

**Under the Neuroeconomics Umbrella: A Framework for Evaluating, Improving, and Modeling
Nutrition Interventions**

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Under the Neuroeconomics Umbrella: A Framework for Evaluating, Improving, and Modeling Nutrition Interventions

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Outline:

I. Setting the Stage

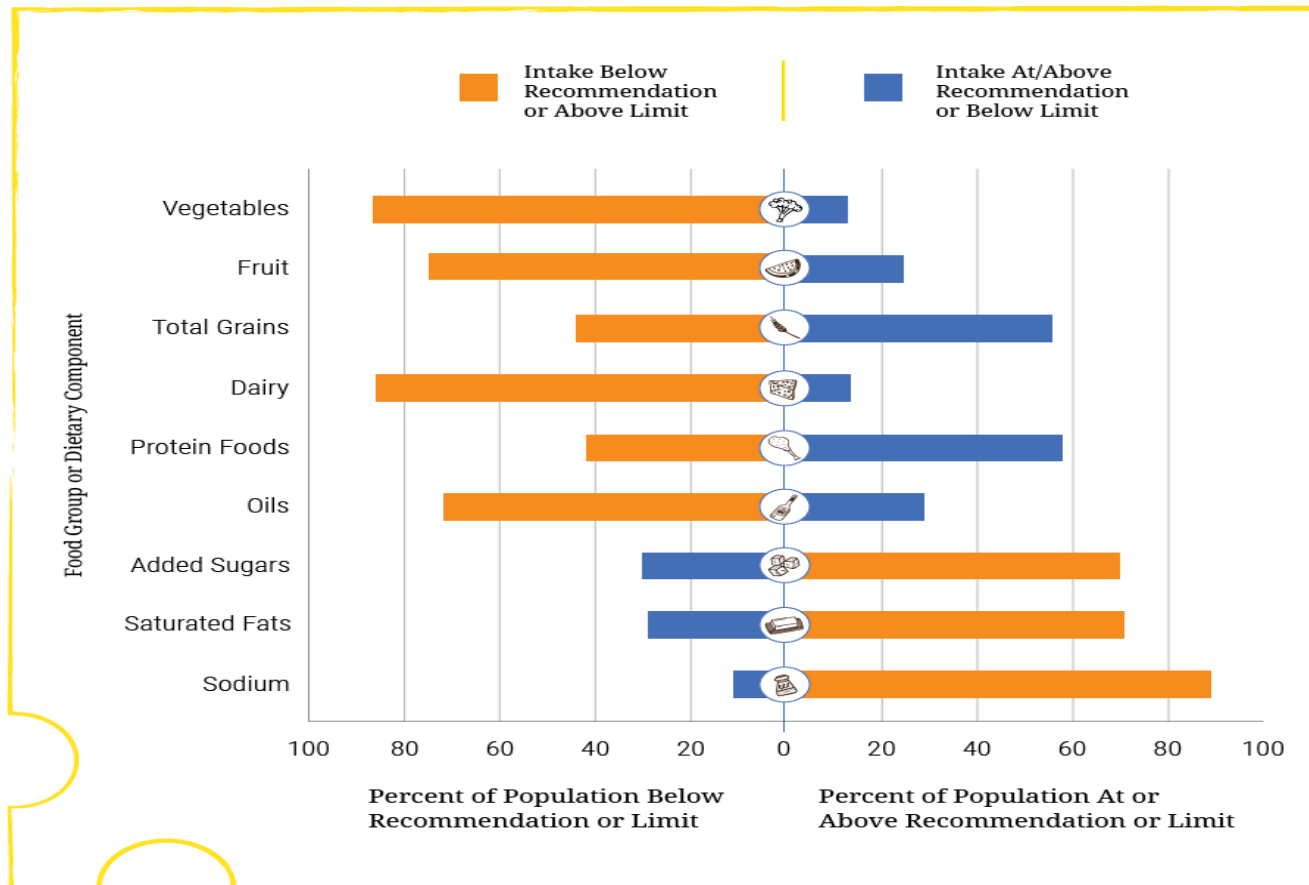
II. Cognitive Resources, Dual Systems and Objectives Framework

III. Can Neuroeconomics and Behavioral Economics Help?

IV. Implications for Some Common Interventions/Policies and
Modeling

V. Conclusions

The Problem



Source: Dietary Guidelines of America. 2015-2020. Chapter 2. Figure 2.1



What are some typical solutions?
(i.e., interventions, policies, programs)



What is common across all of these interventions?

