DECISION FIELD THEORY

A Dynamic Connectionist Model of Decision Making

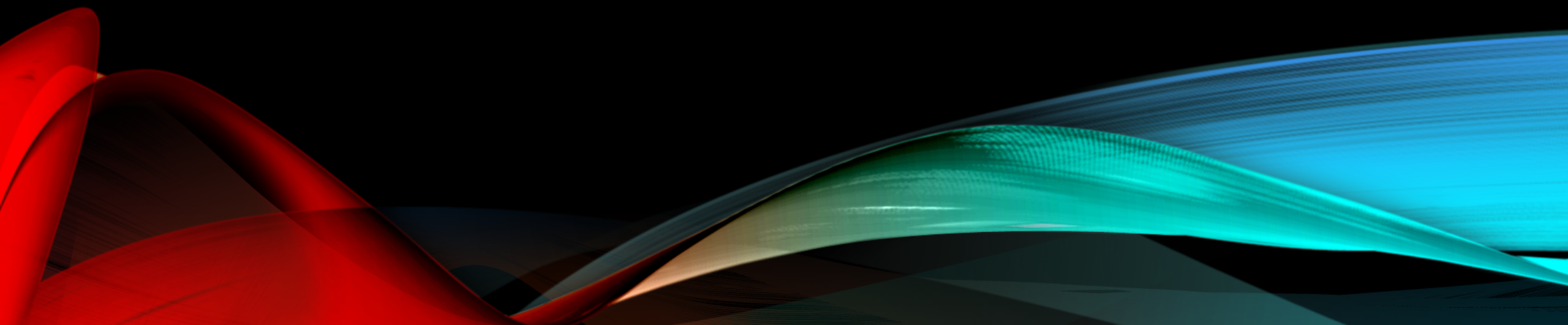
PREFERENTIAL CHOICE

- Large number of alternatives and attributes

- Example: Three cars
  - Three alternatives
  - Two attributes; Economy and Quality
  - Consider three choice effects; Attraction, Similarity, and Compromise

MULTIALTERNATIVE PREFERENTIAL CHOICE

The Basics



MAIN FINDINGS

Similarity Effect

$Pr(A \mid \{A,B\}) > Pr(B \mid \{A,B\})$

BUT

$Pr(A \mid \{A,B,S\}) < Pr(B \mid \{A,B,S\})$

Attraction Effect

$Pr(A \mid \{A,B\}) < Pr(B \mid \{A,B\})$

BUT

$Pr(A \mid \{A,B,D\}) > Pr(B \mid \{A,B,D\})$

Compromise Effect

$Pr(A \mid \{A,B\}) > Pr(B \mid \{A,B\})$

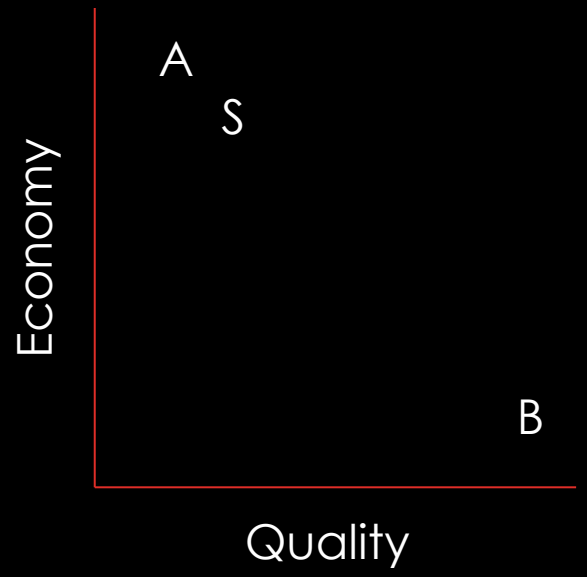
BUT

$Pr(A \mid \{A,B,C\}) \approx Pr(B \mid \{A,B,C\})$

MAIN FINDINGS (CONT)

