decision making

What is decision making?

- We collect and evaluate information to make a single choice or a decision
- Decisions are usually made under conditions of uncertainty: we are never 100% sure of the consequences
  - If possible consequences are unpleasant, then the decision involves risk
- Decisions can be one-time decisions vs. evolving decisions
  - Differences in time pressure
- Expertise and familiarity with the problem

Expertise in decision making

- Most decisions in everyday life are made under complex conditions, often with time pressure → naturalistic decision making
- Reliance on expert knowledge plays a much larger role in natural settings than in most laboratory studies of decision making
  - In most high-stakes tasks, we rely on experts (rather than novices) to make decisions: medical diagnoses, criminal trials, industrial disasters, etc.
  - Experience enables decision-makers to identify reasonable courses of action based on previous experience, large amounts of domain-specific knowledge, and the ability to mentally visualize possible decision outcomes

Training expertise in decision making

Klein, G. (1997). Developing expertise in decision making. *Thinking & Reasoning, 3*(4), 337-352,

- Should we be teaching people to *think* like experts, or to *learn* like experts?
- Experts can recognize patterns, make fine perceptual discriminations (use minute details a “regular” person wouldn’t even notice), recognize anomalies, evaluate courses of action by predicting and simulating future and past states…
  - We can teach those skills in a specific domain
  - But this way we sacrifice flexibility and adaptability to dynamic situations
  - So overall, maybe training specific skills is not the best approach to training expertise
- Alternative plan: identify strategies used by experts to develop their proficiency, and teach people to become reflective practitioners!
  - For example: engage in deliberate practice, explore alternative task strategies, compile extensive experience, obtain critical and constructive feedback, update mental models…

Classes of decision-making research

- Rational or normative decision making: how people *should* make decisions according to some optimal framework
  - research focuses on the violations of that optimal framework and departures of human decision making from optimal prescriptions
- Cognitive or information processing approach: how people *actually* make decisions based on cognitive and situational factors
  - biases and processes that reflect limitations in human attention, working memory, strategy choice, common decision routines (known as heuristics), etc.
  - naturalistic decision-making: how people (usually experts) make decisions in real environments (outside of the laboratory)

What is a good decision?

- Expected value: compare my prediction with the actual outcome
- Hindsight bias (knew-it-all-along): tendency to believe that outcomes have been more predictable than they actually were
- Expertise: experts in a field are known for “good” or exceptional performance
  - However, experts do not always make the best decisions, and they are not always better than novices

- From cognitive science’s perspective, it does not really make sense to talk about what is a good decision. It is more interesting to study *how* decisions are made and how they are influenced by the environment or available information.

Are we rational decision-makers?

Herbert Simon (1957). Models of Man, New York: John Wiley.
Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science, 185*(4157), 1124–1131.

- We are not! But we'd like to think that we are
  - Expected utility and value theories
- Herbert Simon (1957): bounded rationality
  - We select decisions that are satisfactory rather than optimal: good enough given the constraints
- Heuristics and biases (e.g., Tversky&Kahneman, 1974)
- Emotional influences
- Social pressure
- Choice framing

Individual differences, among others…

- …cognitive abilities such numeracy, spatial skill, or reading comprehension levels; workload and working memory capacity; neurological damage, disability and neurodivergence; age; gender; need for cognition and speed of learning new skills; predictions and estimates of one's abilities; meta-cognition

- Situational factors such as current affective states; stress; expertise; motivation

- And even willingness to try new things; openness to experience; individual aversions such as fear of robots or technology

article spotlight: satisficing

Iyengar, S.S., Wells, E.R., & Schartz, B. (2006). Doing better but feeling worse: Looking for the “best” job undermines satisfaction. *Psychological Science, 17*(2), 143-150.