There is some **degree** of information processing
(and subsequent decision making)

Information Processing Degree



Low

High



II. Cognitive Resources, Dual Systems & Objectives

A decision task can be thought of as having a certain cognitive load.

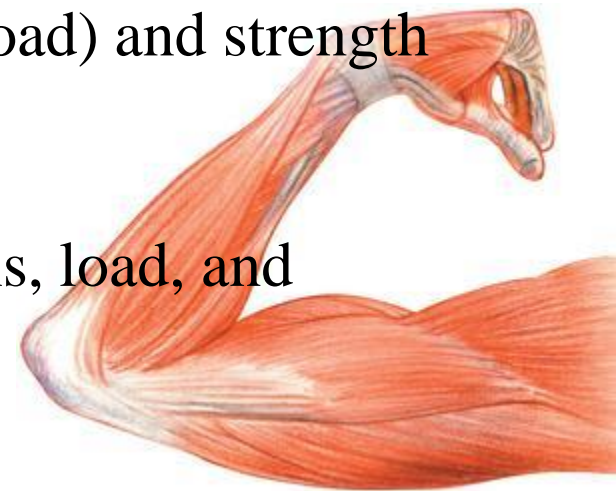
(Standard) Cognitive load – The total amount of mental effort being used in **working memory** in an instructional context (Sweller 1984).



(General) Cognitive load – The weight or demands on **executive control systems** in the brain associated with any activity.

The muscle analogy (e.g., [Muraven and Baumister 2000](#)).

- Muscle endurance depends on weight (load) and strength of muscle.
- Muscle strengthening requires repetitions, load, and success.





Key Concepts

- Cognitive resources at any given point in time are limited and can be depleted.

- Cognitive resources must be allocated to different tasks (*cognitive resource allocation model*)
(e.g., Alonso, Brocas, Carillo 2014; Kool and Botvinick 2014)



- **Dual Systems Processing** (e.g., Evans 1984; Kahneman 2011)

(i) *System 1* - uses a fast, reflexive, automatic, and perhaps ‘mindless’ process that operates heuristically and expends little cognitive resources.

(ii) *System 2* - uses a slow, reflective, analytical, and deliberate process that expends many cognitive resources.



What types of food or evaluation decisions fall into each system?

- System 1

- Ex: candy bowl on your desk
- ‘finishing off’ the fries
- others?

- System 2

- Ex: comparing food labels for two different products
- calculating calories for a meal
- others?



Dual Objectives/Reasons for Food Consumption

(1) ***Hedonics*** – *any immediate sensory effects.*

(2) ***Health*** – *any health effects.*

(Antonides and Cramer 2013; Shiv and Fedorikhin 1999; Sullivan et al. 2015)



Three Major Implications of the Cognitive Resource Allocation Model and Dual Systems/Objectives

1. Cognitive effort is minimized implying a preference for system 1 (e.g., Kool, et al. 2010, 2014).

2. Resource depletion contributes to system 1 use (e.g., Pocheptsova, et al. 2009).

- As your cognitive budget goes down, you are more likely to choose system 1 types of decisions



3. Hedonic decisions are associated with system 1, long-term and health-related decisions are associated with system 2 (e.g., Antonides and Cramer, 2013; Shiv and Fedorikhin, 1999).

