Making wise trade-offs is one of the most important and difficult challenges in decision making”

(Hammond, Keeney, and Raiffa, 1998)
Example of a Multi-alternative & Multi-attribute Problem: Job Decision

<table>
<thead>
<tr>
<th></th>
<th>Job A</th>
<th>Job B</th>
<th>Job C</th>
<th>Job D</th>
<th>Job E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly Salary</td>
<td>$4300</td>
<td>$5100</td>
<td>$3800</td>
<td>$4000</td>
<td>$4600</td>
</tr>
<tr>
<td>Flexibility of work schedule</td>
<td>Moderate</td>
<td>Low</td>
<td>High</td>
<td>Moderate</td>
<td>None</td>
</tr>
<tr>
<td>Skill development</td>
<td>Fair</td>
<td>Excellent</td>
<td>Good</td>
<td>Poor</td>
<td>Very good</td>
</tr>
<tr>
<td>Vacation</td>
<td>14 days</td>
<td>12 days</td>
<td>10 days</td>
<td>15 days</td>
<td>12 days</td>
</tr>
<tr>
<td>Benefits</td>
<td>Health, dental, retirement</td>
<td>Health, dental</td>
<td>Health</td>
<td>Health Retirement</td>
<td>Health, dental</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>Great</td>
<td>Good</td>
<td>Fair</td>
<td>Great</td>
<td>Boring</td>
</tr>
</tbody>
</table>
Outline

  • Used in various forms of judgment analysis – Policy capturing / Conjoint.

– Heuristic or Non-compensatory Decision Models: Tversky (1972)


– Are there limits to adaptivity? Broder & Schiffer (2006)

– Unconscious versus Conscious Modes of Thought and “Good” Decisions
  • Dijksterhuis et al. (2006) and Payne et al. (2008)

– How does the nature of the task and of the context of the decision problem, e.g., choice set, impact how and what we decide?
Strategies for Multi-Attribute Decisions Include:

• **Additive Value or Weighted Value Models: The classic model**
  - “One idea so completely dominates the literature on riskless choice that it has no competitors. It is the additive composition notion.” Edwards and Tversky, (1967).
  - Many variants exist, e.g., Additive Difference Model – based on weighted sum of attribute differences.
  - All variants involve the idea of a compensatory decision process.

• **Lexicographic rule aka Take-the-best or Priority rule.**
  - Focus on most important attribute, if it differentiates.
  - Clearly noncompensatory.

• **Satisficing and Conjunctive models: Simon (1955)**
  - Use of minimum cutoffs on attributes and simple payoff structures.
  - Order of search can determine choice
  - No tradeoffs

• **Elimination-by-aspects**
  - Combines elements of satisficing and lex rule.
  - Frequently used to reduce size of problem

• **Majority of Confirming Dimensions, i.e., a simple version of the additive difference model**

• **Equal Weighting or Counting Rule – Ignore relative importance in the Additive Value Model**
Examples of Simple Decision Rules

• Selecting ski resorts: Select lodge with highest skier traffic; if tied (i.e., with 10%), pick one with the most cooperative management (used by convention and promotion organizer to select sites most conducive to sales events). *The Lexicographic or Priority Rule*

• Computer Sales Projection: Seriously pursue a sales prospect only if the prospect's budget for purchasing the computer has already been approved and our product offers some unique benefit and our firm is viewed as a qualified vendor, and the order will be placed within the next six months. *The Conjunctive Rule*

• Deciding where to eat: First eliminate all restaurants that are either very cheap or very expensive. Next, eliminate all restaurants that do not serve fresh fish. Next, eliminate those that require more than 20 minutes of driving time, etc. *The Elimination-by-Aspects Rule.*
Additive Value Models

\[ X \geq Y \text{ if and only if } V(X) \geq V(Y) \]

where

\[ V(X) = \sum w_i \cdot v(x_i) \]

and where

\[ i \text{ goes from 1 to } n \text{ (total number of attributes or dimensions)} \]

and

\[ V(Y) = \sum w_i \cdot v(x_i). \]
Letter to Joseph Priestley from Benjamin Franklin (September 19, 1772)

Dear Sir;

In the affair of so much importance to you, wherein you ask for my advice, I cannot, for want of sufficient premises advise you what to determine, but if you please I will tell you how.

When those difficult cases occur, they are difficult, chiefly because while we have them under consideration, all the reasons pro and con are not present to the mind at the same time, but sometimes some set present themselves, and at other times another, the first being out of sight. Hence the various purposes or inclinations that alternately prevail, and the uncertainty that perplexes us.

To get over this, my way is to divide half a sheet of paper by a line into two columns; writing over the one pro, and over the other con. Then during three or four days consideration, I put down under the different heads short hints of different motives, that under different times occur to me, for or against the measure.

When I have thus got them all together in one view, I endeavor to estimate their respective weights; and where I find two, one on each side, that seem equal, I strike them both out. If I find a reason pro equal to two reasons con, I strike out the three. If I judge some two reasons con, equal to some three reasons pro, I strike out the five; and thus proceeding I find at length where the balance lies; and if, after a day or two of further consideration, nothing new that is important occurs on either side, I come to a determination accordingly.

And, though the weight of reasons cannot be taken with the precision of algebraic quantities, yet when each is thus considered, separately and comparatively, and the whole lies before me, I think I can judge better, and am less liable to make a rash step, and in fact I have found great advantage in this kind of equation, in what may be called moral or prudential algebra.

Wishing you sincerely that you may determine the best, I am ever, my dear friend, yours most affectionately.

B. Franklin
Key Steps in Additive Value Processes

• **Identify the “relevant” attributes.**
  – A bias towards option, not value-focused thinking.
  – A fallacy of just one attribute. To be discussed.

• **Identify the alternatives (options) in the choice set.**
  – A bias towards yes vs. no rather than choice
  – Suggestion: Do the vanishing option test.

• **Score** or value the attribute values for each alternative (anchor on worst = 0 and best = 10). This is the assignment of individual level values to the individual attributes of each option.
  – Intermediate attribute values often can be set as proportion (degree of) preference improvement to you of going from worst to best attribute value, e.g., 7 (or 70%).

• **Weight** the relative importance of the objectives given the range of possible values on each measure (attribute) of the objectives. This is clearly subjective. *De gustibus non est disputandum.*
  – A key bias: Range Insensitivity.

• **Sum** the weighted attribute scores for each alternative.

