to change it for the worse with negative information, with empirical studies over a range of domains indicating a ratio of relative impact of 2.3 to 5.

Heuristics drawn from these results are therefore that negative attitudes may be about twice as prevalent as positive attitudes, and that new positive information needs to outweigh new negative information also by a factor of two, to change attitudes. The theory of loss aversion from prospect theory provides a useful mathematical framework within which to understand this.

In some instances, loss aversion is of course adaptive, with respect to health and immediate danger, and with respect to relationship and social harmony. But in many respects, it can be maladaptive. In financial terms, it can lead to poorer outcomes than a rational risk-taking strategy that considers expected values of outcomes where probabilities can be accurately estimated. It can manifest

1 Of course estimates of these effects, where measurable in some way, will vary between people, cultures and domains.



in terms of longer-term threats to health, for instance, where daily exercise represents a clear and immediate loss set against a vague and uncertain future state of health. It undermines trust and cooperation where a fear of betrayal can undermine the potential gains from open and collaborative action. In respect of career decisions, it can hold us back in a comfort zone rather than taking a calculated risk to take on an elevation in responsibility. And in general, in high opportunity settings, it can actively work against rational evaluation of potential upsides.

Appendix 1.4 – Seeking Out Positive Signals as a Tactic to Change a System

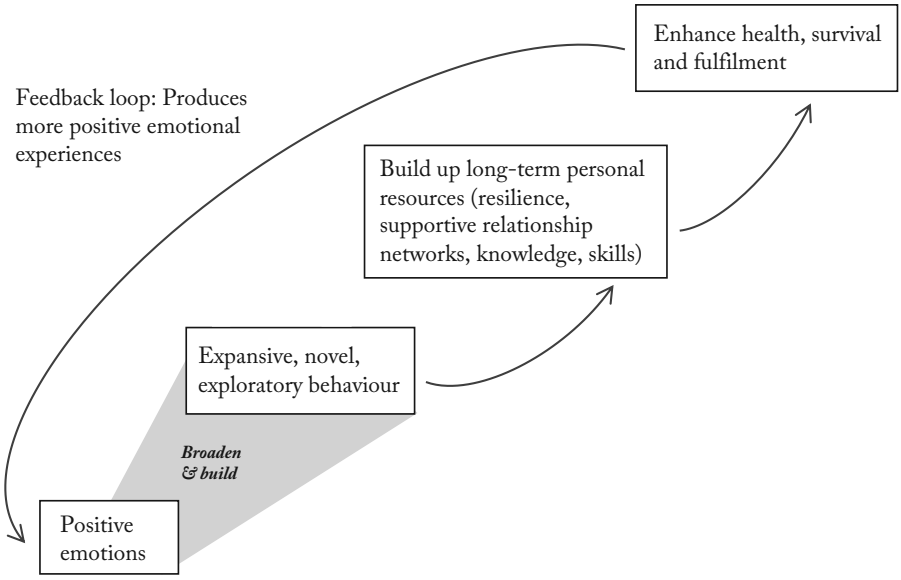
A deliberate attitude of optimism can double our ability to recognize opportunities.

Barbara Fredrickson's (2001) broaden-and-build theory – as depicted below – proposes that positive emotions (joy, interest,

contentment), which optimists experience more frequently, broaden an individual's thought-action patterns, leading to more exploratory, open and creative behaviours.

Pessimists, on the other hand, tend to show a narrower focus, centred on perceived threat. Optimists notice peripheral information that a pessimist would miss, reframe problems as opportunities and explore novel ideas with less fear of failure.

The Broaden-and-Build Theory



Researcher Alice Isen and colleagues (1987) found that deliberate priming of a test group in a laboratory experiment by showing a film with a positive tone, resulted in 75 per cent of these participants solving a problem involving imaginative use of materials they were given, compared to only 20 per cent finding the solution in the control group. The study showed that even a very mild positive feeling, induced just minutes before, dramatically increased creative insight. Isen argued that positive affect makes cognition

more flexible and inclusive, allowing people to see unusual relationships between objects and concepts. Similar relationships have been found showing that positive affect leads to faster decision-making with no reduction in quality, better memory and higher likelihood of achieving win-win agreements in social tasks.

Therefore, a deliberately optimistic mindset can be applied to tune our loss aversion and reduce its maladaptive effects in respect of situations with high gain potential. It permits us to reframe these situations in terms of upside and, furthermore, learn more from success than from punishment or failure. In this way it can offset a general 2:1 pessimistic bias, and by triggering creativity, it can double our ability to recognize new opportunities, compared to the norm.

Appendix 1.5 – Amplification of Positive Behaviour Within a Network

Pro-social behaviour spreads within a network, diffusing knowledge and collaborative behaviour, at least tripling positive outcomes.

Fredrickson found furthermore that over time, a positive mindset and actions build durable personal resources. A key resource built through positivity is prosocial behaviour. A broadened mindset will make an individual more likely to initiate interactions, trust others and deepen relationships. In a network, this is a direct mechanism for link formation and strengthening, and utilization for the mutual benefit of those in the network.

This impact within a network can be thought of as a function of participation, diffusion and collaboration.

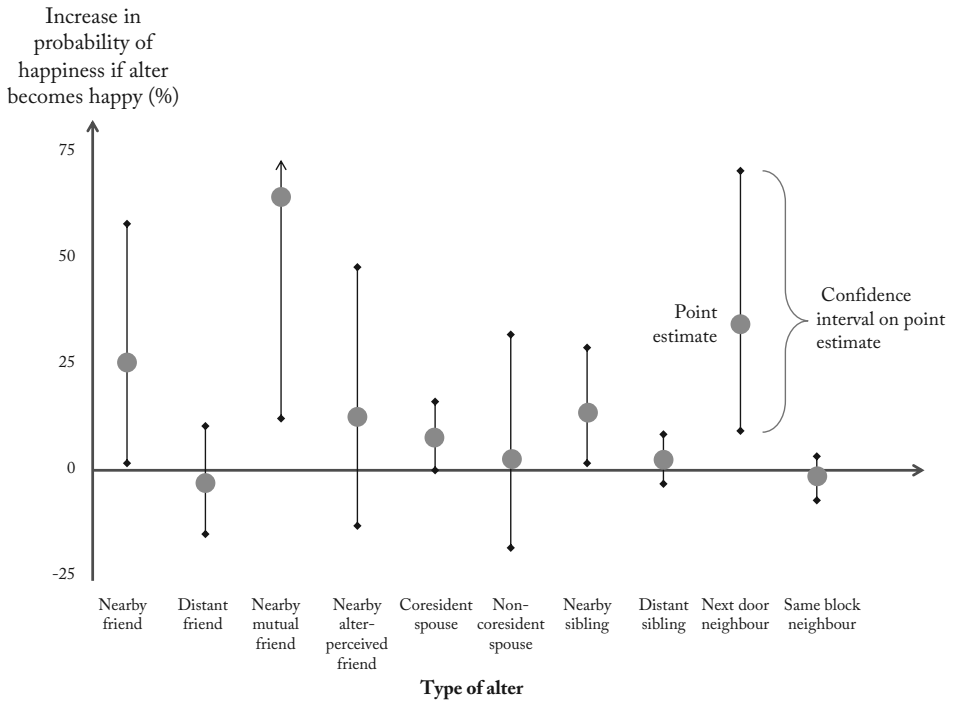
Participation and diffusion

Empirical evidence shows that positivity actively spreads from node to node, and the clustering effects it has in the network enable faster diffusion of information. Fowler and Christakis (2008)

