In Defense and Cultivation of Human Rationality

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Chapter 1

Setting the Stage

1.1 Main Claim Presented, Explained

The Aristotelian dictum that you are a rational animal, as opposed to a mere animal (such as a dog or a chimp or a dolphin), is under severe attack these days. The attackers come from many quarters. Psychologists of reasoning and decision-making declare humans to be hopelessly plagued by bias; behavioral economists say we can’t understand basic probability, and are stunningly, stupidly overconfident; many are calling for an end to requiring students to study math beyond arithmetic, because supposedly that’s really all humans can master; and the “new atheists” point out that most of us believe in something supernatural, and claim that such belief is positively silly. In short, the onslaught is firmly underway, and fierce. This book is a defense of the proposition that Aristotle, suitably modernized, is nonetheless right:

$H$ Humans, at least neurobiologically normal ones, are fundamentally rational, where rationality is constituted by the power to carry out correct logic-based reasoning and decision-making, and to communicate and verify the corrects of this reasoning and decision-making, in response to any problem from a certain infinite set of problems. In addition, this human power marks humans are qualitatively superior to mere animals, since the latter can’t have such power.

There is of course much in need of clarification here. By saying that humans are fundamentally rational, we are saying simply that humans are potentially rational, which implies that statistical generalizations about average-subject performance, at a particular time, in experiments touted as demon-
strations of human irrationality, are largely irrelevant. Put more precisely, we are defending what linguists call a _subjunctive_ claim: Given sufficient training in logic and math, and sufficient nutrition, nurturing, and determination, nearly all neurobiologically normal humans can respond in a perfectly rational manner to the relevant set of problems.

Notice that specifically refer to training and determination. Being rational is something that must be won by hard work. We don’t say that someone who has never picked up a golf club is a great golfer, or that someone who has never sung is a great singer. A consequence of our position and approach is that opponents of math education, such as Baker’s (2013) “The Wrong Answer”, assuming we’re right, are dooming humans to a pre-rational phase of development. But more specifically, our position reveals why people like Baker are so misguided. They are misguided because they assume that just because achieving deep understanding of algebra at the high-school level can be a very taxing thing to do, achieving such understanding is impossible, or at least imprudent.

### 1.2 Defenders of Irrationalism

#### 1.2.1 Ariely

In his tellingly titled _Predictably Irrational_, Ariely writes:

> This book is about human _irrationality_—about our distance from perfection. ... Understanding irrationality is important for our everyday actions and decisions, and for understanding how we design our environment and the choices it presents to us. My further observation is that we are not only irrational, but _predictably irrational_—that our irrationality happens the same way, again and again. (in the chapter Introduction in Ariely 2009)

#### 1.2.2 Kahneman

Kahneman tries to avoid being labeled as an irrationalist. For example, toward the end of his _Thinking, Fast and Slow_, he writes:

> I often cringe when my work with [colleague] Amos is credited with demonstrating that human choices are irrational, when in fact our research only showed that Humans are not well described by the rational-actor model. (2nd complete para. of §“Econs and Humans” in §“Conclusions” in Kahneman 2013)
This makes little to no sense. Kahneman nowhere provides a rigorous definition of the so-called “rational-actor” model, but clearly the basic idea is that on that model, Jones (or Smith, or Brown, or you . . .) is rational insofar as his responses to relevant simulii are in line with the canons of formal logic. If Jones is rational, and doing some deductive reasoning, he’s rational just in case his reasoning is in line with the formal logic of deduction. If Jones is rational, and doing some probabilistic reasoning, he’s rational provided that his reasoning is in line with the formal logic of probability. If Jones is rational, and doing making some moves in a game, or making some decisions, he’s rational exactly if his moves and decisions are in line with the formal logic of games and decisions (given the context he is in). For instance, we’ve known since Aristotle that from

\[
\text{All } A\text{s are } B\text{s}
\]

combined with

\[
\text{Some } C\text{s are } A\text{s}
\]

that it’s rational to infer

\[
\text{Some } C\text{s are } B\text{s.}
\]

And we know that this deduction is rational precisely because it’s sanctioned by formal logic. On the other hand, if Jones infers from the two premises just given that

\[
\text{Alls } C\text{s are } B\text{s}
\]

we know that he has lapsed into making an irrational move; and we know this precisely because his move is at odds with logic.

