

## Thinking and reasoning

### Mental sets

Last time we talked about memory. Today we will talk about how we use our memories to solve problems. Many times we can use what we already know about the world to solve problems. Those are **mental sets**: they are habitual ways in which we think and solve problems. However some problems are new or uncertain and ambiguous, so it's harder to stick to what we already know. Thinking is hard. Research shows that people sometimes overuse their mental sets: they rely too much on what they already know instead of being creative.

**Class demo:** we saw a picture of a square made of dots so that 4 dots were the corners of the square, and there was one dot in the middle of the square, and one dot in the middle of each of the sides of the square. That resulted in a square made of 9 dots. The task was to draw 4 straight lines without the lifting pen so that all of the dots in the square would be connected. Many of us were not able to find a solution. Why? When we think about how to solve that problem, we are limited by the boundaries of the dots; we find it hard to use the space outside of the dots and the square, which is in fact how to solve the problem. We are constrained by a mental set, a belief we have, an implicit rule we try to apply which it turns out is irrelevant to how to solve the problem and which prevents us from coming up with creative solutions outside of the mental set.

Another example: in what year did Christmas and New Year fall on the same year? This is difficult because we are used to thinking about New Year as following and not preceding Christmas. In fact every year, there is one New Year at the beginning of the year and one Christmas towards the end of that same year.

### Heuristics

Heuristics are shortcuts and rules of thumb we use to solve problems. They are very helpful but because they are shortcuts they sometimes get us in trouble. What are some of the heuristics we use and when do they go wrong? There are 3 main heuristics: representativeness, availability and the confirmation heuristics.

#### Representativeness heuristic

You are told about a woman named Linda who is concerned with social justice and often goes to anti nuclear demonstrations, etc. Then you are asked to estimate the probability that she is a bank teller vs. the probability that she is a bank teller who is active in the feminist movement. Most people say that she is more likely to be a bank teller who is active in the feminist movement than a bank teller. Why is that wrong? Well all bank tellers who are active in the feminist movements are part of the population of bank tellers. Since the group of bank tellers who are also feminist is a subset of the group of bank tellers, Linda is more likely to be a bank teller than a bank teller who is also a feminist. The description we were given of Linda is more representative of a bank teller who is also a feminist than it is of a simple bank teller. So we don't base our answer on the overall numbers in each group, but on how well things match our expectations

or prototypes, and this is an error. Another example to drive the point home: if you are asked to estimate the likelihood that someone is a woman vs. the likelihood that she is pregnant woman, it becomes obvious that pregnant women are a subset of all women, that there are many women who are not pregnant, therefore the likelihood that the person is a woman is greater than the likelihood that the person is a pregnant woman.

Representativeness is a rule of thumb for judging the likelihood of things based on how well they seem to represent or match particular prototypes. We make errors when we fail to take into consideration base numbers in the population. For example: Professor Bjorn Erickson lives in America, loves Bergman films, reads Scandinavian literature, etc. Is he more or less likely to be a professor of Swedish literature than a molecular biologist? To answer this question accurately we would follow the following steps:

- We use information on the **shared features**: 90% of the features that describe him match features that describe Swedish literature professors whereas 5% of the features that describe him match features that describe a molecular biologist.
- We use information on the **base rates**: there are 100 Swedish literature professors in the US, but 500000 molecular biologists (the numbers are made up).
- Then we need to multiply the base rates by the percentage of shared features to get an estimate of how many molecular biologists and how many Swedish literature professors like prof. Erickson there are in the US:  $100 \times 90\% = 90$  Swedish literature professors vs.  $500000 \times 5\% = 250$  molecular biologists.
- Prof. Erickson is therefore more likely to be a molecular biologist than a Swedish literature professor.

We usually get those problems wrong because we only focus on the information about the shared features and ignore base rates.

### Availability heuristic

Are there more 4-letter words in English that begin with "R" than 4-letter words that have R in the third place? Most people say that there are more words with "R" in the first place, than words with "R" in the third place, but it's wrong. Why do people get it wrong? When things come to mind easily, we see it as an indicator of how common or frequent they are in the world. The ease with which I can think of things is an indicator of frequency. In English we organize words by how they start rather than how they are in the middle. So it's easier to come up with words that start with R than with words that have R in the middle. The availability heuristic can be defined as our tendency to be overly influenced by events that come easily to mind. In many cases that's a good cue: if something comes easily to mind, it might be that we have encountered it in many occasions, which might indicate that there are many of it in the world. But things might come to mind easily for different reasons.