studied a network of 4,739 individuals followed from 1983 to 2003 in the Framingham study dataset, which among many other variables measured happiness according to the Center for Epidemiological Studies depression scale, including statements put to them relating to positivity such as: 'I felt hopeful about the future.' They found firstly that happiness clusters within the network.

But they also found that increased happiness in a node makes its connections happier – so an increase in the probability of a node becoming happy if another node related to it (called an alter) becomes happy. As per the graph below, it found significant effects on probability of individual happiness from spouses becoming happy (8 per cent effect on the individual), friends (25 per cent) and neighbours (34 per cent).

Happiness is Contagious



Therefore, one's positivity will tend to increase the positivity of others within one's immediate network, forming these dense clusters of positivity.

In general, stronger, more trusting relationships lower the barrier to sharing information, especially complex or valuable information. This can be modelled within network simulations using a higher probability of successful transmission of information across links characterized by high positivity/trust. This has been shown empirically by Levin and Cross (2004). Then, when information is introduced, it spreads faster and more completely through the more densely connected network, fostered by relational positivity. The average path length between any two nodes is lower, making the network more efficient.

But Centola (2010) showed empirically that behaviour also spreads, analysing the transmission of a health behaviour between two different types of networks in an experiment: (1) clustered networks and (2) random networks between people. Across six independent trials, the behaviour spread more quickly (four times faster) and reached a higher level of diffusion as measured by the fraction adopting the behaviour (42 per cent higher) in the clustered network compared to random networks.

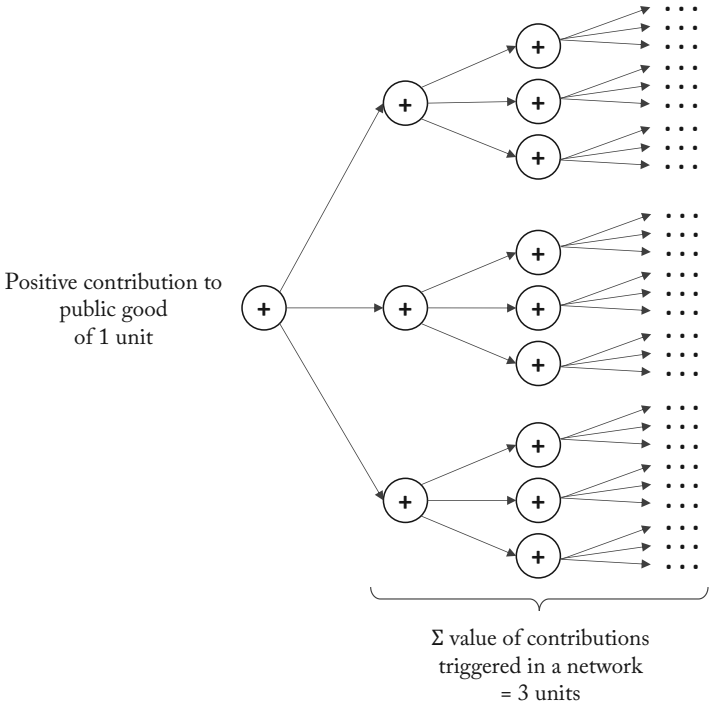
Collaboration

Fowler and Christakis (2010) conducted a public goods game experiment in which participants in groups could contribute money for the benefit of their group. Critically, subjects were randomly reassigned to new groups of strangers in each round, allowing researchers to causally track how one person's behaviour influenced others.

They found that cooperative actions were contagious: a person's contribution was directly influenced by the generosity of their group members from the previous round. This influence then created a 'cascade', spreading across up to three degrees of separation

through the network (from person A to B to C to D). By calculating the total cumulative impact of a single cooperative act – summing both the direct influence on immediate partners and the indirect, downstream influence on others over several rounds – the researchers demonstrated that for every one monetary unit a person initially contributed, it caused a ripple effect that led others in the network to collectively contribute an additional three units, effectively tripling the initial cooperative investment.

Cooperative Actions are Contagious



So, we argue that the multiplicative impact of optimism in a network is the cumulative effect of multipliers for participation, diffusion and collaboration, and therefore at least three times. Putting together the power of optimism to help the individual

discover and correctly value opportunities, with its further power to generate network effects:

More impactful pursuit of opportunities = Increased ability to see opportunities × Enhanced outcomes within a network

$$= 2 \times 3 = 6$$

Therefore, in an interconnected world optimism has demonstrably superior adaptive value, contributes to collective flourishing, and indicatively, can multiply our impact six-fold.

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Appendix 2

The proposed multiplier for time is composed as follows:

Increased effective time available = Effect of better health
× Effect of acquisition of knowledge
× Increased urgency

The sections below provide a basis for estimating what the component effects may be.

Appendix 2.1 – The Log-Time Hypothesis and Time to Make an Impact

Time is subjective and there is less than you think.

Real time progresses linearly, so elapsed time at age R is simply R. Under logarithmic time the position is that, psychologically, the experience of the progression of time means that elapsed time

is a non-linear function of the years already lived. The hypothesis is that the rate of change in perceived time at time *R*, *S(R)*, relative to real time can be expressed, for some constant *k*, as:

$$\frac{dS(R)}{dR} = \frac{k}{R}$$

So total perceived time from R_0 to *R* is:

$$\int_{R_0}^{R} \frac{1}{x}\, dx = \ln\left(\frac{R}{R_0}\right)$$

Often one sets R_0 to 1, measuring from end of the first year, producing:

$$S(R) = \ln(R)$$

So subjective time is a logarithmic function of real time, and perceived life up to an age *x* as a proportion of a total perceived lifespan of 80, is:

$$\frac{\ln(x)}{\ln(80)}$$

Allocating proportions of perceived life to distinct phases, this equation yields the '75:20:5' split:

Phase	Age	Elapsed perceived life	Effective proportion of life to have an impact	Linear proportion of life
Education	0–25	$\frac{\ln(25)}{\ln(80)} - 0 \approx 0.735$	75%	31%
Working life	25–65	$\frac{\ln(65)}{\ln(80)} - \frac{\ln(25)}{\ln(80)} \approx 0.218$	20%	50%
Retirement	65+	$\frac{\ln(80)}{\ln(80)} - \frac{\ln(65)}{\ln(80)} \approx 0.047$	5%	19%