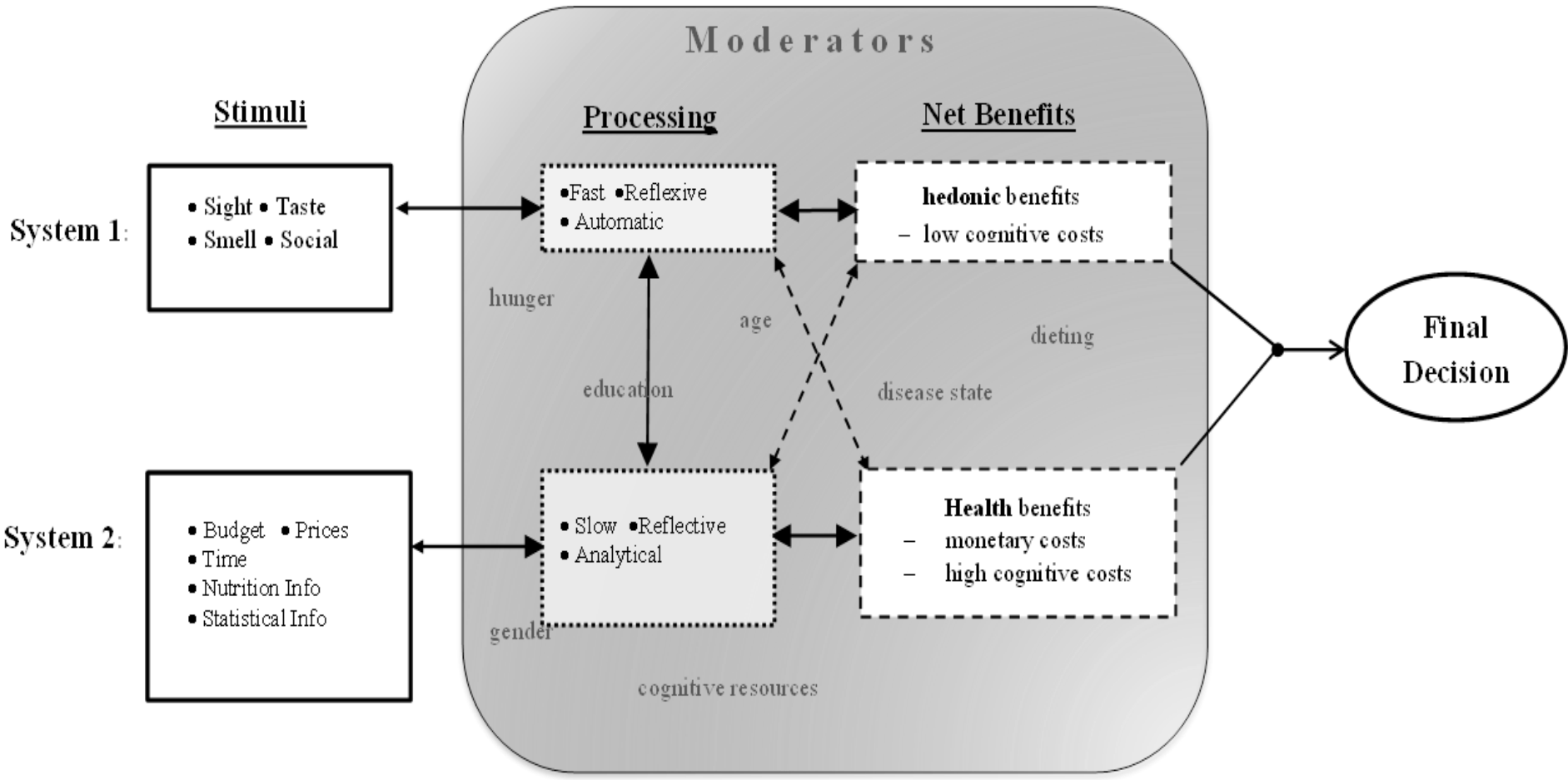


Figure 10.1. Dual Systems - Dual Objectives Schematic of Food Choices Source: Davis and Serrano (2016)



THOUGHT EXPERIMENT #1: MENU CHOICE



Signature
SALADS

<i>New!</i> mediterranean salmon	8.59
bbq chopped chicken	7.59
chopped chicken cobb	7.59
<i>New!</i> salmon caesar	7.99
grilled chicken caesar	6.89
asian sesame chicken	6.99
fuji apple chicken	6.99

Cafe
SALADS

greek salad	5.69
caesar salad	5.29
classic salad	5.29

SIDE CHOICES

WITH YOUR SOUP, SALAD, SANDWICH OR YOU PICK TWO*

french baguette slice
whole grain baguette slice
potato chips
apple

- You are participating in a university experiment about choosing healthy foods?
- Which one would you choose?



