NST IB Psychology

Emotion and motivation – 3

Complex motivated behaviour: behavioural economics and addiction

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Thursday 4, Saturday 6, Tuesday 9 March 2004; 11am
Physiology Lecture Theatre 3

Basic concepts of behavioural economics

What does it mean to be rational?

Agents are things that **act.**

The axioms of utility theory tell us what agents with **rational preferences** should be like.

Irrational agents lose out to rational ones.

axiom: A self-evident truth; a proposition on which an abstractly defined structure is based.

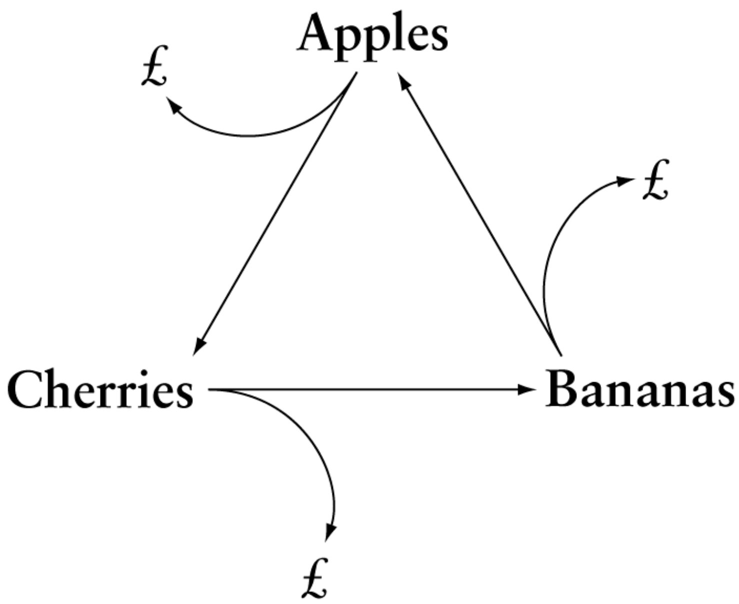
von Neumann & Morgenstern (1947); Russell & Norvig (1995, p474)

An example: it's irrational not to have transitive preferences

Transitivity: *if a relation ♦ is transitive, then if A ♦ B and B ♦ C, then A ♦ C. For example, if A > B and B > C, then A > C.*

Preference order: A > B > C > A

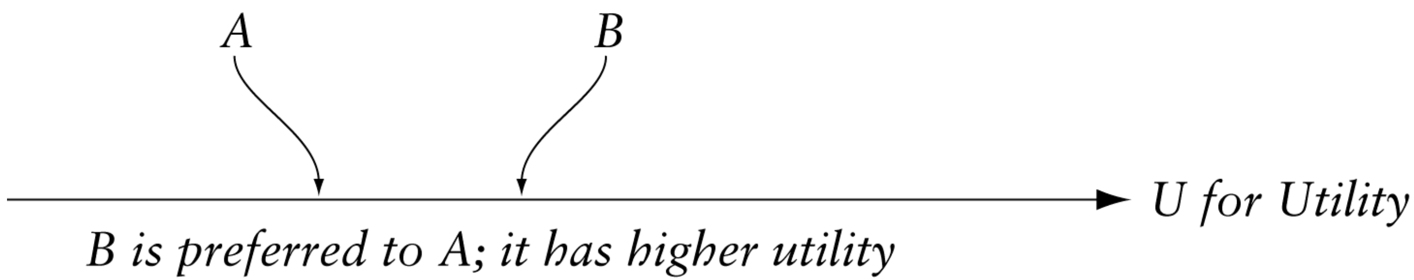
*… an **intransitive** preference.*
The agent is vulnerable to an arbitrage (or 'Dutch book', or 'money pump'):



After Russell & Norvig (1995)

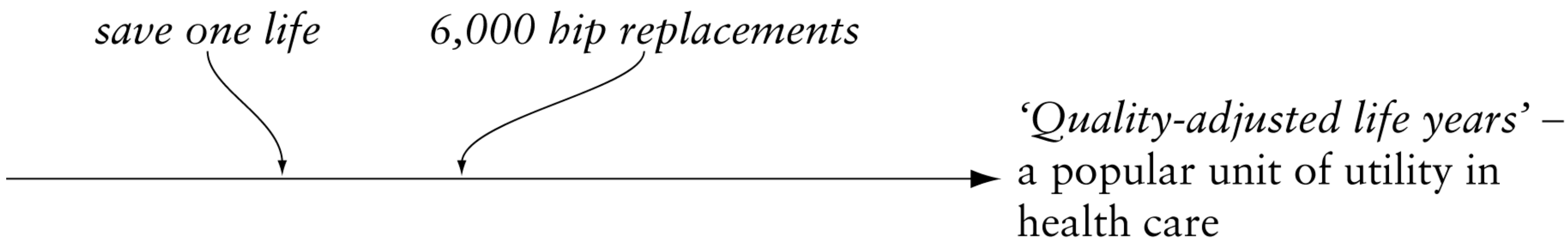
What are your values and goals? Utility functions

To say whether something is **better or worse** than something else, you must be able to compare them on a **single dimension.** For example, on a line.



Utility functions convert preferences to numbers.

So if you are able to compare two different things – such as saving a life and performing 6,000 hip replacements – you must be able to value them in some common way. For example:



One good way to choose: maximizing your utility

"To judge what one must do to obtain a good or avoid an evil, it is necessary to consider not only the good and the evil in itself, but also the probability that it happens or does not happen; and to view geometrically the proportion that all these things have together." (Arnauld, 1662, *Port-Royal Logic*.)

If you have an idea what your actions achieve…

$$p(action \rightarrow outcome_n \mid evidence)$$

and you know the value or **utility** of that outcome…

$$U(outcome_n)$$

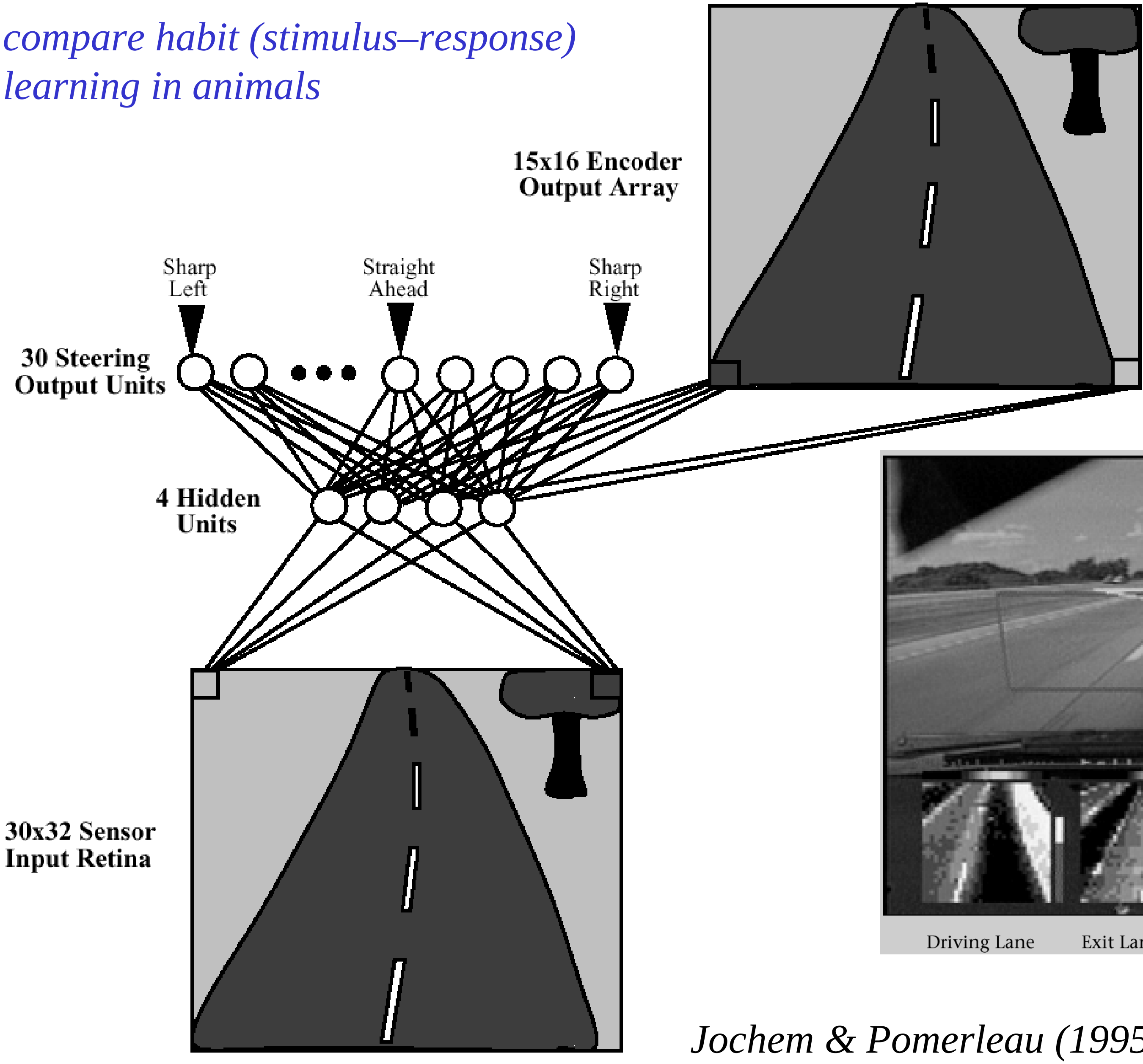
then you know the expected utility of a given action…

$$\Sigma_n\, p(action \rightarrow outcome_n \mid evidence) \times U(outcome_n)$$

… so you can pick the action with the **maximum expected utility.**

Rational behaviour doesn’t need complex, explicit thought

compare habit (stimulus–response)
learning in animals



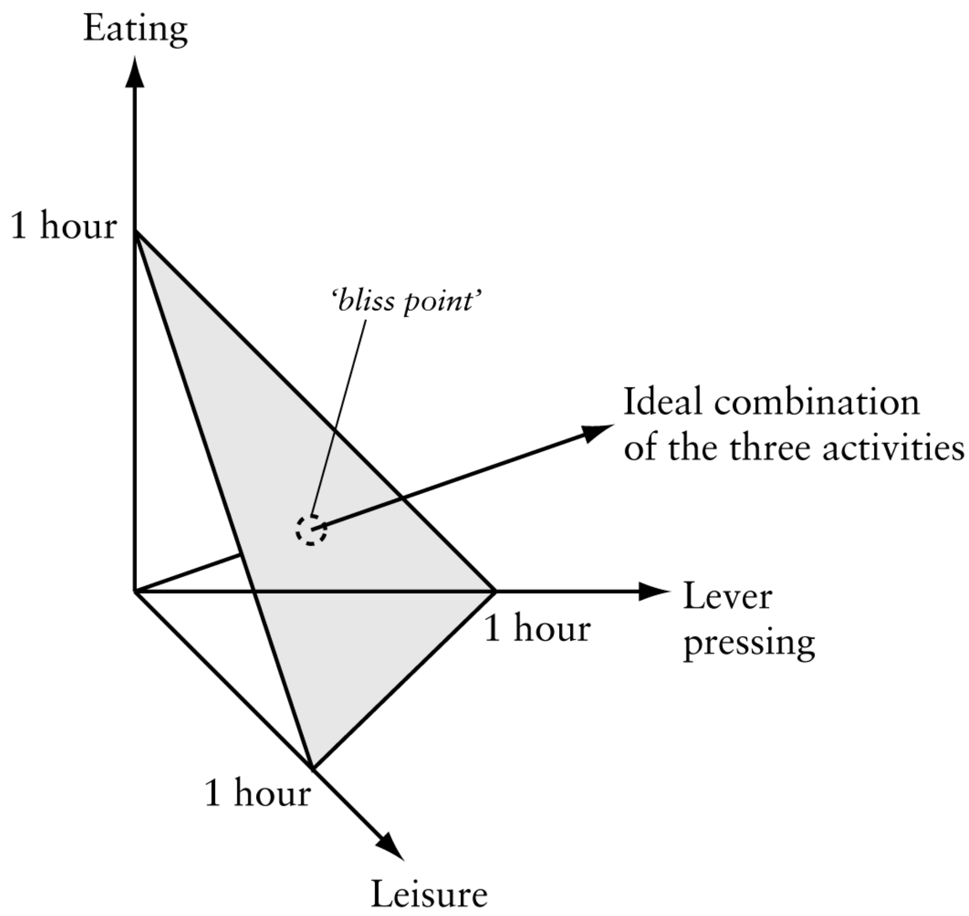
Jochem & Pomerleau (1995); also Watkins (1989)

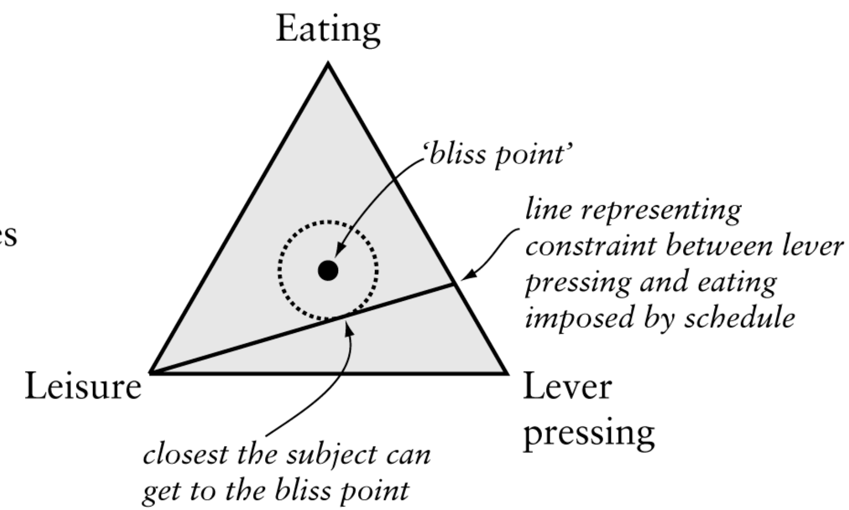
The principle of revealed preference

"I prefer to vote Republican, not to use marijuana or cigars, and never to employ anyone I find sexually attractive."