Article spotlight: satisficing

- Satisficing: just “good enough” heuristic (from Herbert Simon)
  - Satisficers make a decision not by evaluating all available choices, but by settling on the first satisfactory option
  - Maximizers explore all possible options to make the most optimal decision
- Maximizers vs. satisficers in real life
- Researchers followed graduating seniors from 11 colleges and universities
  - Four-year bachelor’s degree; 4th year students are called seniors
  - Academic year: September to May
  - Students usually begin their job search for post-graduation opportunities in the fall semester of their senior year → you want to start your new job as soon as possible after you graduate in May → job offers usually start coming in around February

Maximizers vs. Satisficers in real life

- Three time points:
  - T1: November of senior year: talk to career services and begin post-graduation job search
    - How many jobs are you applying to? How much are you relying on other people (friends, career services)? How terrified are you?
  - T2: February of senior year: in the process of completing applications and getting offers
    - How many interview offers did you receive? How much do you compare yourself to peers? How terrified are you?
  - T3: May of senior year: accepting offers
    - Do you wish you applied to more jobs? How frustrated are you? What offer did you accept?

Maximizers vs. Satisficers in real life

- Results:
  - Maximizing tendencies positively correlated with:
    - Increased option fixation: more focused on needing to apply to more, different, etc. jobs
    - Greater reliance on external influences: depended on friends, career services, etc.
    - Improved job market performance: received more interviews
    - More negative affective experiences: were more anxious and frustrated throughout the process

Maximizers vs. Satisficers in real life

- Results:
  - In November, maximizers anticipated applying for more jobs
    - At high-ranked universities: both maximizers and satisficers applied for a median of 30 jobs
    - At lower-ranked universities: maximizers applied for 20, and satisficers applied for 10
  - In February, maximizers fantasized more about jobs they were not pursuing
  - In May, maximizers reported that they wished they had pursued more options

Maximizers vs. Satisficers in real life

- Even more results!
  - Mean salary for job accepted:
    - Maximizers: $44,515
    - Satisficers: $37,085
    - Difference of $619/month before taxes
- But: satisfaction?
  - Maximizers reported being consistently more stressed, frustrated, and less satisfied with their job offers
- Maximizers do better, but feel worse
- Why?

Maximizers vs. satisficers in real life

- Maybe maximizers are less satisfied than satisficers and experience greater negative affect with the jobs they get because their pursuit for the elusive “best” leads them to consider a large number of possibilities
  - Therefore, high potential for regret or anticipated regret
  - High potential for unrealistically high expectation
  - Mounting opportunity costs
- Psychologists and economists assume that having a choice is beneficial, because it allows decision makers more opportunities for preference matching, and more generally enables utility maximization
  - But this study is part of a growing body of literature showing that decision makers’ appraisal of outcomes may have much more to do with their social values, mispredicted expectations, and affect experienced during the decision-making process itself
  - Maximizers therefore underestimate the affective cost of a process that involves evaluating as many options as possible and fixating on the choices that may be nonexistent
  - Maximizers also overestimate benefits that result from pursuing the best objective outcome
- If the subjective well-being of the decision maker and the objective value of the decision outcome are at odds – which should be prioritized?

decision making

a few of the traps we fall into

Traps we fall into

- Meta-cognition: awareness of what you do know and don’t know
- Planning fallacy: things take longer than they take
- Overconfidence: you think you know more than you know
  - Or you think you have better, more accurate, and complete information than you actually do
  - Or you think you are better at doing something than you are

The illusion of objectivity

Armor, D. A. (1999). The illusion of objectivity: A bias in the perception of freedom from bias. Dissertation Abstracts International: Section B: The Sciences and Engineering, 59(9-B), 5163.
Good review on this: Pronin, E., Gilovich, T, & Ross, L. (2004). Objectivity in the eye of the beholder: divergent perceptions of bias in self versus others. *Psychological Review, 111*(3), 781-799.

- 12-item questionnaire: how objective are you, relative to others?