Given this, when Kahneman says that “[the rational-actor definition of rationality] demands adherence to rules of logic that a finite mind is not able to implement”¹ he supplies all that is needed for us to firmly and accurately classify him as a staunch irrationalist. For, as our $\mathcal{RH}$ makes clear, to be rational is live by logic, or to be such that one can potentially live that way, given the kind of education that the present book provides.

1.3 Some Specimens to Get Your Feet Wet

The subjunctive nature of our claim can quickly be rendered more concrete by way of our first specimen:

¹In 2nd complete para. of § “Econs and Humans” in § “Conclusions” in Kahneman 2013.
The problem is simply this: Is it true that (3) is a valid deduction from (1) and (2)? Why?

Perhaps you gave the right answers (the first of which is: Yes). But even if you didn’t, our point at the moment is that had your past been somewhat different, you would’ve given the correct answers.

A simple parable makes clear that background training is crucial: Suppose that a cabal rules a planet populated with billions of creatures like us. This cabal sets up the planet so that only those in the cabal receive the stimulation and education needed to read and... do higher mathematics etc. Everyone outside the cabal is given minimal intellectual stimulation — and is forced to endure hard labor. As a result, everyone outside the cabal fails any and every single test of rationality. Now, are the illiterate slaves irrational, fundamentally? Obviously not. They are potentially rational. They just haven’t had the requisite training.

1.4 A Welcome Side-Effect of Our Defense

The key thing you need in order to be rational is sustained study of, and practice with, the relevant logic and mathematics, and an ability to use what you have studied in order to reason and decide correctly. In the course of our defense, we’re going to supply at least some of the relevant logic and mathematics to you. Hence, as you receive and judge our case, a pleasant side-effect will materialize: you will move closer to being rational.

1.5 Heroes of the Cause

Aristotle, Aquinas, Kant, Descartes.
1.6. WHAT ABOUT GROUP RATIONALITY?

Let’s use bolded capital Roman letters, with or without subscripts, to denote arbitrary declarative sentences in English. We shall call such letters *propositional variables*. For instance, we might use the propositional variable \( T \) to denote ‘Two plus two equals 4.’ Obviously, \( T \) is true. In addition, we allow propositional variables to be combined by so-called *propositional connectives*; for example by \( \wedge \), which we read as ‘and,’ and by \( \vee \), which we read as ‘or.’ For example, we can construct such *propositional combinations* as

\[
T \wedge R
\]

where \( R \) denotes the declarative sentence ‘Three plus three equals six.’ Similarly, we can also construct such propositional combinations as

\[
R_7 \vee R_3
\]

where the two propositional variables used here denote some declarative sentences again unknown to us.

Now for your challenge: Assume that \( P \) is true. And now supply some propositional variables, and/or propositional combinations, that can be deduced from \( P \) — if in fact any such things can be deduced.

1.5.1 René Descartes

1.6 What About Group Rationality?

1.7 Are Machines Rational?

1.8 Plan and Preview

Plan of the book:
Figure 1.3: René Descartes, who saw an intellectual chasm between mere animals and human persons.
Chapter 2

The Attack from Failures of Deductive Reasoning

This chapter begins with “screw ups” on even “baby logic” (e.g. on prop calc & theory of syllogism), and the rejection of Piagetian rationality as a result. Examples of screw-ups include Wason, J-L, King-Ace, instances of valid syllogisms declared invalid b/c conclusion not true, wise man puzzle (including variants). The chapter includes a refutation of the experimental techniques used to promote the notion that humans are naturally bad at normatively correct deductive reasoning: the exclusion from subject pools of those who have relevant training in math/logic, often no use of scratch paper allowed, no clear idea of what position in a formal hierarchy the items in question occupy, no significant incentive to think slowly and precisely, etc. In fact, many positions in psychology of reasoning are self-refuting: If either normatively correct statistical and probabilistic reasoning doesn’t exist, or eg proof by contradiction is denied, the inferences in the field itself are bankrupt. Formal material: prop calc, FOL, basic modal logic, formal validity. Mathematical induction is also a topic to cover.