Signature **SALADS**

		CALORIES	
		1/2	WHOLE
<i>New!</i> mediterranean salmon	8.59	270	540
bbq chopped chicken	7.59	250	500
chopped chicken cobb	7.59	250	500
<i>New!</i> salmon caesar	7.99	240	480
grilled chicken caesar	6.89	250	510
asian sesame chicken	6.99	200	410
fuji apple chicken	6.99	260	520

Cafe **SALADS**

greek salad	5.69	220	430
caesar salad	5.29	200	390
classic salad	5.29	80	170

SIDE CHOICES

WITH YOUR SOUP, SALAD, SANDWICH OR YOU PICK TWO*

french baguette slice	180
whole grain baguette slice	190
potato chips	160
apple	80

-You are participating in a university experiment about choosing healthy foods?
-Which one would you choose?



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SALADS

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SIDE CHOICES

WITH YOUR SOUP, SALAD, SANDWICH OR YOU PICK TWO*

french baguette slice	
whole grain baguette slice	
potato chips	
apple	

-You are attending a working meeting with your colleagues and are offered a box lunch with the signature salad selections to the left?
-Which one would you choose?



Signature
SALADS

<i>New!</i> mediterranean salmon	8.59
bbq chopped chicken	7.59
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SIDE CHOICES

WITH YOUR SOUP, SALAD, SANDWICH OR YOU PICK TWO*

french baguette slice
whole grain baguette slice
potato chips
apple

-You are super hungry and eating alone.

-You can choose whatever you want, including side choice.

-Which one would you choose?



Signature **SALADS**

		CALORIES	
		1/2	WHOLE
<i>New!</i> mediterranean salmon	8.59	270	540
bbq chopped chicken	7.59	250	500
chopped chicken cobb	7.59	250	500
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french baguette slice	180
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potato chips	160
apple	80

- You are super hungry.
- But you only have \$7.50 in cash and no credit card.
- You are also trying to manage your portion size and calories, so want to limit your main item and side choice to a total of 600 calories.
- Which one would you choose?



Signature SALADS

		CALORIES	
		1/2	WHOLE
<i>New!</i> mediterranean salmon	8.59	270	540
bbq chopped chicken	7.59	250	500
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SIDE CHOICES

WITH YOUR SOUP, SALAD, SANDWICH OR YOU PICK TWO*

french baguette slice	180
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potato chips	160
apple	80

- After sitting in the doctor's office for 1.5 hours and a 5 minute exam, he said your 2 yr. old just has a cold and the visit will cost you \$75.
- You now only have \$25.
- Your spouse said pick up dinner for 3.
- Which one would you choose?





Food Consumption Decisions

- [Wansink and Sobal \(2007\)](#) estimate each day each person may be confronted with up to **200-related food and beverage-related decisions**, many unknowingly or ‘mindless’
- But, **food is not the only thing we make decisions about**



Thought Experiment #2: Working Single Mom

- You have **three kids**, two in elementary school and one in middle school
- You are single and the **sole financial provider and caregiver** for your kids.
- The kids are involved in different **after school activities**.
- You **don't own a reliable car**. You work with other parents to carpool your kids to different activities, which are all at different times.
- Your **elderly parents live in the area** and one has been diagnosed with **Alzheimer's**.
- You **did not finished high school and work at a retailer making \$25,000 per year**.
- You have **chronic foot pain**.
- You **did not learn to cook** and given your schedule, you prefer to eat out.



What are the system 1 vs system 2 implications for food choices under this scenario?

What are the system 1 vs system 2 implications for interventions and policy?



III. CAN NEURO ECONOMICS & BEHAVIORAL ECONOMICS HELP?

Neuroeconomics is a relatively new field of economics that combines methods and theories from neuroscience, psychology, economics, and computer science to better understand the process of economic decision making and the resulting choices.

(Brocas and Carillo 2008; Camerer, Loewenstein, Prelec 2005; Fehr and Rangel 2011; Glichmer and Rustichini 2004).



A behavioral effect is a systematic and repeatable tendency toward a choice alternative resulting from the interaction of a choice environment attribute with a psychological attribute.