"I want to stop smoking."

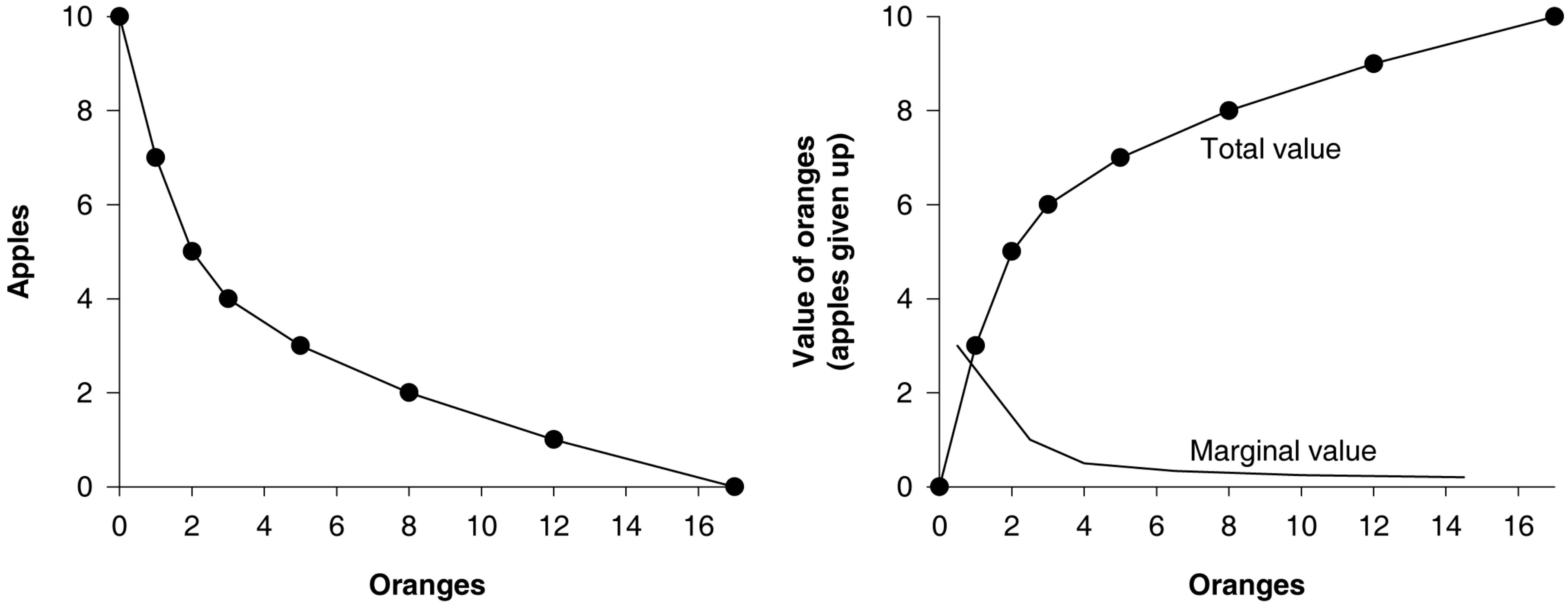
Trying to achieve a ‘bliss point’



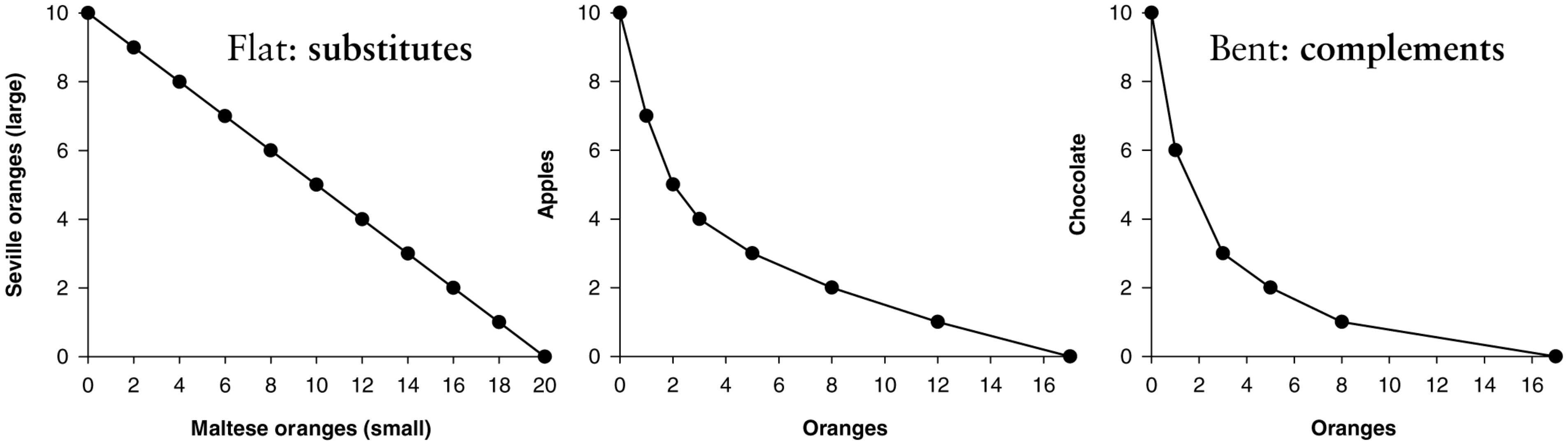


Rachlin (2003)

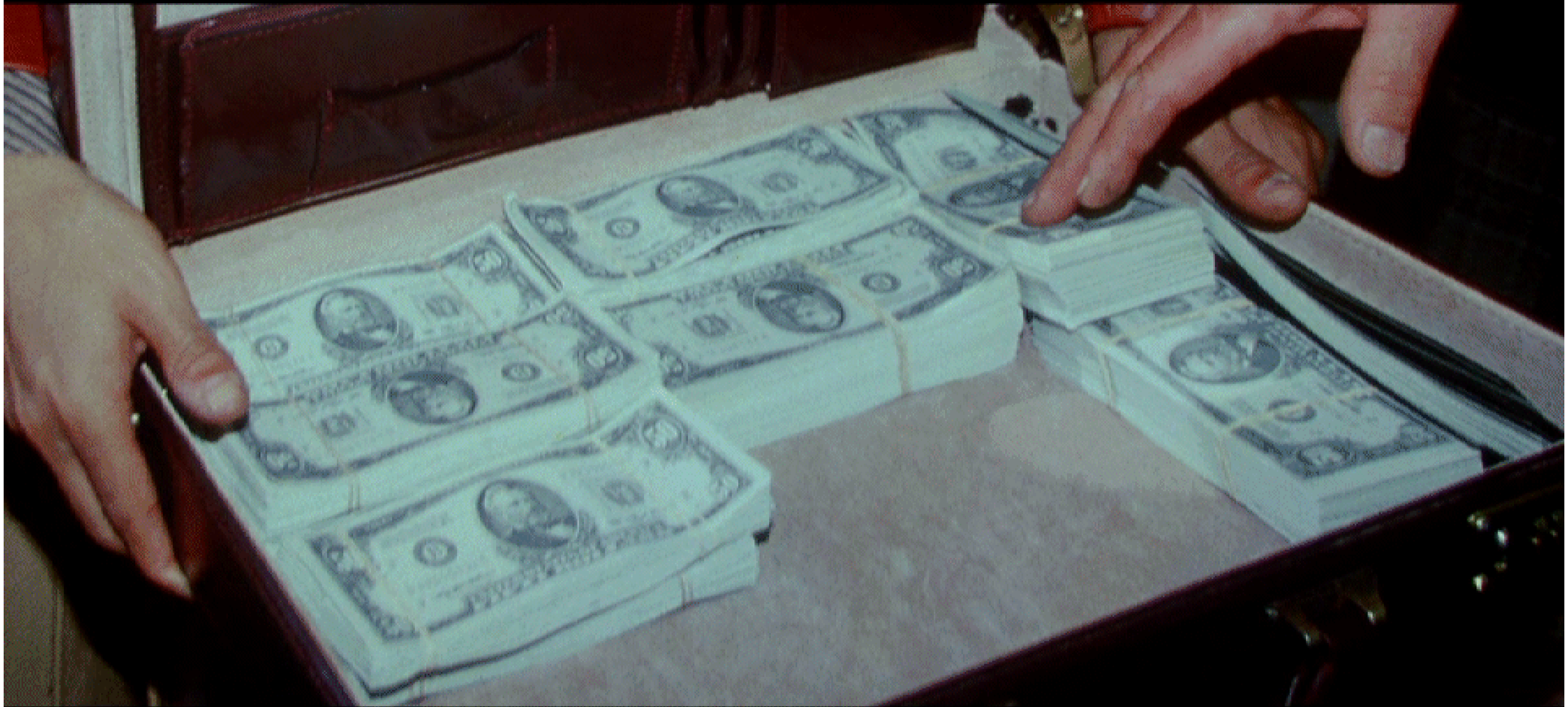
Apples'n'oranges: a barter economy



Substitutability: apples, oranges, other oranges, chocolate

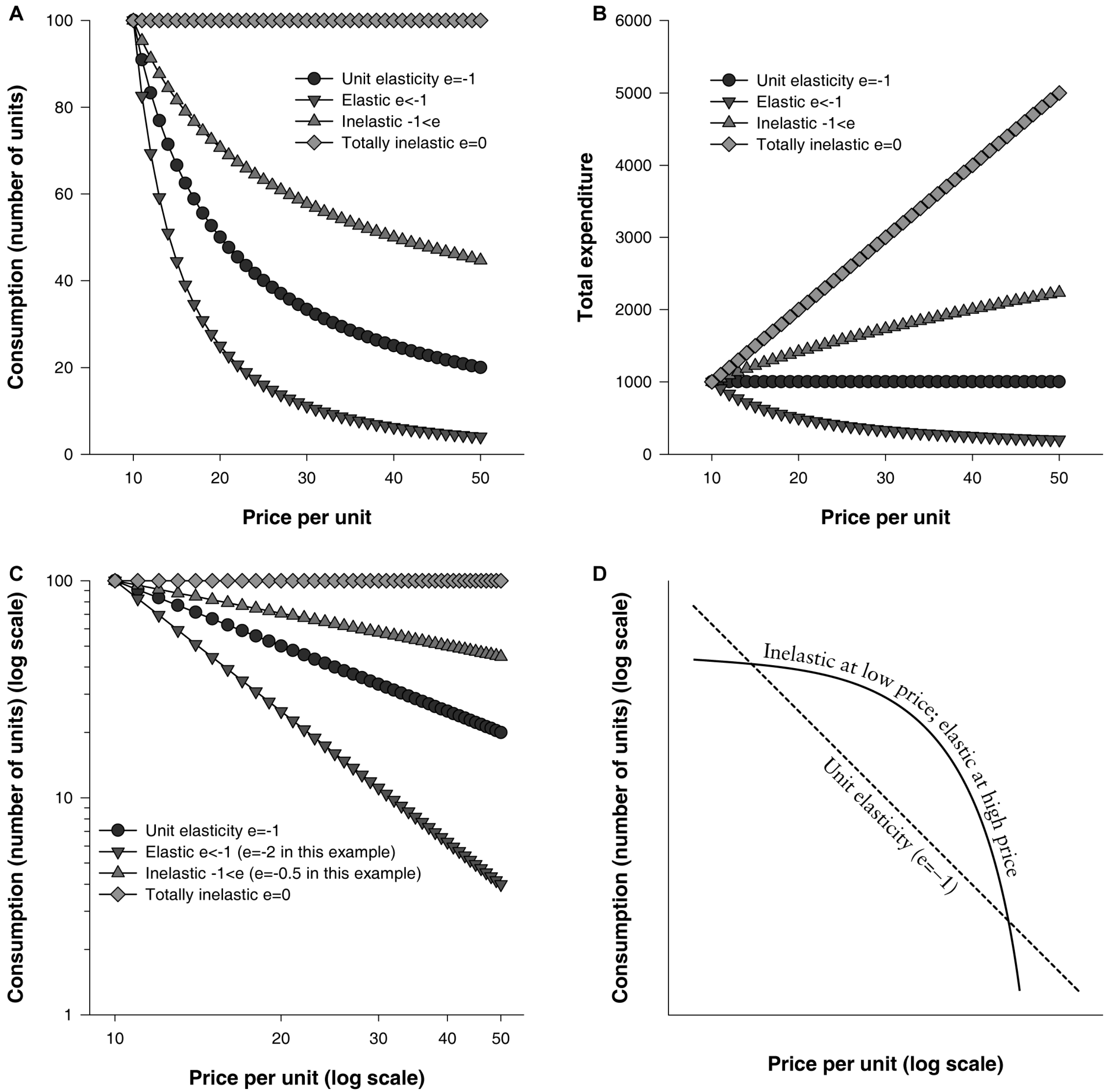


Cash in hand



~640 BC (Lydia): first known coins; 806 AD (China): first known paper money

Own-price elasticity: what happens when price increases?



Cross-price elasticity: gin and tonic

Humans are irrational

Is rational decision-making always the best course?

```
p(eaten | stay) = 0.98
U(eaten) = -999
p(nice view | stay) = 1
U(nice view) = 1.2
EU(stay) = -977.82
p(eaten | run left) = 0.63
p(eaten | climb tree) = 0.91
...
```

You play:	paper	scissors	stone
Your opponent plays:			
paper	0	1	–1
scissors	–1	0	1
stone	1	–1	0

There is no ‘pure’ (non-random) strategy for either player. The best strategy is to choose **at random.**

Russell & Norvig (1995); von Neumann & Morgenstern (1947); Mérö (1998)

Deviations from rationality

Bounded rationality

… can’t work out what’s optimal

Bounded self-interest

… don’t do what’s optimal for you, but sacrifice own interests to help others (rather encouraging!)

Bounded willpower

… make choices that aren’t in your long-term interests

Bounded rationality, i.e. not very clever

New York taxi drivers rent their cabs for 12 hours for a fixed fee. They keep all their revenues and decide how long to work each day.

Rational behaviour to maximize income:

• on good days (e.g. conference in town), drive for longer;
• on bad days, quit early.