2.1 The Wason Selection Task

The two problems discussed in the previous chapter are of a type the primo-genitor of which is the famous and fertile “Wason Selection Task” (WST), first presented by Wason (1966), and shown in Figure 2.1.

When one is looking for evidence that many illustrious 20th- and 21st-century psychologists of reasoning regard our main claim, $R_H$, to be false, an efficient route is to look at what such thinkers have said about WST. For
CHAPTER 2. FAILURES OF DEDUCTION

Figure 2.1: The Wason Selection Task (WST)

Suppose that we have a pack of cards each of which has a (capital Roman) letter written on one side, and a digit from 1 to 9 written on the other side. Suppose in addition that we claim the following rule is true:

\[ V \text{ If a card has a vowel on one side, then it has an even number on the other side.} \]

Imagine that we now deal out for you, upon a table, four cards from the pack, so that what you see, looking down upon the table, is this:

\[
\begin{array}{cccc}
E & T & 4 & 7 \\
\end{array}
\]

Which card or cards should you turn over in order to try to decide whether the rule \( V \) is true or false? Prove that you are correct.

e.g., here is Wason looking back at what he saw to be the reaction of proponents of one of our heroes to subject performance on WST:

The first formal experiments, done partly in Scotland, met with grave looks from dedicated Piagetians; the subjects’ responses were clearly incompatible with “formal operations.” (Wason 1995, p. 296)
2.2. THE THOG PROBLEM

2.2 The THOG Problem

Consider the following quartet \( Q \) of objects:

\[
\begin{array}{cccc}
\Box & \ast & \bigcirc & \bigstar \\
\end{array}
\]

You will notice that each object in \( Q \) has a certain outer shape (circular or square), and a certain — as we shall say — internal attribute (either a dot inside, or a triangle inside). One of us has written down, on a piece of paper \( P \) now hidden, one of these two outer shapes, and one of these internal attributes. We give you the following definition:

\[ D \text{ An object in } Q \text{ is a ROKE if and only if it has either the shape we have written down on } P, \text{ or the internal attribute we have written down on } P, \text{ but not both.} \]

In addition, we inform you that the square with a triangle inside it is a ROKE.

Now, which of the other objects in \( Q \) is ROKE, if any?

There are many valid and efficient ways to prove that the dotted circle is a ROKE, and that it’s the only other member of the quartet other than \( \bigstar \) that is. We give one such route immediately below, which you should make sure you understand.

**Proof:** We use proof by cases. Since we know that the square with an internal triangle is a ROKE, we can consider the two exhaustive cases for what one of us wrote down on the hidden piece of paper \( P \), in light of definition \( D \):

C1 The first case is that we selected the square shape, but no internal triangle; i.e., \( \Box \).

C2 The second case is that one of us selected the circular shape, but with an internal triangle; i.e., \( \bigcirc \).

Since these are the only possible cases for what a Bringsjord wrote on the hidden piece of paper, and since in both C1 and C2 we can deduce that the circle with an internal dot is a ROKE, and that the other two objects in \( Q \) aren’t, the answer is: the dotted circle; i.e., \( \bigstar \). **QED**
CHAPTER 2. FAILURES OF DEDUCTION

2.3 The Propositional Calculus

2.3.1 Language of PC

Given this alphabet, a well-formed formula, or for short a wff, is a string \( u \) of characters taken exclusively from this alphabet, which conforms to the following three rules.