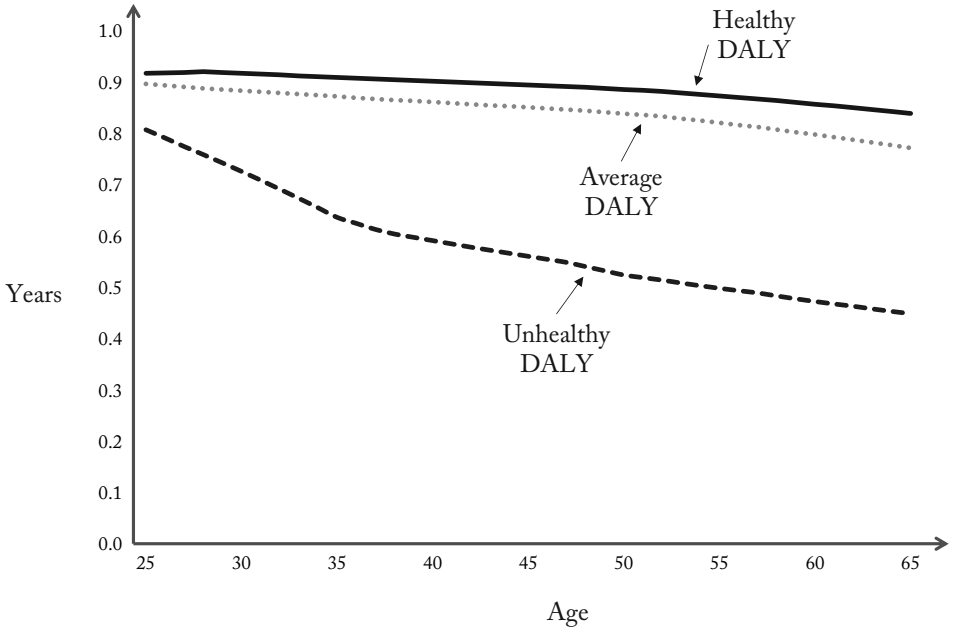
Appendix 2.2 – The Effect of Health on Time

A healthy person has 25 per cent more time to make an impact than an unhealthy one.

One can focus on the experience of the passage of life in good health, which is the effective time to accomplish something. One has control of the relevant levers such as sufficient physical activity, good nutrition, rest and appropriate health screenings. The effect can be quantified using Disability-Adjusted Life Years (DALYs), which measure years lost to ill-health. Adjusting for DALYs makes a year of life for a healthy person worth substantially more than for an unhealthy one.

Assuming that from age eighteen, a healthy person begins to

DALY Value of a Year of Life



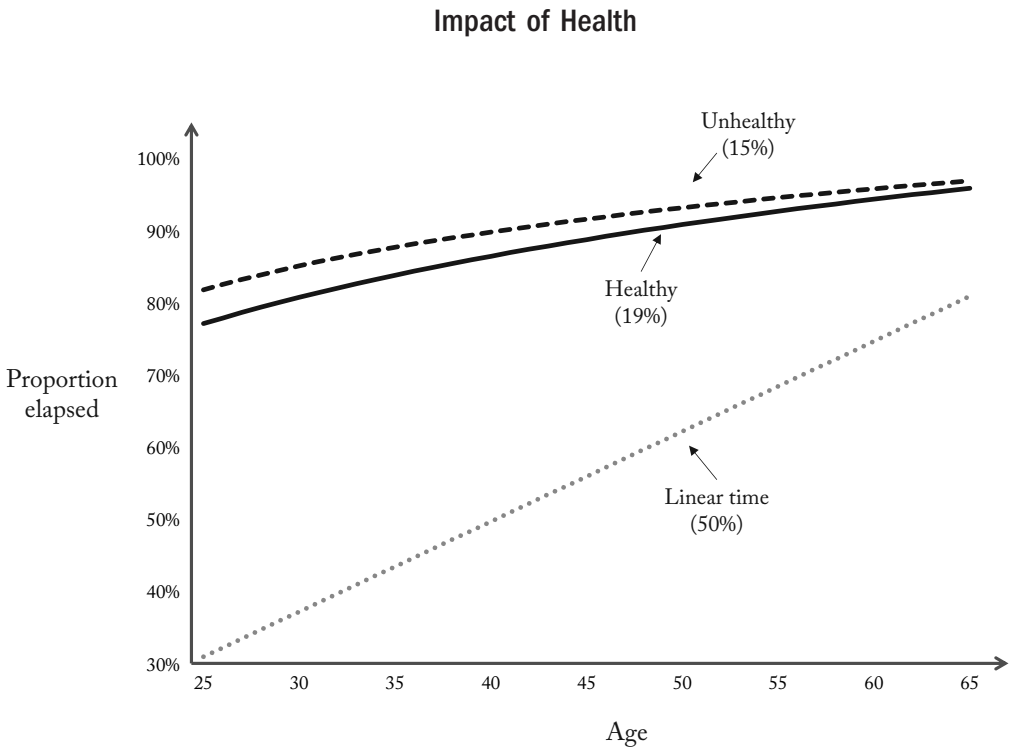
deviate from the average person over a period of ten years, until they are losing half the DALYs per year, and an unhealthy person is losing double the DALYs than average. Plotting what each year of life is worth shows that by age sixty-five, as per the graph below and adjusting for illness, a year of a healthy person's life is still worth about 85 per cent of a year, but for someone unhealthy, by this age a year is worth less than half.

Discounting the value of each year of life to represent its DALY, produces revised curves of actual versus perceived time for healthy and unhealthy people, initially shifting the split to 78:18:4, as perceived life becomes even more front-loaded due to health deterioration in later years.

But as shown in the curves below, good health shifts the passage of perceived time closer to linear, under which 50 per cent of lifespan is available. The result is that a healthy person gets to 19 per cent for the working years, while an unhealthy person is limited to 15 per cent. Maintaining health, therefore, increases the impact of time by approximately 25 per cent relative to an unhealthy person.[1]

1 Another option would be delaying retirement, extending the period of life in work after age sixty-five. But working longer actually buys less than 2 per cent in time to have an impact:

$$\left(\frac{\ln(70)}{\ln(80)} - \frac{\ln(25)}{\ln(80)}\right) - \left(\frac{\ln(65)}{\ln(80)} - \frac{\ln(25)}{\ln(80)}\right) = 1.7\%$$



Appendix 2.3 – The Effect of Knowledge Acquisition on Time

Knowledge increases effective time to make an impact by a further 35 per cent.

Impact can be understood as a function of not only work rate and time, but also knowledge.