• **Select the option that maximizes total value**
More on the Additive Composition Rule

• Capture the idea of tradeoffs or compensatory processing across attributes, i.e., how much weight to assign to each attribute, as a key part of “rationality”. Some have argued that the making of tradeoffs is the most fundamental process of rational decision making.
• Captures the ideas of complete information use.
• Issue of the valuation on each and every relevant attribute, e.g., binary, linear, or nonlinear?
• Note, assumption of independence of attributes to overall value, no interactions.
• Valuation of each option separate from other options.
• Key point: An Additive Model approximates many non-additive models.
Examples of Value Functions:

a) Diminishing utility (value) or sensitivity, b) Increasing utility, and c) Ideal Point

a) The classic form

Example: Preference for Home Sizes

Range of Values = 1800sf to 3200sf

v(1800) = 0 and v(3200) = 100, arbitrary assignment.
Alternative Forms of Additive Models

• Averaging Model where the $w_i$s must sum to 1.0. This is a very common form of the adding rule.
  
  – The key distinction between Averaging and Pure Adding deals with what happens when new information is obtained, e.g., for an applicant with two strongly positive items of information, what happens if a third, moderately positive item of information is obtained?

• Evidence accumulation models.
  
  – In evidence accumulation models like Decision Field Theory, cues are acquired in a sequential (perhaps stochastic) process (Roe, Busemeyer & Townsend, 2001); the cues or attributes independently support options, and their respective contributions to a decision are weighted and integrated until one option is judged as clearly (criterion) better.
  
  – Variations of evidence accumulation models have often been proposed as general models of decision processing.
Figure 1 illustrates a situation where the first cue provides strong evidence (measured on a standard logodds scale) in favor of decision A, but all of the subsequent lower validity cues favor decision B. The log-odds scale is used because it is symmetric about the origin and additive: log-odds of zero mean that each decision is equally favored, and equal positive or negative increments represent equal amounts of evidence in favor of the two alternative decisions. Once all cues have been observed, there is more evidence for decision B than A. Accordingly, for low thresholds (the value two is shown as a concrete example) decision A will be made; for higher threshold values (the value three is shown as a concrete example) decision B will be made.

Newell & Lee (2010)
You can use a variation of “policy capturing” (the Lens model approach) to see how much you “weight” different properties of the credit cards being offered.
Please rate the following credit card options on a 0 to 10 scale, where 0 means “very bad offering” and 10 means “excellent offering.”

<table>
<thead>
<tr>
<th>Card #1</th>
<th>Card #2</th>
<th>Card #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>MasterCard</td>
<td>MasterCard</td>
<td>Visa</td>
</tr>
<tr>
<td>12% interest</td>
<td>20% interest</td>
<td>15% interest</td>
</tr>
<tr>
<td>$2,500 Credit Limit</td>
<td>$7,500 Credit Limit</td>
<td>$7,500 Credit Limit</td>
</tr>
<tr>
<td>Score: ______</td>
<td>Score: ______</td>
<td>Score: ______</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Card #4</th>
<th>Card #5</th>
<th>Card #6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discover</td>
<td>Discover</td>
<td>Discover</td>
</tr>
<tr>
<td>20% interest</td>
<td>15% interest</td>
<td>12% interest</td>
</tr>
<tr>
<td>$5,000 Credit Limit</td>
<td>$2,500 Credit Limit</td>
<td>$7,500 Credit Limit</td>
</tr>
<tr>
<td>Score: ______</td>
<td>Score: ______</td>
<td>Score: ______</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Card #7</th>
<th>Card #8</th>
<th>Card #9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visa</td>
<td>MasterCard</td>
<td>Visa</td>
</tr>
<tr>
<td>12% interest</td>
<td>15% interest</td>
<td>20% interest</td>
</tr>
<tr>
<td>$5,000 Credit Limit</td>
<td>$5,000 Credit Limit</td>
<td>$2,500 Credit Limit</td>
</tr>
<tr>
<td>Score: ______</td>
<td>Score: ______</td>
<td>Score: ______</td>
</tr>
</tbody>
</table>

Note the tradeoffs sometimes required!
### Simple Part Worth Utility Estimation

<table>
<thead>
<tr>
<th>Desirability Score</th>
<th>Visa</th>
<th>MasterCard</th>
<th>Discover</th>
<th>Card #1</th>
<th>Card #2</th>
<th>Card #3</th>
<th>Card #4</th>
<th>Card #5</th>
<th>Card #6</th>
<th>Card #7</th>
<th>Card #8</th>
<th>Card #9</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>5.3</td>
<td>5.7</td>
<td>4.7</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>2</td>
<td>4</td>
<td>8</td>
<td>9</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>12% interest</td>
<td>7.7</td>
<td>15% interest</td>
<td>5.7</td>
<td>20% interest</td>
<td>2.3</td>
<td>12% interest</td>
<td>3.3</td>
<td>15% interest</td>
<td>5.7</td>
<td>20% interest</td>
<td>2.3</td>
</tr>
<tr>
<td>7</td>
<td>$2500 credit limit</td>
<td>3.3</td>
<td>$5000 credit limit</td>
<td>5.7</td>
<td>$7500 credit limit</td>
<td>6.7</td>
<td>$2500 credit limit</td>
<td>3.3</td>
<td>$5000 credit limit</td>
<td>5.7</td>
<td>$7500 credit limit</td>
<td>6.7</td>
</tr>
</tbody>
</table>

### Part Worth Utilities

- **Brand**
  - Visa: 8%
  - MasterCard: 8%
  - Discover: 29%

- **Interest**
  - 12% interest: 63%
  - 15% interest: 17%
  - 20% interest: 9%

- **Credit limit**
  - $2500: 9%
  - $5000: 9%
  - $7500: 1%

### Attribute Importance

- **Brand**
  - Visa: 8%
  - MasterCard: 8%
  - Discover: 29%

- **Interest**
  - 12% interest: 63%
  - 15% interest: 17%
  - 20% interest: 9%

- **Credit limit**
  - $2500: 9%
  - $5000: 9%
  - $7500: 1%
Consumer Preferences for Annuity Attributes: Beyond NPV
Shu, S., Zeithammer, R., & Payne, J. W., JMR, 2015

• Used choice-based conjoint analysis based on a multinomial probit model to measure preferences for features of Life-annuities such as period certain guarantees and various forms of inflation protection.

• Two information presentation conditions were explored.
  – In one of the presentation conditions of our study, we describe each annuity product in terms of its basic attributes as per current industry norms. In another presentation condition, we enrich the product description with non-discounted cumulative payment information for a few representative “live-to” ages. Note that this “enriched information” condition does not provide consumers with additional information – it merely helps them get a sense of possible payoffs given exactly the same underlying attributes. Basic (334 subjects) and Enriched (323 subjects).
Sample Task and Choice Results

Figure 1a: Sample conjoint choice task

If you were 65 and considering putting $100,000 of your retirement savings into an annuity, which of the following would you choose?

