

Cognitive
Psychology

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Judgement
Under
Uncertainty

Heuristics and
Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability

Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring &
Adjustment

Insufficient
Adjustment

Implications

Judgemental Heuristics and Biases

PSYC201: Cognitive Psychology

Mark Hurlstone
Lancaster University

Week 10



Judgement Under Risk and Uncertainty

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Adjustment

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Adjustment

Implications

- Many decisions are based on beliefs about the likelihood of uncertain events or the value of an uncertain quantity:
 - *who will win the election?*
 - *will I be bitten by a shark if I enter the water?*
 - *will the value of the pound rise?*
 - *is the person innocent or guilty?*
 - *which medical procedure is less risky?*
 - *how much is the car worth?*
- Such judgements require assessing probabilities and predicting values
- They involve judgement under uncertainty

Standard Economic Model: Aspects of Decision Making

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Heuristics and Biases

Representativeness

Conjunction Fallacy

Base-Rate Neglect

Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias

Illusory Correlation

Anchoring & Adjustment

Insufficient Adjustment

Implications

(1)

(2)

(3)

\max

$$\sum p(S_j) \cdot$$

$U(O_{ij})$

1. **Preferences** – the rankings people have over a set of options based on their attitudes and values towards their outcomes (3)
2. **Beliefs** – the probabilities people associate with various outcomes occurring (2)
3. **Expected utility maximisation** – people make optimal choices (1, 2, & 3)

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Judgement Under Uncertainty

Heuristics and Biases

Representativeness

Conjunction Fallacy

Base-Rate Neglect

Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias

Illusory Correlation

Anchoring & Adjustment

Insufficient Adjustment

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(1)

(2)

(3)

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2. **Beliefs** – the probabilities people associate with various outcomes occurring (2)
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How *Should* People Make Probability Judgements?

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Judgement Under Uncertainty

Heuristics and Biases

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Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability

Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring & Adjustment

Insufficient Adjustment

Implications

- People should make probabilistic judgements according to the mathematical theory of probability
- There is wide agreement this is the correct normative theory of probabilistic judgement
- Just as preferences are governed by axioms (completeness, transitivity, dominance, and cancelation etc.), beliefs are also governed by the axioms (rules) of probability theory
- People can estimate probabilities correctly, given the relevant information
- They can update probabilities correctly given a sequence of prior outcomes

How Do People *Actually* Make Probability Judgements?

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Judgement Under Uncertainty

Heuristics and Biases

Representativeness
Conjunction Fallacy

Base-Rate Neglect
Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias

Illusory Correlation

Anchoring & Adjustment

Insufficient Adjustment

Implications

- The dominant approach is Kahneman and Tversky's *Heuristics and Biases* programme (Tversky & Kahneman, 1984)
- People do not reason on the basis of formal rules of probability
- Instead, they adopt simplifying heuristics to reach a probability judgement
- Although such heuristics are helpful, they can lead to systematic biases in judgement

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Under
Uncertainty

Heuristics and
Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability

Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring &
Adjustment

Insufficient
Adjustment

Implications

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- ② Availability
- ③ Anchoring and adjustment

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Judgement
Under
Uncertainty

Heuristics and
Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability

Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring &
Adjustment

Insufficient
Adjustment

Implications

- ① Representativeness
- ② Availability
- ③ Anchoring and adjustment

Representativeness (Tversky & Kahneman, 1974)

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Judgement Under Uncertainty

Heuristics and Biases

Representativeness

Conjunction Fallacy

Base-Rate Neglect

Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias

Illusory Correlation

Anchoring & Adjustment

Insufficient Adjustment

Implications

- Common probabilistic judgements include:
 - what is the probability object A belongs to category B ?
 - what is the probability event A originates from process B ?
 - what is the probability process B will generate event A ?
- In such situations, people typically rely on the **representativeness heuristic**:
 - probabilities are judged according to the degree to which A is representative of (or resembles) B
 - when A is highly representative of B , the probability that A originates from B is judged to be high

The Linda Problem (Tversky & Kahneman, 1974)

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Judgement Under Uncertainty

Heuristics and Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability
Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring & Adjustment
Insufficient Adjustment

Implications

Linda is 31 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.