Knowledge increases capability and the density of output per unit of time. This can be modelled by weighting each year by an accumulating knowledge factor operating from age k_0 to R.

$$\sum_{x=k_0}^{R} \frac{1}{x} \cdot Knowledge_x$$

Assume application of the Matthew Effect to the accumulation of knowledge, that change in knowledge over a lifetime is a proportion of the prior volume of knowledge in place, that is, $\Delta k = r.k_0$. This means: $k_1 = k_0 + r.k_0$, that is, $k_1 = k_0.(r+1)$

This we can generalize to give the accumulated impact of knowledge at time x: $k_x.(r+1)^x$

Now assume that after the end of formal education up to age twenty-five, training and deliberate cultivation of experience continue, resulting in an annual accumulation of knowledge of 3 per cent, giving the effective impact of time from age twenty-five to age R.

$$\sum_{x=25}^{R} \frac{1}{x} \,.\, (1.03)^x$$

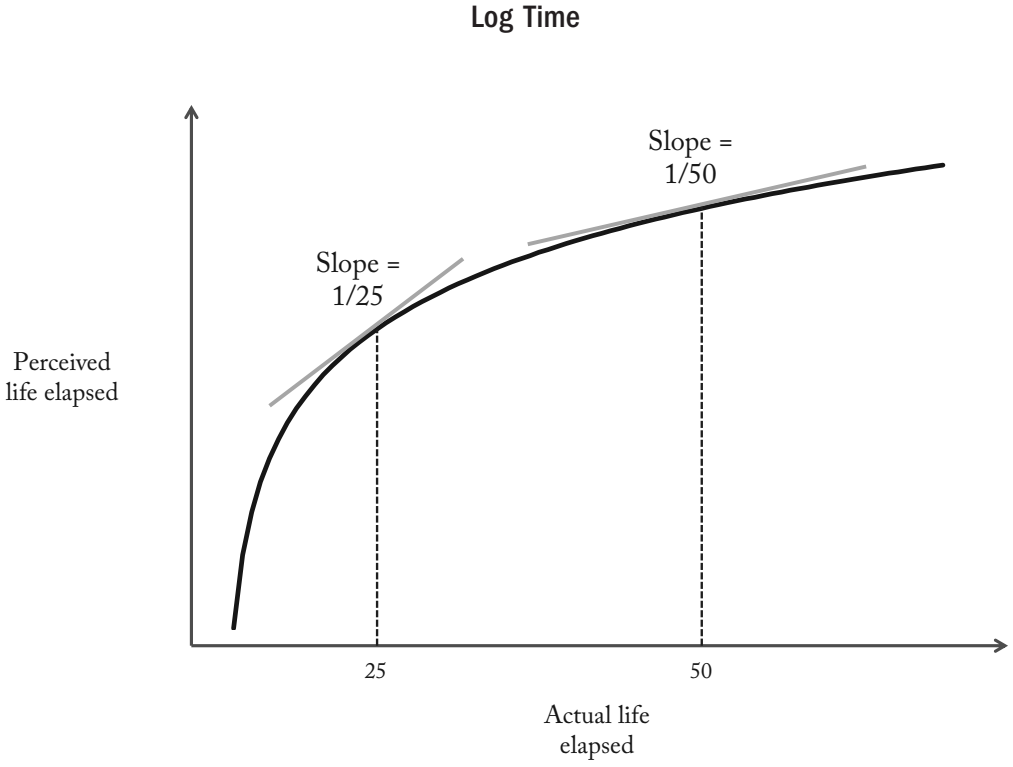
The compounding effect of knowledge acquisition offsets the logarithmic decay of perceived time, bending the life-curve back towards linearity.

Effective impact time increases as one gears it up with knowledge, to 26 per cent. This is approximately 35 per cent higher in relative terms than the 19 per cent of a healthy person.

Appendix 2.4 – Increasing Urgency

By imagining your older self, you can double your sense of urgency.

The experience of the passage of subjective time relative to objective time at two example ages is given by gradients on the logarithmic life curve:



In tabular form:

Age	Slope on curve	First derivative	Interpretation	Sensation of time
25	Steeper	$\frac{dS}{dR} = \frac{1}{25} = 0.040$	Long subjective time per unit real time	Seems to be passing more slowly
50	Flatter	$\frac{dS}{dR} = \frac{1}{50} = 0.020$	Short subjective time per unit real time	Seems to be passing faster

An implication for young people is that to offset complacency about the passage of time, one needs to be deliberate in cultivating a sense of urgency. Someone aged twenty-five imagining themselves

aged fifty could increase their urgency by the ratio of these two slopes, that is, two times. The magnitude of the effect will vary by age.

The implication of applying this urgency on top of the effects of health and knowledge is to further increase effective time to 32 per cent, an increase of 25 per cent on top of the impact of health and knowledge.

The cumulative result of changing one's approach to time can increase its effective quantity as follows:

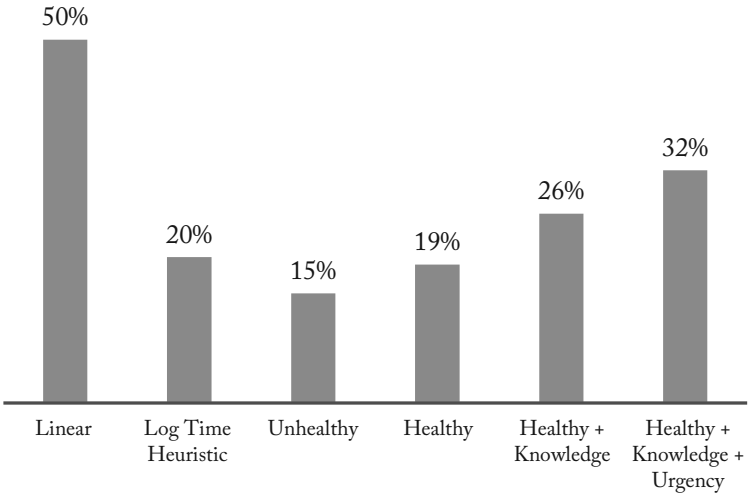
$$\textit{Increased effective time available} = \textit{Effect of better health} \times \textit{Effect of acquisition of knowledge} \times \textit{Increased urgency}$$

$$= (1 + 25\%) \times (1 + 35\%) \times (1 + 25\%) - 1$$

$$\approx 2.1$$

This represents a more than doubling of effective time over an unhealthy person, and nearly double that of the average person. The results of the above sections can be summarized in this graph.

Proportion of Effective Lifetime Spent in Working Years



Appendix 3

Appendix 3.1 – The Effect of Framing on Motivation

Clearly defined, time-bound goals can double motivation by shifting attention implicitly from gains to losses.