- Monthly payments start at $400 ($4,800/year)
  - 7% annual increase in payments
  - 30 years period certain
  - Company rated AA (very strong)
  - A

- Monthly payments start at $600 ($7,200/year)
  - 5% annual increase in payments
  - 10 years period certain
  - Company rated AAA (extremely strong)
  - B

- Monthly payments start at $500 ($6,000/year)
  - $400 annual increase in payments
  - 20 years period certain
  - Company rated AAA (extremely strong)
  - C

- None of these were my only options, I would defer my choice and continue to self-manage my retirement assets
  - none
### Table 1: Attribute levels used in the conjoint analysis

<table>
<thead>
<tr>
<th>Level</th>
<th>Starting monthly income</th>
<th>Company financial strength rating</th>
<th>Annual increases in payments</th>
<th>Period-certain guarantee</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Monthly payments start at $300 ($3,600/year)</td>
<td>Company rated AA (very strong)</td>
<td>Fixed payments (no annual increase)</td>
<td>No period-certain option</td>
</tr>
<tr>
<td>2</td>
<td>Monthly payments start at $400 ($4,800/year)</td>
<td>Company rated AAA (extremely strong)</td>
<td>3% annual increase in payments</td>
<td>5-year period-certain</td>
</tr>
<tr>
<td>3</td>
<td>Monthly payments start at $500 ($6,000/year)</td>
<td></td>
<td>5% annual increase in payments</td>
<td>10-year period-certain</td>
</tr>
<tr>
<td>4</td>
<td>Monthly payments start at $600 ($7,200/year)</td>
<td></td>
<td>7% annual increase in payments</td>
<td>20-year period-certain</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>$200 annual increase in payments</td>
<td>30-year period-certain</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td>$400 annual increase in payments</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>$500 annual increase in payments</td>
<td></td>
</tr>
</tbody>
</table>
Given the expected payout $V_{n,k}$, the dummy variable $AAA_{n,k}$, the price of the annuity $p$ (which we fixed to $100,000$ throughout the study by design) and the $X_{k,n}$ variables, we model the respondent $j$’s utility of the $k$-th annuity in the $n$th choice set as a linear regression:

$$U_{n,k,j} = \alpha_j + \beta_j \left( V_{n,k} - p \right) + \gamma_j AA_{n,k} + \delta_j AAA_{n,k} \times (V_{n,k} - p) + \frac{X_{n,k} \theta_j}{\text{normative model}} + \varepsilon_{n,k,j}$$

(2)

where $\varepsilon_{n,k,j} \sim N(0,1)$ and we normalize the utility of the outside (“none of the above”) alternative $k=0$ to zero to identify the parameters$^7$: $U_{n,0,j} = 0$. This normalization implies that the utility of inside alternatives should be interpreted as relative to self-management of a $100,000$
Figure 2: Demand for annuities with different lengths of period-certain guarantee and different types of annual increases

Starting income $400/month, no period certain

Starting income $500/month, no annual increase

Legend (what varies):
- additive increase
- percentage increase
- starting income

Legend (what varies):
- period certain
- starting income

Note to Figure: Predicted female demand for a AAA annuity. The dashed line without markers represents annuities with different starting incomes, no annual increases, and no period-certain guarantees.
Figure 3: Demand for annuities with exactly $100,000 expected payout

**basic information, male market**

**basic information, female market**

**enriched information, male market**

**enriched information, female market**

Note to Figure: Each line depicts market demand for a AAA annuity that pays out $100,000 in expected net present value, and has a particular type of annual increase, as a function of the period certain guarantee. Starting income is adjusted to achieve the constant payout. Markers indicate combinations that do not require extrapolation beyond the range of starting incomes in the study ($300 to $600 per month). See Table A3 for details.

Legend (type of annual increase):

- none (no increase)
- none, extrapolated
- 3 percent
- 3 percent, extrapolated
- $200
- $200, extrapolated
Summary of Attribute X Information Results

- Regardless of the information presentation, consumers (especially women) overvalue “middle-length” (10-year and 20-year) period-certain guarantees.

- Another attribute that influences preferences “beyond NPV” is inflation protection via annual payment increases, and its influence depends on the way product information is presented.

- We find that consumers who see only basic attribute information undervalue annual increases and show stronger preference for fixed nominal annual increases relative to percentage increases, holding the expected payout constant.

- However, consumers who also see a table with contingent cumulative payouts undervalue annual increases much less and do not care whether the increases are expressed in the form of percentages or dollars.
Two Decision Traps (Biases)

- Option thinking, not Value-focused Thinking
  - Why am I making this decision?
  - Too few Attributes considered.

- Failure to consider ranges on objectives or attributes of value in assessing decision weights. This is called “Range Insensitivity.”
Decision Trap 1

• We tend to focus on choosing between alternatives and forget to ask what are the objectives? That is, why are we making this decision?
• People seem to insufficiently think both in terms of breadth (different categories) and depth (objectives within a category).
  – Research suggests that individuals, left to their own devices, often fail to identify up to half of the objectives that they later acknowledge to be important (Bond et al., 2008).

• At the extreme, focus is on just one goal (attribute)
Warning: Beware of Focusing on a Single Objective at the time of Choice. This is another fallacy of One (narrow framing) like just considering just one future.

• “People waffling over a decision may benefit, in the short-term, from paring down the number of details they are weighing and instead selecting one or a few important values to use in basing their decision. For example, in making a decision about whether to buy a costly piece of new medical equipment, a hospital executive may weigh the expense, expertise needed to operate it and space requirements against its effectiveness.

• But ultimately, in order to avoid getting mired in a prolonged debate, the executive may decide on a core value—say, how well the equipment works for taking care of patients—that can be used to help make the decision.”

WSJ 9/28/2010, Why so many people can’t make decisions.

• The tendency to focus on a single objective is particularly acute when the decision is being made under stressful conditions.
Decision Trap 2:
Failure to consider ranges on objectives or attributes of value

- To illustrate this issue, Keeney has asked numerous individuals in government, the news media, businesses, and universities the following question: “In cleaning up hazardous waste sites, what is more important: the economic cost of cleanup or the health consequences?”
  - Everyone answers, and almost always the response is health consequences.

- Then Keeney asks this question: “In cleaning up hazardous waste sites, what is more important: reducing the health consequences from 20 to 10 people who get seriously ill for one week and then recover or reducing in the economic cost of cleanup from $2 billion to $1 billion?”
  - Now, almost all of these same individuals respond that the economic cost is more important.