- directly - compared to an average student?
  - 90% of participants reported being more objective than a typical student
- indirectly – assess yourself and an average student on two independent questionnaires
  - 88% of participants evaluated themselves as more objective than an average student
- in person – assess yourself and a person sitting across the table from you
  - 67% of participants saw themselves as more objective

Confirmation bias

- Confirmation bias: we give more weight to evidence in favor of our argument
  - People with opposing views on the topic can see the same evidence and interpret it as in their favor
- Disconfirmation bias: we put way too much effort trying to debunk or refute arguments opposing our own

- Extreme example: Festinger's *When prophecy fails*
  - A sociological investigation into cognitive dissonance, but also a powerful example of confirmation bias and reactions to disconfirmation of belief

When prophecy fails

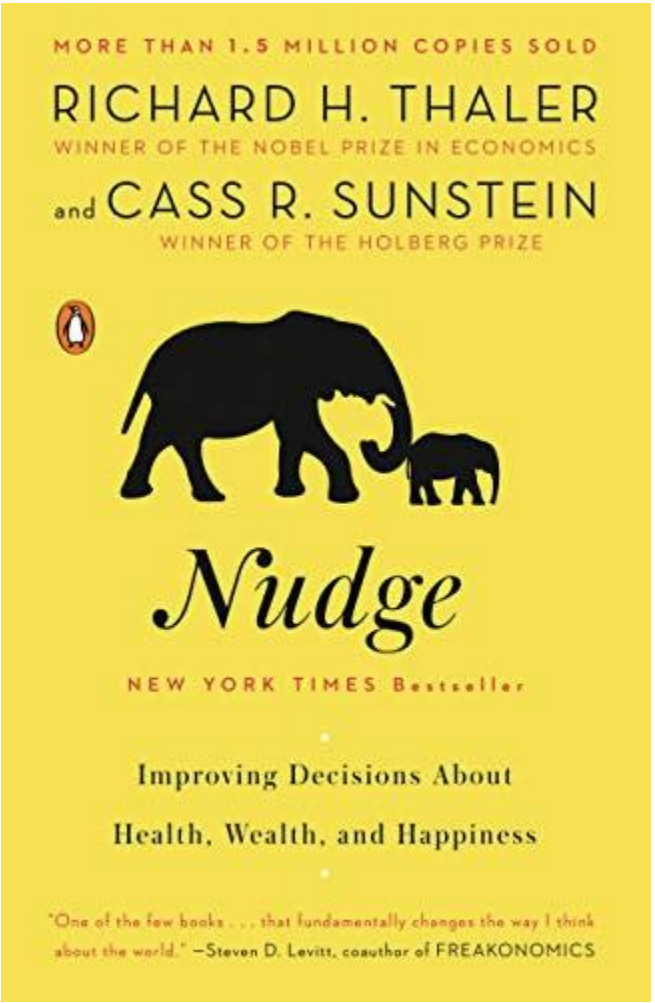
Festinger, L., Riecken, H. W., & Schachter, S. (1956). When prophecy fails. University of Minnesota Press. https://doi.org/10.1037/10030-000

- Dorothy Martin from Chicago received information from an extraterrestrial race Sanada from planet Clarion and formed a small cult called the Seekers
- The believers were to be spared from death as chosen ones
  - What do you do when you learn that the world is going to end? → You quit your job, sell your property, and expect to be rescued by aliens! But only after removing all the metal from your clothing (such as bras and zippers) so it doesn't damage the spacecraft.
- But the spaceship (obviously) did not come to their rescue
  - So… now what? How do you interpret the hard, nondisputable evidence against your belief? → cognitive dissonance
  - Enter confirmation bias: cult members believed that their devotion has spared them from the wrath of aliens → they strongly believed the prayed the end of the world away

Defining nudging

Thaler, R. H., & Sunstein, C. R. (2008). Nudge: Improving decisions about health, wealth, and happiness. Yale University Press.