1. Every atomic formula is a wff.
2. If \( \phi \) is a wff, then so is \( \neg \phi \).
3. If \( \phi \) and \( \psi \) are wffs, then so is \( \phi \star \psi \), where \( \star \) is one of the four connectives \( \land, \lor, \rightarrow, \leftrightarrow \).

2.4 The Moriarty Bomb Problem

2.5 Problems at the Level of FOL

2.6 Problems at the Level of Modal Logic
Chapter 3

Behavioral Economics and the Attack from Failures of Probabilistic Reasoning

Perhaps start with coverage of probabilistic logic, with a focus on probabilistic entailment (vs deductive entailment of the classical form). Here use essentially the sequence in /Thinking, Fast and Slow/, a possible required book: Linda, Heuristics, & Logic; Overconfidence; Bad Choices, Framing Effect, Prospect Theory. Coverage of multi-valued logic. Linda problem analyzed with the spatial foundations of probabilistic logic. Show that the problems are trivial. Should Groopman’s cases be solved here? Is his book a possibility? The critique of Gigerenzer’s myopic focus on heuristics perhaps included.
3.0.1 Linda and Lousy Logic

Perhaps Kahneman’s (2013, first page of Chapter 15) most famous cluster of experiments revolves around the fictional Linda, who is first described for subjects, before they then receive a single question; see Figure 3.1.

**Figure 3.1: The Linda Problem (“stark” version)**

<table>
<thead>
<tr>
<th>Linda is thirty-one years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which of the following alternatives is more probable?</td>
</tr>
<tr>
<td>• Linda is a bank teller.</td>
</tr>
<tr>
<td>• Linda is a bank teller and is active in the feminist movement.</td>
</tr>
</tbody>
</table>

Kahneman writes:

This stark version of the problem made Linda famous in some circles, and it earned us years of controversy. About 85% to 90% of undergraduates at several major universities chose the second option, contrary to logic. (2013, Chapter 15)

Selection of the second option is irrational because it is indeed illogical. But why is the second option an illogical choice?
3.1 Basic Probability for the Rational Response

3.1.1 Kolmogorov’s Axioms

Kolmogorov (1933) gave us the axioms of probability rather a long time ago. Where the underlying formal language is that of the propositional calculus, with which, at this point you are familiar, they are the following four:

K1 $\forall p(0 \leq p(\phi) \leq 1)$
K2 If $\models \phi$, the $p(\phi) = 1$.
K3 If $\{\phi\} \vdash \psi$, then $p(\phi) \leq p(\psi)$.
K4 If Inc $\{\phi, \psi\}$, then $p(\phi \lor \psi) = p(\phi) + p(\psi)$.

3.1.2 Proving that the Rational Response is Right

Here’s a proof from Kolomogorov’s Axioms (KA) that the principle to which Kahneman (2013, Chapter 15) appeals in his discussion of Linda, logic, and System 2 is an outright theorem in probability logic:

**Theorem:** $p(\phi \land \psi) \leq p(\phi)$.

**Proof:** Obviously, $\{\phi \land \psi\} \vdash \psi$. In fact, the deductive rules in the propositional calculus that we have explicitly noted included this one:

$\frac{\phi \land \psi}{\phi / \psi}$

But then from the relevant instance of axiom K3 of KA, viz.

If $\{\phi \land \psi\} \vdash \psi$ then $p(\phi \land \psi) \leq p(\phi)$,

we have by *modus ponens* our desired result. QED
3.2 On the Meaning of Life

3.2.1 Beyond Utility to Meaning

Kahneman, let us grant, makes new and welcome distinctions between types of utility. But rationality includes much more than a capacity to thinking rigorously about utility, and make decisions on the basis of the fruit of that thinking. Rationality, real rationality, includes an ability to productively ponder the “meaning of life.” And such meaning is a different animal:

\[
\text{happiness} \neq \text{meaning of life} \\
\text{rightness} \neq \text{meaning of life} \\
\text{worthwhileness} (\text{value}) \neq \text{meaning of life}
\]

Assumption: meaning of life is a different variable, and on a gradient. We are after deep meaning.
3.2.2 Camus, Russell et al.: Life Has No Meaning

Camus:

(1) Life has meaning only if God exists and we can live forever with Him (as in e.g. orthodox Christianity).