Illustration: which kills more people? Electrocution or asthma? Homicide or diabetes? Lighting or appendicitis? When we try to answer those questions, we are influenced by vividness. Asthma kills more people than electrocution, diabetes kills more people than homicides, and appendicitis kills more people than lighting. We think it's the other way around because we are influenced by vividness.

Class video: the role of media coverage in increasing vividness and influencing beliefs about frequency. In the video clip, we saw that the media coined the term "road rage", and coverage of events related to "road rage" had increased so much and was so exaggerative that people started believing that road rage was very frequent, and getting worse over time when in fact it wasn't. Also the media sometimes takes research facts out of context and use them the wrong way to back up their stories. We think that plane crashes kill more people than car crashes but it's wrong, again we are influenced by vividness: plane crashes receive a lot more media coverage than car crashes which are routine, so people think that plane crashes must be more deadly.

### Confirmation heuristic

The psychologist Wason conducted a classic experiment that demonstrates the confirmation heuristic. Participants in the study saw four cards: one with "A" on it, one with "2" on it, one with "x" on it and one with "3" on it. They are told that if there is a vowel on one side of the card, there must be an even number on the other side. Then they are asked to choose the cards that must be turned to verify that the rule is not violated. Most people turn the card with "2" and the card with "A". True: the "A" card must be turned to make sure there is an even number on the other side. But the "2" card is not necessary. There is nothing in the rule that says that if there is an even number, there has to be a vowel. The card that people should have also chosen to turn is the card with "3". If that card has a vowel on the other side, then we know the rule has been violated. Why do we get it wrong? We have a confirmation bias. The card with "2" is attractive because it's a chance to check that the information is consistent with the rule. We like information that is consistent, and we don't like information that disconfirms what we believe. The confirmation bias is a tendency to look for evidence that will confirm not falsify a hypothesis. People aren't always bad at the Wason card selection task. They are good when the rule involves detecting cheaters. In that version, participants do the same task but they are given the following cards: one with "beer", one with "22", one with "soda" and one with "17". The numbers represent the ages of people who are holding drinks. Then participants are asked which cards they need to turn to check that all people who are drinking alcohol are 21 and older. People get it right: they turn the card with "beer" and the card with "17". This is equivalent to the other problem, but the other problem is too abstract, so we get it wrong.

We are finished covering heuristics, we will now cover decision making.

### Decision-making

There are two theories of decision-making:  
Expected utility theory which comes out of rational choice models in economics  
Relativism which comes from the work of psychologists and which is replacing expected utility theory.

#### Expected utility theory

The value of something depends on its expected utility, which can be calculated as follows:

Expected utility of an event = probability of the event happening \* the value of the event + probability of the event not happening \* the value of the event not happening

Example: a guy wants to ask a girl for a date, there is a chance that she will refuse, and he is trying to determine the expected utility of his decision to ask.

Expected utility of asking = probability that the girl will accept \* how cool it would be if she accepted + probability that she refuses \* how much it would suck if she refused.

According to expected utility theory, the guy should decide to ask only if the expected utility is positive. He should not ask if the expected utility is negative.

Coin toss example: you are trying to decide whether or not to take a bet for a coin flip: if it's heads, you get \$10, if it's tails you give away \$3. What's the expected utility of the bet? The probability of obtaining heads = the probability of obtaining tails = .5.

Expected utility of the bet =  $.5 * \$10 + .5 * \$3 = \$3.5$ . It's positive therefore you should take the bet.

### Relativism

Expected utility theory focuses on explaining human decision-making in terms of maximization of gains and minimalization of losses. But the expected utility model of human decision-making is not complete. Relativism is a different model that was proposed to complete expected utility theory. In the relativism model, decision making is not based on how much something is worth at all times, but on how much something is worth right now, given the current condition of the decision maker. Expected utility theory assumes that the value of things is constant over time. Relativism assumes that the value of things changes based on where you are and how you are thinking in the moment. In other words it's important to take into account the immediate context of decision-making. Relativism argues that humans are not making decisions based on cold facts, rationality and logic; they are influenced by other factors. Those factors might be considered irrational, but it doesn't mean that humans are wrong in considering them. The next part will describe some of those factors: presentism, intertemporal intransitivity, honoring sunk costs, decreasing impact of increasing values, the endowment effect, loss aversion, influence of the number of options, influence of emotions.