Linda is a teacher in elementary school.

Linda works in a bookstore and takes Yoga classes.

Linda is active in the feminist movement.

Linda is a psychiatric social worker.

Linda is a member of the League of Women Voters.

Linda is a bank teller.

Linda is an insurance sales person.

Linda is a bank teller and is active in the feminist movement.

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Heuristics and Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability
Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring & Adjustment
Insufficient Adjustment

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Linda is a bank teller and is active in the feminist movement.
(T&F)

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Heuristics and Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability
Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring & Adjustment

Insufficient Adjustment

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Linda is a bank teller. (T)

Linda is an insurance sales person.

Linda is a bank teller and is active in the feminist movement.
(T&F)

Most participants (85%) indicated that $P(F) > P(T \& F) > P(T)$

Conjunction Fallacy (Tversky & Kahneman, 1974)

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Uncertainty

Heuristics and
Biases

Representativeness
Conjunction Fallacy

Base-Rate Neglect
Gambler's Fallacy

Availability

Retrieval Bias

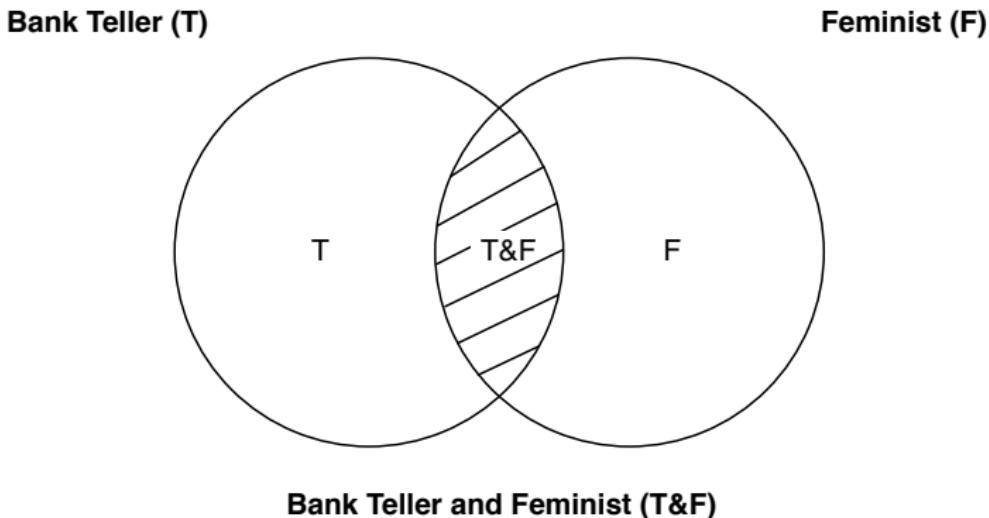
Search-Set Bias

Illusory Correlation

Anchoring &
Adjustment

Insufficient
Adjustment

Implications



- A basic rule of probability theory is that a conjunction cannot be more probable than either of its conjuncts (conjunction rule)

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Judgement
Under
Uncertainty

Heuristics and
Biases

Representativeness
Conjunction Fallacy

Base-Rate Neglect
Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias

Illusory Correlation

Anchoring &
Adjustment

Insufficient
Adjustment

Implications

- When making probabilistic judgements, people should take into account the prior probabilities of outcomes
- For example, in deciding whether Linda is a bank teller or a teacher in an elementary school, you should factor into account the frequency of these occupations in the population
- However, if people rely on the representativeness heuristic, then they should neglect the base rate (**base-rate neglect**)
- Instead, the judgement is made on the basis of whether Linda is more representative of a bank teller or an elementary school teacher

Base-Rate Neglect (Kahneman & Tversky, 1983)