In addition to the pessimism bias described above, prospect theory explains why framing effects, that is, how choices or goals are presented, influence decisions. Setting a goal can be considered in microeconomic terms to be equivalent to placing one's actions on the S-curve of value. Vague aims with no accountability will tend to situate on the gain side of the curve.

However, the same aims expressed very clearly, that is, as goals, with time-bounds, preferably shared or made public, will situate the intended actions on the loss side of the curve, since they become psychologically more like losses, with failure to achieve them now having a relatively higher price.

Under Tversky and Kahneman's estimate of λ, expressing objectives in terms of concrete goals can therefore double their motivational power.

$$\textit{Effort multiplier} = \textit{Increase in motivation} = \lambda \approx 2$$

Appendix 3.2 – How the First Three Principles Connect

Small gains across opportunity, time and effort compound to multiply overall impact.

$$\Delta\ \textit{Impact} = f(\Delta\ \textit{Opportunity}, \Delta\ \textit{Time}, \Delta\ \textit{Effort})$$

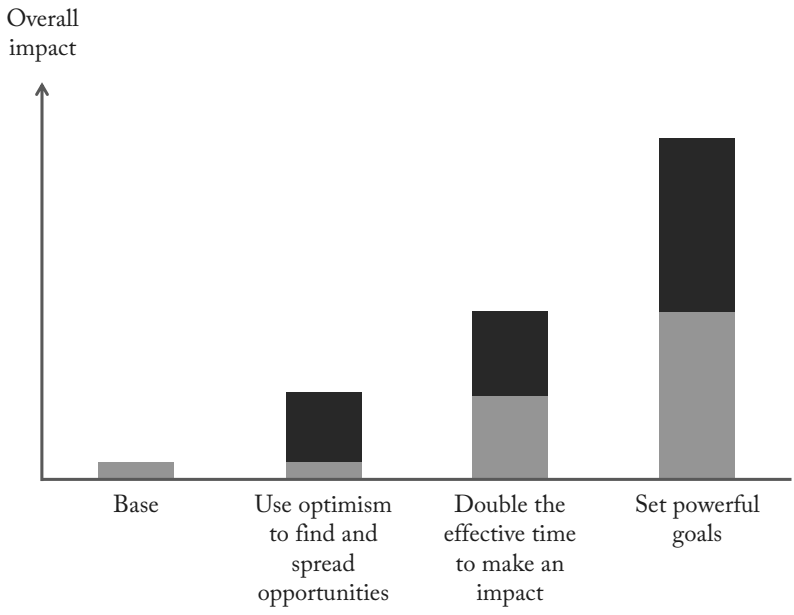
The effects of each of Optimism, Health, Knowledge and Urgency and Goal-setting, increase the impact of our actions, and conceptually can multiply, as shown in graph below:

- Application of deliberate positivity doubles the chances of finding opportunities, and with network effects, triples the value that can be generated from them.

- Doubling time doubles the effective period in which to exploit these opportunities in the network.

- Goal-setting enlists loss aversion to double motivation (both personally and within the network).

Multiplier Effects



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Appendix 4

Appendix 4.1 – How the Pareto Principle Differs from the Pareto Distribution

The Pareto principle is a heuristic; the Pareto distribution is a function.

In everyday usage, the terms 'Pareto principle' and 'Pareto distribution' are often used interchangeably, but this is not strictly correct. For mathematicians and purists, the distinction is significant – especially when we graph the two or analyse events 'in the tail' of the distribution. While the nuances may not be critical for every reader, those interested in precision may find the explanation in this appendix helpful.

The Pareto principle, also known as the 80/20 rule, says that roughly 80 per cent of outcomes result from around 20 per cent of causes. This is a rule of thumb that is widely used in business and society. For example, Microsoft reported that fixing the top 20 per cent of bugs would eliminate 80 per cent of crashes, and in criminology, a small number of repeat offenders are said to be responsible for a large proportion of crime. The Pareto principle is an approximation, a heuristic meant to highlight the skewed distribution of cause and effect in various real-world scenarios.

On the other hand, the Pareto distribution, sometimes called the Pareto power-law distribution, is a mathematical function that describes a situation where a small number of extreme events dominate the system. Unlike the loosely defined Pareto principle, a Pareto distribution follows a precise power-law relationship (as described in the following appendices). It describes phenomena where a small number of occurrences exert a disproportionate influence – such as with stock market crashes, natural disasters or pandemics – where rare, extreme events cause massive disruption.

While both concepts capture the essential Pareto idea of dispro-

portionate impact from a few causes, the Pareto distribution is a formal statistical model, whereas the Pareto principle is a generalized empirical observation. The key difference between them becomes especially important when depicted on a graph.

When the Pareto principle is plotted, the typical convention is to represent it as a bar graph with categories arranged in descending order of impact. The X-axis represents causes, the Y-axis outcomes. Highest impact causes appear first, with lower-impact causes stretching to the right and forming a tail. In the bar graph, low impact events are in the tail and so the tail is of little significance.

In contrast, when the Pareto distribution is plotted, the convention is to draw it as a line graph showing a steep drop followed by a long tail stretching along the X-axis. The X-axis typically represents a variable (such as magnitude of earthquakes) arranged in ascending order, from low values on the left to high values on the right. The Y-axis represents the probability/likelihood of the event. In the line graph, high impact, low probability events are in the tail – so the tail is very important.

Apart from the graphs, why does this distinction matter? The truth is they both capture the same type of disproportionate relationship. However, the Pareto principle tends to be used when talking more generally about decision-making or prioritizing effort, whereas the Pareto distribution – with its warning to focus on events in the tail – is the more accurate term for analysing extreme system-altering events.

These two Pareto terms differ furthermore from the concept of 'Pareto optimality', which in the disciplines of economics and game theory describes a situation in which resources are allocated in the most efficient possible way, meaning that no individual can be made better off without making someone else worse off. A situation where a Pareto improvement is possible is, for example, when A has a book about history and B a book about science but

A prefers science to history, and B vice versa. Pareto optimality can be obtained if they swap. But if A has a pizza and B has none, then while the situation is unfair, it is also Pareto-optimal, in that B cannot be made better off without A becoming worse off.

Appendix 4.2 – The Prevalence of Normal Distributions versus Power-Law Dynamics

Most outcomes are not evenly distributed – a few dominate the rest.