- Thaler & Sunstein (2008, p. 6): "…any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives."



Nudging and health

Marteau, T. et al. (2011). Judging nudging: can nudging improve population health? BMJ, 342(7791), 263-265.

- Improving population health requires behavioral changes on the individual level
- Two classes of interventions:
  - Nudging: increase visibility of the smoke-free lifestyle through mass media campaigns, reduce cues for smoking by keeping cigarettes, lighters, and ashtrays out of sight
  - Regulating: increase price of cigarettes, ban smoking in public places

Two categories of nudges

Johnson, E. J., Shu, S. B., Dellaert, B. G., Fox, C., Goldstein, D. G., Häubl, G., ... & Wansink, B. (2012). Beyond nudges: Tools of a choice architecture. *Marketing Letters, 23*(2), 487-504

- Tools for structuring the choice task – what we present
- Tools used in describing the choice options – how we present it

- Consider this: there is no such thing as a neutral architecture. Any way a choice is presented influences what the decision-maker chooses. All choices have a (usually implicit) *default* – so even when no choice is made, we are still making a choice to preserve the status quo.
  - Nudging is when the architect makes an architecture that encourages certain (types of) choices
  - Nudging is therefore a special case of decision making and affordances

"The same factors that lead us to make a mindless suboptimal or unhealthy choice can often be reversed to help us make a mindless better choice."

Johnson, E. J., Shu, S. B., Dellaert, B. G., Fox, C., Goldstein, D. G., Häubl, G., ... & Wansink, B. (2012). Beyond nudges: Tools of a choice architecture. *Marketing Letters, 23*(2), 487-504.

Defaults

Dinner, I., Johnson, E. J., Goldstein, D. G., & Liu, K. (2011). Partitioning default effects: why people choose not to choose. *Journal of Experimental Psychology: Applied*, 17(4), 332.

- A default is a status quo option, or a “do nothing” option → if you make a decision to not make a decision, the outcome will be the default decision option
  - Example: the latte in a coffee shop is made with regular milk, and vegan milk needs to be specifically requested
- Default options are chosen more often than expected if the option was not labeled the default → same outcome might not be as frequently chosen if we need to actively choose it
- Choice architects should be mindful of ethical risks involved in setting defaults

Do defaults save lives?

Johnson, E. J., & Goldstein, D. G. (2003). Do defaults save lives? *Science*, 302, 1338-1339.

- Research question: why do people choose to become organ donors?

- Classical economic view: people have preferences with regard to organ donation, and people can make that decision themselves – so people who do not become organ donors simply find too little value in organ donation
  - Increasing organ donation requires changing attitudes
- Alternative view: preferences are constructed, and the default option for organ donation influences choices in three ways
  - Decision-makers might believe that defaults are suggestions by the policy-markers, therefore implying a recommended action
  - Making a decision involves effort, whereas accepting the default is effortless
  - Defaults often represent the existing status quo, so a change usually involves a trade-off

Do defaults save lives?

Johnson, E. J., & Goldstein, D. G. (2003). Do defaults save lives? *Science*, 302, 1338-1339.

- How can one become a potential organ donor?
  - Presumed consent strategy: people are organ donors unless they register not to be (opt-out policy)
  - Explicit consent strategy: people are not organ donors unless they register to be (opt-in policy)

Do defaults save lives?

Johnson, E. J., & Goldstein, D. G. (2003). Do defaults save lives? *Science*, 302, 1338-1339.

- Online experiment; 161 responders were asked whether they would like to be donors on the basis of one of three questions with varying defaults:

- Opt-in condition: assume you had just moved to a new state where the default was not to be an organ donor, and they were given a choice to confirm or change that status → 42% effectively consented
- Opt-out condition: same, but the default was to be a donor → 82% effectively consented
- Neutral condition: simply choose without a prior default → 79% effectively consented

Do defaults save lives?

