The New Science of Pleasure
Consumer Behavior and the Measurement of Well-Being

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Frisch Lecture
Econometric Society World Congress, London
August 20, 2005

ABSTRACT: Economists since the days of Adam Smith and Jeremy Bentham have traditionally viewed consumers as driven by relentless and consistent pursuit of self-interest, with their choices in the marketplace providing all the measurements needed to reveal their preferences and assess their well-being. This theory of the consumer is empirically successful, and provides the foundation for most economic policy. However, the traditional view is now being challenged by new evidence from cognitive psychology, anthropology, evolutionary biology, and neurology. This paper surveys this evidence and what it implies for the measurement of consumer choice behavior and well-being.

[1]This research was supported by the E. Morris Cox endowment at the University of California, Berkeley, and by the National Institute on Aging of the National Institutes of Health.

Contents

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1. At the bottom of the food chain of economic analysis is the consumer, whose behavior and well-being motivate the whole gauntlet of questions from mechanism design to incentive theory to project evaluation. Understanding and modeling consumer well-being was central in early economics, and remains so. The neoclassical model of the consumer is largely a finished subject, but new studies of consumer behavior and interesting new measurements challenge this model. I anticipate that this modern behavioral revaluation of the consumer will lead to profound changes in the way economics is done.

2. This paper surveys the history of measurement of consumer behavior and well-being, with particular attention to the lessons and opportunities afforded by new measurement methods coming into economics from cognitive psychology, anthropology, market science, and neurology. I will not sweep clean – many important subjects and important contributors are going to be left out or covered superficially, and for this I apologize. I will concentrate on the perceptions, emotions and behavior of individual consumers, and will not take up the important issues of interpersonal comparisons, social choice, and economic policy evaluation.

In outline, I will start with the views of some of the classical economists on happiness and utility. I will discuss first attempts at measurement, followed by the flowering of demand analysis in the age of Sir Richard Stone. I will then turn to expansions of neoclassical demand measurement, and finally to the new frontiers of measurement shared by economics and other disciplines.

I. Pleasure, Pain, Utility

3. Systematic study of consumer motivation and well-being started with Jeremy Bentham, who still sits in University College London, and is the life of any party of economists that he joins. In Introduction to the Principles of Morals and Legislation, published in 1789, Bentham laid out the concepts of consumers driven by self-interest to increase pleasure and reduce pain: "My notion of man is that ... he aims at happiness ... in every thing he does." Bentham and his successors explored the economic implications and moral content of utilitarianism, but despite their quantitative rhetoric, they were not much concerned with the actual measurement of happiness. It is not that they considered utility unmeasurable. Quite the opposite: utility existed, and its measurement was in their view a task that could be left to the psychometricians. Choice was viewed as an automatic consequence of self-interest, not as behavior that could put utilitarianism to test. Pursuit of happiness explained everything, and predicted nothing.

4. A comment by Taussig (1912), at the end of the classical era, summarizes nicely the utilitarian attitude:

> "An article can have no value unless it has utility. No one will give anything for an article unless it yield him satisfaction. Doubtless people are sometimes foolish, and buy things, as children do, to please a moment's fancy; but at least they think at the moment that there is a wish to be gratified. Doubtless, too, people often buy things which, though yielding pleasure for the moment, or postponing pain, are in the end harmful. But here ... we must accept the consumer as the final judge. The fact that he is willing to give up something in order to procure an article proves once for all that for him it has utility, – it fills a want."

5. It is interesting to review the writings of Bentham and his successors, not for how to measure well-being, but rather for what it is one is trying to measure, the nature of pleasure and pain, and the reach and limits of utilitarianism.

Bentham thought about the pursuit of happiness in ways that did not fit into the later neoclassical synthesis, but which resonate with contemporary behavioral studies. Bentham's utility was attached to the experience or sensation that objects and actions produced, their pleasure-increasing or pain-reducing effect. Later, utility became identified with a state of being, with the consequences of actions rather than the processes producing these consequences. The behavioral revaluation supports the earlier view that attaches utility to process rather than to consequence. Second, Bentham almost always distinguished increased pleasure and reduced pain as two distinct sources of happiness. Perhaps this was just his disposition to say anything worth saying more than once. Or, perhaps he recognized early on that organisms quickly habituate, and are asymmetrically sensitive to gains and losses from homeostasis. Third, he stated that enlightened self-interest involved reciprocity, and the well-being of others influenced one's own well-being.

Fourth, he laid out four critical dimensions that determine the utility of an experience: intensity, duration, certainty vs. uncertainty, and propinquity or remoteness. Clearly, Bentham's first two dimensions anticipated the utility of an episode as an integral of intensities over some duration, although formalization of that idea would not come until Edgeworth a century later. The third dimension anticipated a utility theory for risky prospects, and the fourth, intertemporal preferences and discounting.

6. Edgeworth in 1880 bridged the classical and neoclassical traditions in consumer theory. In his classical mode, he thought of utility as something palpable, amenable to measurement by the psychometricians and best left to the practitioners of that profession. He did call, somewhat wistfully, for a hedinometer that could read out the intensity of pleasure:

> "Let there be granted to the science of pleasure what is granted to the science of energy, to imagine an ideally perfect instrument, a psychophysical machine, continually registering the height of pleasure experienced by an individual, exactly according to the verdict of consciousness, or rather diverging therefrom according to a law of errors. From moment to moment the hedonimeter varies; the delicate

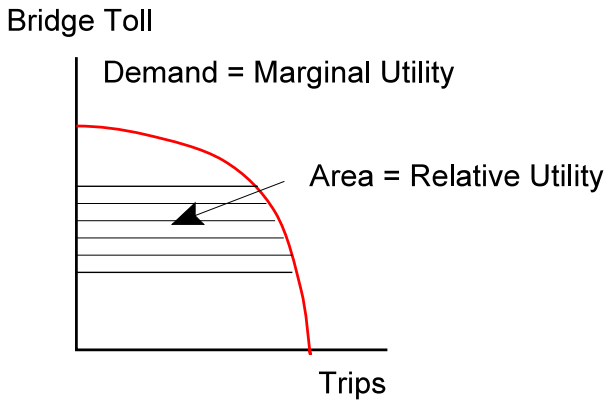
index now flickering with the flutter of the passions, now steadied by intellectual activity, low sunk whole hours in the neighbourhood of zero, or momentarily springing up toward infinity. ”

7. Edgeworth envisioned the level of happiness associated with an experience as the integral of the intensity of pleasure over the duration of the event, a formalization of Bentham's original dimensions, and the beginning of the neoclassical theory of intertemporal utility:

The continually indicated height is registered by photographic or other frictionless apparatus upon a uniformly moving vertical plane. Then, the quantity of happiness between two epochs is represented by the area contained between the zero-line ... and the curve traced by the index.”

Edgeworth went on, following William Stanley Jevons, to consider the possible complication that the same objective time may correspond to different *rates* of thought and feeling in different periods, so that two dimensions are required to characterize utility, the *intensity* of pleasure (measured in just perceivable increments) and *subjective time*. This distinction reappears in the modern behavioral revaluation, where the *sensation* that objects or actions produce is termed *experience utility*, recorded either in real time (*instant utility*) or in retrospective evaluation of past episodes (*remembered utility*). The subjective time of Jevons and Edgeworth anticipated differences between remembered utility and the integral of instant utilities, and intertemporal inconsistency in discounting of future instant utilities.

8. Adam Smith in (1776) described how "haggling and bargaining in the market" would achieve "rough equality" between value in use and value in exchange. Working at the fringes of mainstream economics, Jules Dupuit in 1844 and Hermann Gossen in 1854 deduced that consumers exhibiting diminishing marginal utility would achieve maximum utility by equalizing across various goods the marginal utility per unit of expenditure. Dupuit was remarkably prescient, recognizing that the demand curve can be identified with a marginal utility curve for a good, provided the marginal utility of money remained constant, and showing that the area behind the demand curve then gave a measure of “relative utility”, or *consumer surplus* in Marshall's later terminology.