It is often implicitly or explicitly assumed that outcomes of phenomena and opportunities follow a normal distribution, with probability density function:

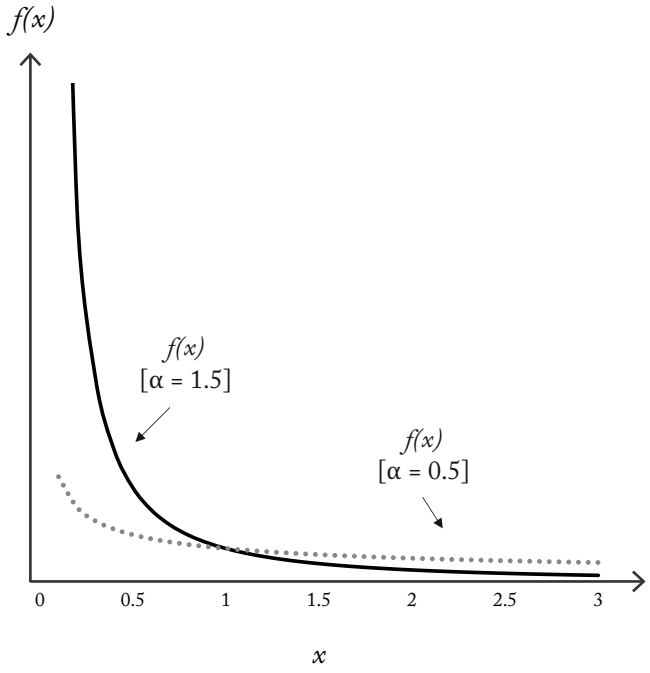
$f_X(x) = \frac{1}{\sigma\sqrt{2\pi}}\, e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$, with mean μ, and standard deviation (or sigma) σ

But many phenomena in nature and human affairs follow a power-law distribution. These are characterized generally by a mathematical relationship where one quantity varies as a power of another, that is, takes the form:

$$f(x) = k.x^{-\alpha}$$

where k and α are constants. The exponent α determines the shape of the curve, in particular a lower α produces a heavier tail, as below (assuming $k = 1$), for instance in the graphs below.

Power-Law Curves



Based on this type of structure, it has been possible to estimate the values of α from empirical data.

Phenomenon[1]	Alpha value or range
Land ownership in Italy (Pareto's original study)	1.16
River basin areas	1.5
Species abundance	1.5
Frequency of use of words	1–2.2
Population of US cities	1–2.3

1 Examples from M. E. J. Newman, 'Power laws, Pareto distributions and Zipf's law', 2005.

Intensity of solar flares	1.8
Asteroid size	1.85
Intensity of wars	1.8–2
Frequency of family names	1.94
Size of forest fires	2
Website links	2
Social network followers, connections	2
File sizes on computer	2
Net worth of Americans	2.09
Telephone calls received	2.22
Number of hits on websites	2.40
Magnitude of earthquakes	2–3.04
Diameter of moon craters	2–3.14
Copies of books sold in the US	1.75–3.51
Number of citations to papers	3.04

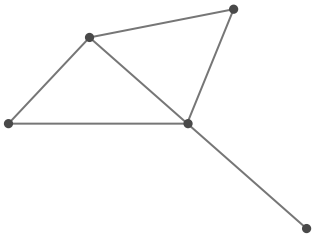
The α corresponding to these example phenomena typically ranges from 2 to 3, with a lower α corresponding to greater inequality.

Power-law distributions, like Pareto, are ubiquitous in natural and human systems and frequently arise from their network dynamics. The mechanism of 'preferential attachment' provides a model for this process. In a growing network, new nodes connect to existing nodes with a probability proportional to the number of links those existing nodes already have. The Barabási–Albert model (Barabási & Albert, 1999) generates such networks. This example illustrates the evolution of such network structures, and the corresponding distribution of node degree.[1]

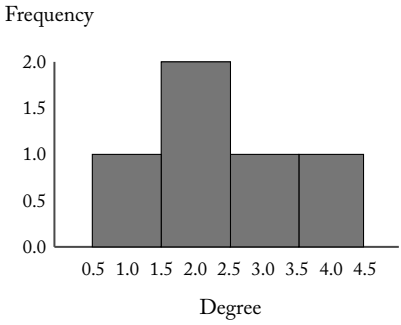
1 'Degree' of a node refers to the number of connections it has to other nodes.

Stage 1

Network Graph – 5 Nodes

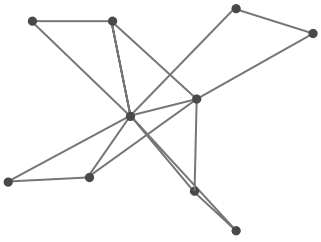


Degree Distribution – 5 Nodes

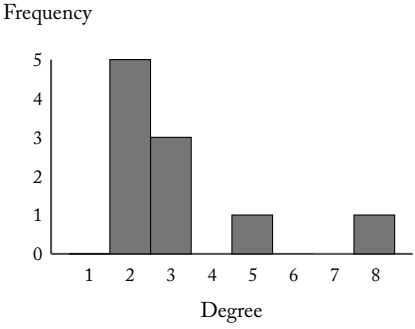


Stage 2

Network Graph – 10 Nodes



Degree Distribution – 10 Nodes

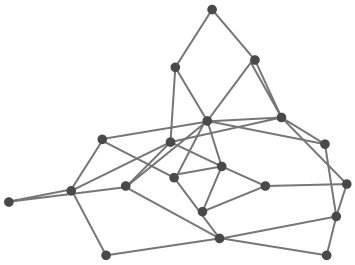


Stage 1 shows 5 nodes with few connections and little structure. Stage 2 shows 10 nodes, with a broader spread in node degree beginning to emerge.

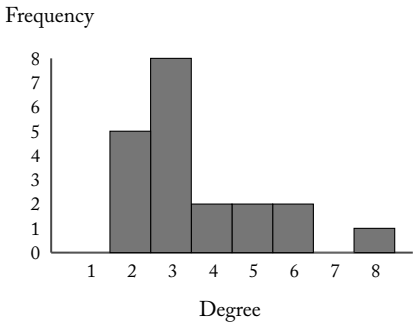
At stage 3, with 20 nodes, the degree distribution spreads out further. It starts to become clear that some nodes are more connected than others. It is at Stage 4, with 50 nodes, that central nodes with many connections become apparent, and the distribution of node degree is becoming clearer.

Stage 3

Network Graph – 20 Nodes

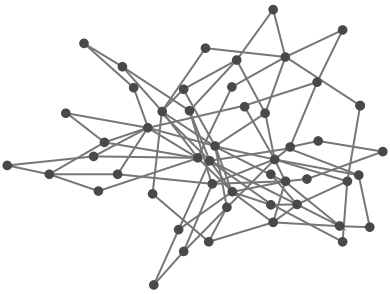


Degree Distribution – 20 Nodes

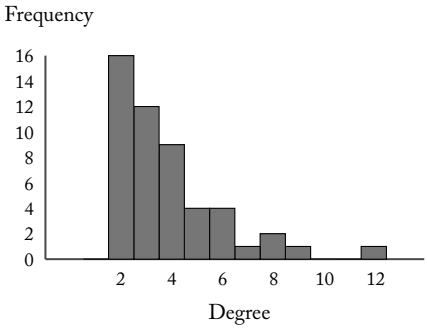


Stage 4

Network Graph – 50 Nodes



Degree Distribution – 50 Nodes



Continuing growth of this classic BA model, the resulting node degree distribution *P(x)*, can be seen to follow a power-law distribution proportional to x^{-3}. This simple mechanism of growth and preferential attachment explains the structure of many real-world networks, where a feedback loop causes popular hubs to attract new links at an accelerating rate.