(2) God doesn’t exist.

Therefore:

(3) Life doesn’t have meaning.

And Russell:

That man is the product of causes which had no prevision of the end they were achieving; that his origin, his growth, his hopes and fears, his loves and his beliefs, are but the outcome of accidental collocations of atoms; that no fire, no heroism, no intensity of thought and feeling, can preserve an individual life beyond the grave; that all the labors of all the ages, all the devotion, all the inspirations, all the noonday brightness of human genius, are destined to extinction in the last death of the solar system, and the whole temple of Man’s achievement must inevitably be buried beneath the debris of a universe in ruins—all these things, if not quite beyond dispute, are yet so nearly certain, that no philosophy which rejects them can hope to stand. (Russell 1957)

Suicide, in light of this? Camus: No.
Hamlet: No — for radically different reasons.
3.2.3 Meaning via The Infinite-and-Unlimited
Chapter 4

Explorations in
New-Millennium Rational Economics

4.1 The Singularity, the MiniMaxularity, & Human Disemployment

4.2 The Bi-Pay Auction

4.3 Is the market efficient?

First remind the reader of Kahneman’s pessimism. Then present the efficient-market propositions. Then prove that the market isn’t efficient by factoring in communication from activist investors, which provides an “escape” form of investing. Activism can include, of course, communication in social media.

4.4 Chain Stores, Entrepreneurs, & Games

Define the chain store problem from Selten’s original paper. He called the discrepancy a “paradox.” We’ll get to real paradoxes. Here, we simply have a failure of standard game theory to provide an adequate machinery with which to model the real world. There’s no paradox, because we already know that standard game theory is inadequate anyway, so the contradiction is easily removed.
4.4.1 Selten’s Chain Store “Paradox”

4.4.2 The Solution: Real-World Deterrence & Communication
The Wise Man Puzzle

As a first step, we consider the Wise Man Puzzle, which efficiently introduces the elements we need to address the Chain Store “Paradox.”

The Third Wise Man: “I have a white fez!”

**Proof:** “I can prove that I have a white fez: Suppose for *reductio* that I have a black fez. Given this, it follows that what WM2 sees is that I have a black fez (and that WM1 has a white fez, which I too of course saw from the start). But WM2 already knew from what WM1 said that — to repeat — it can’t be the case that WM2 and WM2 have black fezes. Since he knew this, and since if I had a black fez he would therefore know that he (i.e., WM2) has a white fez, he wouldn’t have reported his ignorance. But he *did* report his ignorance. This contradiction implies that the supposition that I have a black fez is incorrect. Ergo, I have a white fez! QED

The solution can be given with assistance from diagrams denoting some relevant mental models. To begin, we have the model that corresponds to WM2’s point of view, and then next the model that corresponds to WM3’s point of view:

\[
\begin{array}{ccc}
\text{Start (WM2’s pov)} \\
\hline
\checkmark & \? & \checkmark \\
WM1 & WM2 & WM3 \\
\hline
\text{Model 1}_2
\end{array}
\]

\[
\begin{array}{ccc}
\text{Start (WM3’s pov)} \\
\hline
\checkmark & \checkmark & \? \\
WM1 & WM2 & WM3 \\
\hline
\text{Model 1}_3
\end{array}
\]

At this point, WM1 reports his ignorance. (He is of course entirely correct in asserting that he doesn’t know what color fez he has, because only if WM2 and WM3 had had black fezes would he know that he has a white fez.) At this point, then, WM2’s point of view is summed up like this:

\[
\begin{array}{ccc}
\text{Start (WM2’s pov)} \\
\hline
\checkmark & \checkmark & \checkmark \\
WM1 & WM2 & WM3 \\
\hline
\text{Model 2}_2
\end{array}
\]

\[
\begin{array}{ccc}
\checkmark & \checkmark & \checkmark \\
WM1 & WM2 & WM3 \\
\hline
\text{Model 3}_2
\end{array}
\]