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Judgement Under Uncertainty

Heuristics and Biases

Representativeness

Conjunction Fallacy

Base-Rate Neglect

Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias

Illusory Correlation

Anchoring & Adjustment

Insufficient Adjustment

Implications

- Participants judged the profession of an individual allegedly sampled from a pool of 100 engineers and lawyers
- Two factors manipulated:
- Condition:
 - low engineer (30 engineers + 70 lawyers) vs. high engineer (70 engineers + 30 lawyers)
- Personality description:
 - personality description vs. no personality description

Base-Rate Neglect (Kahneman & Tversky, 1983)

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Judgement Under Uncertainty

Heuristics and Biases

Representativeness

Conjunction Fallacy

Base-Rate Neglect

Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias

Illusory Correlation

Anchoring & Adjustment

Insufficient Adjustment

Implications



Or



Condition	Personality Description	Actual $P(\text{Engineers})$	Judged $P(\text{Engineers})$
Low Engineer	Yes	.30	.50
High Engineer	Yes	.70	.55
Low Engineer	No	.30	.30
High Engineer	No	.70	.70

Base-Rate Neglect (Kahneman & Tversky, 1983)

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Judgement Under Uncertainty

Heuristics and Biases

Representativeness

Conjunction Fallacy

Base-Rate Neglect

Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias

Illusory Correlation

Anchoring & Adjustment

Insufficient Adjustment

Implications



Or



Condition	Personality Description	Actual $P(\text{Engineers})$	Judged $P(\text{Engineers})$
Low Engineer	Yes	.30	.50
High Engineer	Yes	.70	.55
Low Engineer	No	.30	.30
High Engineer	No	.70	.70

Personality description → representativeness heuristic

No personality description → base rate

Gambler's Fallacy

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Judgement
Under
Uncertainty

Heuristics and
Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability
Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring &
Adjustment
Insufficient
Adjustment

Implications

- The representativeness heuristic can also explain the **gambler's fallacy** (Kahneman & Tversky, 1973)
- People expect a sequence of events produced by a random process will represent the key characteristics of that process even when the sequence is short
- Produces the expectation that a departure from the average behaviour of some system will be corrected in the short-term
- People who think they are due a car accident because they have not experienced one for several years are committing the gambler's fallacy

Gambler's Fallacy

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Judgement
Under
Uncertainty

Heuristics and
Biases

Representativeness

Conjunction Fallacy

Base-Rate Neglect

Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias

Illusory Correlation

Anchoring &

Adjustment

Insufficient

Adjustment

Implications

- Consider the sequences of outcomes arising from the flipping of a fair coin eight times:
 - HHHHHHHH
 - HHHHHHHT
 - HTTTHHTH
- In terms of degree of representativeness: HHHHHHHH < HHHHHHHHT < HTTTHHTH

Chance is viewed as a 'self-correcting process'

- a departure from the average behaviour of some system will be corrected in the short-term

Gambler's Fallacy

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Judgement
Under
Uncertainty

Heuristics and
Biases

Representativeness

Conjunction Fallacy

Base-Rate Neglect

Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias

Illusory Correlation

Anchoring &
Adjustment

Insufficient
Adjustment

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Insensitivity To Sample Size

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Judgement
Under
Uncertainty

Heuristics and
Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability
Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring &
Adjustment

Insufficient
Adjustment

Implications

- The gambler's fallacy can be explained in terms of the **law of small numbers**
- People exaggerate the degree to which small samples should resemble the population from which they are drawn
- For the coins, the “population” would be half heads and half tails
- A belief in the law of small numbers would exaggerate the degree to which a sample (e.g., a sequence of eight coin flips) will resemble the population and consist of half heads and half tails

Judgemental Heuristics and Biases

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Judgement
Under
Uncertainty

Heuristics and
Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability

Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring &
Adjustment

Insufficient
Adjustment

Implications

- ① Representativeness
- ② Availability
- ③ Anchoring and adjustment

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Cognitive
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Judgement
Under
Uncertainty

Heuristics and
Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability

Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring &
Adjustment

Insufficient
Adjustment

Implications

- 1 Representativeness
- 2 Availability
- 3 Anchoring and adjustment

Availability Heuristic (Tversky & Kahneman, 1983)