- Keeney then asks how is it that the health consequences are initially more important and yet the economic cost is more important in the second situation.

- The response is invariably that it is not worth $1 billion to avoid the 10 serious illnesses.

- Is the former question answered using system 1 thinking and the later system 2 thinking?
Summary

• Much Evidence and many arguments for the Additive Value Model. **By far, the most often used model for preferences.**
  
  – Captures key ideas of **rationality** (the making of tradeoffs)
  
  – **Often** seems to fit the outcome data, e.g., market research and conjoint analysis.
  
  – **Simple** to model preferences – relate to the work on the Lens model.
  
  – People do **report** use when making tradeoffs.

• **Used to provide insights into relative values across attributes, and also the properties of values for individual attributes.**
Three Behavioral Properties of Values

• Referent dependent

• Loss aversion

• Diminishing sensitivity
Reference point (target, aspiration level) dependent values and beliefs.

• People value changes from a reference point much more than absolute values. Often the changes are coded as either gains or losses.

• Reference values are often defined by the status-quo

• Reference values can be targets or goals set by self or by others

• Reference values also can be set by a social comparison
Real-world examples of reference dependence

• Income Targeting for Taxi drivers.

• Credit cards – A cash discount or a credit card surcharge?

• PAR in golf.

• Social Security Claiming
Gold, Silver, Bronze

• Olympic bronze medalists are happier than silver medalists.
  ▪ According to assessments of “displayed affect” during medal ceremonies
  ▪ Silver medalists compare themselves to the gold medalist (“if only ... then I would have won).
  ▪ Bronze medalists compare to possibility of not medaling
    → Different reference points
Question

Which of these two people is happier right now?

– Judy has $1,000,000 in her 401(k) and lost $100 bill

– Dave has $100,000 in his 401(k) and found $100 bill
Loss Aversion

• Loss Aversion, i.e., losses loom larger than equal gains. People appear to differ in their degree of loss aversion.

• “The concept of loss aversion is certainly the most significant contribution of psychology to behavioral economics (Kahneman, 2011, p.300).”

• Evidence – Value of gambles and the famous mug studies.
  – 50:50 gamble with a loss of -$100, how much of a gain is needed to make such a gamble just acceptable?
  – Mug Studies
    • Half of the subjects get a mug and half do not. The mug owners are invited to sell their mugs and the others are invited to buy them.
    • The results show that those with the mugs demand twice as much to give up their mugs as others are willing to pay for them.
    • Implication: values are unclear and influenced by simply who has been given a mug.
Who Will Focus Harder and Make Fewer Errors?

• A Professional golfer shooting for a birdie on a golf hole, or

• A Professional golfer shooting for par on a golf hole.
Loss Aversion Happens to Others
Recap

• The **Additive Value model** is the classic descriptive and normative model of decisions with multiple objectives.

• Further the Additive Value model often describes judgments and choices very well.

• Further, people do make explicit tradeoffs between attributes of alternatives.

• By using tools based on the Additive Value model significant insights into the nature of human preferences have been gained.

• But?????
Choice and Process Evidence against the Additive model

– Does not explain some important results, see the “Economist” example of a context effect and test of value maximization, see next pages.

– Information processing costs – multiple options, multiple attributes. That is, “bounded rationality”.

– Emotional costs – How much is a life worth?

– Social cost of justifying a decision to others.

– Not what people say they are using in some situations.
Test of Value Maximization

• One of the standard assumptions of rational (additive) choice theory is “menu-independence”.

• Menu-independence is also referred to as “independence of irrelevant alternatives” or context-independence.

• Menu-independence follows from the assumption that a decision maker has a complete preference order over all options, and that - given an offered set - the decision maker always selects the option highest on that order, i.e., “value maximization.”
Adding Options to Switch Preferences: Which subscription would you prefer?

• **A) Economist.com subscription.** $69 per year for one-year subscription to Economist.com. Includes online access to all articles from the Economist since 1997. A subscription to Economist.com does not include delivery of print copies of *The Economist*.
  • 68%

• **B) Print and instant free web subscription.** $129 per year. One-year subscription to the print edition of *The Economist* and immediate online access.
  • 32%

• **A) Economist.com subscription.** $69 per year for one-year subscription to Economist.com. Includes online access to all articles from the Economist since 1997. A subscription to Economist.com does not include delivery of print copies of *The Economist*.
  • 16%

• **B) Print subscription.** $129 per year. One-year subscription to the print edition of *The Economist*.
  • 0%

• **C) Print and instant free web subscription.** $129 per year. One-year subscription to the print edition of *The Economist* and immediate online access.
  • 84%

See Dan Ariely.
Variety of other Context and Task Effects Exist

• Compromise Effect

• Number of Alternatives

• Defaults

• Time Pressure

• Cognitive load and **FLUENCY**
Compromise Effect – Simonson & Tversky

• Situation 1:
  – Grill 2 3 4
  – Cooking Area 220 280 340
  – Weight 7 lbs 10 lbs 13 lbs
  – Choice 29%

• Situation 2
  – Grill 3 4 5
  – Cooking Area 280 340 400
  – Weight 10 lbs 13 lbs 16 lbs
  – Choice 47%

Note, use at Duke to help save money on computer costs
Heuristic Choice Strategies:
Bounded Rationality
Bounded Rationality

- The main characteristic of system 2 is that it is **lazy** (Kahneman, 2011).

- “What a person cannot do he will not do, no matter how much he wants to do it.” (Simon, 1981)
Some Mechanisms for Simplification

- Ignore information in search and consideration of attributes or dimensions
- Ignore magnitudes of the attribute information in the evaluation of information.
- Process by attribute rather than by alternative.
- Limit how importance information is used
  - Just to guide search
  - Equal weighting
- Limit consideration of alternatives
One-reason (Priority) Heuristics

Focus on most important attribute, if it differentiates. If not, move to the second most important attribute, and repeat until choice can be made.

Clearly a non-compensatory decision rule.