Four Behavioral Economic Effects Relevant for Food Choices

1. *Environmental cue effect* is a tendency to increase or decrease consumption in response to an environmental cue
 - Most Wansink “mindless” type effects
 - Examples: proximity of food, odor, serving size, noise, music, lighting, socialization
 - Key: System 1 processing



2. *Default effect* - the tendency to accept the option made available, even when some apparently more preferable alternative is available

- Weak vs Strong Defaults
- Example: Combo meal with side of fries vs side of apple slices
- Key: System 1 processing



3. *Ambiguity effect* is the tendency for individuals to choose options where the probability of a favorable outcome (e.g., taste) is known over an option where the probability of the favorable outcome is unknown

- Hedonic known, Health is ambiguous
- Ex: future effects of an healthy unsavory meal; role of taste preference
- Key: System 2 processing required to evaluate



4. *Decision fatigue effect* is the tendency for the quality or consistency of decisions to erode as more decisions have to be made (e.g., multiple decisions or temptations)

- Ex: Eating when traveling with many unknowns; Being extremely tired; single, limited resource, mother example; weight management strategies.
- Key: System 2 processing leads to decision fatigue faster



IV. IMPLICATIONS FOR SOME COMMON INTERVENTIONS/POLICIES

Intervention	Instrument/Behavioral Effect	System	Likely Effectiveness
Soft Drink Tax	Price		