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Judgement Under Uncertainty

Heuristics and Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability

Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring & Adjustment

Insufficient Adjustment

Implications

- People judge the frequency of a class or the probability of an event by the ease with which instances or occurrences spring to mind
- Applies to recall of previous occurrences as well as generation of possible occurrences:
 - how often do you remember horse A beating horse B
 - how many ways can you imagine a novel plan going wrong
- Known as the **availability heuristic** (Tversky & Kahneman, 1983)
- Useful since instances of frequent classes are usually recalled better than instances of less frequent classes; likely occurrences are easier to imagine than unlikely ones

Biases Due to Retrievability of Instances (Tversky & Kahneman, 1983)

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Judgement Under Uncertainty

Heuristics and Biases

Representativeness Conjunction Fallacy

Base-Rate Neglect Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias Illusory Correlation

Anchoring & Adjustment

Insufficient Adjustment

Implications

- Participants heard lists of famous personalities of both sexes
- Then judged frequency of male and female names (actual frequency was identical)
- Two sets of lists:
 - males relatively more famous than females
 - females relatively more famous than males
- Participants judged the class with more famous personalities as more numerous



Richard Nixon



Elizabeth Taylor

Biases Due To Effectiveness of A Search Set (Tversky & Kahneman, 1983)

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Judgement
Under
Uncertainty

Heuristics and
Biases

Representativeness

Conjunction Fallacy

Base-Rate Neglect

Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias

Illusory Correlation

Anchoring &

Adjustment

Insufficient

Adjustment

Implications

- Under timed conditions, people required to generate words from word fragments of the form:

① _____ing

② _____n_

- People generate more words in (1) than in (2) even though first class is a subset of the second
- The first form is more 'available' in memory
- Estimates of the frequency of words in text also higher for (1) than for (2)
- Suggests people's frequency estimates are based on the ease with which people can retrieve instances

Illusory Correlation (Chapman & Chapman, 1969)

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Judgement Under Uncertainty

Heuristics and Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability
Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring & Adjustment
Insufficient Adjustment

Implications

- Judges given information about hypothetical mental patients
- Consisted of a clinical diagnosis and a drawing of a person made by the patient
- Judges estimated the frequency each diagnosis (e.g., suspiciousness) was paired with various features of the drawing (e.g., peculiar eyes)
- Judges markedly overestimated the frequency of co-occurrence of diagnoses and drawing features
- This effect was labeled **illusory correlation**



Illusory Correlation (Chapman & Chapman, 1969)

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Judgement Under Uncertainty

Heuristics and Biases

Representativeness Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability
Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring & Adjustment
Insufficient Adjustment

Implications

- Certain characteristics are more readily associated with certain body parts
- Suspiciousness is more readily associated with the eyes than any other part of the body
- Strong associates (e.g., suspiciousness → peculiar eyes) will tend to be judged as having co-occurred together frequently
- Events that have frequently co-occurred will be more available in memory
- This creates the false impression that the two things are causally related

Overweighting of Small Probabilities

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Judgement Under Uncertainty

Heuristics and Biases

Representativeness

Conjunction Fallacy

Base-Rate Neglect

Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias

Illusory Correlation

Anchoring & Adjustment

Insufficient Adjustment

Implications

- After a plane crash or a terrorist attack, people overestimate the probability of a crash or attack
- The probability of such events is incredibly low
- But such events, when they do occur, are highly vivid, emotive, and recent
- This means they are highly accessible in memory and can weigh in on our judgements of probability of future similar events
- Sometimes availability is not well aligned with probability

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Judgement
Under
Uncertainty

Heuristics and
Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias

Illusory Correlation

Anchoring &
Adjustment

Insufficient
Adjustment

Implications

- 1 Representativeness
- 2 Availability
- 3 Anchoring and adjustment

Judgemental Heuristics and Biases

Cognitive
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Judgement
Under
Uncertainty

Heuristics and
Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability

Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring &
Adjustment

Insufficient
Adjustment

Implications

- 1 Representativeness
- 2 Availability
- 3 Anchoring and adjustment

Anchoring and Adjustment

Cognitive
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Judgement
Under
Uncertainty