Actual behaviour:

• set a target for the day (e.g. twice the rental fee), and quit when you reach it.
• This strategy means you work less on good days and more on bad days.

Camerer et al. (1997)

Providing risk information?

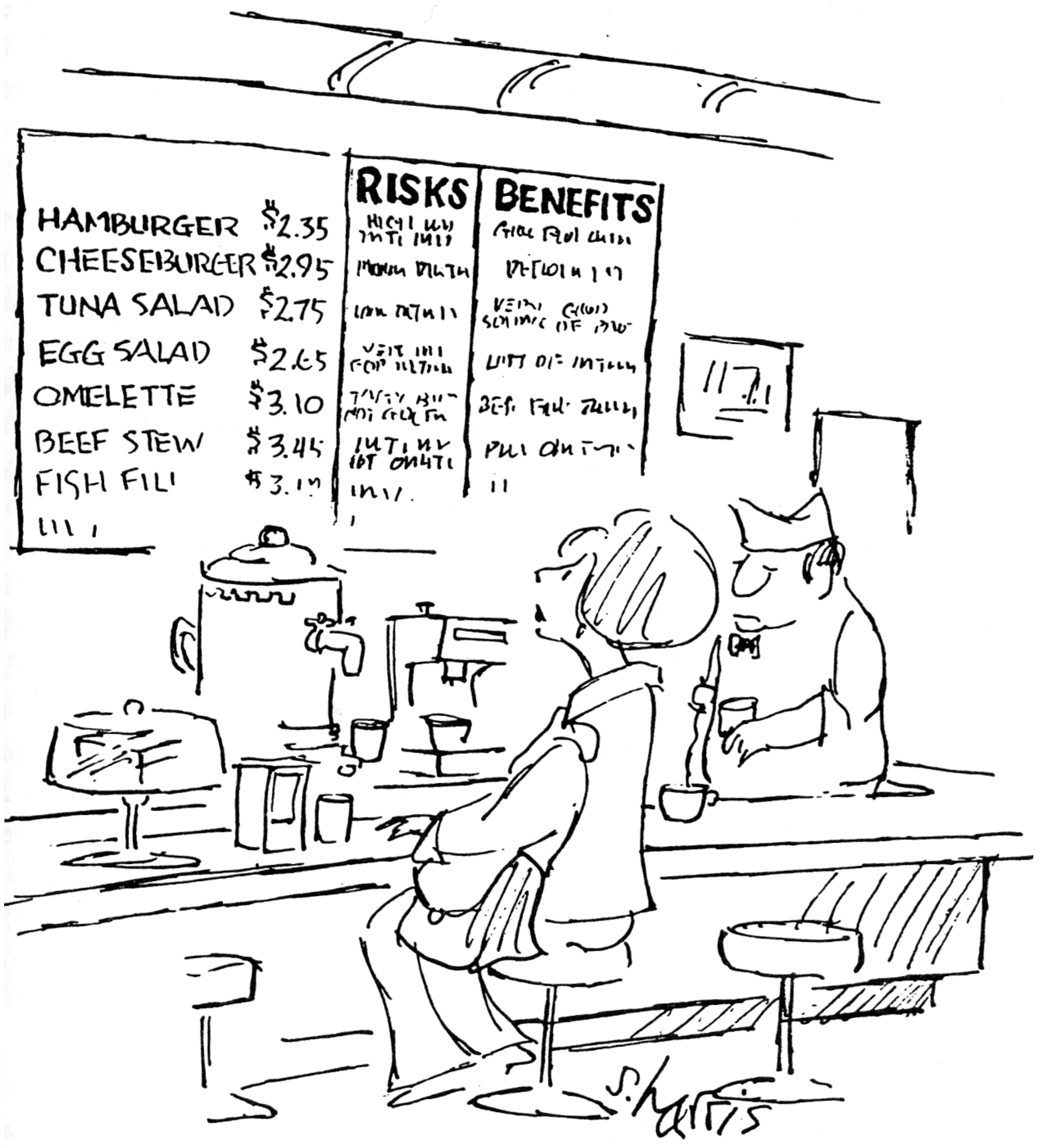
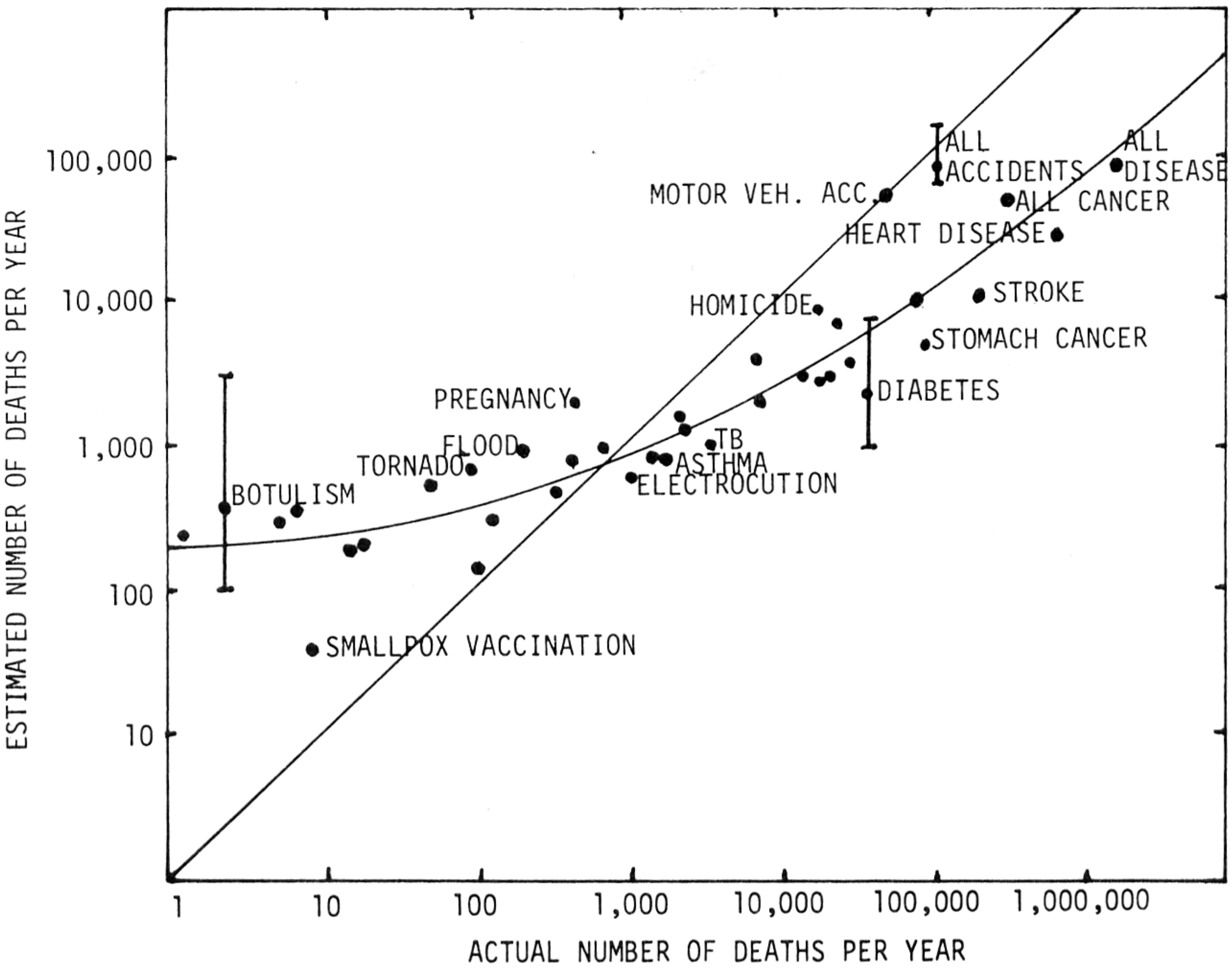


Figure 5. Drawing by S. Harris; © 1979 *The New Yorker Magazine.*

Liebeck v. McDonald's, 1992. 16% third-degree burns to a 79-y-old woman following a coffee spill (at ~85°C: takes 2–7s to cause third-degree burns). $160,000 compensatory damages; $2.7 million punitive damages (later reduced to $480,000). Safer at 70°C (takes 60s for severe burns).

People are bad at assessing risk



Lichtenstein et al. (1978)

Risk perception and what you read in the papers

Table 2. *Statistical frequency and newspaper coverage in the Eugene, Oregon,* Register Guard *and the New Bedford, Massachusetts,* Standard Times *for 41 causes of death*

Cause of death	Rate per 2.05×10^8 U.S. Res.	Subjects' estimates	Reported deaths R-G	Reported deaths S-T
1. Smallpox	0	57	0	0
2. Poisoning by vitamins	1	102	0	0
3. Botulism	2	183	0	0
4. Measles	5	168	0	0
5. Fireworks	6	160	0	0
6. Smallpox vaccination	8	23	0	0
7. Whooping cough	15	93	0	0
8. Polio	17	97	0	0
9. Venomous bite or sting	48	350	0	0
10. Tornado	90	564	36	25
11. Lightning	107	91	1	0
12. Non-venomous animal	129	174	4	2
13. Flood	205	736	4	10
14. Excess cold	334	314	0	0
15. Syphilis	410	492	0	0
16. Pregnancy, birth & abortion	451	1,344	0	0
17. Infectious hepatitis	677	545	0	0
18. Appendicitis	902	605	0	0
19. Electrocution	1,025	766	5	0
20. MV/train collision	1,517	689	0	1
21. Asthma	1,886	506	1	0
22. Firearm accident	2,255	1,345	8	1
23. Poison by solid/liquid	2,563	1,013	3	3
24. Tuberculosis	3,690	658	0	0
25. Fire and flames	7,380	3,336	94	46
26. Drowning	7,380	1,684	47	60
27. Leukemia	14,555	2,496	1	0
28. Accidental falls	17,425	2,675	15	7
29. Homicide	18,860	5,582	278	208
30. Emphysema	21,730	2,848	1	0
31. Suicide	24,600	4,679	29	19
32. Breast cancer	31,160	2,964	0	0
33. Diabetes	38,950	1,476	0	1
34. Motor vehicle accident	55,350	41,161	298	83
35. Lung cancer	75,850	9,764	3	2
36. Stomach cancer	95,120	3,283	0	1
37. All accidents	112,750	88,879	715	596
38. Stroke	209,100	7,109	12	4
39. All cancer	328,000	45,609	25	12
40. Heart disease	738,000	23,599	49	30
41. All disease	1,740,450	88,838	111	87

Combs & Slovic (1979). Note may be a cause or an effect of human risk perception.

Inconsistency: risk depends on how you phrase the question?

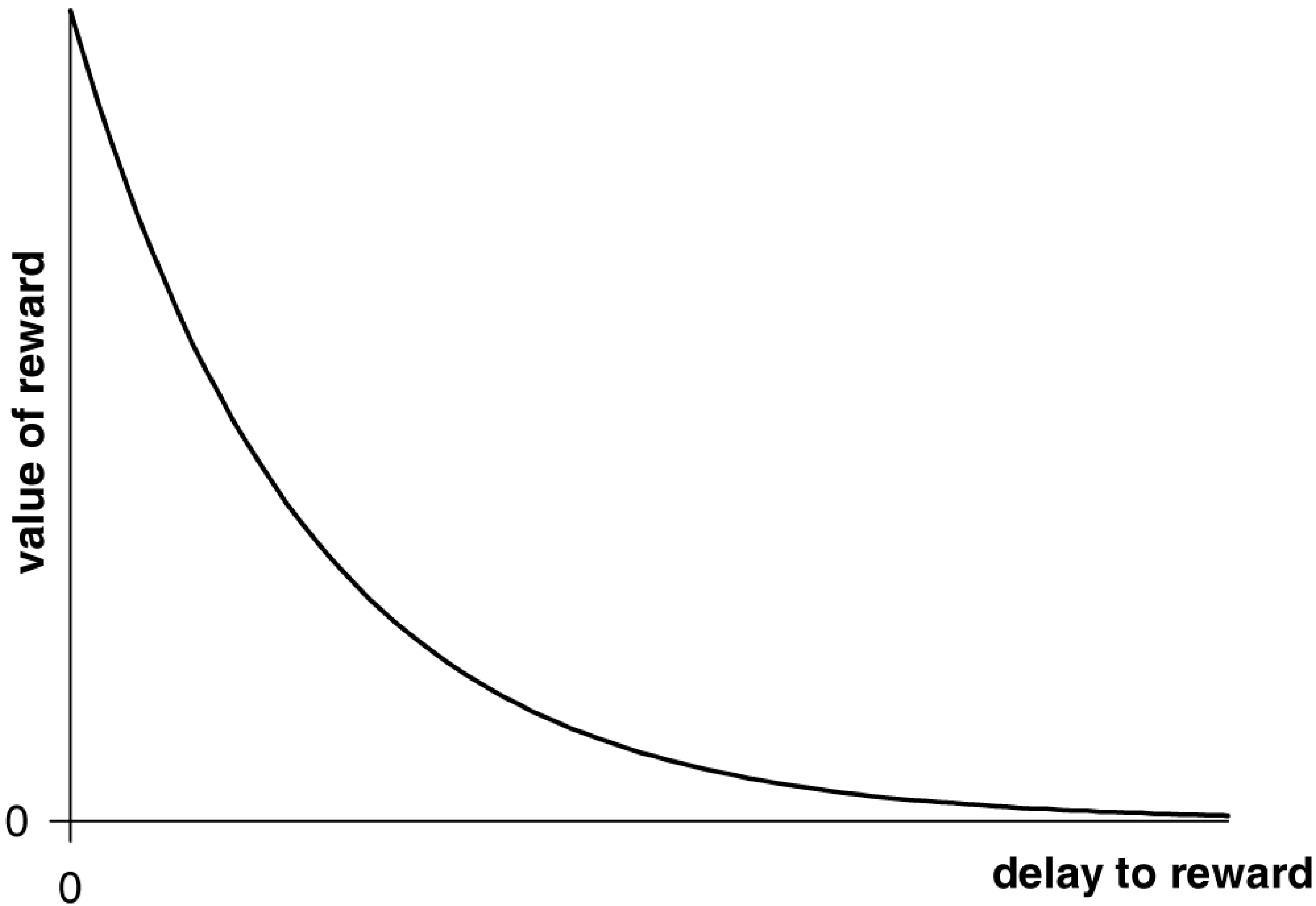
Table 6. *Lethality judgments with different response modes, geometric means*

	Death rate per 100,000 afflicted				
Malady	Estimated lethality rate	Estimated number that died	Estimated survival rate	Estimated number that survived	Actual lethality rate
Influenza	393	6	26	511	1
Mumps	44	114	19	4	12
Asthma	155	12	14	599	33
Venereal disease	91	63	8	111	50
High blood pressure	535	89	17	538	76
Bronchitis	162	19	43	2,111	85
Pregnancy	67	24	13	787	250
Diabetes	487	101	52	5,666	800
Tuberculosis	852	1,783	188	8,520	1,535
Automobile accidents	6,195	3,272	31	6,813	2,500
Strokes	11,011	4,648	181	24,758	11,765
Heart attacks	13,011	3,666	131	27,477	16,250
Cancer	10,889	10,475	160	21,749	37,500

Note: The four experimental groups were given the following instructions:
(a) Estimate lethality rate: For each 100,000 people afflicted, how many die?
(b) Estimate number died: *X* people were afflicted, how many died?
(c) Estimate survival rate: For each person who died, how many were afflicted but survived?
(d) Estimate number survived: *Y* people died, how many were afflicted but did not die?
Responses to questions (b), (c), and (d) were converted to deaths per 100,000 afflicted to facilitate comparisons.
Source: Fischhoff & MacGregor, 1980.