9. Dupuit's idea of solving the inverse problem, recovering utility from demand, was brought into the mainstream by Jevons, Edgeworth, John Marshall (1899), and Vilfredo Pareto (1900) at the end of the 19th century, and remains today the standard approach to

measuring and predicting consumer welfare. At that time, economists also began to step back from introspective explanations of utility, instead treating it as a black box whose inner workings were not their concern. Two quotes from Irving Fisher's thesis in 1892 make this clear.

> To fix the idea of utility, the economist should go no further than is serviceable in explaining economic facts. It is not his province to build a theory of psychology.
>
> Whether the necessary antecedent of desire is "pleasure", or whether independently of pleasure it may sometimes be "duty" or "fear" concerns a phenomenon of the second remove from the economic act of choice.

The emphasis on characterizing utility solely by the demand behavior it produced became the centerpiece of neoclassical consumer theory, perfected by Eugen Slutsky (1915), John Hicks (1939) and Paul Samuelson (1947), and in its purest statement forming the theory of revealed preference. This was a great logical achievement, but the demands of measurement also narrowed and stiffened the way economists thought about preferences. The domain of utility moved from activities or processes to the commodity vectors that were their consequences, and self-interest was defined narrowly to include only personally purchased and consumed goods, so that reciprocity and altruism became inconvenient complications.

II. First Measurements

10. It is convenient in discussing measurement of neoclassical utility to use the theory of duality, with indirect utility functions and expenditure functions linked to demands through Roy's identify and Shephard's identity, respectively. Major features of these dual functions follow from the envelope theorem, developed by Rudolph Auspitz and Richard Lieben in 1889, and applied to consumer theory first by Irving Fisher, and later by Harold Hotelling (1935), Rene Roy (1942), and Paul Samuelson (1947). The full power of dual methods for derivation of demand systems or recovery of utility in econometric applications was not realized until the end of the 1950's, after the circulation of Fenchel's unpublished lecture notes on convexity, and the demonstration by Ron Shephard of the formal duality of input requirement sets and cost functions. I myself learned from Marc Nerlove and Hirofumi Uzawa how dual methods could be used to develop demand systems and implement econometric models of production and utility. For notation, let $\mathbf{p} = (p_1,\ldots,p_n)$ denote a price vector, $\mathbf{x} = (x_1,\ldots,x_n)$ denote a vector of demands, $u = U(\mathbf{x})$ a utility function, $u = V(y,\mathbf{p})$ an indirect utility function, and $y = M(u,\mathbf{p})$ an expenditure function. Then,

$$V(y,\mathbf{p}) = \max_x \{U(\mathbf{x}) \mid \mathbf{p}\cdot\mathbf{x} \leq y\},$$

$$M(u,\mathbf{p}) = \min_y \{\mathbf{p}\cdot\mathbf{x} \mid U(\mathbf{x}) \geq u\},$$

and market demands satisfy

$$\mathbf{x} = X(y,\mathbf{p}) = -V_p(y,\mathbf{p})/V_y(y,\mathbf{p}) = M_{\underline{p}}(u,\mathbf{p})|_{u=V(y,p)}$$

by the Roy and Shephard identities. One has the duality mappings

$$y \equiv M(V(y,\mathbf{p}),\mathbf{p})$$

$$U(\mathbf{x}) = \min_p V(\mathbf{p}\cdot\mathbf{x},\mathbf{p}) = \min \{u|\mathbf{p}\cdot\mathbf{x} \geq M(u,\mathbf{p}) \text{ for all } \mathbf{p}\}$$

11. In the days before digital computers, data on consumer behavior was limited and statistical computation was laborious. Consequently, empirical measurement of utility came slowly. One of the first serious attempts was made by Ragnar Frisch in 1932, specializing a framework initially proposed by Irving Fisher, and using 31 monthly observations from 1920 through 1922 on income and the price and consumption of sugar in Paris. Frisch's formulation now seems restrictive and a little awkward, but it was suited to the computational limits of the day and contained several important ideas, notably separable utility and composite commodities. In modern terminology, Frisch postulated that the demand for sugar could be written as the inverse of the marginal utility of sugar divided by the marginal utility of money:

$$x = X(y/P,p/P) \equiv f'(p/P)/g'(y/P),$$

where p was the price of sugar, y was income, P was a price index for a composite of the remaining commodities, g' was a decreasing function interpreted as the marginal utility of money, and f' was a decreasing function interpreted as the inverse marginal utility of sugar.

This demand function has an associated indirect utility function with an additively separable structure

$$u = V(y/P,p/P) = g(Y/P) - f(p/P),$$

and the property that the marginal utility of money is independent of the price of sugar. This form satisfies the quasi-convexity requirement on indirect utility functions on a domain where g is less concave than f. This allows the (scaled) relative utility associated with two different sugar prices to be computed by the Dupuit-Marshall device,

$$V(y/P,p'/P) - V(y/P,p''/P) = g'(y/P)\cdot\int_{p'}^{p''} X(y/P,p/P)\,dp/P.$$

III. The Stone Age

12. Econometric demand analysis flowered in the 1960's, as improved data and digital computers made serious empirical work possible. The real starting point was the contribution of Richard Stone in 1954, who worked with demand systems linear in income that were derived from Cobb-Douglas demands, translated to allow committed expenditures,

$$x_i = C_i(p_1,...,p_n) + \theta_i(y - C(p_1,...,p_n))/p_i \ .$$

Here, y is income, $p_1,...,p_n$ are commodity prices, $C(p_1,...,p_n)$ is a committed expenditure, concave and linear homogeneous in prices, and $\theta_1,...,\theta_n$ are positive parameters summing to one. The Stone system is a special case of Terance Gorman's polar form,

$$x_i = C_i(p_1,...,p_n) +(y - C(p_1,...,p_n))/P_i(p)/P(p),$$

derived from an indirect utility function $u = (y – C(p))/P(p)$, where committed expenditure C(p) and a price index P(p) are concave, conical functions. The Gorman polar form can be generalized by introducing a monotone transformation of deflated income,

$$u = g(y/P(p)) - C(p)/P(p),$$

allows more general Engle curves. Frisch's original solution for analysis of the demand for sugar is of this generalized Gorman polar form.

13. In the 1960' and 1970's, a variety of econometric demand systems were proposed, many derived from specifications of expenditure or indirect utility functions. A number of these developments were done at Berkeley. One of the first was developed in 1963 by my student Erwin Diewert from a cost function that was quadratic in square roots of prices. I pointed out that since this system could be interpreted as a second-order Taylor's expansion of any smooth cost function, it had the nice property that at the approximation point it could reproduce all the own and cross-price elasticities of the original. We named this the flexible functional form property, and it became one of the criteria guiding subsequent developments. My colleague Dale Jorgenson and his student Larry Lau devised the translog system, another flexible functional form. Another major contribution to the specification of demand systems, influenced by both the Berkeley tradition and by Terance Gorman, is the Almost Ideal Demand System proposed by Angus Deaton and John Muellbauer. This is a Gorman generalized polar form with translog committed expenditures and a Cobb-Douglas price index.

14. The utility-consistent demand systems introduced in the 1960's and 1970's generally worked well to explain demand at the market level. A recent paper by Lester Taylor (2005) summarizes results from estimating neoclassical demand systems using U.S. Consumer Expenditure Survey quarterly expenditure by urban area and ACCRA Cost of Living indices across urban areas in six expenditure categories. Taylor points out that there are substantive aggregation, quality, and taste heterogeneity issues in the use of such data, but his results are generally consistent with other studies, and consistent across different functional forms. He finds that Stone, indirect addilog, and direct addilog systems give qualitatively similar results.