For example, selecting ski resorts: Select lodge with highest skier traffic; if tied (i.e., with 10%), pick one with the most cooperative management (used by convention and promotion organizer to select sites most conductive to sales events).
One-reason (Priority) Heuristics

- Focus on most important attribute, if it differentiates. If not, move to the second most important attribute, and repeat until choice can be made.
- Clearly a non-compensatory decision rule.
- Can lead to clear decision errors, see next slides, but
- Fast and frugal.
- For example, selecting ski resorts: Select lodge with highest skier traffic; if tied (i.e., with 10%), pick one with the most cooperative management (used by convention and promotion organizier to select sites most conductive to sales events).
Tversky (1969): Intransitive Choices - 1

- **Transitivity** as a basic condition of coherent choice. If \( X > Y \) and \( Y > Z \) then \( X \) should be preferred (>) to \( Z \).
  - Luce Choice Model: \( P(x, A) = \frac{u(x)}{\Sigma U(y)} \) for all \( y \) in \( A \), where \( U(A) \) is some form of weighed additive model.
  - Stochastic forms of transitivity – weak stochastic, moderate stochastic, and strong stochastic transitivity. WST = \( P(x,y) > .5 \) and \( P(x,z) > .5 \), implies \( P(x,z) > .5 \). SST = \( P(x,z) \) is at least equal to the max of the two conditioning probabilities.

- Violations of transitivity can lead to a person acting as a “money-pump”. Suppose a person prefers \( y \) to \( x \), \( z \) to \( y \), and \( x \) to \( z \). Assume the person has \( x \) to start with. It is reasonable to assume that he or she is willing to pay a sum of money to replace \( x \) with \( y \). Similarly, he or she should be willing to pay a sum of money to replace \( y \) with \( z \). And, he or she should be willing to then pay a sum of money to replace \( z \) with \( x \). Thus, the person ends up with the same option and less money. (Note, rationality as a way to avoid exploitation by others.)

- Intransitivity also implies that if an option is to be selected in a series of pair comparisons, then the chosen option is a function of the order in which the pairs are presented.

- Tversky (1969) argues that order dependence is “certainly an undesirable property of a decision rule.”

• When might intransitivities occur?
  – Lexicographic semi-order model

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>2e</td>
<td>6e</td>
</tr>
<tr>
<td>Y</td>
<td>3e</td>
<td>4e</td>
</tr>
<tr>
<td>Z</td>
<td>4e</td>
<td>2e</td>
</tr>
</tbody>
</table>

Alternatives, X, Y< & Z
Attributes (Dimensions) I > II
E = JND
• Experiments demonstrating predictable intransitive patterns of choice do exist.

• Additive Difference Model
  \[ X > Y \iff \sum_{i=1}^{n} [U(x_i) - U(y_i)] \geq 0 \]

• Model use as a function of display and modes of processing: Alternative-based versus Attribute-based.

• Ease of use arguments

• Question: What is rational?
Tversky (1972): Elimination-by-Aspects –1

• Concepts of simple scalability and independence of irrelevant alternatives (IIA).
  – \( P(x,y) \geq \frac{1}{2} \) iff \( P(x, A) \geq P(y, A) \)
  – Luce Choice Model: \( P(x, A) = \frac{u(x)}{\sum U(y)} \) for all \( y \) in \( A \).

  – Independence of Irrelevant Alternatives (IIA): Preference ordering between \( A \) and \( B \) is the same regardless of the presence of a third option \( C \)
  – Regularity: For all \( x \) that are elements in the set \( A \) which is a subset of the set \( B \), \( P(x, A) \geq P(x, B) \). That is, adding an option cannot increase the probability of choosing one of the existing options.

• Violations of IIA? Do similar alternatives “hurt”? “Real world” examples?

• Also, choice probabilities reflect both values and difficulty of comparison. Rome vs. Paris vs Paris + $1 example
Tversky (1972): Elimination-by-Aspects –2

• EBA Theory
  – Attribute focused
  – Note Satisficing on attribute values

• Tests
  – The constant-ratio model seems to be valid for unitary alternatives (e.g., dot patterns) that are usually evaluated as wholes (System 1 thought?), but not for composite alternatives that tend to be evaluated in terms of their attributes or components (System 2 thought?).

• The probability of selecting an alternative depends not only on its overall value, but also on its relations to other available alternatives. That is, preferences are context-dependent.

• Global rationality in the sense of reflecting attribute values but not local rationality in the sense of an elimination process.
People use more than one strategy: Contingent Processing

How do people decide how to decide?
• Assumptions
  – People have a variety of strategies for processing information and making a choice.
  
  – The strategies vary in their cognitive effort and decision accuracy differentially across task environments.
  
  – People use the decision strategy that best balances the goals of minimizing cognitive effort versus maximizing accuracy, given the demands of the environment and their individual tradeoffs between effort and accuracy.
Cognitive Effort and Decision Strategies

• Decision strategies are sequences of mental operations (elementary information processes, EIPs) such as READS, COMPARISONS, ADDITIONS, and ELIMINATIONS.

• The cognitive effort needed to reach a decision using a particular strategy is a function of the total number and type of EIPs used by that strategy, with the relative effort levels of various strategies contingent upon task environments.

• Do EIPs Describe Effort?
Bettman et al., 1990

• Trained decision makers to use various strategies in different environments.

• Results show that weighted EIP counts account for about 84% of the variance in decision times and about 65% of the variance in self-reports of effort.

• The weights for the various EIPs were essentially the same regardless of the decision strategy used. The estimates of the time taken for each EIP were in line with prior cognitive research.

• Significant individual differences existed in the effort associated with particular EIPs.
Computer Simulation Study of the Effort and Accuracy of Decision Strategies

• Using Monte-Carlo simulation techniques, and the modeling of EIPs as If-Then operations, 12 different decision strategies have been investigated in a variety of decision environments.

• Relative Accuracy = (EV heuristic rule choice - EV random rule choice) / (EV of Expected Value rule choice - EV random rule choice).

• The environments have varied in terms of task complexity (number of alternatives and attributes), positive or negative conflict or correlational structures, time pressure (constraints and opportunity costs), and the degree of dispersion of weights (probabilities) within each alternative (e.g., .30, .20, .22, and .28 versus .12, .68, .05, and .15, for a four-outcome [attribute] gamble).

• Dispersion of weights has proven to be very important in the literature. Compensatory versus non-compensatory task environments. For example w(a1) < w(a2) + w(a3) or w(a1) ≥ w(a2) + w(a3)?
Summary of Simulation Results

• Heuristic choice strategies can approximate the accuracy of normative procedures while requiring substantially less cognitive effort. See graph.

• No single heuristic does well across all decision environments. A decision maker using heuristics must be adaptive to maintain a high level of accuracy AND minimize effort. He or she needs to use a “toolkit” of decision strategies. See graph.

• Under time constraints, several heuristics are more accurate than a truncated normative procedure. Strategies like the lexicographic rule that are attribute-based and emphasize breadth of processing do better.