Impulsivity and self-control

Temporal discounting: devaluing the future



Smaller-sooner and larger-later rewards

Would you rather have £20 now, or £40 next year? We can call it *impulsive* to choose the smaller-sooner reward, and *self-controlled* to choose the larger-later reward. Three guesses about why people are impulsive (Ainslie, 1975):

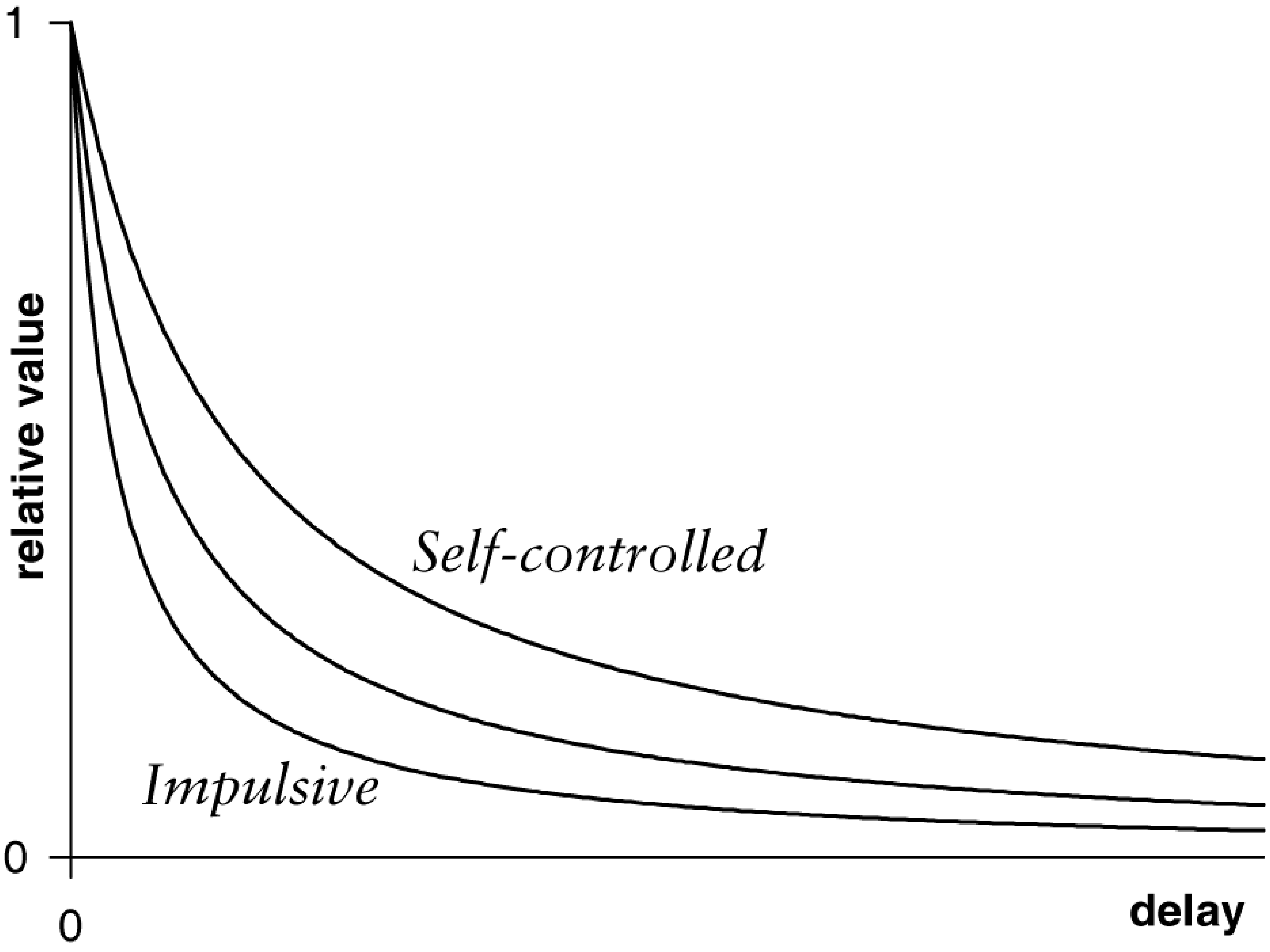
- They lack insight into the consequences of their actions

- They are aware of the consequences of their actions, but are unable to suppress some lower principle ("the devil, repetition compulsion, classical conditioning")

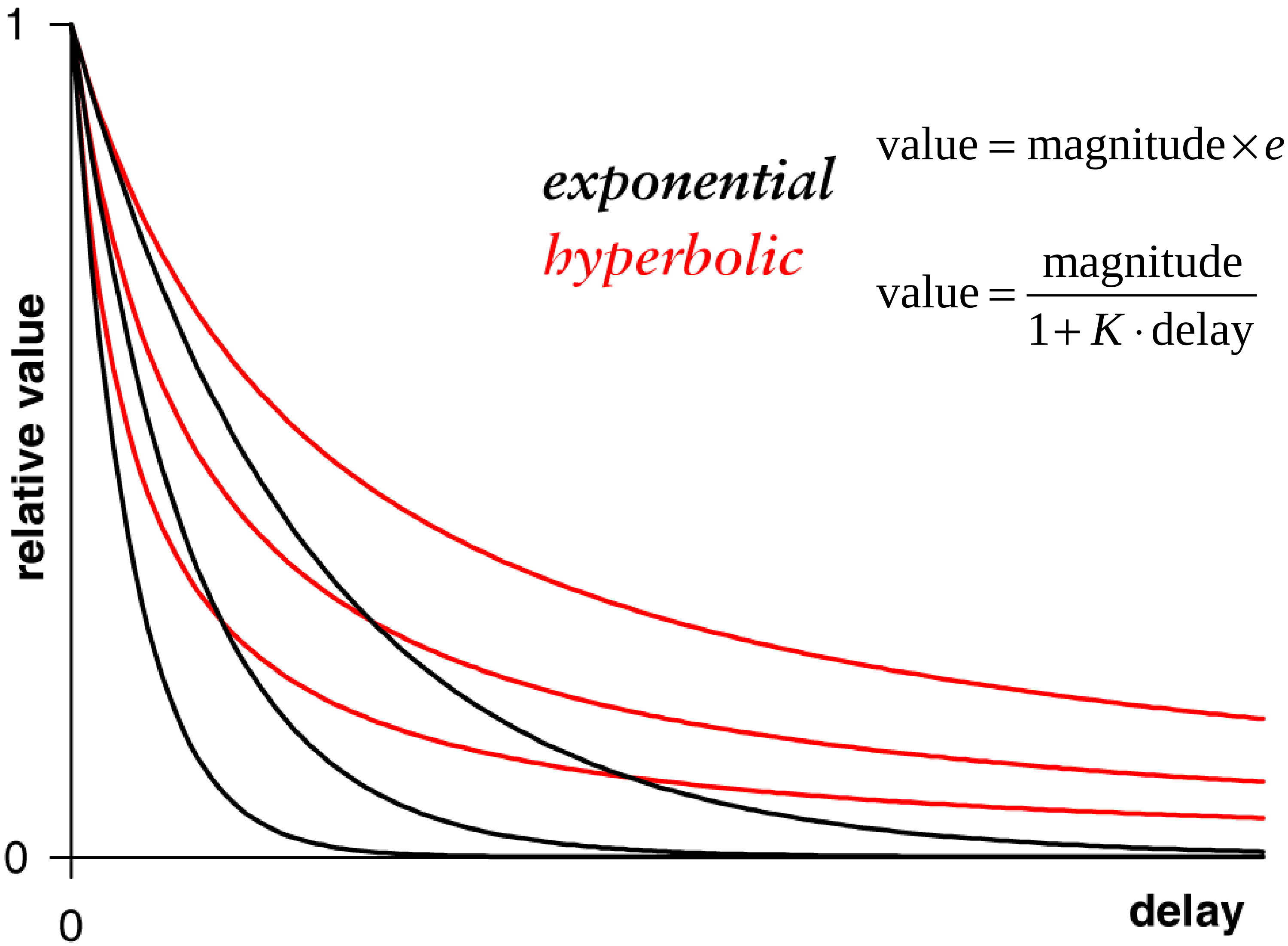
- They are aware of the consequences of their actions, and choose rationally according to their value system, but their values are distorted so that imminent consequences have a greater weight than remote ones — reduced value of delayed reinforcement.

Ainslie (1975)