Lester Taylor, 2005

Price and Total Expenditure Elasticities
Almost Ideal Demand System
CES-ACCRA Surveys 1996

(calculated at sample mean values)

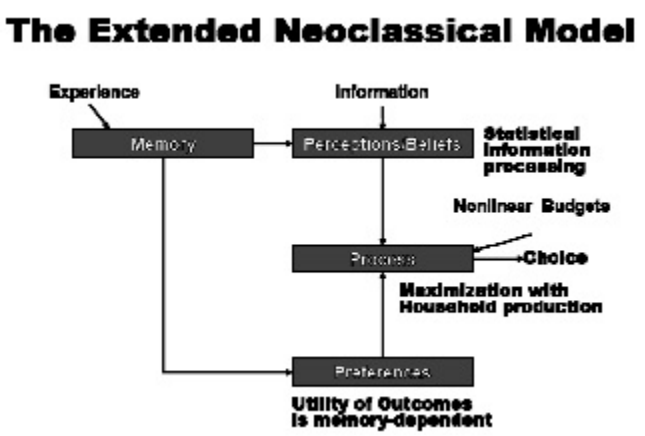
	food	shelter	utilities	trans.	healthcare	misc.	total expenditure
food	-0.2981	0.6644	0.0599	-0.0013	0.1400	-0.5044	0.4469
shelter	-0.1105	-0.8285	0.1909	0.1902	0.2782	-0.5777	0.8876
utilities	-0.1071	0.1638	-0.7222	0.0523	-0.0669	0.1783	0.4612
trans.	-0.6134	-0.2520	-0.2471	-1.3739	-0.7627	1.5824	1.7250
healthcare	-0.7813	0.0023	0.4260	-0.0129	-0.9375	0.8318	0.6338
misc.	0.4395	-0.2179	-0.2267	-0.0154	0.0470	-1.1448	1.2150

IV. Expansions

15-16. As microdata on individuals have expanded, neoclassical demand systems predicated on linear budget sets and representative consumers have proved uncomfortably restrictive. They could not deal easily with preference heterogeneity, acquired tastes, shifting hedonic attributes of commodities, non-linear budget sets, time, space, or uncertainty, and the frequent cases of zero and lumpy purchases. It was necessary to expand the domain of the theory.

17. This was done initially by retaining the central elements of the standard neoclassical consumer theory, and bringing back some of the broader components of utilitarianism in a way that was consistent with the neoclassical core. This meant preserving the tenets of consumer sovereignty, rational perceptions, and preference maximization, but admitting the influence of experience and memory on perceptions and on current preferences.

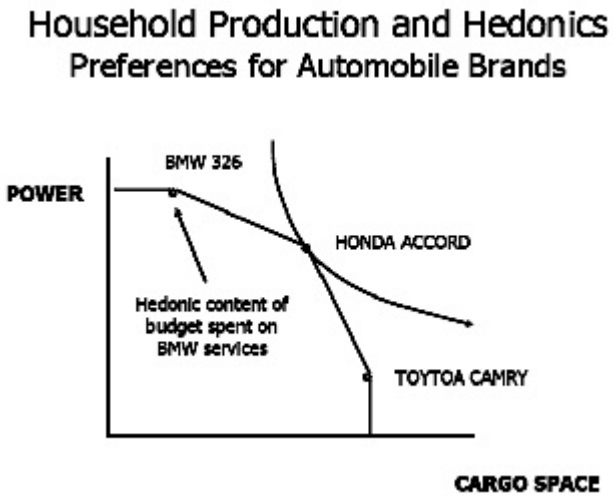
18. The extension of neoclassical consumer theory to handle both unobserved preference heterogeneity and tastes acquired as the result of observable experience and history was just a reaffirmation of circumstances admitted in the neoclassical model, but pushed aside to facilitate econometric estimation. The primary problems are practical; how to measure and fold into the utility function all the varied experiences of consumers, and how to embed within the system and characterize the distribution of unobservable components of tastes. However, there are also conceptual challenges: How much of unobserved taste variation is a permanent individual effect, and how much is time-varying? Is it possible to untangle state-dependence and unobserved individual effects in consumer panels, the Heckman initial-values problem? Is it possible to separate heterogeneity in perceptions from heterogeneity in tastes when choice alternatives are risky or ambiguous? Is it possible to identify the distribution of preferences from market-level demand observations? The answer to the last question depends on what one knows about the resources available to individuals; see Debreu (1974), McFadden-Mas Collel-Mantel-Richter (1974), Matzkin (2005).



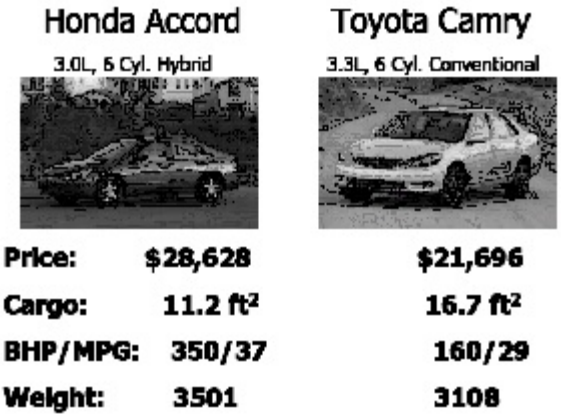
19. The neoclassical focus on linear budgets and convex preferences neglected a range of consumer behavior that is apparent at the level of the individual, the lumpiness and mutual exclusivity of many consumer choices such as school, job, and brand of automobile. It also neglected the important economic area of nonlinear pricing, arising from two-part and nonlinear tariffs, and progressive taxes. Extending econometric consumer theory to handle these applications required attention to the role of taste heterogeneity, and to the characterization of budget alternatives. The duality methods that are so useful in linear budget problems are hampered here, but still valuable, for example in my work on modeling discrete choice using stochastic indirect utility functions. One important observation for measurement of consumer well-being is that non-linear budget sets are a powerful tool for identification. For example, when budgets are restricted to binary comparisons, one recovers preferences directly.

20. Econometricians moved in the 1970's from treating commodities as objects with fixed attributes to hedonic models in which consumers care about generic attributes that can be met through various quantities and combinations of market goods. The simplest form of hedonics, dating to Kevin Lancaster in 1966, allowed the hedonic content of a unit of a market good to vary with the design of its manufacturer, and assumed in implementation that these dimensions of content could be measured. Thus, consumers desired power and

cargo space in cars, and automobile brands carried these attributes in various amounts determined by their design.