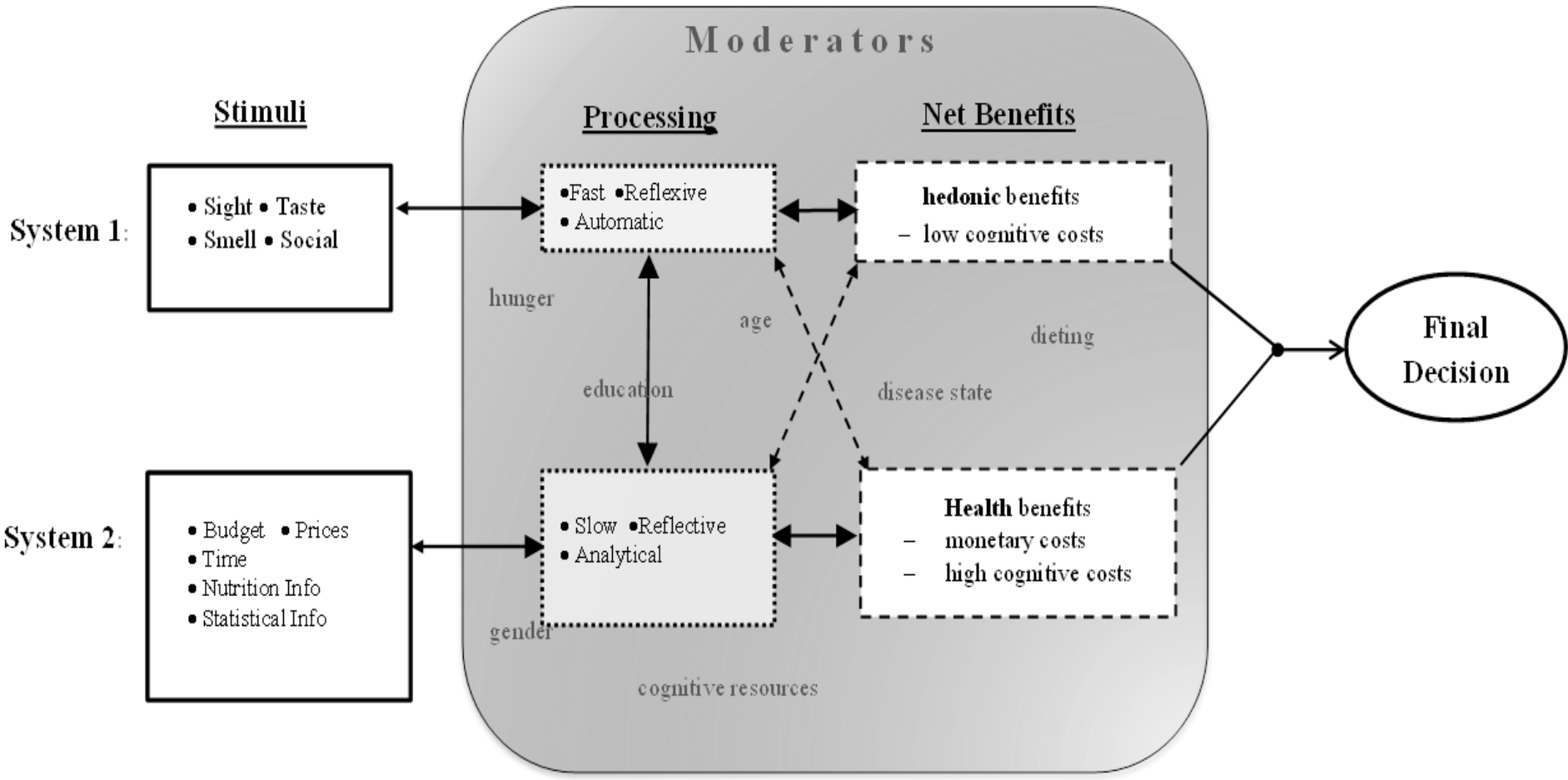


Figure 10.1. Dual Systems - Dual Objectives Schematic of Food Choices



Intervention	Instrument/Behavioral Effect	System	Likely Effectiveness
Soft Drink Tax	Price	2	Low



Intervention	Instrument/Behavioral Effect	System	Likely Effectiveness
---------------------	-------------------------------------	---------------	-----------------------------

Soft Drink Tax

Price

2

Low

Redesign Facts Panel

Redesigned Facts Panel

Nutrition Facts	
8 servings per container	
Serving size	2/3 cup (55g)
Amount per 2/3 cup	
Calories	230
% DV*	
12%	Total Fat 8g
5%	Saturated Fat 1g
	<i>Trans Fat</i> 0g
0%	Cholesterol 0mg
7%	Sodium 160mg
12%	Total Carbs 37g
14%	Dietary Fiber 4g
	Sugars 1g
	Added Sugars 0g
	Protein 3g
10%	Vitamin D 2mcg
20%	Calcium 260mg
45%	Iron 8mg
5%	Potassium 235mg
* Footnote on Daily Values (DV) and calories reference to be inserted here.	