Impulsive and self-controlled individuals discount differently



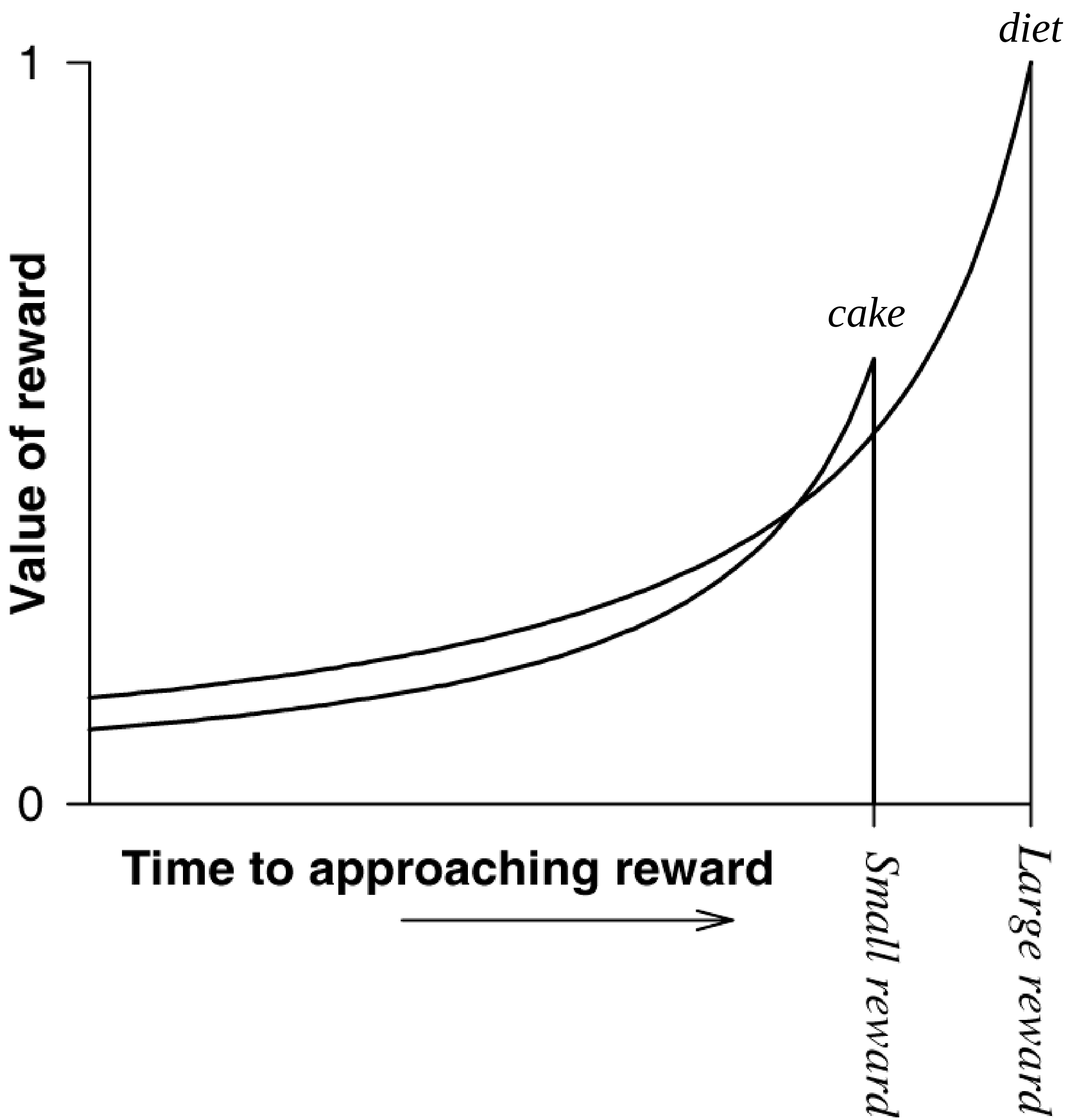
Hyperbolic temporal discounting



$$\text{value} = \text{magnitude} \times e^{-K \cdot \text{delay}}$$

$$\text{value} = \frac{\text{magnitude}}{1 + K \cdot \text{delay}}$$

Choosing future rewards: preference reversal



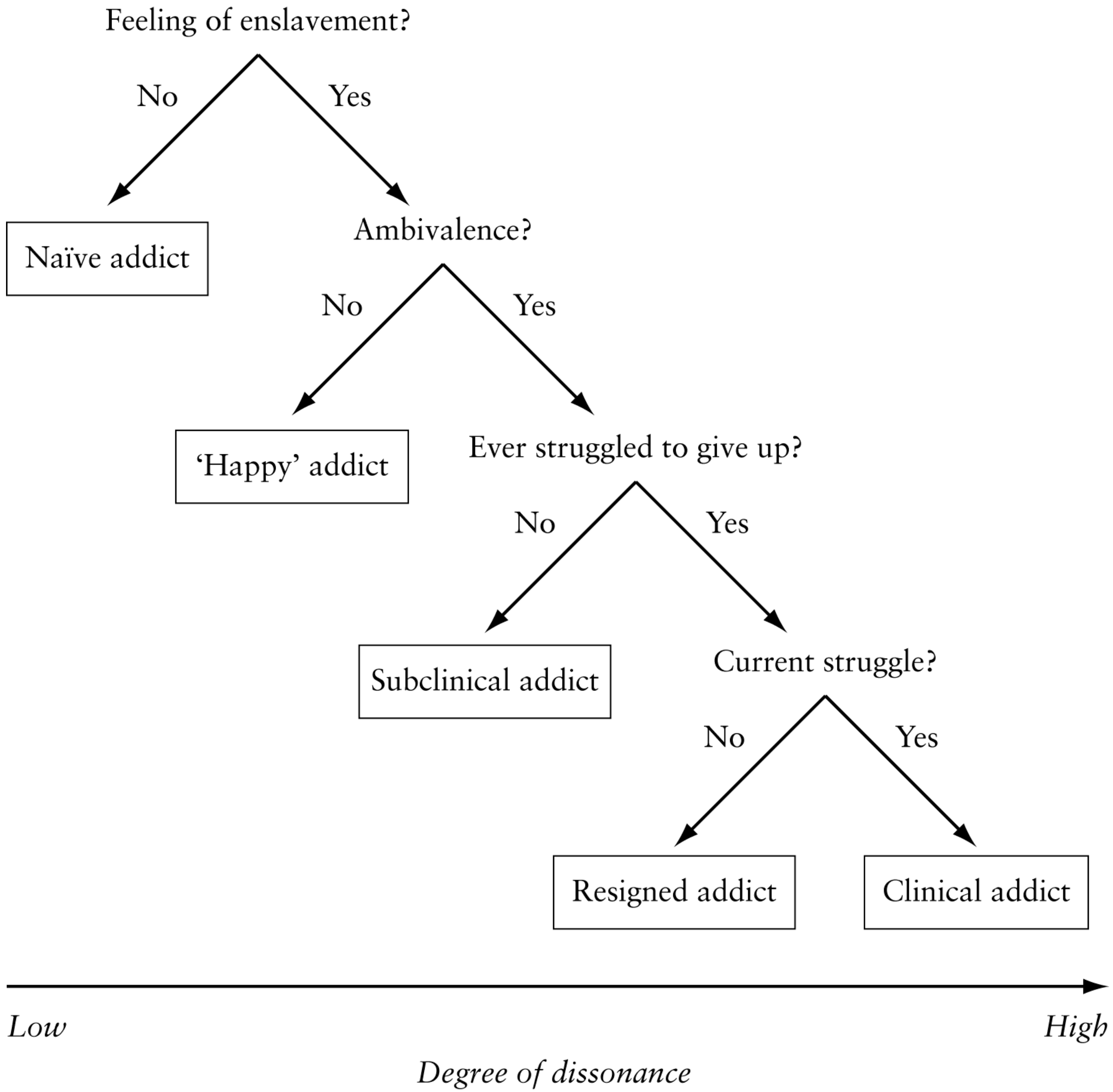
Ainslie (1975)

Pre-commitment as a means of self-control

Homer (1700 BC?) *Odyssey*; Waterhouse (1891) *Ulysses and the Sirens*

Addiction: abnormal motivation?

Involuntary or inconsistent? Different types of addict?



Skog (2003)

Drugs aren't all irresistible: casual use and 'chipping'

Addiction is not all-or-nothing.

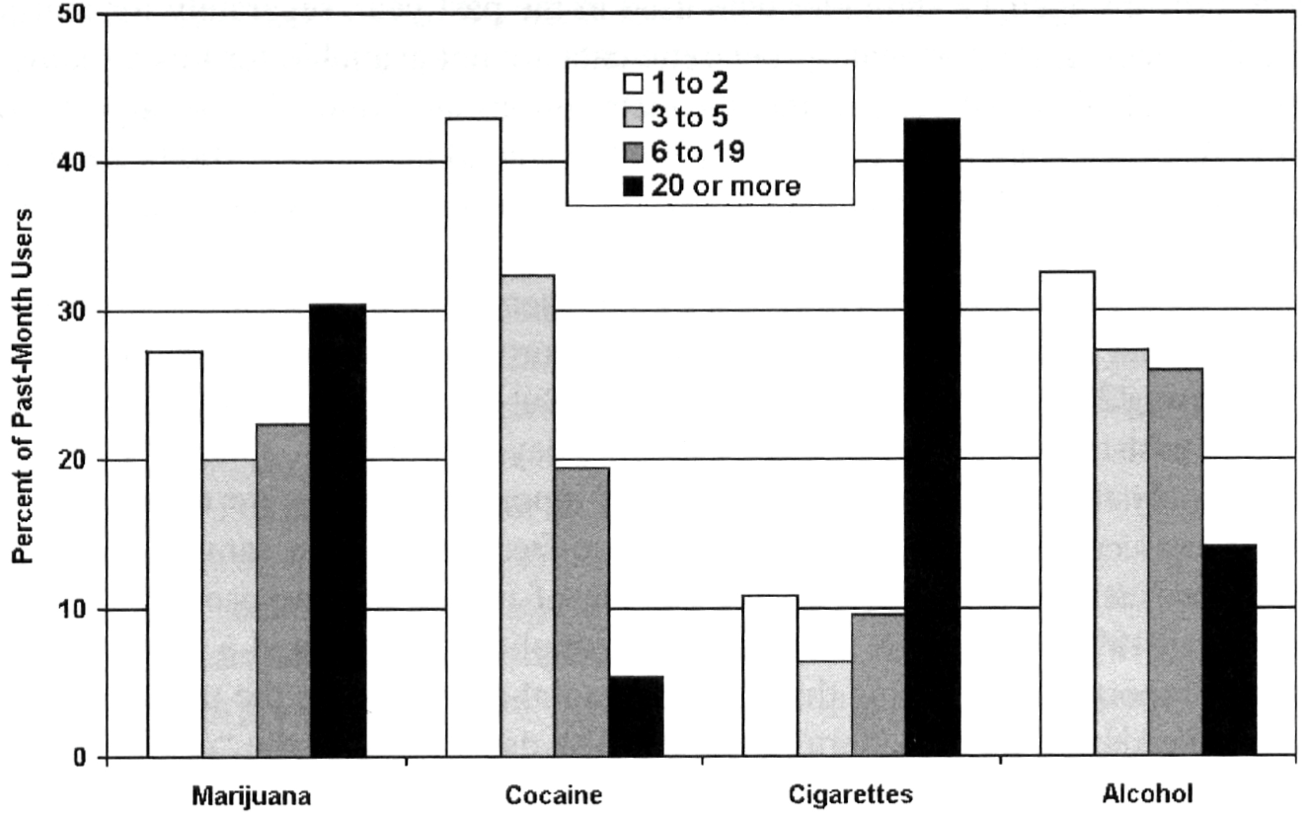


Figure 2: Days of use in past month.

Most (>75%) of those dependent on an illicit drug recover.

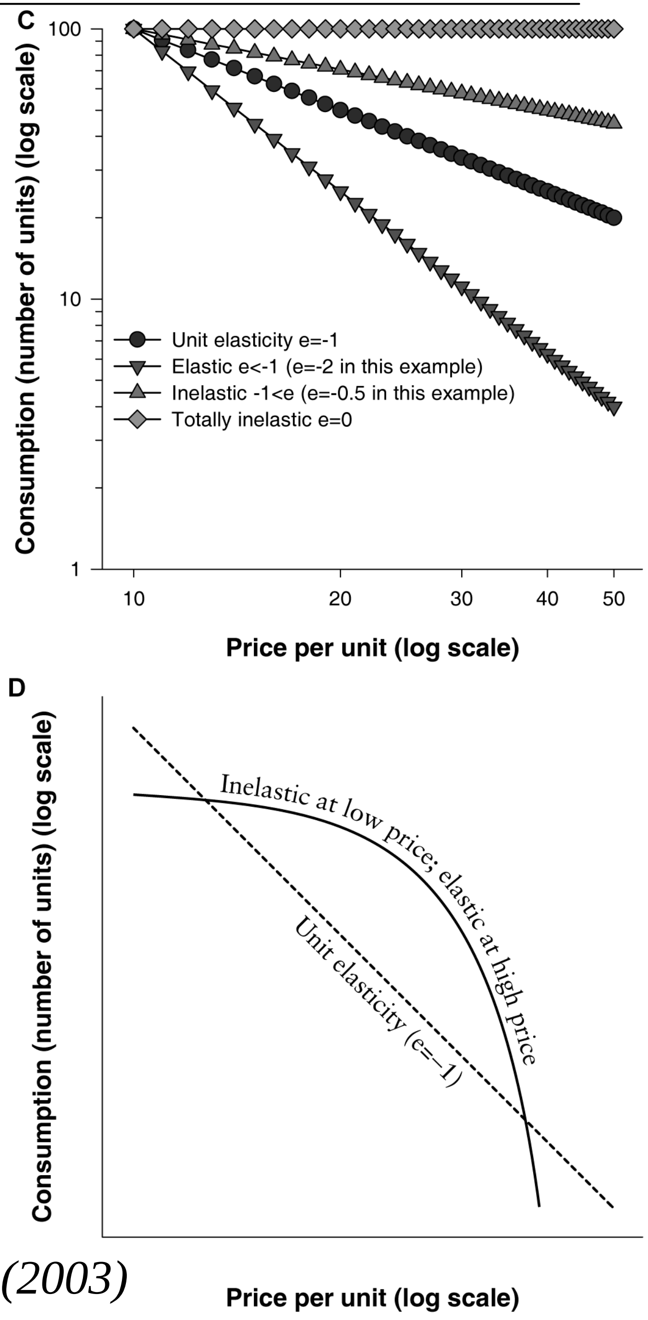
MacCoun (2003); NHSDA (2000); Heyman (2003, p.100); Warner et al. (1995)

Is addiction inelastic demand?

The more you're addicted, the more you will sacrifice other things (money, work, socializing) rather than sacrifice the drug.

Demand for drugs **can** be inelastic (e.g. cigarettes: about –0.4), and more inelastic than the demand for food. But drug demand elasticity isn't usually 0 — demand isn't totally inelastic.

And both vary: if you're hungrier, your demand for food becomes more inelastic. If smokers haven't smoked for a while, their demand is more inelastic. And drug elasticity varies with price, as is normal.



Heyman et al. (1999); Madden & Bickel (1999) Chaloupka et al. (2003)

Rational addiction?

‘[T]he addict looks strange because he sits down… surveys future income, production technologies, investment/addiction functions, and consumption preferences over his lifetime… maximizes the discounted value of his expected utility, and decides to be an alcoholic. That’s the way he will get the greatest satisfaction out of life. Alcoholics are alcoholics because they want to be alcoholics, *ex ante*, with full knowledge of [the] consequences.’

And we know that people’s preferences are **not** consistent over time, which is irrational in that it does not maximize their obtainable reward.

Becker & Murphy (1988); Winston (1980); Ainslie & Monterosso (2003)

A bottom-up view: drugs change the brain

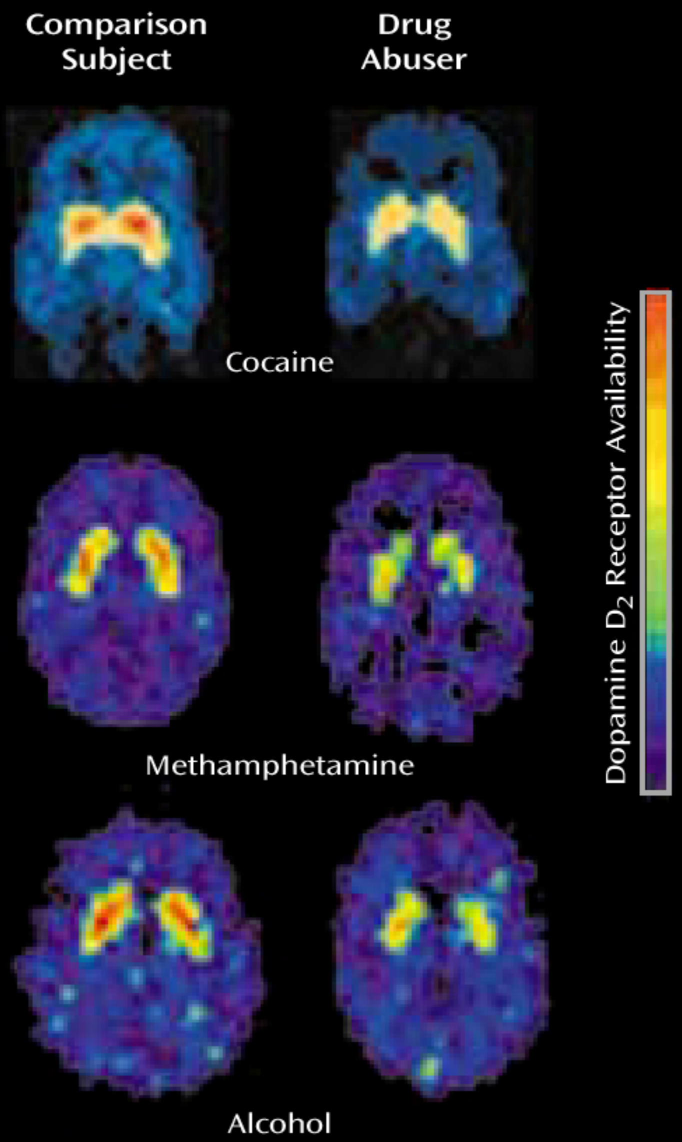
Drugs might

• act in the same way as natural reinforcers (perhaps more potently, or sometimes with less satiation)

• alter the balance of processes contributing to action (e.g. create habits quickly, superseding goal-directed action; enhance effect of conditioned stimuli; etc.)