21. Economist's traditional collection of revealed preference data for market goods can be augmented by experiments on hypothetical market choices, which can readily be cast in terms of hedonic dimensions. This is the method of conjoint analysis, adapted in market research from its psychophysical roots (Thurstone, 1931; Luce and Tukey, 1964; Carroll, 1969; Green et al, 2001), and tied to models of stochastic preferences as a result of early econometric work on discrete choice models. In a review of consumer demand experiments, Ivan Moscati (2004) gives a remarkable bit of intellectual history. The first conjoint experiment on consumer demand was done by the psychologist Leon Thurstone in 1931 at the urging of his University of Chicago colleague Henry Schultz. Thurstone presented his paper at the 1932 meeting of the Econometric Society, with Ragnar Frisch and Harold Hotelling commenting from the audience on the critical differences between hypothetical and real choices. Thurstone's method was noted and dismissed by Nicholas Georgescu-Rogen (1936) and by Allen Wallis and Milton Friedman (1942), for three good reasons, the hypothetical nature of the offered choices, the difficulty of detecting indifference, and the difficulty of controlling experimentally for the effect of income and prices. Thurstone is not mentioned in the neoclassical treatises of Hicks and Samuelson, and there were no economists involved in the initial applications of conjoint analysis in marketing. However, truncated versions of conjoint analysis, termed contingent valuation, vignette analysis, or self-reported preference, later became popular among some applied economists and political scientists; see Rossi (1979), McFadden (1986,1994), Green et al (1998), Carson et al (2000), Frey et al (2002), King et al (2004). The use of hypothetical market decisions remains controversial among economists, with some reason, as it is difficult to achieve the verisimilitude of real markets in the laboratory, and cognitive inconsistencies that are not obvious in low-frequency real market choices may be glaring in high-frequency, repeated laboratory choices. However, hypothetical market methods, also called stated preference methods, have become a proven tool in marketing for designing and positioning new products. For example, experiments on



automobile brand choice can determine with great predictive accuracy the distributions of preference weights that consumers give to various vehicle features; see Urban et al, 1990, 1997; Dahan, Hauser, et al (2002); Train and Winston, 2005.

22. Let's take a closer look at hedonics. Consumers may be thought of as obtaining various hedonic quantities through a combination of the hedonic content of market goods and household production of hedonic content. An automobile contains as hedonic content "horsepower" and "cargo capacity", and requires the production activities of driving and parking to facilitate foraging for food and the hedonic sentiment of feeling full. Household production is a fact of life whose presence influences consumer's economic behavior, enriches the interpretation and complicates the measurement of utility, and provides additional measurement opportunities. Economists recognize this, and invoke household production ideas to explain time allocation, and facilitating activities like travel decisions. Nevertheless, textbook sections on household production are usually starred. I think the reason for this is that unless one has measurements on household production activities or hedonic products of the household production process, one cannot distinguish household technology from tastes. Let $\mathbf{z} = (z_1,\ldots,z_K)$ denote hedonic quantities, $\mathbf{x} = (x_1,\ldots,x_N)$ denote market goods, $\mathbf{p} = (p_1,\ldots,p_N)$ denote market good prices, and y denote income. Let $F(\mathbf{z},\mathbf{x}) \leq 0$ denote the household production function, and $U(\mathbf{z})$ the utility function. Then, the consumer's indirect utility satisfies

$$V(y,\mathbf{p}) = \max_{z,x} U(\mathbf{z}) \text{ s.t. } F(\mathbf{z},\mathbf{x}) \leq 0,\ \mathbf{p}\cdot\mathbf{x} \leq y$$

Given this indirect utility function, apply the duality mapping

$$U^*(\mathbf{x}) = \min_p V(\mathbf{p}\cdot\mathbf{x},\mathbf{p})$$

to obtain a reduced form utility function of the market goods. Then U* has the conventional properties of a neoclassical utility function. This construction does not require convex preferences and household production possibilities, and leaves household production implicit. However, there is potentially a great deal to be learned when it is possible to measure some post-household-production hedonic quantities. Variation in household production functions may be a source of apparent taste variation in utility, or may attenuate the impact of taste variations on market transactions. The hedonic measures z may be conventional economic ones, like horsepower and cargo space, or may be proximate to the organism; e.g., calorie intake or alleostatic load. Knowing something about the hedonic landscape, as in the work of Heckman-Matzkin-Neshelm (2002) on demand for jobs with different safety levels, or in my work on residential location when faced with environmental hazards (McFadden, 2003), it is often possible to recover the distribution of preferences when consumers operate at active margins. Careful analysis of household production, augmented by hedonic measurements from conjoint analysis and

by physiological measures, is in my opinion one of the neglected frontiers in econometric study of consumer behavior.

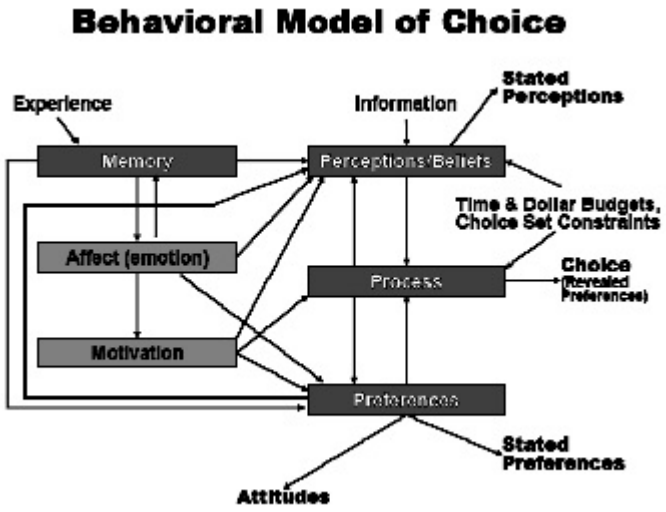
V. New Frontiers: A Behavioral Revaluation of the Consumer

23. Three new frontiers will be discussed: Experiments on Perception and Choice, Sociality of Choice, and Biology of Sensation.

24. Neoclassical consumer theory implies that people should relish choice, and welcome the choices offered by free markets. Yet, people are challenged by choice. In the words of a Dutch proverb, He who has choice has trouble.

25. Choice can be overwhelming. I am sure you will recognize yourself in Peter Vicary-Smith's description of supermarket behavior: "A trip to the supermarket offers weekly exposure to a choice of thousands of products. But most of us say that we simply try to get through the process as quickly as possible, relying on brand familiarity, habit, and responses to store layout to scale down the range of choices we actually have to make."

26. Not all choices are wise. We limit our own choices through procrastination, rules, pre-commitment, habit, and imitation. This bounded rationality is easy to understand when we view choice as part of the household production process, an activity that requires time and cognitive effort. Perceptions have to be sharpened, experience retrieved and evaluated, emotions distilled. Ambiguity and risk offer the prospect of dissonance and regret.



27. A schematic for behavioral models of choice differs from the neoclassical schematic primarily by adding affect and motivation as factors in choice, relaxing the rigid requirement that preferences are sovereign and king of the sentiments, and adding lots of possible feedbacks. However, there is a more fundamental difference. Neoclassically trained economists, and I include myself here, think of these behavioral elements as arising from the limits of memory and cognitive capacity that bound rationality, slips or anomalies that the individual will detect and correct if they become obvious. Other social scientists and biologists think of this instead as a product of evolution, the result of a rough correspondence between generalized self-interest and survival, a hodge-podge of rules, processes, and strategies that mimic rationality in circumstances where rationality

increases survival value. Day-to-day economic choices are explained by either paradigm, but perception and choice in novel situations tests the neoclassical premise, and challenges easy transitions between conventional demand analysis and the effect of novel economic policy on consumer well-being.

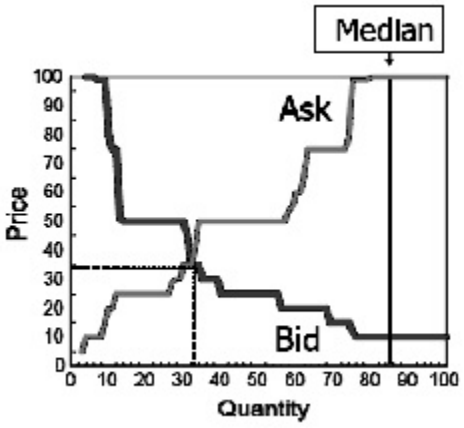
Measurement of economic consumer behavior will of course continue to center on studies of revealed market behavior, with traditional consumer expenditure surveys augmented by electronic tracking of consumer purchases through scanner data, high frequency sampling through internet panels, and increasing exploitation of natural experiments. These measurements will be supplemented by conjoint analysis studies of choice behavior in hypothetical markets, and a great deal more data from microeconomic surveys, experimental economics, marketing science, and cognitive psychology. Perhaps the most interesting and challenging new measurements come from fields not commonly allied with economics, sociology, anthropology, evolutionary and cellular biology, and neurology. I will give an overview of this research, starting with more traditional experiments in cognitive psychology, then measurements and experiments in sociology and anthropology, and concluding with findings and experiments in biology and neurology.