Hechtlinger et al. (2024) offer a framework for understanding why big decisions – like emigration, marriage or career changes

– have a greater impact on subsequent decisions than smaller, everyday choices. Among their five main dimensions in which transformative life decisions differ from small, routine decisions, are two in particular:

- *Change of self – big decisions like emigration or leaving a religion can shift one's identity, beliefs and life trajectory.*

- *Irreversibility – many big decisions are difficult or impossible to undo, which leads to cascading consequences from the point at which they are decided, for example, the decision to have children.*

These dimensions mean that big decisions are not isolated – they reconfigure the context in which future decisions are made, whether defining what subsequent choices will be available, or defining one's future emotional states and evolving beliefs.

Applying the network model to life in general, one assumes that transformative decisions function as major nodes. Their high degree of influence on subsequent choices means they operate under a preferential attachment dynamic with respect to the addition of subsequent nodes. As a result, it is likely that the impact of the actions one takes in life follows some kind of power-law shape.

Appendix 4.3 – The Pareto Distribution

The Pareto distribution models outcomes where a small number of events account for a disproportionately large share of value.

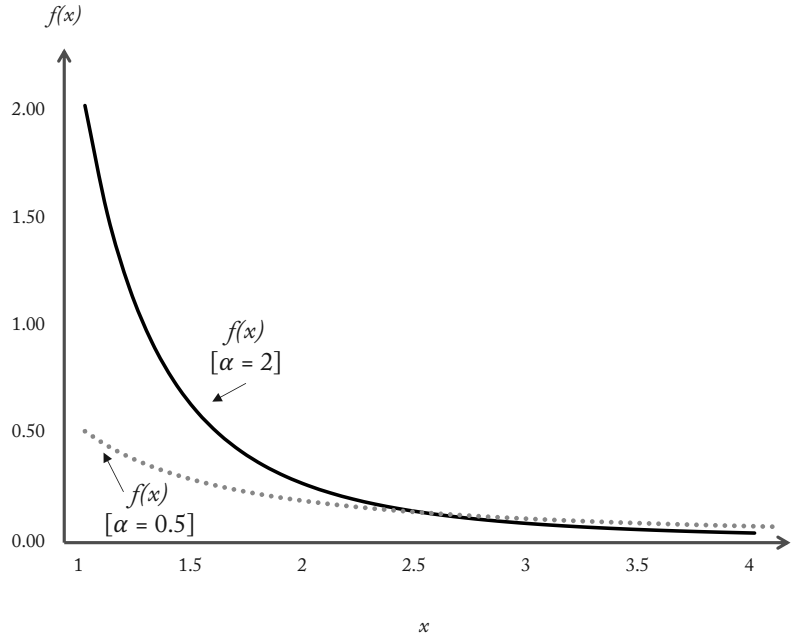
The Pareto distribution is a continuous probability distribution following a power law. It is defined such that a random variable X has the following probability density function:

$$f_X(x) = \begin{cases} \dfrac{\alpha x_m^a}{x^{\alpha+1}} & \text{for } x \geq x_m \\ 0 & \text{for } x < x_m \end{cases}$$

where x_m is the minimum value of X for which the distribution is defined. This minimum is necessary to ensure that the distribution is properly normalized and reflects the natural lower bounds observed in the real world with respect to phenomena that follow a Pareto distribution.

α still governs the heaviness of the tail of the distribution, so a low α produces a heavier tail, as below (assuming $x_m = 1$). This means relatively more of the instances of X sampled from the distribution will take a higher value.

Pareto Probability Density Functions



The expected value of a random variable following a Pareto distribution is:

$$E(X) = \begin{cases} \infty & \text{for } \alpha \leq 1 \\ \frac{\alpha x_m}{\alpha - 1} & \text{for } \alpha > 1 \end{cases}$$

The cumulative density function gives the probability that the random variable X is less than a value x:

$$F_X(x) = \begin{cases} 1 - \left(\frac{x_m}{x}\right)^{\alpha} & \text{for } x \leq x_m \\ 0 & \text{for } x > x_m \end{cases}$$

Appendix 4.4 – How Pareto Moves the Mean

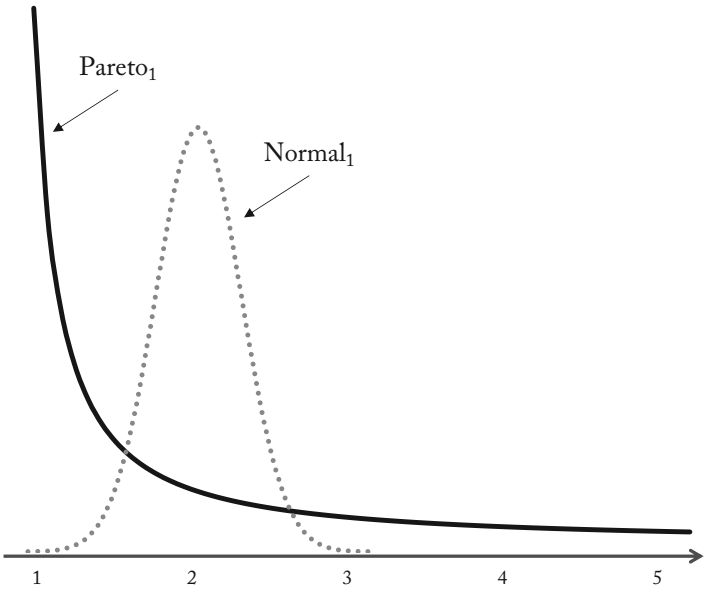
Unlike normal distributions, Pareto systems allow small shifts to produce outsized changes in the mean.

The overall result of a system which follows a statistical distribution is a function of the mean of that distribution.

Assume a phenomenon like the scale of an opportunity, X (in arbitrary units), follows a Pareto distribution with $\alpha = 2$ and $x_m = 1$. Its mean is then 2, and variance is undefined.

Now assume also a belief that this phenomenon follows a normal distribution with the same mean, and a variance of 0.08, therefore standard deviation of 0.28. These can be graphed as follows.