• Task variables have the greater influence on cognitive effort while context variables have the greater influence on accuracy.
Graph of Simulation Results

- Relative Accuracy (%WADD)
- Effort (Total EIPs)

Decision Environment – Low Dispersion
Decision Environment – High Dispersion

WADD
EQW
LEX
EBA
RC

MCD
Tests of Adaptive Decision Making:
Payne, Bettman, & Johnson (1988): Experiments

• Task: Choice among sets of four-outcome gambles.
• Low vs. high dispersion of probabilities (weights) and no versus some time pressure.
• Use of process-tracing techniques (the Mouselab system to monitor information acquisition behavior) as well as response times and choice.
  – Measures of the amount of processing
  – Measures of the selectivity of processing
  – Measures of the pattern of processing
• Output and Process measures of decisions
Beyond Outcome Measures of Choice
Some Search and Process Properties of Decision Strategies

• Weighted Additive
• Additive Difference
• Lexicographic
• Elimination-by-Aspects
• Majority of Confirming Dimensions
• Satisficing or the conjunctive model

• Compensatory, consistent information use, alternative-based.
• Compensatory, consistent, attribute-based
• Noncompensatory, highly selective processing of information, simplified valuation, yes or no, attribute-based.
• Noncompensatory, selective, attribute-based.
• Partially compensatory, consistent, attribute-based.
• Noncompensatory, selective in terms of alternatives and use of binary values, alternative-based
# Search Properties

<table>
<thead>
<tr>
<th></th>
<th>Job A</th>
<th>Job B</th>
<th>Job C</th>
<th>Job D</th>
<th>Job E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly Salary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexibility of work schedule</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skills development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vacation</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Benefits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enjoyment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probs.</td>
<td>Outcome 1</td>
<td>Outcome 2</td>
<td>Outcome 3</td>
<td>Outcome 4</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>Gamble A</td>
<td>[ ]</td>
<td>$8.39+</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td>Gamble B</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td>Gamble C</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td>Gamble D</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
</tbody>
</table>

Choose one: Gamble A  Gamble B  Gamble C  Gamble D
Are People Adaptive? — Results from Payne, Bettman, et al.

• Greater dispersion in weights leads to less processing, more selectivity, and more processing by attribute, e.g. a lex. or priority type heuristic rule.

• Greater time pressure leads to less processing, more selectivity, and more processing by attribute.

• A goal emphasizing accuracy more leads to more processing, less selectivity of processing, and more processing by alternative, e.g., use of the WADD model.

• Negative correlational structures (conflict) lead to more processing, less selectivity of processing, and more processing by alternative.
Consequences and limits to adaptive decision behavior

• In general, the more adaptive a subject is to changes in task and context variables, the better he or she does, e.g., more use of the lex rule under time pressure leads to higher payoffs.

Learning how to select strategies: Rieskamp & Otto, 2006 - 1

• Task: Which of 2 (3) options are more credit worthy or will produce more oil.

• Each option defined on six binary cues. Cue validities given, or in one case learned.

• Trial feedback plus cumulative feedback on payoffs.

• Search for information either free or costly and either boxes stayed open or just one at a time.

• 7 blocks of 24 trials each
Learning how to select strategies: Rieskamp & Otto, 2006 - 2

• Results, see table on next page
  – Strategies that performed well over time became more likely to be selected.

  – Payoffs increased from €1.36 to €2.50 (E1), €2.32 to €3.21 (E2), €1.11 to €1.55 (E3), and €1.54 to €1.74 (E4).

  – Initial preference for WADD rule, .70 (E1), .51 (E2), .57 (E3), and .60 (E4).
### Rieskamp & Otto, 2006 - 3

<table>
<thead>
<tr>
<th></th>
<th>1st Trial</th>
<th>7st Trial**</th>
<th>Envirn.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WADD Strategy</td>
<td>67%*</td>
<td>88%</td>
<td>Comp.</td>
</tr>
<tr>
<td>LEX or (TTB)</td>
<td>28%***</td>
<td>71%</td>
<td>Noncomp</td>
</tr>
<tr>
<td>Ave Payoff</td>
<td>€1.36</td>
<td>€2.50</td>
<td></td>
</tr>
</tbody>
</table>

*Predicted % strategy used to make choices.  
**Most learning occurred by trial #4.  
*** Initial Pref for WADD strategy
Maladaptive Routines in Strategy Selection: Broder & Schiffer, 2006 - 1

• Idea that routines can be “efficient” but also represent a “bet” on a stable world.
• Routines at the level of option preference, e.g., route-to-work, and at the level of strategies, e.g., a “routine way to solve a multi-attribute problem.
• Does strategy selection change when the environment changes or is there a persistence to strategy use that can be maladaptive?
• The basic task is to choose the best stock from a set of 3 stocks defined by four binary cues, e.g., profit growth and increase in the number of employees. Cue information was hidden and could be purchased.
• Compensatory environment: Payoff = 32c1 +26c2 +22c3 + 20c4 + or – rand (5)
• Non-compensatory environment: Payoff = 47c1 +25c2 +17c3 + 10c4 + or – rand (5)
• 160 Trials divided into two phases. 80 trials in phase 1 followed by 80 trials in phase 2, either with or without a hint of a change. Profit or lost and cumulative earnings shown after each trial.
• Two experiments – vary in how explicitly different the 2nd phase was.

Results

- In the compensatory environments – 78% and 79% used a compensatory rule. In the non-compensatory environments – 50% and 44% used a compensatory rule.
- Differences exist across environments and strategy use in terms of payoffs
- People who adapted in the “right” way performed better.
- A large asymmetry in the “stickiness” of strategies. If compensatory first (FR), only 13.5% change. If TTB first, 56% change.
- Hints on change had a little effect, added incentives had none.

<table>
<thead>
<tr>
<th></th>
<th>Comp Envir.</th>
<th>Non-comp Envir.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTB</td>
<td>27.5</td>
<td>80.1</td>
</tr>
<tr>
<td>FR</td>
<td>63.7</td>
<td>61.4</td>
</tr>
</tbody>
</table>
Summary

• The classic descriptive and normative model of decisions with multiple objectives is the Additive Value model.
• The Additive Value model often describes judgments and choices very well. Further, people do make explicit tradeoffs between attributes of alternatives.
• As suggested by Bounded Rationality, people also use a variety of heuristic strategies to solve multi-attribute decision problems.
• A major question is how do people decide how to decide?
• One approach assumes some form of meta-decision making involving considerations of goals such as minimizing cognitive effort and maximizing choice accuracy. Other goals might also be considered such as ease of justifying decisions to others.
• Another approach assumes that the selection of strategies is more driven by learning.
• There is a criticism of this “toolbox” framework in terms of being too undefined.
Additional Research Questions

• The conscious versus unconscious thought debate.