28. There are now extensive experiments and insights from cognitive psychology that contradict the neoclassical model of rational choice, many originally conducted by Amos Tversky and Danny Kahneman. These suggest that preferences are malleable and context-dependent, that memory and perceptions are often biased and statistically flawed, and decision tasks are often neglected or misunderstood. The table is a summary of major cognitive anomalies that appear in psychological experiments and surveys; for more details, see Rabin (1996), McFadden (1999).

EFFECT	DESCRIPTION
COMPREHENSION	
Completion/Substitution	Missing or ambiguous parts of question are reconstructed
Disjunction	Failure to reason through or accept the logical consequences of choices
Engagement/Awareness	Limited attention to and engagement in the cognitive task
Format/Mode	Availability influenced by format, visual or auditory presentation
Construal	Question interpreted as one the subject is able (or prefers) to answer
Translation	Question terminology translated into subject's personal vocabulary
RETRIEVAL OF FACTUAL AND AFFECTIVE MEMORY	
Affective attenuation	Affective memories are recalled with diminished intensity
Availability	Memory reconstruction is tilted toward the most available and salient information
Primacy/Recency	Initial and recent experiences are the most available
Reconstructed Memory	Imperfect memories rebuilt using contemporary cues and context, historical exemplars, commonly employed search criteria
Selective Memory	Coincidences are more available than non-coincidences
Telescoping/Temporal	Compression and attenuation of history, inconsistent time discounting

JUDGMENT AND THE FORMATION OF PERCEPTIONS AND BELIEFS	
Anchoring	Judgments are influenced by quantitative cues contained in the decision task
Context/Framing	History and framing of the decision task influence perception and motivation
Endowment	No action is the "safe" choice. "The devil you know is better than the devil you don't"
Extension	Representative rates are more available than integrated experience
Prominence/Order	The format or order of decision tasks influences the weight given to different aspects
Prospect	Inconsistent probability calculus, asymmetry in gains and losses
Regression	Attribution of causal structure to fluctuations; failure to anticipate regression to mean
Representativeness	Frequency neglect in exemplars
TASK DEFINITION, AND THE DECISION AND REPORTING PROCESSES	
Awareness	Recognition of choices, subjective definition of choice set
Construal/Constructive	Cognitive task misconstrued, preferences constructed endogenously
Prevarication/Projection	Misrepresentation for real or perceived strategic advantage or to project self-image
Suspicion/Superstition	Subjects mistrust offers and question motives of others in unfamiliar situations, avoid choices that "tempt fate"
Rule-Driven	Choice guided by principles, analogies, and exemplars rather than utilitarian calculus; rules induce *pro forma*, focal responses

29. One example of an anomaly that challenges the neoclassical model is the *endowment effect*, a consumer aversion to trade from any given status quo, or *agoraphobia*. The endowment effect was beautifully illustrated in a classical experiment by Jack Knetsch (1989) in which a random assignment of coffee cups produced a large gap between WTP and WTA, with less trading than one would anticipate would be needed to reach a Pareto efficient reallocation; see also Kahneman, D.; Knetsch, J.; Thaler, R. (1990). I conducted a comparable experiment in an introductory microeconomics course at Berkeley, using pencils embossed with the course name. About half of the 345 students, 172, were randomly assigned a pencil. Then, a Vickery sealed-bid uniform price double auction was held to reallocate the pencils.



30. The market cleared with 32 pencils traded, at a price of 35 cents. The median of the sealed bid prices was 10 cents, while the median of the sealed ask prices was 100 cents, the same large gap between WTP and WTA that appeared in the cup experiment.

31. The income effect of being endowed with a pencil is negligible, so that with random assignment the distributions of money marginal utilities of a pencil should be the same for buyers and sellers. Further, the Vickery auction is truth-revealing. Then if consumers are neoclassically rational, there should be no endowment effect.

32. Consider a market with N participants with values $v_1 \leq ... \leq v_N$ drawn from a common value distribution F(v). Suppose pencils are endowed at random, with K receiving a pencil. Then, one expects the participants to be distributed according to the following table:

	Receive pencil (K)	No Pencil (N-K)
Value $\leq v_{N-K}$	K(N-K)/N	$(N-K)^2/N$
Value $> v_{N-K}$	K^2/N	K(N-K)/N

Then, a market with truth-revealing offers should clear at a purchase price near v_{N-K}, and the number of pencils traded should be near K·(N-K)/N. In the experiment, N = 345, K = 172, v_{N-K} = 35, and K·(N-K)/N = 86.25. The actual trade of 32 pencils is far short of the quantity expected to clear the market. Further, a runs test confirms (T-Stat = 12.5) that buyers and sellers do not have the same value distribution. Thus, there is a strong endowment effect, generated instantaneously by random allocation of pencils. Either tastes are changing endogenously, with quick habituation to the status quo, or agoraphobia is real -- consumers find trade an edgy experience, instinctively mistrust the market, and resist trading for small gains..

33. Without going into experimental details, I will mention two additional areas that show puzzling cognitive anomalies. The first is choice among lotteries. A stylized summary is that consumers display (i) an endowment effect, evaluating lotteries as changes from a reference point that may be sensitive to framing, (ii) an asymmetric loss aversion effect, in which the consumer is more sensitive to losses than to gains, displaying risk aversion for gains and risk seeking for losses, and (iii) a certainty effect in which sure outcomes are overvalued relative to lotteries. In addition, there are (iv) an isolation or cancellation effect in which common aspects of alternative lotteries are ignored when they are compared, (v) a segregation effect in which a riskless component of a lottery is evaluated separately from the risky component, and (vi) a mode effect in which pricing a lottery is treated as a qualitatively different task than choosing between lotteries. One of the consequences of these effects is that consumers will often refuse to take any share of either side of an offered lottery, a result consistent with the observed paucity of real-world wagers. Kahneman and Tversky attribute these effects to an editing process that determines the reference point and the perception of lottery outcomes as gains or losses, and to systematic mispreception of probabilities. An additional reason that individuals are ambigious about lotteries, and often avoid them, is the supersititious belief that there are hidden causal forces at work, interventions that place the lottery in ambigious relationship to the rest of life. People believe they are lucky, or unlucky, or that their luck has to change. We have selective memory for coincidences. You remember running into a friend at a surprising place, or a particularly good night a poker; you forget all the times you did not encounter a friend or had an unremarkable night. Chance jolts the harmony of

conscious belief; relief from this dissonance is gained by imposing an order over chaos, weaving a fabric of cause and effect, out of jumbled coincidences. The mind accepts and emphasizes those coincidences which reaffirm the perceived order of the universe, ignores and forgets inconsistent data, and shrouds each offered lottery in ambiguity. Superstition can arise and persist even when people are consistently Bayesian. Start with a prior that admits the possibility of complex, hidden causal paths. The experiments that life offers, and selective memory of outcomes, allows these cognitive castles in the air to survive; see McFadden, 1974; Hastie and Dawes, 2001.

34. Hyperbolic discounting occurs when individuals systematically underweight future consequences relative to contemporaneous ones, and make choices that gratify now and leave lasting regret, in patterns that cannot be explained by maximization of consistently discounted present value of instantaneous utility. If one thinks of the current instance as a reference point in time, then this phenomena resembles those surrounding the endowment effect, with the future neglected because it is ambigious and difficult to anticipate, and lacks saliency. Edgeworth gave one of the reasons to take your gratification immediately: "A 'bird in the bush' may never come to hand."