Johnson, E. J., & Goldstein, D. G. (2003). Do defaults save lives? *Science*, 302, 1338-1339.

- Effective consent percentages in countries requiring *explicit consent:*
  - Denmark – 4.25%
  - Netherlands – 27.5%
  - UK – 17.17%
  - Germany – 12%
- Effective consent percentages in countries with presumed consent:
  - Austria – 99.98%
  - Belgium – 98%
  - France – 99.91%
  - Hungary – 99.97%
  - Poland – 99.5%
  - Portugal – 99.64%
  - Sweden – 85.9%

Self-nudging

- Some interventions are more effective when people do not know the underlying mechanism (or that there even is an intervention)
- But what if decision makers **do** want to encourage themselves to make a better choice, **and** they understand they just need a little push? → self nudging
  - Become your very own decision architect!
  - Self-nudging interventions could expand the scope of application to the private domain, typically inaccessible to public choice architects
  - Maybe even a more ethical/practical variant of nudging?

Individual differences: age

Johnson, E. J., Shu, S. B., Dellaert, B. G., Fox, C., Goldstein, D. G., Häubl, G., ... & Wansink, B. (2012). Beyond nudges: Tools of a choice architecture. *Marketing Letters, 23*(2), 487-504
Reed, A.E., Mikels, J.A., & Simon, K.I. (2008). Older adults prefer less choice than young adults. *Psychology and aging, 23*(3), 671-675.

- Number of alternatives: how many choice options should the decision maker have?
  - More options increase the chance of offering a preference match to the consumer
  - More options place a greater cognitive burden on consumers because of the additional need to evaluate the options

- 78-year-olds prefer 4-6 choices, whereas 20-year-olds prefer double that many!

rational decision making

Steps; Expected Value; Expected Utility

Rational Decision Making: steps

1. Identify all possible options (including doing nothing)
2. Quantify the value (or cost) of consequences which may arise if each course of action is adopted
3. Assess the likelihood of each consequence actually happening
4. Integrate across all possibilities

Expected Value

Expected Value: how well a player can expect to do in a particular casino game over a series of fixed bets

Assumption: a rational thinker will make choices that maximize expected value

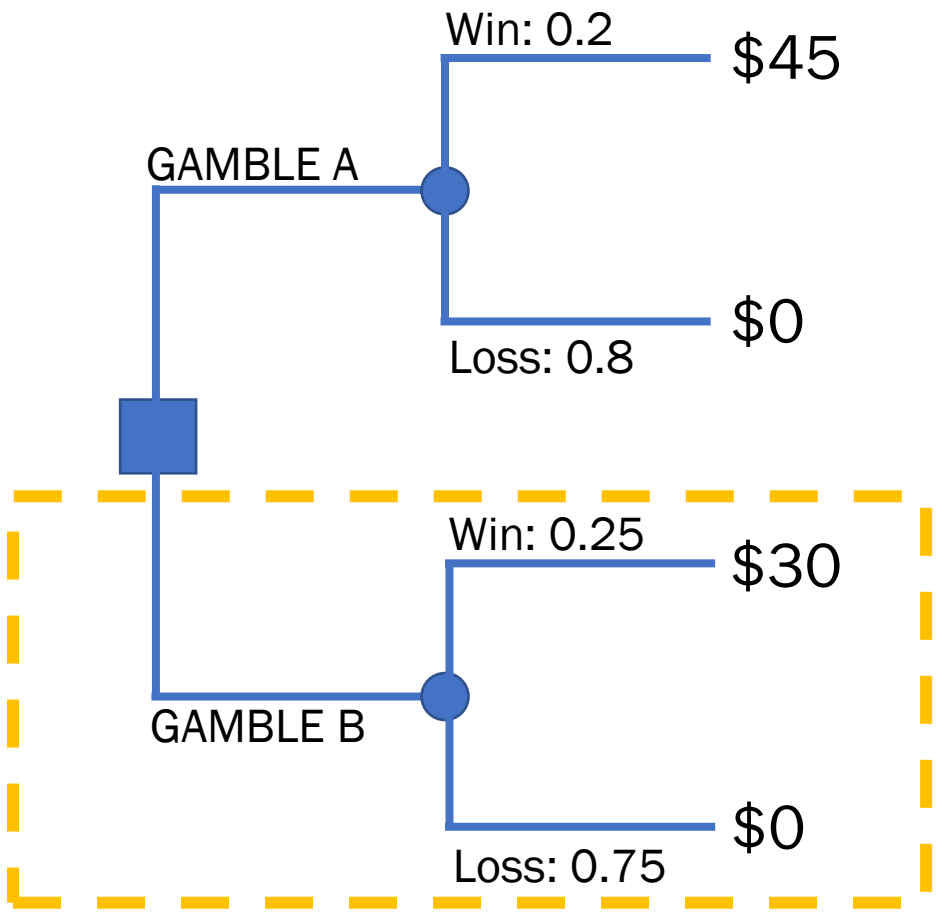
Which gamble would you choose?