• alter decision-making (acutely and / or chronically)

• create new motivational states



Goldstein & Volkow (2002) Striatal dopamine D2 receptors

An example of a new motivational state: opiate withdrawal

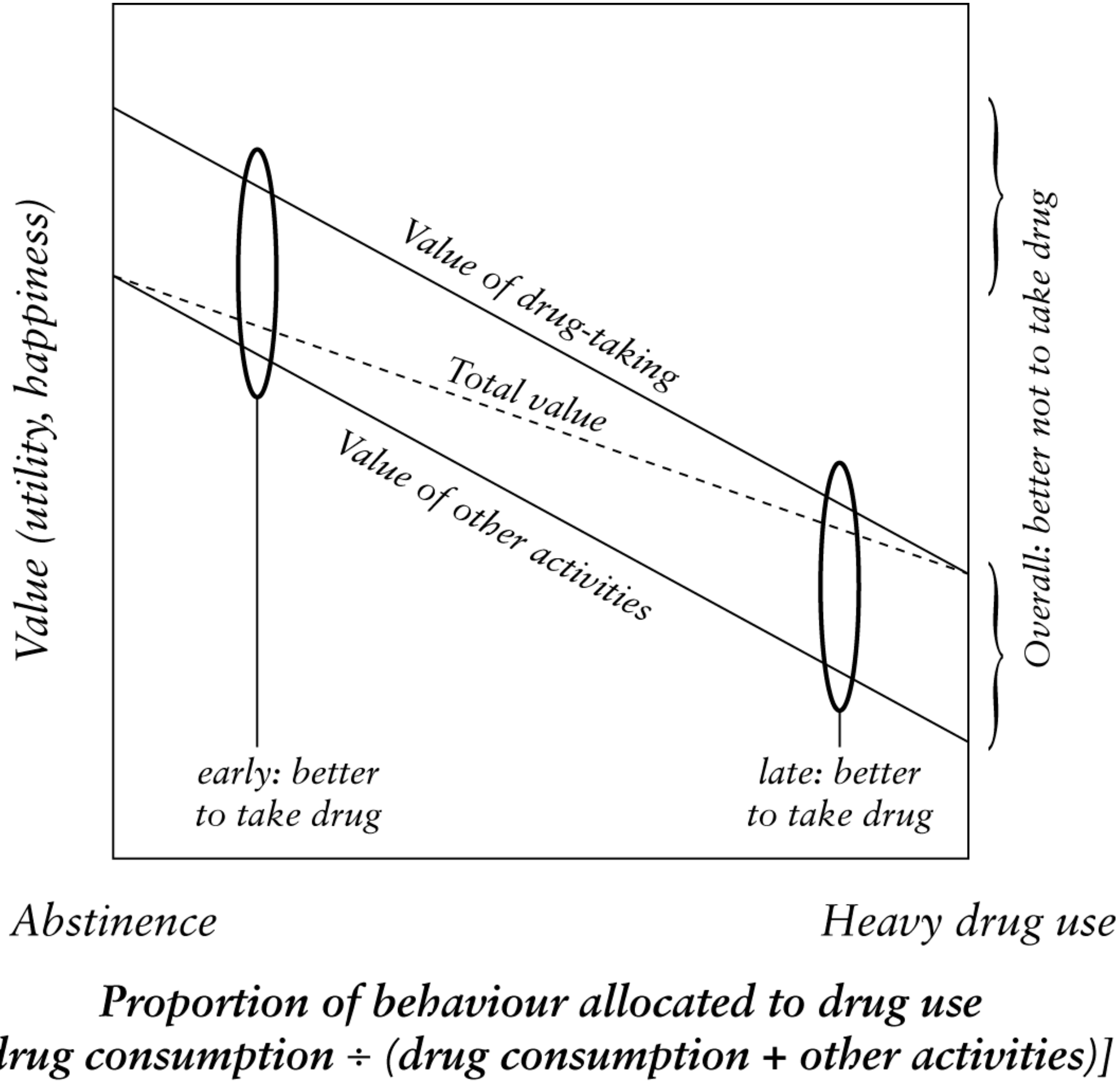
Opiate withdrawal is highly unpleasant.
Opiates may be taken to alleviate withdrawal.
Withdrawal enhances the value of opiates.

The ‘primrose path’ to addiction

*Drugs can **reduce the value of future activities** — both drug-related and non-drug-related.*

‘The alcoholic does not choose to be an alcoholic. Instead he chooses to drink now, and now, and now, and now… Alcoholism emerges… without ever having been chosen.’

*The ‘primrose path’ exemplifies **short-termism.***



Hernnstein & Prelec (1992), Rachlin (1997, 2000)

Steeper temporal discounting: addicts' view of the future

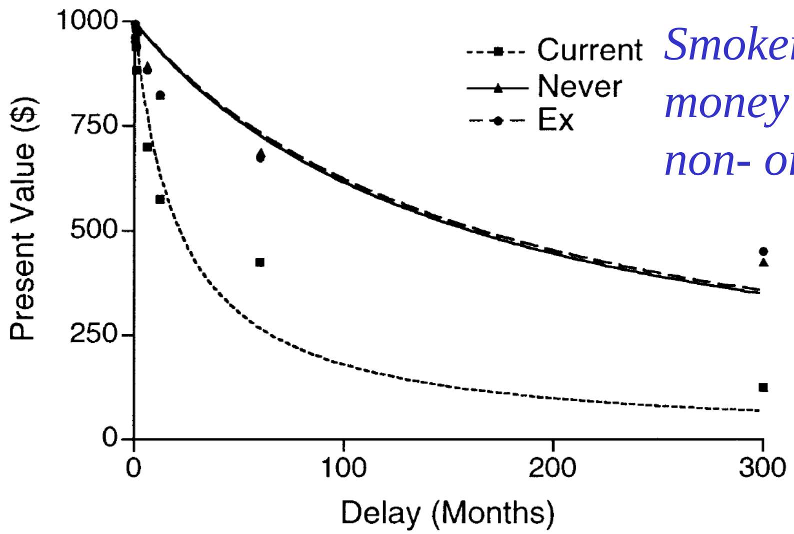
Heroin addicts and matched controls were asked to complete the following story:

"After awakening, Bill began to think about his future. In general, he expected to…"

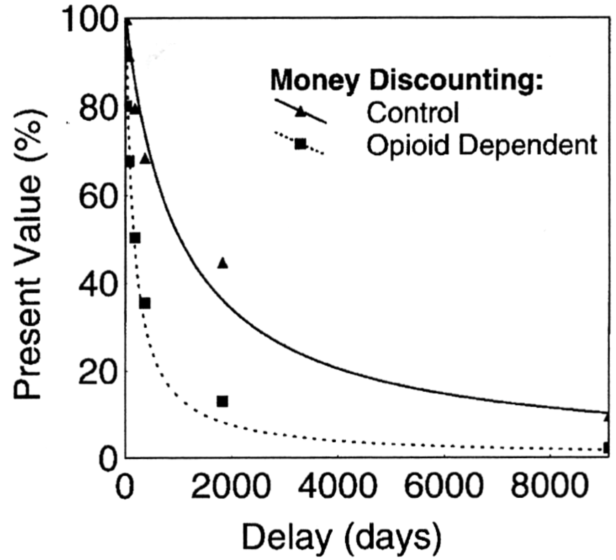
The content of the subjects' stories was not relevant — but their timescale was measured. On average, heroin addicts referred to a future of **9 days,** whereas controls referred to a future of **4.7 years.**

Petry et al. (1998); Bickel & Johnson (2003)

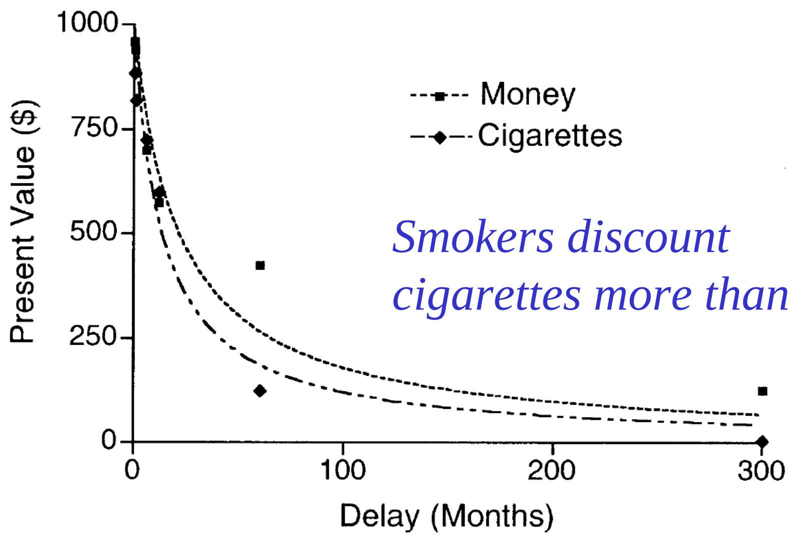
Steeper temporal discounting in addicts



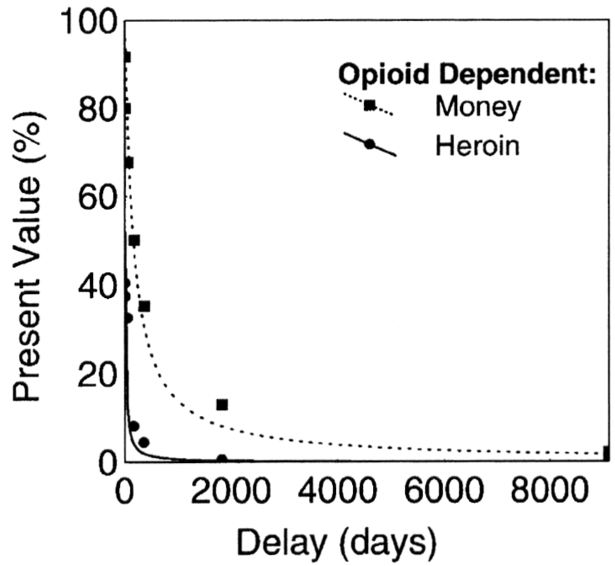
Smokers discount money more than non- or ex-smokers



Similarly for heroin addicts



Smokers discount cigarettes more than money



Bickel et al. (1999), smokers; Madden et al. (1999), heroin addicts

Treating addiction

Highly controversial!

Don’t search for ‘a cure’ for addiction?

Addiction is not all-or-nothing.

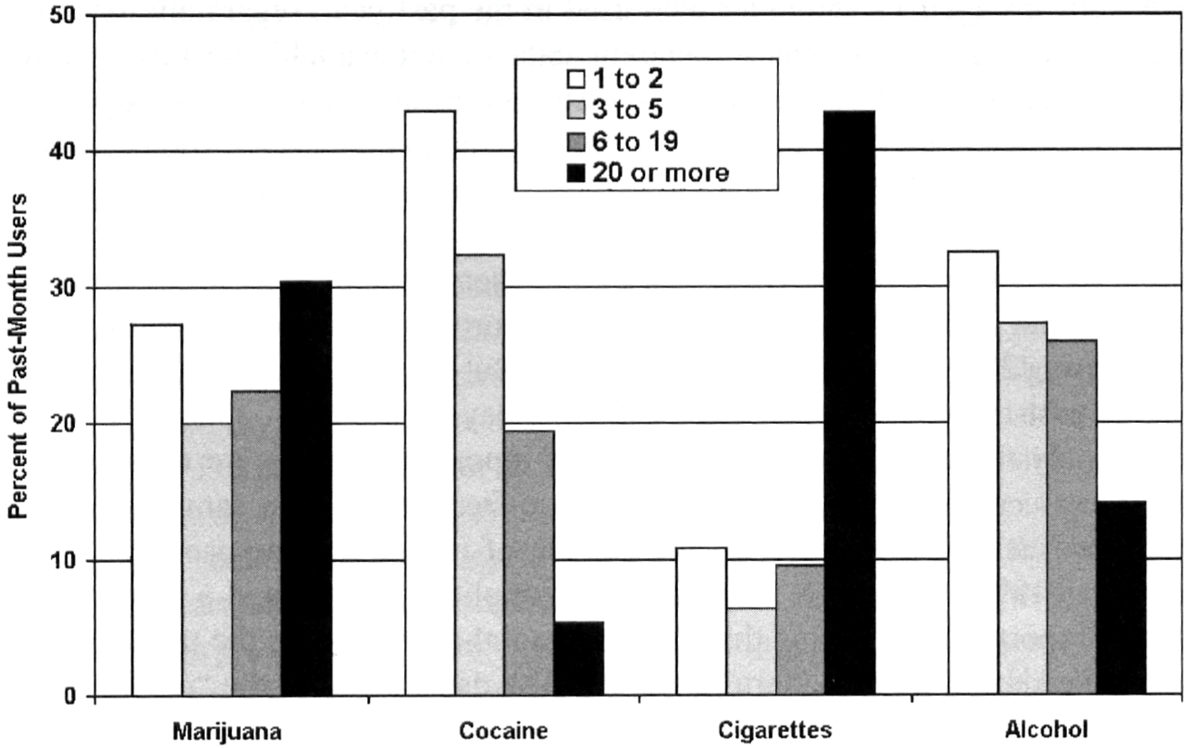


Figure 2: Days of use in past month.