• Are different modes of thought “better” in terms of making multi-attribute choices?

• Dijksterhuis & Nordgren (2006) argue that for complex problems less conscious thought is better than more conscious thought when deciding what action to choose (see pages 103-104). Specifically, the individual should delegate thinking about complex matters to the unconscious.

• When is less conscious thought more? (When is more conscious thought less?)
Unconscious Thought - Dijksterhuis

• What is the relative value of conscious thought versus unconscious thought in dealing with complex multi-attribute choice problems? Idea of two modes of thought.
• Conscious thought is defined as thought while the task is the focus of one’s conscious attention. Unconscious thought occurs when one’s conscious attention is directed elsewhere. Attention is the key.
• Basic Experiment:
  – People are given information, often in a random fashion but sometimes blocked, e.g., 4 options defined on 12 attributes. One option is relatively more attractive.
  – Sometimes people respond immediately, others respond after thinking about the decision for a specified period of time (3 or 4 minutes), or after doing a distraction task (anagrams) or a similar period of time knowing that they would later make a decision.
  – Basic result is that unconscious thought is better than conscious thought.
• Conscious thought is said to be constrained by low capacity, more stereotyping, is less good at weighting the relative importance of attributes, more able to follow precise rules, more convergent, and less able to deal with more complex problems.
• Unconscious thought is best at information integration, not acquisition.
• For complex problems less conscious thought is better than more conscious thought when deciding what action to choose.
### Instructions:
The cars below have the following attributes indicated. Please choose the best car based on this information.

<table>
<thead>
<tr>
<th>Car</th>
<th>Mileage</th>
<th>Handling</th>
<th>Trunk Space</th>
<th>New</th>
<th>Color Availability</th>
<th>Service</th>
<th>Legroom</th>
<th>Ease of Shifting Gears</th>
<th>Cupholders?</th>
<th>Sunroof?</th>
<th>Environ. Friendliness</th>
<th>Sound System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dasuka</td>
<td>Poor</td>
<td>Good</td>
<td>Small</td>
<td>New</td>
<td>Available in very few colors</td>
<td>Poor</td>
<td>Little</td>
<td>Easy</td>
<td>Yes</td>
<td>Yes</td>
<td>Not very good</td>
<td>Good</td>
</tr>
<tr>
<td>Hatsdun</td>
<td>Good</td>
<td>Good</td>
<td>Large</td>
<td>Very New</td>
<td>Available in many different colors</td>
<td>Excellent</td>
<td>Poor</td>
<td>Difficult</td>
<td>Yes</td>
<td>Yes</td>
<td>Relatively good</td>
<td>Poor</td>
</tr>
<tr>
<td>Kaiwa</td>
<td>Good</td>
<td>Poor</td>
<td>Large</td>
<td>Old</td>
<td>Available in many different colors</td>
<td>Excellent</td>
<td>Plenty</td>
<td>Easy</td>
<td>No</td>
<td>No</td>
<td>Faintly good</td>
<td>Poor</td>
</tr>
<tr>
<td>Nabusi</td>
<td>Poor</td>
<td>Poor</td>
<td>Small</td>
<td>Old</td>
<td>Available in many different colors</td>
<td>Poor</td>
<td>Plenty</td>
<td>Difficult</td>
<td>No</td>
<td>Yes</td>
<td>Not very good</td>
<td>Poor</td>
</tr>
</tbody>
</table>

Based on this information provided, which car would you choose? Please circle one.

A. Dasuka
B. Hatsdun
C. Kaiwa
D. Nabusi
Dijksterhuis et al. (2006, Science)  
Results

**Conscious with fixed time**  
**Unconscious thought – anagrams,** e.g., WOSN = snow

*Choice = 1 of 4 cars with 12 attributes. Percentages represent choice of “best” car - Hatsdun*

22% 60%

*Dijksterhuis et al. (2006, Science) – the individual should delegate thinking about complex matters to the unconscious (p. 1007).*

*Dijksterhuis (2004) found that the option characterized by more positive attributes was chosen significantly more often in an unconscious-thought condition (59%) than when participants responded immediately (36%) and was chosen more often, though not significantly so, in the unconscious-thought condition than in a conscious-thought condition (47%).*
Overview of the Payne et al. (2008) studies and hypotheses

• Compared performance in three thought conditions: conscious thought for a fixed time (CT-FT), self-paced conscious thought (CT-SP), and unconscious thought (UCT).

  – Constraining thought time (i.e., CT-FT condition) is perhaps a deficient instantiation of conscious thought if there is too much time to think, so that attention shifts to information of lesser relevance (dilution).

  – Hypothesis that CT-SP > CT-FT.

• Test the three thought conditions in two choice environments. In one environment mimic the environment used before. In a second choice environment, make the magnitudes of the attributes matter more.

  – Hypothesis that CT-SP > UCT in the second environment.
**Do “real outcomes” and the magnitudes of the outcomes matter?**

Participants selected their preferred lottery from four different options. Options were defined by payoffs for 12 equiprobable events defined by drawing 1 of 12 numbered balls from a bingo cage.

This task shares the same basic structure used by Dijksterhuis and his colleagues: four options, 12 attributes (or events), and positive and nonpositive outcomes (money won vs. no money won). However, we varied the magnitude of the positive outcomes (e.g., $2 vs. $13 won). If one assumes more money is preferred to less, the preference ordering over the attribute values is clear; this task allows attribute magnitudes to vary while other factors that might influence weighting are held constant.