- Gamble A: 20% chance to win $45.
- Gamble B: 25% chance to win $30.

Calculating expected value of a gambling scenario:

(probability of winning) x (amount won per bet) + (probability of losing) x (amount lost per bet)

Expected value



Which gamble would you choose?
Gamble A: 20% chance to win $45.
Gamble B: 25% chance to win $30.

(probability of winning) x (amount won per bet)
+ (probability of losing) x (amount lost per bet)

Expected value A = 0.20 x $45 + 0.80 x $0 = $9

Expected value B = 0.25 x $30 + 0.75 x $0 = $7.50

Problem with Expected Value

- Expected value theory conflicts with people's intuitions.

Another example:

- A: $1 million
- B: 50% chance of $3 million

- Expected Value of A: $1,000,000
- Expected Value of B: $1,500,000

- Expected Value theory argues you should prefer B to A, but many people prefer A to B.

Problem with Expected Value

- Why? Decision researchers claim that the satisfaction from getting $3 million wouldn't be much greater than the satisfaction we'd get from $1 million.
- We conduct a utility scale where we try to quantify the amount of satisfaction.
- If 0 corresponds to nothing (no satisfaction), 100 corresponds to $3 million (satisfaction from getting $3 million), what number would correspond to $1 million? the guarantee of getting $1 million trumps the possibility of winning $3 million, because there isn't a large satisfaction difference between $1 million and $3 million
- Furthermore, expected utility theory assumes that *equal outcomes of two choices should have no effect on the relative desirability of one gamble over the other*.
  - Equal outcomes should "cancel out" (independence axiom of expected utility theory: two gambles mixed with a third irrelevant one will maintain the same order of preference as if the two are presented independently of the third one)

Expected Utility

Experiment 1			
Gamble 1A		Gamble 1B	
winnings	chance	winnings	chance
$1 million	100%	$1 million	89%
		nothing	1%
		$5 million	10%

Experiment 2			
Gamble 2A		Gamble 2B	
winnings	chance	winnings	chance
nothing	89%	nothing	90%
$1 million	11%	$5 million	10%

Expected Utility prediction:

- the relative values of choices 1A and 1B must be the same as the relative values of choices 2A and 2B
- If you preferred 1A over 1B, you should have also preferred 2A over 2B

Ok, but how?

Expected Utility

Experiment 1			
Gamble 1A		Gamble 1B	
winnings	chance	winnings	chance
$1 million	89%	$1 million	89%
$1 million	11%	nothing	1%
		$5 million	10%

Experiment 2			
Gamble 2A		Gamble 2B	
winnings	chance	winnings	chance
nothing	89%	nothing	89%
$1 million	11%	nothing	1%
		$5 million	10%

- if we split gamble 1A into two probabilities of winning $1 million, we can split it into a probability of 89% and a probability of 11%. This does not change the overall probability of being granted a million dollars, but it shows that the two gambles have a common factor here.
- And we can do a similar thing with gambles 2A and 2B – we can isolate the common factor between the two option choices.