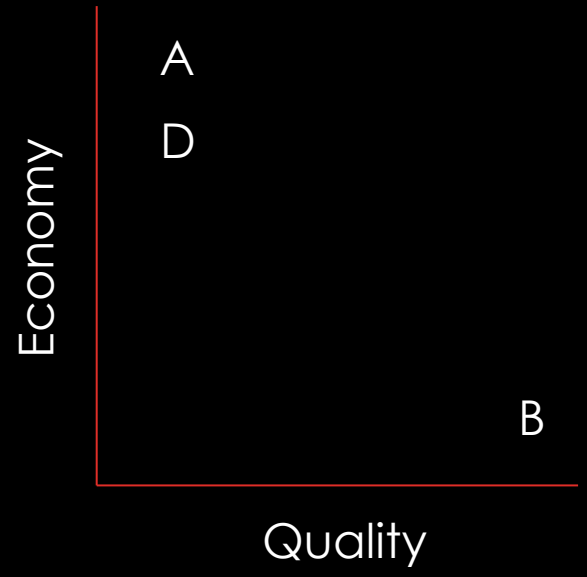
Similarity Effect

Three Cars



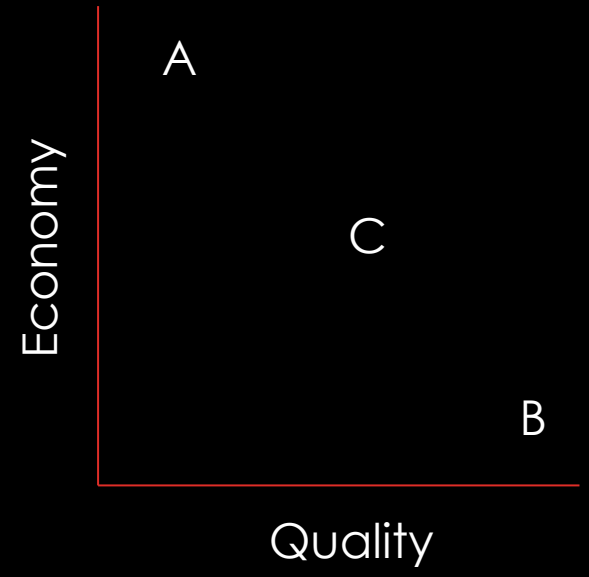
Attraction Effect

Three Cars



Compromise Effect

Three Cars



MULTIALTERNATIVE DYNAMIC DECISION PROCESS

Valences: At any moment in time, each alternative in the choice set is associated with a valence value.

Component 1: Personal evaluation

Component 2: Attention weight

Component 3: Contrast comparison

- $\mathbf{V}(t) = [v_i(t), \dots, v_n(t)]'$

Component 1

- m_{ij}
- $\mathbf{M_j} = [m_i, \dots, m_n]'$
- $\mathbf{M} = [\mathbf{M_j} | \dots | \mathbf{M_n}]$

Component 2

- $W_j(t)$
- w_j
- $\mathbf{W}(t) = [W_j(t), \dots, W_n(t)]'$
- $\mathbf{MW}(\boldsymbol{t})$

Component 3

- $v_i(t) = W_j(t)m_{ij} + \cdots + W_n(t)m_{in} - \frac{[(W_j(t)m_{hj}+\cdots+W_n(t)m_{hn})+\cdots+(W_j(t)m_{gj}+\cdots+W_n(t)m_{gn})]}{n}$
- Process represented by defining a contrast matrix, denoted $\mathbf{C}$.

Matrix Product Form

- $\mathbf{V}(\boldsymbol{t}) = \mathbf{CMW}(t)$

MULTIALTERNATIVE DYNAMIC DECISION PROCESS

Valences: Example: Three cars

- $\mathbf{V}(t) = [v_A(t), v_B(t), v_C(t)]'$

Component 1

- $\mathbf{M_E} = [m_{\mathrm{AE}}, m_{\mathrm{BE}}, m_{\mathrm{CE}}]'$
- $\mathbf{M_Q} = [m_{\mathrm{AQ}}, m_{\mathrm{BQ}}, m_{\mathrm{CQ}}]'$
- $\mathbf{M} = [\mathbf{M_E}|\mathbf{M_Q}]$

Component 2

- $\mathbf{W}(t) = [W_{\mathrm{E}}(t) W_{\mathrm{Q}}(t)]'$

Component 3

- $v_{\mathrm{A}}(t) = W_{\mathrm{E}}(t) m_{\mathrm{AE}} + W_{\mathrm{Q}}(t) m_{\mathrm{AQ}} - \frac{[(W_{\mathrm{E}}(t) m_{\mathrm{BE}} + W_{\mathrm{Q}}(t) m_{\mathrm{BQ}}) + (W_{\mathrm{E}}(t) m_{\mathrm{CE}} + W_{\mathrm{Q}}(t) m_{\mathrm{CQ}})]}{2}$
- $\mathbf{C} = \begin{bmatrix} \mathbf{1} & {}^{-\mathbf{1}}/_{\mathbf{2}} & {}^{-\mathbf{1}}/_{\mathbf{2}} \\ {}^{-\mathbf{1}}/_{\mathbf{2}} & \mathbf{1} & {}^{-\mathbf{1}}/_{\mathbf{2}} \\ {}^{-\mathbf{1}}/_{\mathbf{2}} & {}^{-\mathbf{1}}/_{\mathbf{2}} & \mathbf{1} \end{bmatrix}$

Matrix Product Form

- $\mathbf{V}(t) = \mathbf{CMW}(t)$

MULTIALTERNATIVE DYNAMIC DECISION PROCESS

Preferences: At any moment in time, each alternative in the choice set is associated with a preference strength.

- $P_i(t)$
- $\mathbf{P}(\mathbf{0}) = \mathbf{0}$
- $\mathbf{P}(t) = [P_i(t), \ldots, P_n(t)]$

- $\mathbf{P}(t+1) = \mathbf{S}\mathbf{P}(t) + \mathbf{V}(t+1)$

MULTIALTERNATIVE DYNAMIC DECISION PROCESS

Feedback Matrix: The feedback matrix **S** contains the self-connections and interconnections among the choice alternatives.

- S_{ii}
- S_{ij} for $i \neq j$
- $S_{ij} = F[d(A_i, A_j)]$
- $\mathbf{S} = \begin{bmatrix} 0.95 & -0.09 & -0.001 \\ -0.09 & 0.95 & -0.003 \\ -0.001 & -0.003 & 0.95 \end{bmatrix}$

MULTIALTERNATIVE DYNAMIC DECISION PROCESS

Parameters: Altogether there are four sets of parameters that need to be specified to derive predictions.

- $\mathbf{w}$
- $\mathbf{M}$
- $\epsilon(t)$
- $\mathbf{S}$

SOURCES

- Roe, R. M., Busemeyer, J. R., & Townsend, J. T. (2001). Multialternative decision field theory: A dynamic connectionst model of decision making. *Psychological review*, *108*(2), 370.
- Jessup, R. (2019). Personal interview with L Stevens.