35. The remembered utility effect occurs when memory of a painful or pleasurable episode is dominated by sensation at the peak and end of the episode, rather than being determined as an integral of experienced intensities over the duration of the episode. A related phenomenon in psychology is labeled the primacy/recency effect. We remember the first and last instances of some significant experience, less well the intermediate and integrated experience.

For example, a study by Kahneman and Varey (1991) of experienced pain during colonoscopies, and recall of the episode, finds that adding pain of reduced intensity at the end of an episode improves overall recall of the experience. Kahneman, Wakker, and Sarin (1996) document in a number of experimental settings this phenomenon of duration neglect and concentration on recent experience, what one might call hyperbolic memory.

A deeper reason for the phenomena of hyperbolic discounting and remembered utility is given by the psychologist George Lowenstein (1996) -- it is difficult to recall or anticipate affective or emotional state. We may remember being in pain, and have a strong aversion to the anteceedents of a painful experience, but we cannot relive the experience itself. Consequently, we may forget affective history, and fail to adequately protect ourselves against repeating it.

36. I will return to some of the results from experimental psychology and economics when I take up the biology of pleasure, but first I want to talk about the sociality of choice. Obviously, man is a social animal, identified with family and kin, and with troups, tribes, ethnicities, and nationalities. This has several consequences for economic choice behavior. First, individuals may look to their social networks for information. Second, they may look to social networks for approval, and use accountability to limit choice. Third, they may out

of pure self-interest engage in mutually beneficial reciprocity, simple when the acts are syncronous, involving more complex elements of reputation and trust when they are not. Pursuing comparative advantage, with division of labor and trade, is a form of reciprocity. Fourth, they may engage in genetic altruism, making choices that are in the interest of their progeny rather than themselves as individuals. Fifth, they may exhibit altruistic behavior that does not obviously serve their personal or genetic self-interest, such as incurring costs to sanction greedy behavior.

37. People make interpersonal comparisons all the time, judging the desirability of options from the apparent satisfaction and advice of others. While personal experience is the proximate determinant of the utility of familiar objects, and may be extrapolated to similar objects, our primary sources of information on new objects come from others, through observation, advice, and association.

There is a large literature in economics about the sociality of consumption, from Dusenberry on relative consumption and the sensitivity of savings behavior to relative income within a society and relative insensitivity to its absolute level of income, to conspicuous consumption, to fads and bandwagon effects. However, while sociality has been recognized as important, the mechanisms of its operation have been obscure, and it has not led to a simple formalization comparable to that for conventional demand theory.

One major way sociality may work is simply through transmission of information, learning by imitation rather than learning by doing. The more painful a potential mistake, the more valuable information that may help avoid mistakes. McFadden & Train (1996) show that in innovation games with uncertain payoffs, it may pay to wait, and learn by observing rather than learn by doing. Manski (1991) has explored the possibility that individuals faced with dynamic stochastic decision problems that pose immense computational challenges may simply look to others to infer valuation functions to be used to judge the future payoff of current acts, or to infer satisfactory policies. An objection to such copycat behavior is that it fails to take account of the individual's idiosyncratic tastes, and correcting this quickly gets the individual back into the computational difficulties that imitation was intended to circumvent. But if tastes as well as perceptions are modified socially, the relevance and value of the lessons from others increases.

38. Economic demographer Hans Peter Kohler (2001) has investigated the effect of word-of-mouth communication from friends on choice of contraceptive. He studies Korean peasant women, who have access to relatively little public information on efficacy, costs, and side effects of new contraceptives. Choices within villages show little diversity, but there is substantial, persistent diversity across villages. This pattern not explained by income, education, or price differences.

Word of mouth communication from friends was found to be the important explanation of most women's choices. Lack of inter-village mobility explained multiple equilibria, with persistent inter-village differences.

Thus, some apparent taste heterogeneity is due to the boundedly rational practice of imitation in balkanized social networks. The moral is that no measurement system that fails to account for social network effects can be complete.

39. In addition to providing information, social networks may discipline the behavior of members through concensus on social norms, accountability for choices, and sanctions for behavior that violates norms. The individual gains from affiliation with such networks if imitation and conformity save energy, if the "expectation that one will be called upon to justify one's beiielfs, feelings, or actions, to others" improves decision-making, and if approval is itself a source of pleasure. We engage in a great deal of automatic or intuitive thinking, or one might say semi-conscious or background thinking, in daily decisions. For example, an experienced driver does not go through a conscious process of deciding to change lanes. Automatic thinking saves energy, and time. The classical idea of herd mentality is that social animals find it easier and more comfortable to adhere to a group, accept group roles, and mimic group behavior than to act independently. Accountability reinforces herd mentality in fixed groups, and promotes safety in numbers. Individual membership may be voluntary, as in the pellaton of tightly packed riders in a bicycle race, with riders tighly clustered and constrained in order to save energy in preparation for "breakaways".

40. I will discuss evolution, culture, and altruism in three steps: self-interested reciprocity, genetic altruism, the evolution of pure altruism.

41. Reciprocity. The utilitiarians recognized humans as social animals. Bentham observed the importance of reciprocity:

> "By the self-regarding principle, the more urgent the need a man feels himself to have of the kindness and good will of others, the more strenuous and steady will be his exertion for the obtaining it. ... The stronger a man's need of the effective benevolence of others, the stronger the inducement he has for the manifesting effective benevolence as towards them."

Self-interested reciprocity is simple to establish when it is synchronous, as in bilateral barter. However, asychronous reciprocity requires reputation and trust. If you give me $20 for a bin of grapes, I have to trust that your $20 bill is genuine and can be used later to acquire things that I want. If you take the grapes in exchange for a promise of a bottle of wine in the future, I must trust you to keep your promise. In the words of Kenneth Arrow, "Trust is an element in every commercial transaction".

42. Norms for fair practice, and sanctions for bad behavior, may evolve in social networks to facilitate asychronous reciprocity, and individuals may conform to these norms even in novel situations where the normal cycle of approval and reputation is suspended. Consider the single-shot ultimatum game with anonymous players: Player 1 proposes a division of a prize of 100 units. If Player 2 accepts, they get the proposed shares;

otherwise, both get nothing. It is rational for Player 2 to accept any positive amount, and thus rational for Player 1 to offer the minimum positive amount. However, if the probability of acceptance a(s) by player 2 is less than one when the share s offered by player 1 is less than one, then player 1's optimal strategy is to maximize a(s)·(1-s). The first-order condition is $a'(s)/a(s) - 1/(1-s) = 0$. For example, $a(s) = s^{\beta}$ gives the optimal offered share $s = \beta/(1+\beta)$.

Students in a cross-section of developed countries play similarly, but not rationally. Offers are usually 42 to 50 percent of the prize, and offers less than 20 percent are rejected about half the time ($\beta = 0.43$, $s = 0.30$).

43. Isolated cultures offer natural experiments for testing the impact of social norms on trust and reciprocity. Sam Bowles and a team of experimental economists and ethnographers have conducted anonymous ultimatium game experiments in 15 isolated societies. Four of these are the Lamalera, a cooperative whale-hunting culture in Indonesia, the Ache, seasonal foraging bands in Paraguay, the Hadza, hunter-gatherer bands in Tanzania, and the Machiguenga, horticultural family groups in Peru. The research finds strong cultural differences, with large mean offers among the Lamalera, who have ritualized rules for cooperation and sharing, and low mean offers among the Machiguenga, who have little experience in interaction outside the family. Within a culture, lower offers generate more rejections, but willingness to incur the cost of rejecting an offer differs substantially across cultures. The research concludes that violation of the selfishness axiom is common across cultures, but with differences that are a product of the social and economic lives of the subjects. The more integrated and market-oriented the contacts between individuals, influenced by the technologies available for subsistence, the stronger a norm for "fair play", and the more willing respondents to punish selfish behavior at a cost to themselves.