Expected Utility

This common factor is that equal factor that the independence axiom is talking about. And the common factor, or the equal factor, between two choices, should bear no relevance to the actual choice of gamble.

Experiment 1			
Gamble 1A		Gamble 1B	
winnings	chance	winnings	chance
$1 million	89%	$1 million	89%
$1 million	11%	nothing	1%
		$5 million	10%

Experiment 2			
Gamble 2A		Gamble 2B	
winnings	chance	winnings	chance
nothing	89%	nothing	89%
$1 million	11%	nothing	1%
		$5 million	10%

- After disregarding the 89% chance of winning the same outcome then 1B is left offering a 1% chance of winning nothing and a 10% chance of winning $5 million, while 2B is also left offering a 1% chance of winning nothing and a 10% chance of winning $5 million.
- Hence, choice 1B and 2B should now clearly be seen as the same choice. In the same manner, 1A and 2A should also now be seen as the same choice.

Expected Utility: Violation

- Most people prefer 1A over 1B: you are certain you are going to win in A, but only have 99% chance of winning in B
- But then most people prefer 2B over 2A: when there is no certainty, the higher amount of money is attractive enough for you to ignore the slightly lower probability of winning

The Allais paradox:

- The anticipated regret of a decision drives people towards lower but certain payoff
- But what if the certain outcome is not gain, but loss?

Violations of Optimal Integration

Expected Utility prediction:

- the two questions are formally identical
- choice 3 and 4 were obtained by subtracting the probabilities of 1 and 2 each by a factor of 10
- the relative values of choices 1 and 2 must be the same as the relative values of choices 3 and 4
- if you preferred 1 over 2, you should have also preferred 3 over 4

The violation:

- Most people prefer 1 over 2, but 4 over 3

In an epidemic, which of the following two choices do you prefer

Choice 1: 80% chance of losing 100 lives

Choice 2: 100% chance of losing 75 lives

In an epidemic, which of the following two choices do you prefer

Choice 3: 8% chance of losing 100 lives
Choice 4: 10% chance of losing 75 lives

Failure of decision analysis: Ford Pinto

- The gas tank was placed behind the rear axle – when Pinto was hit from behind, there was a chance the gas tank would explode
- Decision analysis: total cost of relocating the tank to the front ($11 per car) compared to expected dollar value of lives saved (valued at $200,000 per “soul”) by tank relocation
- Conclusion: the total cost of tank relocation was calculated to be greater than the financial utility associated with saving lives and avoiding injuries
- Problem: cost of liability suits, punitive damages, and negative publicity resulting from this analysis were not considered
- Legal case: Grimshaw v. Ford Motor Company (119 Cal.App.3d 757, 174 Cal.Rptr. 348); movie: Class Action, 1991

information processing theories

Query Theory and Endowment Effect

Information Processing Theories

Rational Decision Making, main assumption: people accurately evaluate utility for various options, so if we look at how people make decisions, we will gain insight into how people evaluate utility/value of those options.

Information Processing, main assumption: decision making recruits basic processes from memory, attention, perception (and so on), so in order to understand how people make decisions, we need to first study how people sample, retrieve, and integrate decision-relevant information. If we first study *how* people acquire decision-relevant information, then we will understand how people make decisions.

Query theory

Johnson, E. J., Häubl, G., & Keinan, A. (2007). Aspects of endowment: A query theory of value construction. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*(3), 461-474.

- Basic assumptions:
  - People's preferences, like all knowledge, are subject to the processes and dynamics associated with memory encoding and retrieval. Preferences are therefore constructed from responses to a series of mental questions.
    - So: when agents are faced with a decision, they naturally "decompose" the overall question into a series of smaller component questions: "queries." Answers to those queries then build up a preference, leading to a decision.
    - The order of queries is important too: earlier queries have a stronger effect on forming a preference than later queries. The order of queries is often dictated by agent's implicit goals
  - As a result, various aspects of the situation are recruited from memory in a serial manner (one after another).