**Presentism:** we value immediate rewards more than we value long term rewards. We know that exercising and a healthy diet has long term health benefits. But when we think about the time we would sacrifice on the treadmill, and giving up that hamburger we want right now, we might feel like it's not really worth it.

**Intertemporal intransitivity:** the subjective value of things depends on when we think we need to make the decision. Would you rather have \$50 now or \$60 in a month? How about \$50 in 12 months vs. \$60 in 13 months? People usually prefer \$50 now to \$60 in a month, but they prefer \$60 in 13 months to \$50 in 12 months. In both cases, there is a difference of one month and \$10 between the two offers. But in the 1<sup>st</sup> case, you can think of ways to use the \$50 right now, so it makes it more attractive.

**Honoring sunk costs:** prior decisions influence present decisions. You spend \$10 to watch a movie at a theatre. Not only is the movie 2 hours long, but it's horrible, yet you

stay because you have already paid, even though you could spend those 2 hours doing something a lot more interesting and either way your \$10 are already gone. This is not logical, yet we do it.

**Increasing values have decreasing impact:** would you drive across town to pay \$28 for a stereo that costs \$48 at a closer location? Most people say yes. Would you drive across town to pay \$38928 for a car that costs \$38948 at a closer location? Most people say no. In both cases, you would save \$20 by driving across town. But those \$20 don't feel like much when you have already spent a lot of money.

**The endowment effect and loss aversion:** losing something feels worse than gaining it would feel good. People feel worse about losing \$5 than they feel happy about finding \$5. We are more motivated to avoid losses than to obtain wins of same magnitude. In the experiment testing the endowment effect, some participants were given a mug, then they were asked how much they would be willing to sell it for. Other participants were not given a mug, but were asked how much they were willing to pay to buy it. Participants who already owned the mug wanted to sell it for an average of \$7.12, participants who did not own a mug were willing to buy it for an average of \$2.82. Buyers want to gain the mug, but don't like losing money, so they offer a small amount. Sellers will gain money but don't want to lose the mug, so they offer the mug for a large price. How things are framed also affects decision-making: framing things in terms of what you can gain vs. what you can lose shifts whether or not we are willing to take risks. We don't want to risk losing, but we don't mind risking gaining even if both choices end up with the same expected utility.

**The number of options we have changes our expectations:** We live in a culture in which we are constantly told that having more choices is better for us, because it makes it easier to find exactly what we are looking for. Maybe more choice isn't always good. Sometimes having many options makes decision making very painful and not fun. Also sometimes when there are too many other available options, we question what we chose to do, and we are not as happy about it. A researcher tested this: people were in 2 conditions. In one condition, they could choose one piece of chocolate among 6 pieces; in the other condition they were to choose 1 piece among 30 pieces. Then the participants were asked how good was the chocolate. People who chose among 30 pieces rated the chocolate as less good. When there are 30 pieces to choose from, you are more likely to think that you must have missed the good one and to regret your choice and be less happy about it.

**Role of emotion in decision-making:** most reasoning research has focused on thinking and ignored the role of emotions. In the past 10 years, psychologists have been thinking much more about the role of emotions. The trolley problem has been studied a lot: A trolley is coming really fast. The rails separate at some point: on one side there is one workman, on the other side there are 5 workmen. It looks like the trolley is going to kill the 5 workmen, but if you pull the switch the trolley will deviate and kill the one workman instead. Is it morally right to pull the switch? Most people say yes. In a different version of the trolley problem: the trolley looks like it's going to kill 5 workmen. But if you push one big guy who is standing on the bridge, he will stop the trolley but he will die. The problems are identical because you would need to kill one person to save 5

people. But in the version where it's necessary to push someone, people think it's morally wrong. Imagining oneself pushing someone evokes strong emotions that affect the decisions we are willing to make.

The main idea in relativism is that humans often stray from logical and rational decision making because they decide from where and how things are in the moment.