Society	Mean Offer	Rejection
Lamalera – hunting village	57%	NC
Ache – foraging band	48%	0%
Hadza – foraging band	40%	19.2%
Machiguenga – hort. family	26%	4.8%

44. Genetic Altruism is the phenomenon of self-sacrifice for the good of your family or kinship group. Genetic altruism appears to explain cooperation in most species, and appears to have a convincing evolutionary basis:

William Hamilton, an icon of sociobiology, in 1964 wrote

> "The force of evolution favors "selfish" genes, those that promote their own reproduction. Individuals do not consistently do things for the good of their group, their family, or even themselves. They consistently do things for the good of their genes."

Matt Ridley, in an entertaining 1996 account of the evolution of sociality, wrote "None of your ancestors died celibate."

The principle, although not the name genetic altruism, appeared early in classical economics. Paraphrasing Adam Smith (1853),

> "Every man feels [after himself, the pleasures and pains] of the members of his own family. Those who usually live in the same house with him, his parents, his children, his brothers and sisters, are naturally the objects of his warmest affections. They are naturally and ususally the persons upon whose happiness or misery his conduct must have the greatest influence."

Edgeworth in 1881 noted that

> "... efforts and sacrifices ... are often incurred for the sake of one's family rather than oneself. The action of the family affections 'has always been fully reckoned with by economists', especially in relation to the distribution of the family income between its various members, the expenses of preparing children for their future career, and the accumulation of wealth to be enjoyed after the death of him by whom it has been earned."

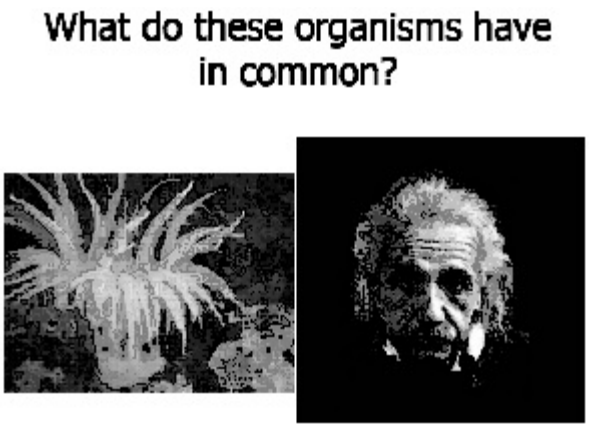
45. The operation of genetic selection could be very indirect. Thus, the acquisition of language, the exploitation of comparative advantage, the formation of successful defences against mauraders and disease, and a disposition to "fair play" that reduces interpersonal conflict, may all arise from the selective advantage to group traits that promote sociality. Then altruistic behavior, including gifts to unrelated individuals with no possibility of personal gain, might be explainable as an indirect consequence of genetic self-interest. If so, the center of the original utilitiarian concept of relentless pursuit of pleasure could still hold, with group selection leading to the real, selfish pleasure we get from altruism to family and kin. As Paul Samuelson demonstrated in 1994, this works if the pressures of group selection are sufficient to offset the Gresham's law of individual selection, in which altruistic traits will be driven out by antagonistic selfish traits.

However, experimental studies of altruistic punishment collected and carefully interpreted by Ernst Fehr (2003) suggest that evolutionary pressure for group selection is not consistent enough, and the costs of altruistic punishment in large groups are too high, to explain the pervasive and distinguishing level of altruism in large human groups. His conclusion is that human altruism is a mystery that selfish genes and selection cannot fully explain, something about our wiring that may not fit the utilitarian notion of a hedinometer calibrated to experience pleasure from genetic survival. What is important for a discussion of the measurement of well-being is to understand that whatever its roots, our perceptions of the well-being of others do affect our own behavior and sense of well-being, in ways that may be simply explained by genetic altruism and group selection.

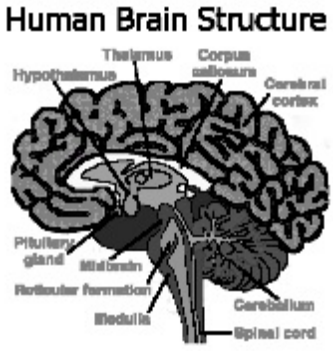
46. Sensation and Edgeworth's hedinometer: Brain science offers a new frontier for consumer measurements, through identification of reward structures and neurotransmitters in the brain, and study of the impact of choice problems on the brain in the presence of

experimental treatments. These measurements include brain activity (fMRI and PET tomography), brain electrochemistry (probes, peptides, and radionucleides), physical intervention (gene manipulation, structural manipulation in animals, and natural experiments in brain-damaged humans), and behavior intervention (manipulation of the choice environment, measurement of response).

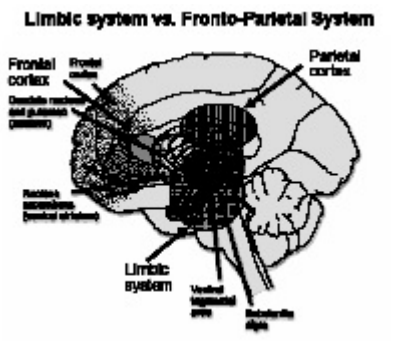
47. What do these two organisms have in common? The organism on your left is a sea anemone, which has no brain, responds entirely by reflex, is fixed in its position throughout its mature life, and is completely symmetric. By contrast, the organism on your right has a very large brain, responds using exquisite logic, emphasizes the relativity of its position, and has a front and back. Yet, the difference between a sea anemones and this human are less than might appear. Over 90 percent of the DNA sequences in humans are also present in the DNA of a sea anemone. Interestingly, the DNA of the sea anemone contains, unexpressed, most of the sequences that in humans produce eyes, fronts, and backs.



48. The early biologists observed that as the human embryo developed, it seemed to go through stages of evolution, from a simple one-celled creature to its complex final form. That view was superficial, but it does seem to be the case that human physiology, and in particular, the structure of the brain, is consistent with a layering of added functionality over a simpler and more primitive core. Here are diagrams taken from school texts, useful for those of you whose knowledge is as elementary as my own. The aspects of brain function that we identify with being human – language, the cognitive processes of deduction and induction, the ability to empathize and interact with others, are primarily sited in frontal lobe of the cerebrum, the outer layer of the brain whose relative size and complexity in humans differentiate us from most other species. The more basic limbic system, buried at the base of the cerebrum and containing the thalamus, hypothalamus, amygdala, and hippocampus, is heavily involved in emotion and the reward pathways that are associated with sensations of pain and pleasure, particularly the amygdala, which is sometimes termed the "switchboard of the brain", and is active in animal behavior at a visceral level, approach and avoidance, foraging, territory, and reproduction. The cerebellum and Medulla manage body functions. The left and right hemispheres of the brain are symmetric in structure, but substantially specialized in function.



49. The brain is a potent chemical factory, producing peptides that act as neurotransmitters and neuromodulators that bind to receptors on neurons and act to either excite or inhibit neuron firing. The distinction is that neurotransmitters are directly active, and the neuromodulators act as toggle switches that reverse the excitatory/inhibititory action of neurotransmitters. Peptides are a few amino acids linked by bonds between their carboxyl and amino groups, much simpler than proteins which are long-chain polymers of amino acids. A few examples of natural peptides and related molecules are Dopamine, a pleasure/reward transmitter and pain supresser; Epinephrine, a stress or threat transmitter; Bradykinin, a pain transmitter; and Oxytocin, a regulator of approach-avoidance behavior, promoting "tend and befriend" rather than "fight or flight", trust, sexual bonding, and maternal instinct.