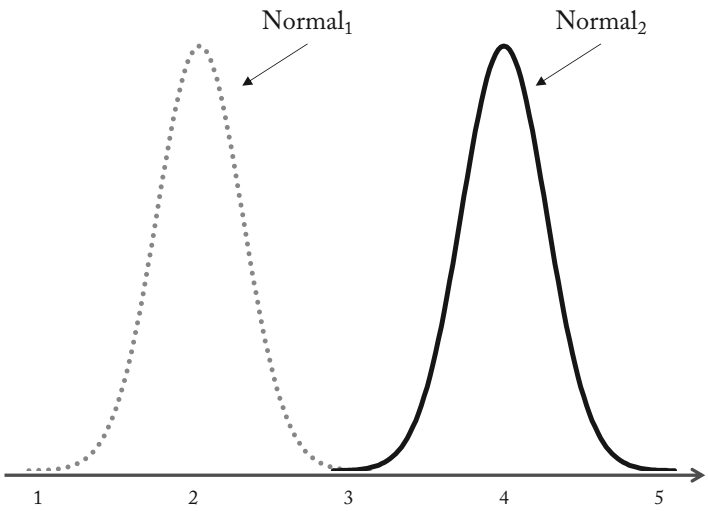
Pareto – Normal Comparison



We want to compare how much one must shift each distribution to obtain a doubling of the mean.

For the Normal distribution, this involves doubling the mean parameter, to 4, producing the following, leaving the variance constant:

Normal Comparison



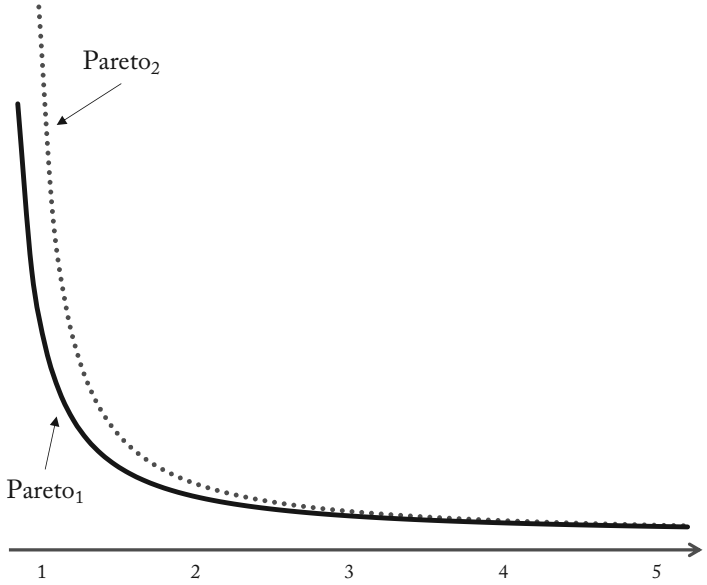
This requires shifting an amount of the distribution equivalent to more than 99 per cent:

$$F_{Normal_1}(x) - F_{Normal_2}(x)$$

where x is the crossing point of the two distributions.

To shift the Pareto mean, there is far less to move. To achieve a mean of 4, the alpha parameter needs to be 1.33, giving the following new distribution.

Pareto Comparison



The amount of distribution shifted is far less, equivalent at the crossing point to about 15 per cent:

$$F_{Pareto_1}(x) - F_{Pareto_2}(x)$$

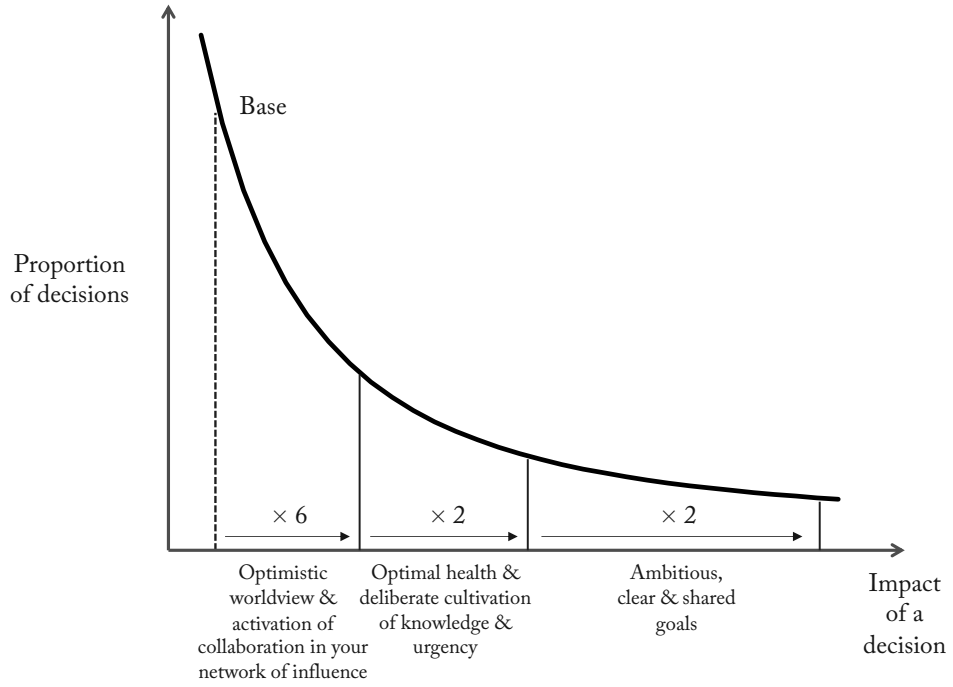
So, a small relative shift in the distribution can have an outsized influence on the mean.

Appendix 4.5 – How the Four Principles Connect

Applying the four principles together compounds impact, shifting ordinary actions into the extreme tail of outcomes.

Assume a Pareto distribution for the impact of our actions, and a multiplicative effect from each of the first three Principles on impact:

Scaled Up Impact in a Pareto World



Now, assuming for a Pareto distribution of life decisions a parameter of 2 (in the range described in Appendix 4.2), and $x_m = 1$, corresponding to one's minimally important decisions, we get a mean impact of 2. Take as a base, decisions with an impact of 1.1, corresponding illustratively to those made by someone with default levels of pessimism, poor health and knowledge, low urgency and no goals. Then applying each Principle in turn, we multiply up the impact, and for each result use the cumulative density function of the distribution to compute how much of the distribution exceeds that result.

So as per the table on page 288, to start with, 83 per cent of the distribution exceeds the value of 1.1. Multiplying that value by

six, we get that already only 2.3 per cent of the distribution exceeds 6.6. And after all three Principles apply in succession, getting to a cumulative multiplier of 24, the impact of an action is 26.4, which will fall in the top 0.14 per cent of all actions. This is to say that the result is that an ordinary decision can become approximately a one-in-700 impact decision.

	Multiplier	Impact	$1 - F_x(x)$
Base	-	1.1	82.64%
x Optimism	6	6.6	2.30%
x Time	2	13.2	0.57%
x Goals	2	26.4	0.14%

Systematic application of Optimism, Time and Goal-setting will therefore generate the kind of actions that lie far into the Pareto tail, where they will have a significantly multiplied impact.

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