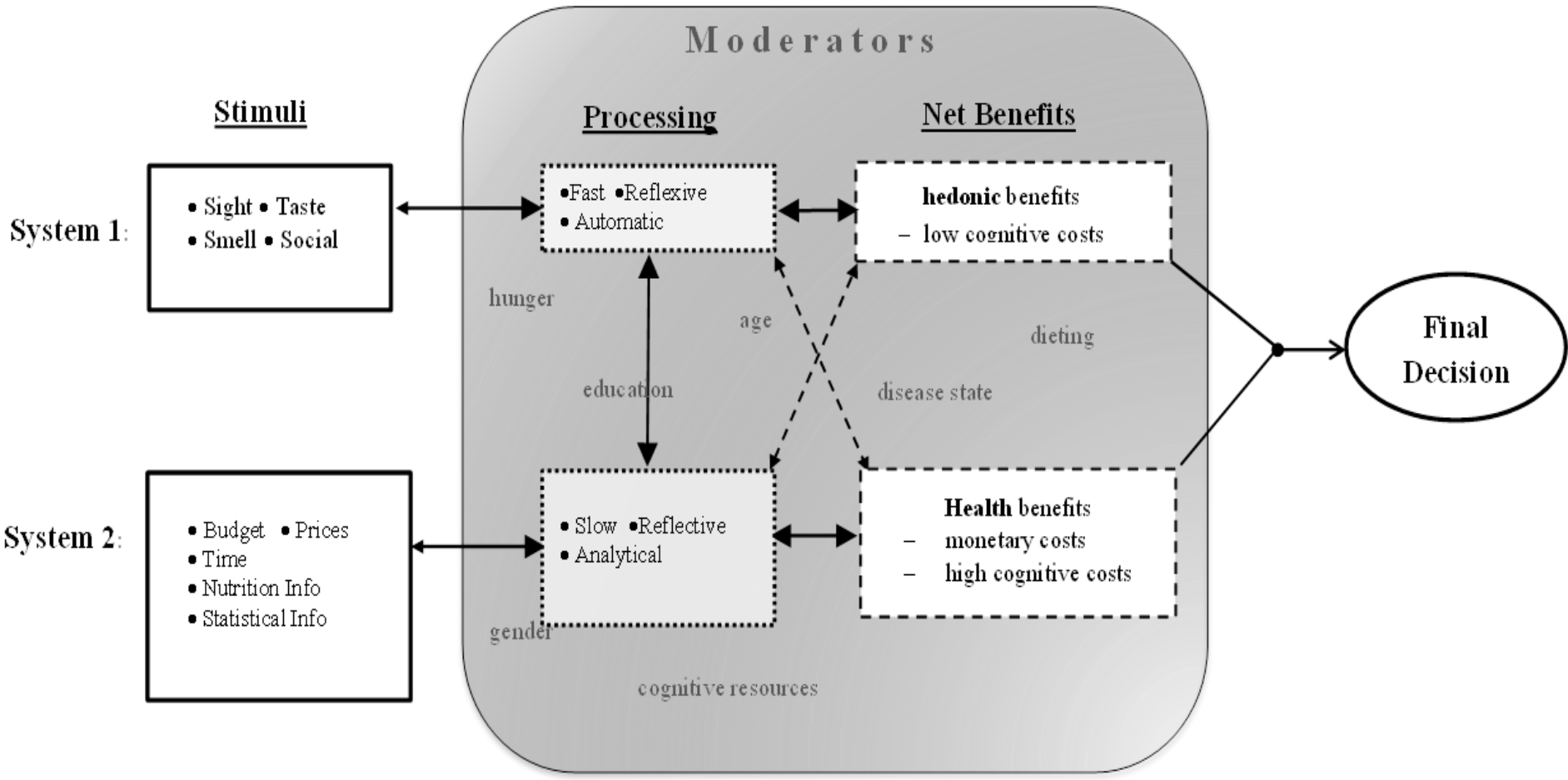


Figure 10.1. Dual Systems - Dual Objectives Schematic of Food Choices



Intervention	Instrument/Behavioral Effect	System	Likely Effectiveness
Soft Drink Tax	Price	2	Low
Redesign Facts Panel	Knowledge/Ambiguity	2	Low
Nutrition Curriculum	Knowledge/Ambiguity	2	Low
Smart Lunchroom Design	Environmental Cues, Default Effects		