We made decisions “real” for our participants by drawing a numbered ball from the bingo cage and providing them with the monetary payoff corresponding to the option they chose. Two types of options are focal: options with the largest number of positive outcomes (the accuracy criterion used in prior work by Dijksterhuis and his colleagues) and options with the highest EV (a standard accuracy criterion for risky choice that takes attribute magnitudes into account).
## Payoffs for the 12 Equal-probable Events and Expected Values for Each Option

<table>
<thead>
<tr>
<th>Game and option</th>
<th>Event (number rolled)</th>
<th>Expected value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Game A</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HiEV (Wynn)</td>
<td>0 0 0 0 0 0 8 9 10 11 12 13</td>
<td>$5.25</td>
</tr>
<tr>
<td>P(win) (Mirage)</td>
<td>0 0 0 2 4 5 6 7 8 9 10 11</td>
<td>$5.17</td>
</tr>
<tr>
<td>Decoy (Mandalay)</td>
<td>0 0 0 0 0 3 5 6 7 12 13</td>
<td>$3.83</td>
</tr>
<tr>
<td>Filler (Venetian)</td>
<td>0 0 0 0 0 0 0 2 3 4</td>
<td>$0.75</td>
</tr>
<tr>
<td>HiEV (Luxor)</td>
<td>0 0 0 0 0 0 8 9 10 12 14 16</td>
<td>$5.75</td>
</tr>
<tr>
<td>P(win) (Rio)</td>
<td>0 0 0 2 3 4 5 6 7 8 9 10</td>
<td>$4.50</td>
</tr>
<tr>
<td>Decoy (Platinum)</td>
<td>0 0 0 0 0 3 5 6 7 14 16</td>
<td>$4.25</td>
</tr>
<tr>
<td>Filler (Sahara)</td>
<td>0 0 0 0 0 0 0 2 4 12</td>
<td>$1.50</td>
</tr>
</tbody>
</table>

**Note.** Outcomes were presented on the screen in a random order. Names of the options are given in parentheses. HiEV = option with the highest expected value; P(win) = option with the greatest probability of winning something.
Payne et al. (2008) – Results - Sample Sizes, Percentage of Participants Choosing Each Option, and EV Gain in Games A and B

<table>
<thead>
<tr>
<th>Game and condition</th>
<th>n</th>
<th>HiEV</th>
<th>P(win)</th>
<th>Decoy</th>
<th>Filler</th>
<th>EV gain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Game A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conscious thought, fixed time (CT-FT)</td>
<td>38</td>
<td>42</td>
<td>21</td>
<td>32</td>
<td>5</td>
<td>.62</td>
</tr>
<tr>
<td>Unconscious thought (UCT)</td>
<td>42</td>
<td>36</td>
<td>45</td>
<td>19</td>
<td>0</td>
<td>.79</td>
</tr>
<tr>
<td>Conscious thought, self-paced (CT-SP)</td>
<td>40</td>
<td>28</td>
<td>50</td>
<td>15</td>
<td>8</td>
<td>.75</td>
</tr>
<tr>
<td><strong>Game B</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conscious thought, fixed-time (CT-FT)</td>
<td>46</td>
<td>30</td>
<td>37</td>
<td>28</td>
<td>4</td>
<td>.36</td>
</tr>
<tr>
<td>Unconscious thought (UCT)</td>
<td>41</td>
<td>27</td>
<td>37</td>
<td>34</td>
<td>2</td>
<td>.33</td>
</tr>
<tr>
<td>Conscious thought, self-paced (CT-SP)</td>
<td>46</td>
<td>52</td>
<td>26</td>
<td>17</td>
<td>4</td>
<td>.56</td>
</tr>
<tr>
<td>Immediate</td>
<td>27</td>
<td>33</td>
<td>26</td>
<td>41</td>
<td>0</td>
<td>.38</td>
</tr>
</tbody>
</table>

EV gain was calculated as follows:
\[
\text{EV gain} = \frac{(\text{EV of chosen option} - \text{EV of decoy})}{(\text{EV of HiEV option} - \text{EV of decoy})};
\]
EV gain was equal to 0 for choice of the filler.
HiEV = option with the highest expected value (EV);
P(win) = option with the greatest probability of winning something.
Additional Results

• The median decision time was significantly lower in the immediate-choice condition (7 s) than in the CT-SP condition (18 s), $\chi^2(1, N = 73) = 12.41, p < .0004$, Cramer’s $\phi = .41$.

• The CT-SP condition was distinguished from the immediate-choice condition in that performance declined as more time was taken in the CT-SP condition, but improved as more time was taken in the immediate-choice, perhaps because of dilution effects as conscious thought proceeded.
Expected Value of Conscious Thought

CT = Conscious Thought & I = Intuitive

<table>
<thead>
<tr>
<th>Kind Environments</th>
<th>Wicked Environments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good Execution</td>
<td>Poor Execution</td>
</tr>
<tr>
<td>Good Execution</td>
<td>Poor Execution</td>
</tr>
<tr>
<td>Good Execution</td>
<td>Poor Execution</td>
</tr>
<tr>
<td>Good Execution</td>
<td>Poor Execution</td>
</tr>
</tbody>
</table>

Analytical
- Conscious thought
- Rule-based
- Make tradeoffs

Quasi-Rational
- Unconscious
- Associative
- Avoid explicit tradeoffs

Intuitive
- How often?
- How much?

Δ(CT – I)  Δ(CT – I)  Δ(CT – I)  Δ(CT – I)

Adapted from Reid Hastie & Robin Hogarth
Summary: Conscious vs. Unconscious

- In a complex task, self-paced conscious thought, like unconscious thought, outperformed a fixed period of conscious thought.

  - Thus, the comparative results for the UCT and CT-FT conditions reported by Dijksterhuis et al. may demonstrate more that a fixed period of conscious thought is a poor way to structure conscious thought than that unconscious thought is generally better than conscious thought.

- When the magnitudes of the payoffs—not just whether the values were good or bad—mattered more, self-paced conscious thought led to better choices than unconscious thought.

- It is critical to take into account the interaction of forms of processing (modes of thought) with the task demands (choice environments) and the ability to implement a strategy when giving prescriptive advice (Payne, Bettman, & Schkade, 1999).
Do features of the problem (cues) determine how much intuition versus reasoning is used? Inbar, Cone, and Gilovich (JPSP, 2010)

- Studies ask people whether it is best to decide on the basis of intuition or rational analysis.
- Subjects were told that some decisions are “made mainly on the basis of intuition or gut feelings” while other decisions are “made mainly on the basis of reason or rational analysis.”
- Rate choice dilemmas on in terms of the extent to which [it] should be based on intuition (1) or rational analysis (9).
- Overall, a slight preference for rational analysis (Cornell students). Large variations across dilemmas, e.g., selecting a dessert to deciding where to locate a toxic dump.
Relationships between Problem Cues and Decision Mode

• The more objective the evaluability of the outcome, the more step-by-step the decision, the more complex the decision, and the more important the decision, the greater the tendency to decide rationally.

• The Ratio-bias paradigm. (1 winner vs. 9 losers) or (9 winners and 91 losers). When the task was framed as more sequential, the choice of the smaller (1 winner of 10%) earn was much higher 70% vs. 38%.

• The more ambiguous the presentation of information (words like exactly versus about) the more people selected the more intuitive and less rational (ambiguity averse) option.
Summary

- Additive Weighting Models
- Heuristic strategies
- Deciding how to decide
- Unconscious versus Conscious Thought