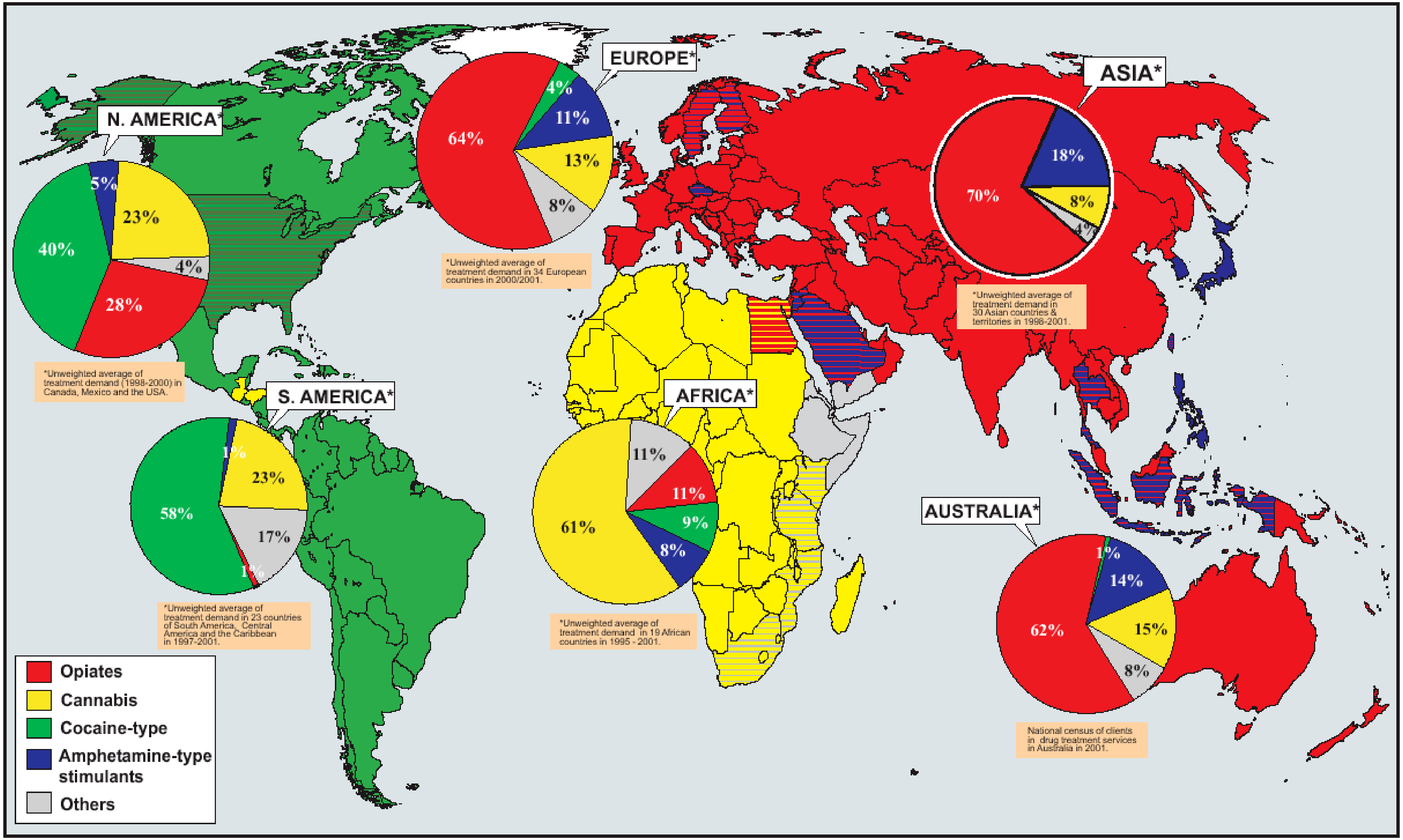
Total harm reduction? e.g.

$$\text{total harm} = \text{average harm / use} \times \text{number of users} \times \text{average amount used}$$

MacCoun (2003)

Illicit drugs around the world

Main problem drugs (as reflected in treatment demand) in the late 1990s (updated in 2003)



Sources: UNODC, Annual Reports Questionnaire Data/DELTA and National Government Reports.

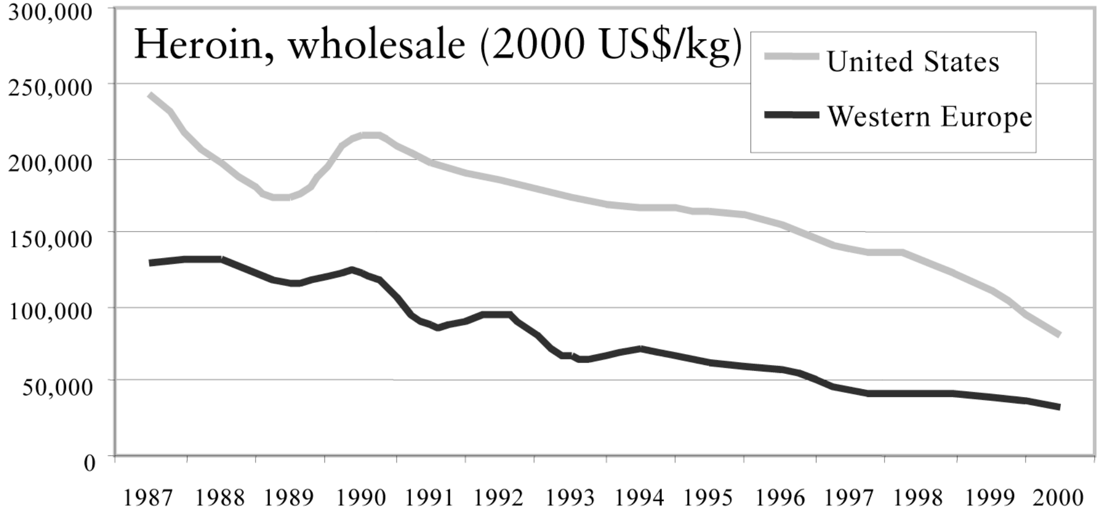
UN (2003)

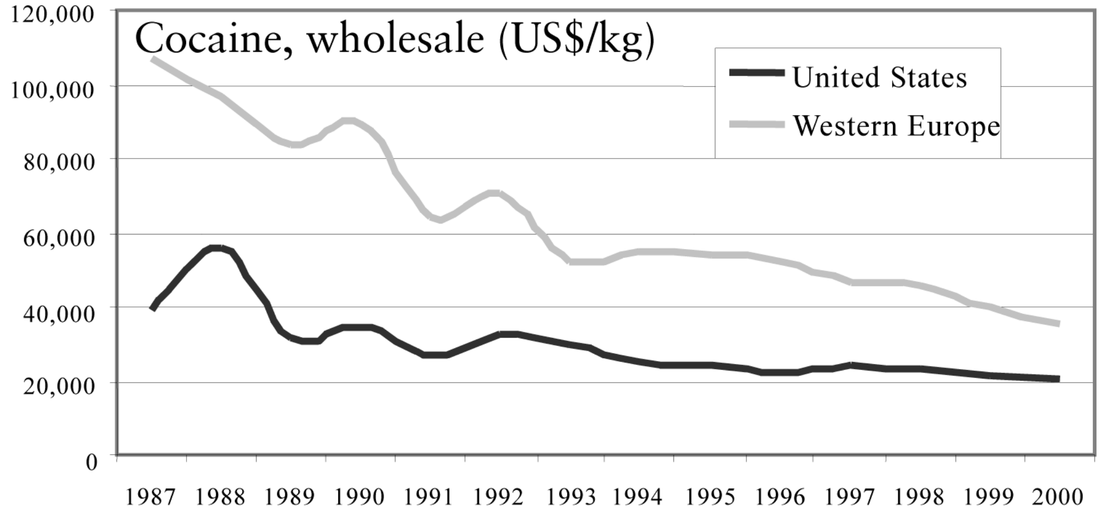
Money, money, money… The price of illicit drugs

US drug budget: >$19 billion
UK: £1 billion (£380m policing, £400m treatment)

World-wide illegal drug trade: ~£400 billion (same as global trade in oil and gas)

Heroin costs ~£1 / g to make, £12–£40 / g to the NHS, and £67–£300 / g on the street (impure!). Addicts spend up to ~£50 / day.

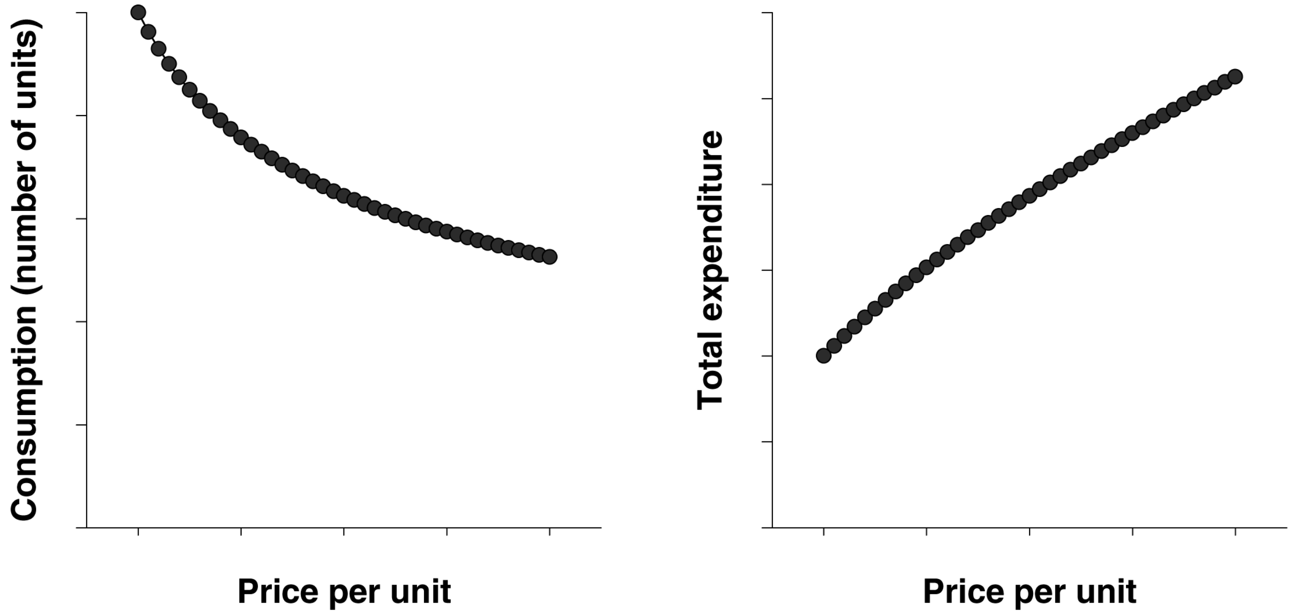




USA (2002); UK (2000); Shaw (2000); UN (2001); McCollister & French (2003)

If price goes up: consume less, spend more (inelastic demand)

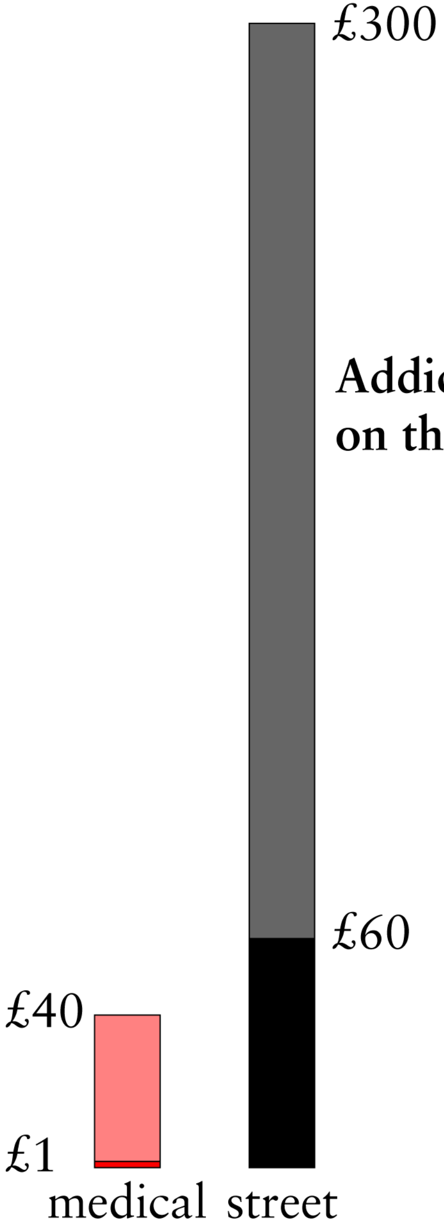
Criminalization is intended to increase price, reduce use.
Works, partly: price *is* much higher than it would otherwise be.
Likelihood of using cocaine: elasticity is about –0.4.



But high prices drive smuggling (big profits). UK intercepts ~20% of drugs. Substantial crime (dealer and addict). In the USA, treating addicts saves $2,000 / y in health costs and $42,000 / y in crime. In the UK, 30% of those arrested are dependent on an illegal drug.

Saffer & Chaloupka (1995); McCollister & French (2003); Shaw (2000)

What would legalization do? — Scenario A (libertarian)

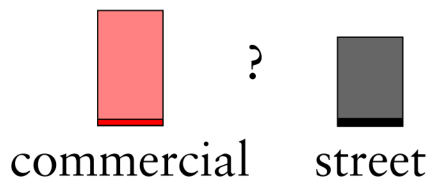


Current situation

Price example: heroin.
This scenario is speculative!