Most people think of economic activity as quite cerebral, learned through lengthy education and shaped by culture. If the brain is the hardware, then the utilitarian calculus might be pictured as software, an operating system that is stored and run at various, possibly-relocatable hardware sites, and is modified, Linix-like, by experience and selection. In this view, monitoring the brain can tell you something about the burden the software places on the hardware, but relatively little about what the software is doing. However, the picture that is now emerging is that economic behavior, like the brain itself, has layers. Working a spreadsheet to balance a retirement portfolio is indeed a high-level, learned skill. However, trading to exploit comparative advantage and the division of labor, and to balance endowments and tastes, appears very early in human prehistory. There is archeological evidence that the neanderthals traded shells and flints over long distances. Some non-human species also engage in trade within kinship bands. Therefore, you should not be surprised to learn that hardware, the limbic system and its reward pathways, are associated with economic decisions in a substantial and relatively direct way. In particular, the ventral tegmental dopamine reward pathway in the amygdala qualifies as the brain's primary center for recording pleasure, and appears to be active when we are involved in matters of threat, trust, sex, and economic trade. If you have ever dismayed over convincing students that economics is a sexy subject, you can now tell them that economic activity and sex share the same neurotransmitters and receptors.

50. Much of the information on the neurological foundations of economic behavior comes from measuring brain activity through levels of cellular energy consumption, using imaging techniques such as functional MRI and PET scans. Used in combination with experimental treatments with electrical probes, neurotransmitters, and neuromodulators, and experimental presentation of economic decision-making tasks in games or markets, one has a powerful tool for detecting the links between choice and sensations of pleasure or pain. Brain-damaged humans and animals allow imaging under conditions under which some brain pathways are blocked. This is not quite Edgeworth's hedinometer. The linkages from psysiological sensation to conscious interpretation and reasoning may be

complex, and physiology may give an incomplete picture, just as computer hardware monitoring gives an incomplete picture of what software is doing. In addition, being entombed in an MRI at 90 decibels may not induce the same cognitive process as a visit to your local bookstore. Nevertheless, it should be clear than any ability to measure directly in the brain the impact of economic choice tasks on reward pathways is potentially an immensely powerful tool for linking economic activities and consumer well-being.

51. I will outline a scattering of results from human and animal studies that provide an intriguing picture of how sensation is directly influenced by economic tasks. The topics are Pleasure versus Pain, Addiction blockers, Deferred Gratification, and Trust.

52. How do organisms process sensations of pleasure and pain? The answer goes directly to the question of whether there is a single, absolute physiological scale of well-being, and whether the organism consciously or unconsciously acts out of self-interest to maximize this quantity. First, both behavioral observation and brain studies indicate that organisms seem to be on a hedonic treatmill, quickly habituating to homeostasis, and experiencing pleasure from gains and pain from losses relative to the reference point that homeostasis defines; see Sanfay et al, 2003. People quickly grow to accept the city in which they are located, their job, their mate, and their health status. They may recognize and complain about unfavorable absolute states, but their levels of satisfaction by various measures are not nearly as differentiated as they would have to be if their sensation of well-being was experienced on an absolute scale. Second, the picture that emerges from brain studies is that the ventral tegmental dopamine pathways in the limbic/amygdala region play a central role in experiencing pleasure, and also mitigate, with a lag, the sensation of pain; see Becerra et al, 1999. Adaptation to homeostasis and differentiation between the pleasure and pain circuits coincide with the powerful endowment and loss aversion effects, and sensitivity to framing and context, found in behavioral studies, and suggest that these phenomena are tied fundamentally to brain structure. This is good news and bad news for utilitarians: the limbic system reward pathways seem to correspond to a utility pump, but specialized brain circuitry processes experience in ways that are not necessarily consistent with relentless maximization of hedonic experience.

53. Ivan Diamond, a neurologist at the University of California, San Francisco who studies ethanol addiction, finds that this and other substance addictions work primarily by stimulating ventral tegmental dopamine pathways, although addiction once established has other physiological effects. His laboratory has engineered neuromodulators that block the D2 dopamine receptors in this reward pathway; these will eventually lead to effective therapies for ethanol addiction. I cite this work because it shows, indirectly, the close relationship between these reward pathways and economic behavior. Diamond and his colleagues operate an experimental bar in which the spending rate is observed for alcoholics treated with various blockers; this rate is a very good predictor for the efficacy of the blocker.

54. David Laibson and colleagues have investigated the processing of intertemporal choices. They find that choices involving delayed gratification are primarily processed in the frontal system, and those involving immediate gratification are primarily processed in the limbic system. Thus, eating a candy bar now activates the limbic pleasure center of the brain, deciding to delay gratification requires thought. Unless these systems work together in harmony, time-inconsistent behavior results.

55. One of the interesting bits of contemporary biology has been the establishment for a variety of species of simple direct links from particular genes to the production of and receptors for specific neurotransmitters, and from this to specific social behavior. Specific genes control the production and efficacy of the peptide oxytocin in the brain, and this in turn appears to control sexual attraction and behavior in everything from fruit flys to voles to humans. One may ask why these biological findings have any relevance to our discipline. The answer is that sexual reproduction requires close interaction between organisms, and to achieve such interaction requires a suspension of distrust. The oxytocin peptide appears to have the genetic role of promoting trust and bonding between the sexes. This is relevant to economics because trade, and more generally interactions in economic games, also involve elements of trust. Kenneth Arrow is quoted as saying "every commercial transaction involves an element of trust." Thus, in its fundamentals, the primitives of economic behavior and sexual behavior may be the same neurotransmitters and reward pathways in the brain. In a study that strikes at the heart of neoclassical consumer theory, Ernst Fehr and associates (2005) administer oxytocin or a placebo to subjects, and then ask them to play the trust game. In this game, an investor is given 100 MU, and has the option of placing Y MU with an anonmyous trustee, who then receives triple this amount, and then chooses to send Z MU back to the investor. The trustee's game is a dictator game in which norms of fairness and reputation matter, but the rational response in a single-shot anomyous game is to return nothing. By backward induction, the investor should send nothing. In fact, both the investment and the return are usually positive, with the level of investment higher in subjects who are administered the "trust" peptide oxytocin. However, oxytocin has no effect on play of the dictator subgame, where trust does not matter. The conclusion is that economic perceptions and decisions are sensitive to brain chemistry, and succeptible to chemical manipulation.

56. **The Future**

What are the challenges and measurement opportunities in the future of research on consumers' economic behavior and well-being? Even from a neoclassical perspective, the role of experience and memory on perceptions and preferences, non-linear budget sets, household production, and hedonics complicate the identification of utility and well-being, but also offer new measurement opportunities, through the added information contained in choice in nonlinear budget sets, and through natural and designed experiments that alter household production possibilities. New frontiers challenge the standard assumption of maximization of individualistic utility, indicating that social networks as information sources,

reciprocity, and altruism enter human behavior and cannot be ignored. There are new opportunities to study the sociality of choice through experiments that manipulate the information provided through social networks, the effect of approval, and the role of cultural and social norms through comparative study of isolated societies. Finally, the striking ties between brain physiology and behavior in economic decisions, and new methods for measuring and manipulating brain activity, offers the possibility of powerful experiments in which economic, social, and physiological treatments are employed to identify and isolate the causal foundations of economic choice behavior.

This is a wonderful time to be a young economist. I urge you all to rush through graduate training in some or all of neurology, biochemistry, cognitive psychology, and anthropology, and with the full toolkit this provides, get to work on completing the new science of pleasure, and the enlightened perspectives this will bring to economic policy and the well-being of consumers.

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