And of course WM3’s point of view can be summed up in mental-models fashion like this:
Fortunately for WM3, before anything else happens, WM2 announces his ignorance: he reports that he doesn’t know which of Model 2 and Model 3 corresponds to reality. This allows WM3 to affirm Model 3 as reality, and to announce the fact that he, i.e. WM3, has a white fez. His reasoning is simple: “If Model 2 were real, WM2 would have seen the black fez on my head. That would have allowed him to eliminate Model 3, which means he would have a white fez, and he would have proudly announced this fact. Since he didn’t do that, Model 3 it is, and white fez have I!

<table>
<thead>
<tr>
<th>Start (WM3’s pov)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perhaps:</td>
</tr>
<tr>
<td>WM1</td>
</tr>
<tr>
<td>Perhaps:</td>
</tr>
<tr>
<td>WM1</td>
</tr>
</tbody>
</table>
Chapter 5

Paradoxes: Medicine for the Mind

To learn how to think rationally, perhaps nothing beats tackling these! They force meta-cognition, which is part and parcel of rationality.

Cover time travel paradoxes? How about Newcomb’s Paradox?

Two senses of the concept of a paradox: formal/abstract, versus more realistic and context-dependent.

5.1 The Lottery Paradox
5.2 The Liar
5.3 Zeno’s Paradoxes
5.4 The Bogus Barber

Now we transition to the “formal” paradoxes... If the ones that motivated ZFC were used, this would provide a foundation for Steeple/CH. So that means Russell’s Paradox, Richard’s Paradox.
Chapter 6

Darwin’s Dumb Ideas

My slides for “Darwin’s Dumb Idea” lead off, & probably forms one entire section. Paper from Hummel showing that despite what many lay folks think, chimps, let alone Darwin’s vaunted dogs, are pretty darn dim. No continuous & fundamentally equal cognition from dogs to monkeys to man. My review of Pinker’s *How the Mind Works*. Formal material: prop calc, FOL, formal validity. But more than that, general problem-solving, planning. Goal analysis from a logicist point of view? ADR? Problem-solving here seems more robust than dealing with little logic problems. Use logicist planning? But more than that, general problem-solving, planning. Goal analysis from a logicist point of view? ADR? Problem-solving covered here will need to be more robust that dealing with little logic problems. Use logicist planning? Make it clear that we’re not in need of creativity here? Formal material?

Might want to put the next chapter into this one, as Darwin’s second great mistake.
Chapter 7

Language as the Grand Separator

Fundamental Separator b/t Humans and Mere Animals. Offense here. This will be a claim on my part. How do we do it? Showing how astounding our capacity is. Computational learning theory. Chomsky. Chomsky Hierarchy. The birth of cog sci. Bashing monkeys again: they can’t converse. Will need to introduce grammars. And lambda-calculus?
Chapter 8

The Attack on Human Rationality from New Atheism
CHAPTER 8. ATTACK FROM NEW ATHEISM

The Argument for Human Irrationality from Atheism
\(\begin{align*}
(1) & \text{ Most people believe that God exists.} \\
(2) & \text{ Anyone who believes that God exists is irrational.} \\
\therefore (3) & \text{ Most people are irrational.}
\end{align*}\)

8.1 Hapless Harris

Here summarize and refute the believers-do-bad-things argument. Transition from consideration to the “fire” of hell to Russell.

8.2 Rash Russell

Here summarize and refute Russell’s believers-believe-in-hell argument.
Chapter 9

Steeples of Rationalistic Genius

Leibniz & Newton, & the differential and integral calculus. Gödel. Incompleteness. CH. Goodstein’s Theorem. My metric for alien-fair GI, & creativity. This is offense.
Bibliography