Addicts must buy
on the black market

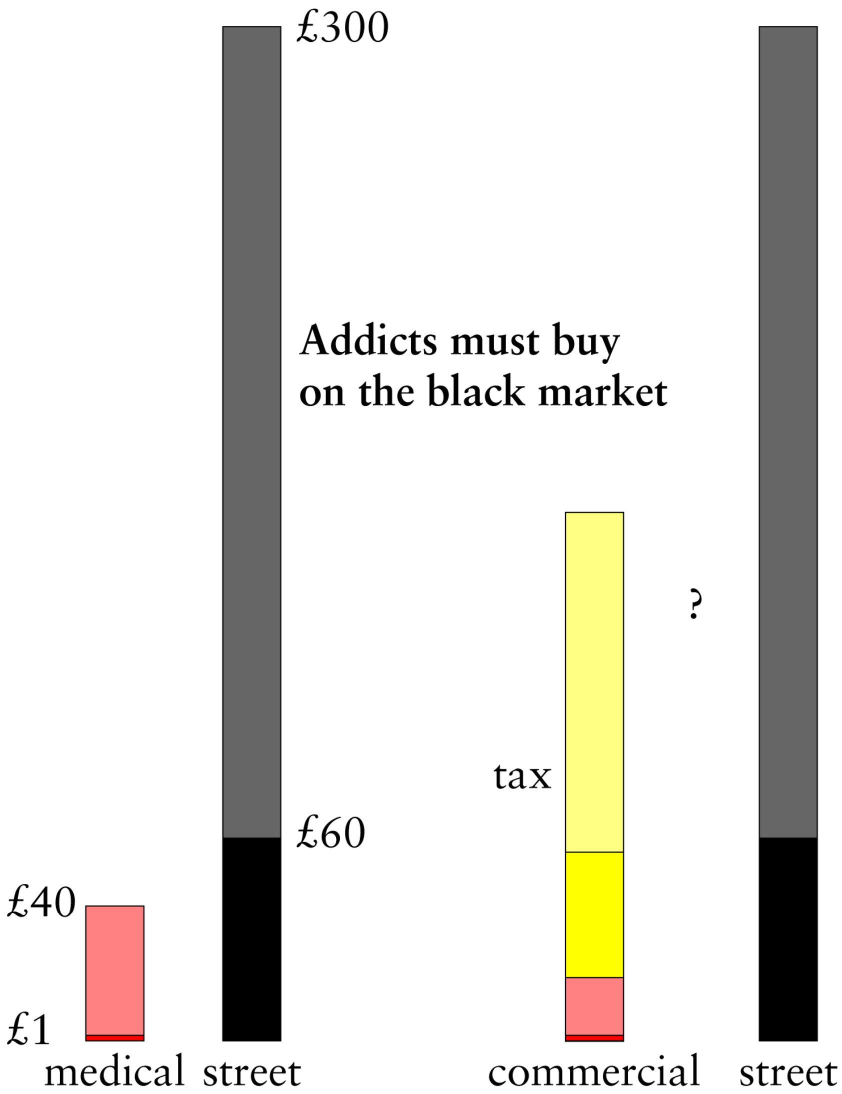
Addicts can choose their source.
Commercial products compete with each other.
Commercial price falls.
Black market price falls (legal: no risk any more).
The black market must price lower than companies.
Black market revenue dwindles.
(When did you last buy coffee on the black market?)
Total consumption increases.



Scenario A: full legalization

What would legalization do? — Scenario B (the taxman cometh)

Price example: heroin.
This scenario is speculative!

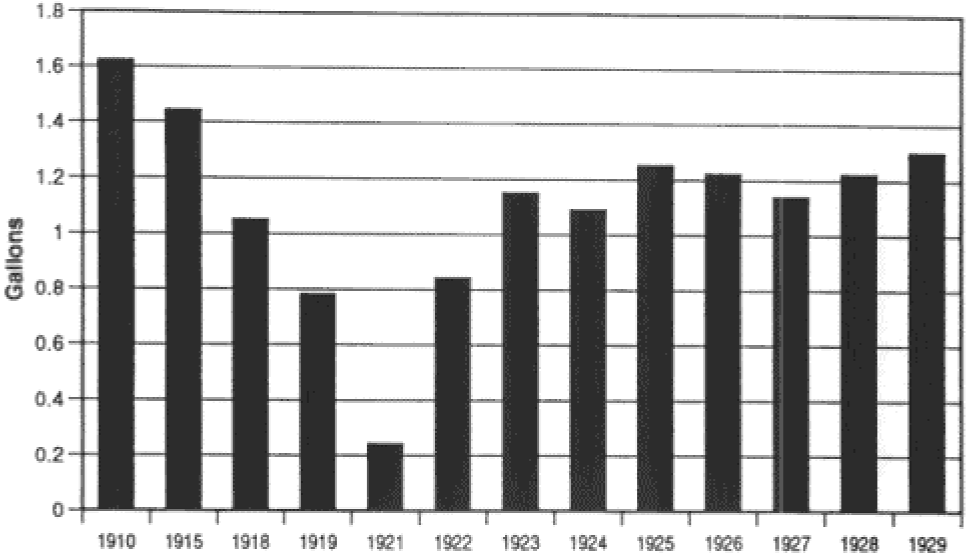


Current situation **Scenario B: legalize (limited); tax**

Addicts can choose their source.
Commercial products compete with each other.
Black market price kept high by policing (illegal: risk).
Commercial product pure/easy to obtain.
Tax until just preferable to black market.
Black market revenue dwindles.
(When did you last buy alcohol on the black market?)
Crime diminishes? (Black market smaller; drug cheaper.)
Health costs of impure drugs drop.
Total consumption increases, but less than Scenario A.
Tax revenue can be spent as society chooses.

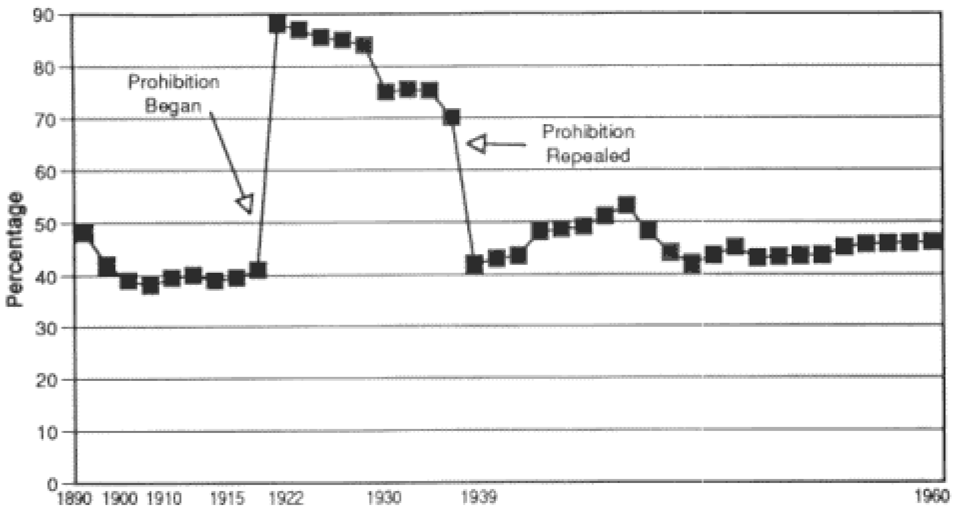
Criminalizing tobacco and cigarettes?

Consumption

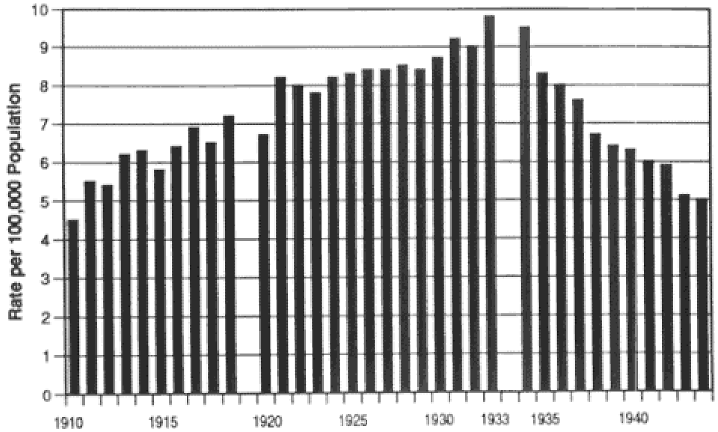


Prohibition (1920–1933)

Expenditure on spirits (% of total alcohol expenditure)



Homicide



Prohibition

Thornton (1991)

Taxing tobacco and cigarettes

Alcohol: annual cost to society ~£11 billion (of which ~£3 billion to NHS)? Tax revenue £11 billion.

Tobacco: health cost to NHS ~£1.5 billion. Tax revenue £9.5 billion. Total NHS spending £68 billion (2002–3).

Elasticity of demand for tobacco: –0.4. (When price goes up, some people quit and some smoke less.) Lab and real world. More elasticity at higher prices (and therefore for poorer people). Elasticity of demand for alcohol: –1.69 (wine) to –0.76 (beer).

Cross-price elasticity: cigarettes and alcohol are either complements or independent, so reducing the consumption of one doesn't promote consumption of the other.

UK (2003); Smith (1999); Parrott et al. (1998); Chaloupka et al. (2003); Gruber et al. (2002)

Treating individual addicts: why?

Price, price, price

Increasing price decreases consumption, and the converse. Price increases can be

- financial (e.g. tax)
- practical (availability, e.g. restrictions on alcohol sales)
- social (e.g. stigmatizing smokers)
- legal / social (e.g. workplace / restaurant smoking bans)

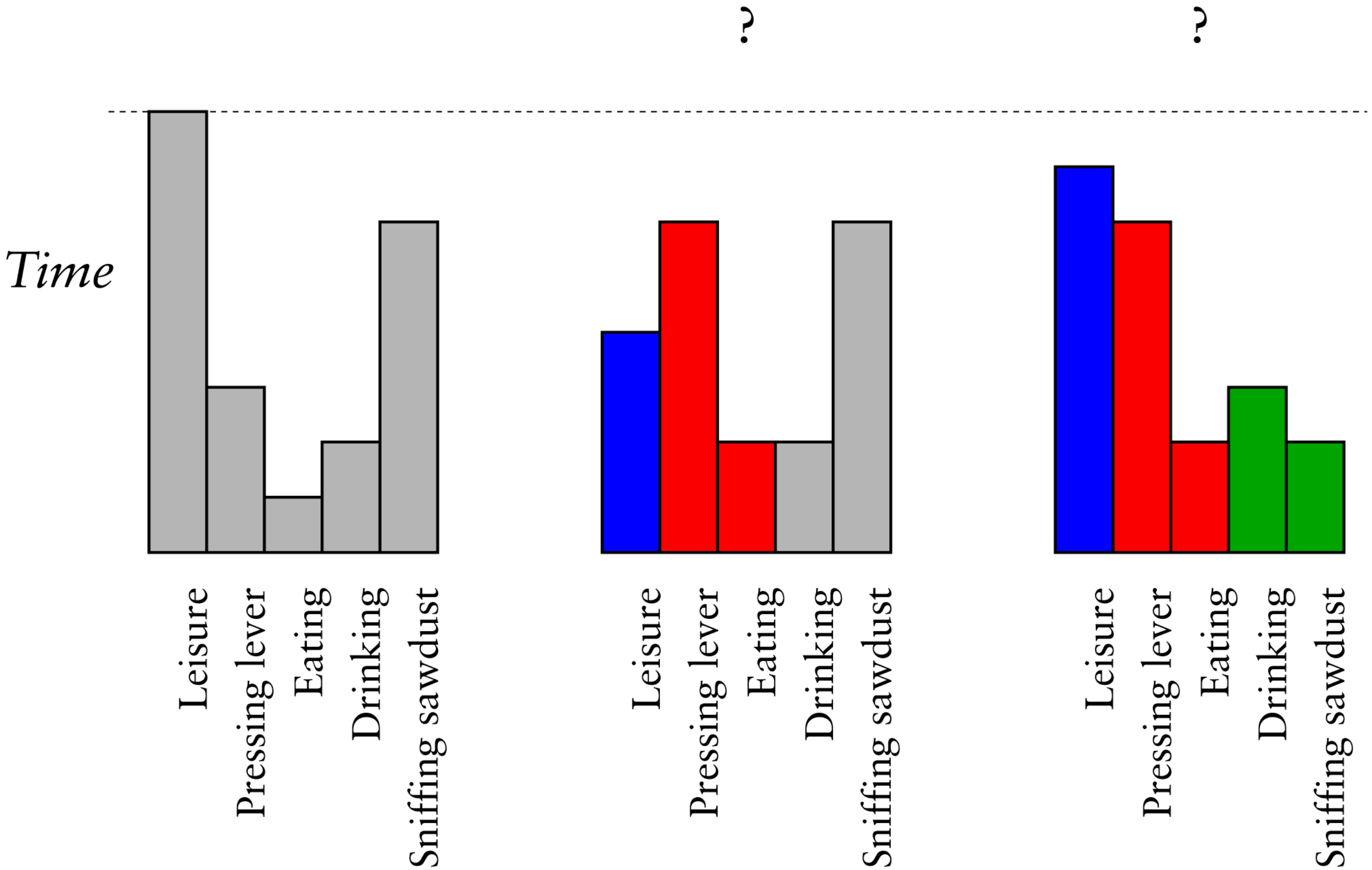
If price falls, consumption tends to increase.
Alcohol prices have fallen over the last few decades in real terms.

Increasing alcohol prices can

- reduce alcohol consumption
- reduce hepatic cirrhosis
- reduce deaths caused by drunk drivers
- reduce violent crime

Chaloupka et al. (2002, 2003); Keeler et al. (1993); Madden & Bickel (1999)

Providing alternatives: substitutability in the work of a lab rat



In order to eat more, the rat must press the lever. So it can trade leisure for lever-pressing. But how much leisure it ends up with also depends on the substitutability of food and leisure, the substitutability of leisure for drinking and sniffing, etc.

Providing alternatives to drugs

Focusing on *financial* costs of (e.g.) cigarettes means you focus on substituting *things that you can buy with money* for cigarettes.

But you can’t buy social support with the money you save by not smoking.

- Making it easier to obtain substitutes for drugs helps addicts quit, just like making drugs harder to obtain.
- Rewarding abstinence directly (with money or other rewards) also promotes abstinence.

- Self-control techniques such as precommitment also help addicts to quit.

Rachlin (2003); McCollister & French (2003); Green & Fisher (2000); Heyman (2003); Ainslie (2001)

Reducing the value of drugs directly

Pharmacologically reducing the value of drugs

- methadone (opiates)
- nicotine patches (tobacco)
- disulfiram (alcohol)
- vaccination (cocaine)

… or perhaps reducing the craving for drugs

- dopamine D3 antagonists

For the addict, all can be seen as self-control strategies — taking one drug now to avoid taking another drug later!

And better knowledge of the risks…

Using reasoning biases to inform about risk

Summary

- We saw last time that motivated behaviour can be examined at a low level (e.g. goal-directed action + habits + Pavlovian conditioned motivation).
- But motivated behaviour is subject to economic influences, and can also be analysed in economic terms.
- This allows prediction of behaviour, to some extent.
- Humans are not completely rational (a good thing in some situations?). They deviate from rationality in specific ways, some of which are well defined.
- Hyperbolic discounting of future rewards is irrational; it leads to preferences that are inconsistent over time, and impulsivity.
- These concepts can be used to understand and to treat problems such as addiction, both in society as a whole and for individual addicts.