Endowment effect

Johnson, E. J., Häubl, G., & Keinan, A. (2007). Aspects of endowment: A query theory of value construction. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*(3), 461-474.

- People charge more for selling a product than they are willing to pay for that same product → I think a mug that I am selling is worth more money than the same mug if I am buying it
- One interpretation: *loss aversion*
  - People are more concerned about the loss of a certain value (greater loss in utility), than they appreciate the gain of the same amount (increase in utility)
  - I worry more about losing DKK50 than I care about gaining DKK50: a potential loss has greater subjective consequences than potential gain of the same amount

Endowment effect

Johnson, E. J., Häubl, G., & Keinan, A. (2007). Aspects of endowment: A query theory of value construction. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*(3), 461-474.

- Query theory explains the endowment effect:
  - When a person is asked to decide *how much money* they are willing to spend on a product (buyers), or *how much money* they are willing to sell the product for (sellers), they go through a series of mental queries
  - Step 1: considering the advantages of current state
    - Buyers: what are the reasons for not owning the product?
    - Sellers: what are the reasons for owning this product?
  - Step 2: considering the opposite state of affairs
    - Buyers: what are the reasons for owning the product?
    - Sellers: what are the reasons for not owning this product?

Endowment effect

Johnson, E. J., Häubl, G., & Keinan, A. (2007). Aspects of endowment: A query theory of value construction. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*(3), 461-474.

- In the experiment:
  - Selling condition: the mug is yours to keep, but you will later have an opportunity to sell it for some amount of money
    - Sellers demanded an average of $5.71 for the mug
    - Sellers produced more positive thoughts about the mug and more negative thoughts about the money: value-increasing
    - Sellers were more likely to start off by talking about value-increasing judgments, and later talk about value-decreasing judgments
  - Choosing condition: you can choose between receiving the mug, or receiving some amount of money
    - Choosers equated the value of the mug to $3.42
    - Choosers produced more negative thoughts about the mug and more positive thoughts about the money: value-decreasing
    - Choosers were more likely to start off by talking about value-decreasing judgments, and later talk about value-increasing judgments

improving decision making through design

Improving decision making through design

- Education and training programs: can I train my users?
  - Transfer of skill: the extent to which a person will be able to perform a new task because of his or her practice with a related task
    - Failures of transfer: when a skill performed in one task does not translate to performance on another task
  - Instead, focus on improving performance in specific task environments, because most reasoning is based on context-specific knowledge
    - This goes against Klein (1997) we discussed earlier: Klein argues we should train people to *learn* like experts, not to *perform* like experts
      - Recommendation applicable to training programs, but not to specific product design (unless you're in EdTech)

Improving decision making through design

- Improve the design of task environments
  - Present task-relevant information in a perceptually accessible way
    - Visual cues, hierarchies, etc.
  - Present task-relevant information at the point of performance
    - Supermarkets: price tag right next to the product → limited possibility of assuming wrong price
  - Present more task-relevant information in an easily accessible format
    - Supermarkets: price-per-unit, price-per-kilogram → helps make a more informed decision about a price of an item
  - Default options must be grounded in research and align with user's best interests
  - Be aware of both desired and accidental effects of nudging and anchoring

Improving decision making through design

- Developing decision aids
  - Goal: force the decision maker to conform to the choice prescribed by normative theories
  - Decision support systems and decision analysis

- For example, patient decision aids: https://decisionaid.ohri.ca/AZlist.html
  - Key issue: information visualization in decision support systems
  - Must be mindful of individual differences between users
  - Emotional load of the decision: treatment choice tool will be different than what should I eat for dinner choice tool