Heuristics and
Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability
Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring &
Adjustment

Insufficient
Adjustment

Implications

- People often make judgements by starting from an initial value that is then adjusted to yield the final answer
- The starting point may be suggested by the formulation of the problem
- Alternatively, it may be the result of a partial computation of the problem
- The adjustment tends to insufficient—different starting points yield different estimates that are biased toward the initial anchors
- This is known as the **anchoring heuristic**

Anchoring and Insufficient Adjustment (Tversky & Kahneman, 1974)

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Heuristics and Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability

Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring & Adjustment

Insufficient Adjustment

Implications

- Is the percentage of African countries in the United Nations less than or greater than 10 (65)? Yes/No
- What percentage of African countries belong to the United Nations?

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Cognitive Psychology

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Heuristics and Biases

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Base-Rate Neglect Gambler's Fallacy

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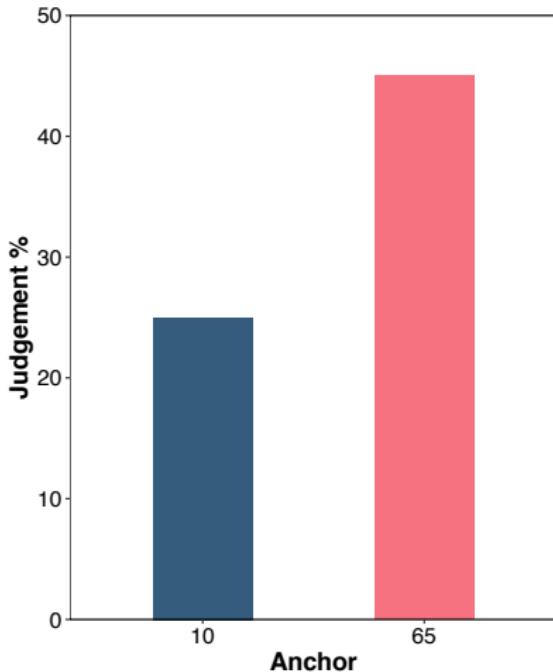
Illusory Correlation

Anchoring & Adjustment

Insufficient Adjustment

Implications

- Is the percentage of African countries in the United Nations less than or greater than 10 (65)? Yes/No
- What percentage of African countries belong to the United Nations?
- People anchor on the initial arbitrary number given before their absolute judgement but insufficiently adjust their estimate



Anchoring and Insufficient Adjustment (Tversky & Kahneman, 1974)

Cognitive Psychology

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Heuristics and Biases

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Base-Rate Neglect Gambler's Fallacy

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Search-Set Bias

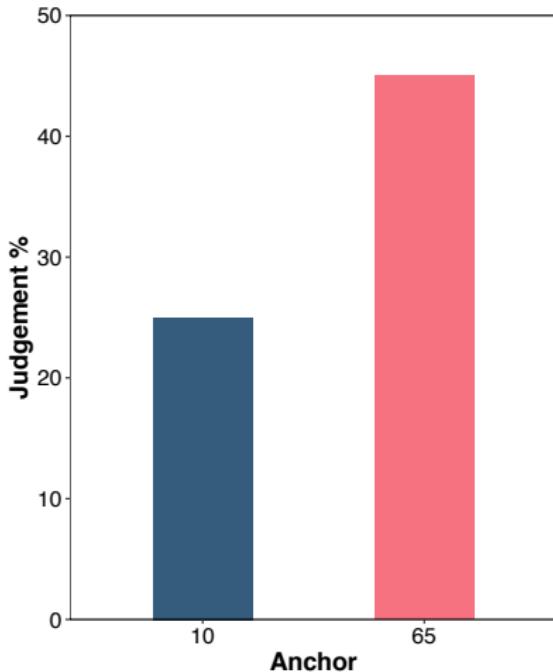
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Anchoring & Adjustment