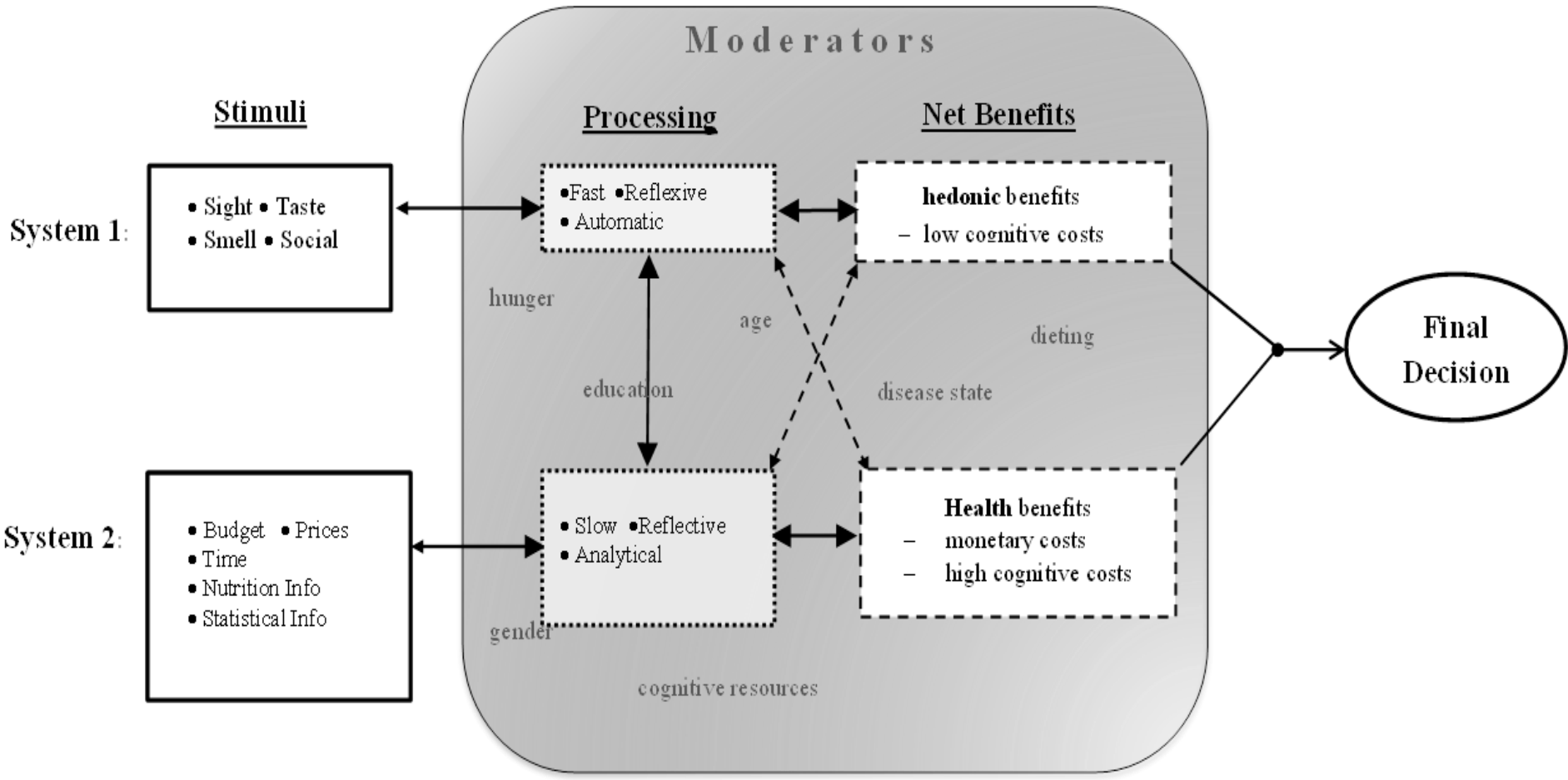


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Intervention	Instrument/Behavioral Effect	System	Likely Effectiveness
Soft Drink Tax	Price	2	Low
Redesign Facts Panel	Knowledge/Ambiguity	2	Low
Nutrition Curriculum	Knowledge/Ambiguity	2	Low
Smart Lunchroom Design	Environmental Cues, Default Effects	1	Higher



Sketch of Random Utility Based Model

Key Components:

- Household production type utility function
- “Commodities” being produced with food choice are hedonic and health
- Hedonic effect is immediate, sensory based.
- Health effect is in the future and “discounted” because of time preferences and uncertainty of health effects
- The “full price” includes out-of-pocket cost, time cost, and cognitive cost.
- System I stimuli affect hedonic component, but also time preference weight and cognitive cost.
- System II stimuli affect Health component, but also time preference weight, certainty weight, and cognitive cost.



Sketch of Random Utility Based Model

Conceptual Structure:

- **Mediators** – Channels through which variables/stimuli operate. Opening the “Black Box”.
- **Moderators** – Factors that accentuate or attenuate the effects of variables.
- **Mediators** in this model for food choices are
 - Commodities, Discount weight, Certainty weight,
 - Income and time constraints – price and time cost
 - Cognitive resources - cognitive cost
- **Moderators** in this model for food choices are
 - Education, Age, Gender, etc



Direct Frischian Net Utility Function (O'Donohue and Rabin; Ruhm)

$$U_{ij} = [h(F_j) + \beta_j \cdot \rho_j \cdot H(F_j)] - (p_j + w_j t_j + c_j) F_j$$

With System I and II Stimuli

$$U_{ij} = [h(F_j; S_j^I) + \beta_j(S_j^I, S_j^{II}) \cdot \rho_j(S_j^{II}) \cdot H(F_j; S_j^{II})] - [p_j + w_j t_j + c_j(S_j^I, S_j^{II})] F_j$$

Indirect Utility Function for Estimation with Moderators with error

$$V_j = (S_j^I, S_j^{II}, p_j, w_j, t_j, c_j; M) + \varepsilon_j$$



Standard Probit RUM Implementation

$$\text{Prob}(V_j > V_k) = \Phi(S^I, S^{II}, p, w, t, c; M)$$



Conclusions

- The neuroeconomics, cognitive resources, and dual systems and objectives approach to thinking about food decisions is a unifying framework for analyzing both traditional and behavioral economic factors.
- Progressive programs will not only consider the content of the information being provided, but will also considered ways to reduce its cognitive load in order to make them more effective.



Conclusions

- While one can certainly look at “derived” reduced form RUM choice models, more progress is likely to be made by exploring to what extent factors and moderators affect the mediators as this will help us better understand the decision making process.