Insufficient Adjustment

Implications

- Is the percentage of African countries in the United Nations less than or greater than 10 (65)? Yes/No
- What percentage of African countries belong to the United Nations?
- People anchor on the initial arbitrary number given before their absolute judgement but insufficiently adjust their estimate
- Replicated across multiple judgement scenarios



Anchoring and Insufficient Adjustment (Tversky & Kahneman, 1974)

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Judgement Under Uncertainty

Heuristics and Biases

Representativeness
Conjunction Fallacy
Base-Rate Neglect
Gambler's Fallacy

Availability

Retrieval Bias
Search-Set Bias
Illusory Correlation

Anchoring & Adjustment

Insufficient Adjustment

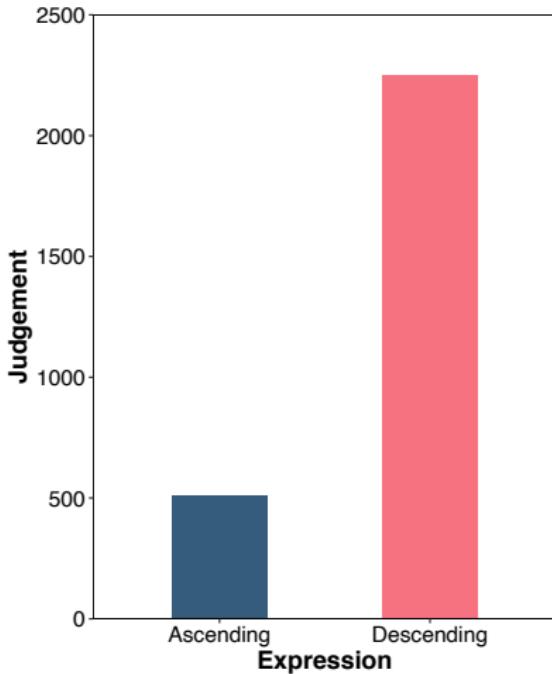
Implications

- Anchoring also occurs when individuals anchor on an incomplete computation
- High school students estimated, within 5 seconds, one of the following numerical expressions:

$$\begin{aligned} 1 & \quad 1 \times 2 \times 3 \times 4 \times 5 \times 6 \\ & \quad \times 7 \times 8 \\ 2 & \quad 8 \times 7 \times 6 \times 5 \times 4 \times 3 \\ & \quad \times 2 \times 1 \end{aligned}$$

Anchoring and Insufficient Adjustment (Tversky & Kahneman, 1974)

- Anchoring also occurs when individuals anchor on an incomplete computation
- High school students estimated, within 5 seconds, one of the following numerical expressions:
 - 1 $1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8$
 - 2 $8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$
- The correct answer is 40,320



Summary of Heuristics

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Psychology

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Judgement
Under
Uncertainty

Heuristics and
Biases

Representativeness

Conjunction Fallacy

Base-Rate Neglect

Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias

Illusory Correlation

Anchoring &
Adjustment

Insufficient
Adjustment

Implications

1 Representativeness:

- employed when people are asked to judge the probability that an object or event A belongs to class or process B

2 Availability:

- employed when people are asked to assess the frequency of a class or the plausibility of a particular development

3 Anchoring:

- employed in numerical prediction when a relevant value is available

Implications

Cognitive
Psychology

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Judgement
Under
Uncertainty

Heuristics and
Biases

Representativeness

Conjunction Fallacy

Base-Rate Neglect

Gambler's Fallacy

Availability

Retrieval Bias

Search-Set Bias

Illusory Correlation

Anchoring &

Adjustment

Insufficient

Adjustment

Implications

- The standard economic model states that people *should* make probability judgements based on the axioms of probability theory
- People *actually* make such judgements using simple heuristics that are often effective but yield systematic biases
- The reliance on such heuristics often yields violations of the basic axioms of probability theory (e.g., the conjunction rule)
- This is problematic for the standard economic model
- However, the biased nature of judgement is consistent with prospect theory

Additional Reading

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Angner, E. (2012, Chapters 4 & 5). *A Course in Behavioural Economics*. Palgrave Macmillan.

A copy of the book chapters is located in the same folder as these lecture slides.