

Do Environmental Economists Need Brains?*

Random neural activity stimulated by
Roe and Haab

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* after Camerer, Loewenstein, and Prelec, "Neuroeconomics: Why Economics Needs Brains"

Highlights of Paper (1)

0.0T mrc
Ex: 1
fMRI_tests/3D_MPRAGE_Axial
Se: 2/143
Im: 72/128
Ax: 125.7 (COI)
A University of Oregon - CNI
BILL HARBAUGH
043Y M fntest
Acq: 2002 Jun 07
Acq_Tm: 14:17:04.981000

256 x 256

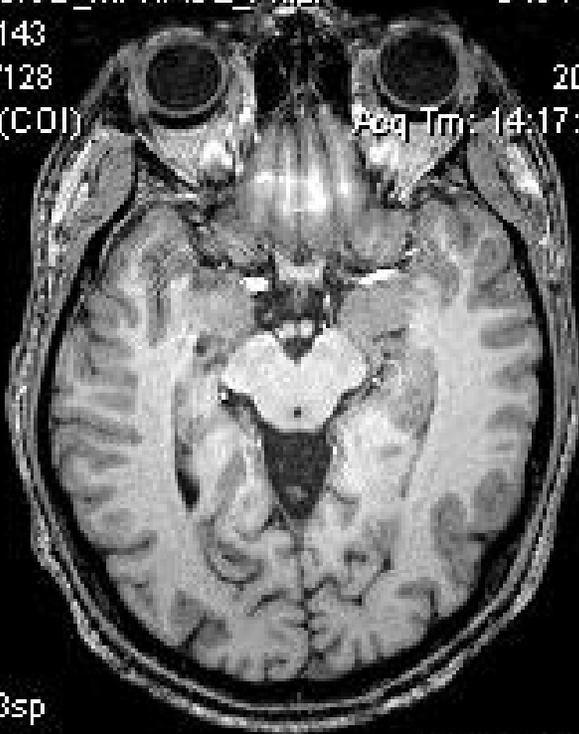
R

L

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TR: 11.1
TE: 4.3
HE
1.3thk/-1.3sp
W:548 L:327

P

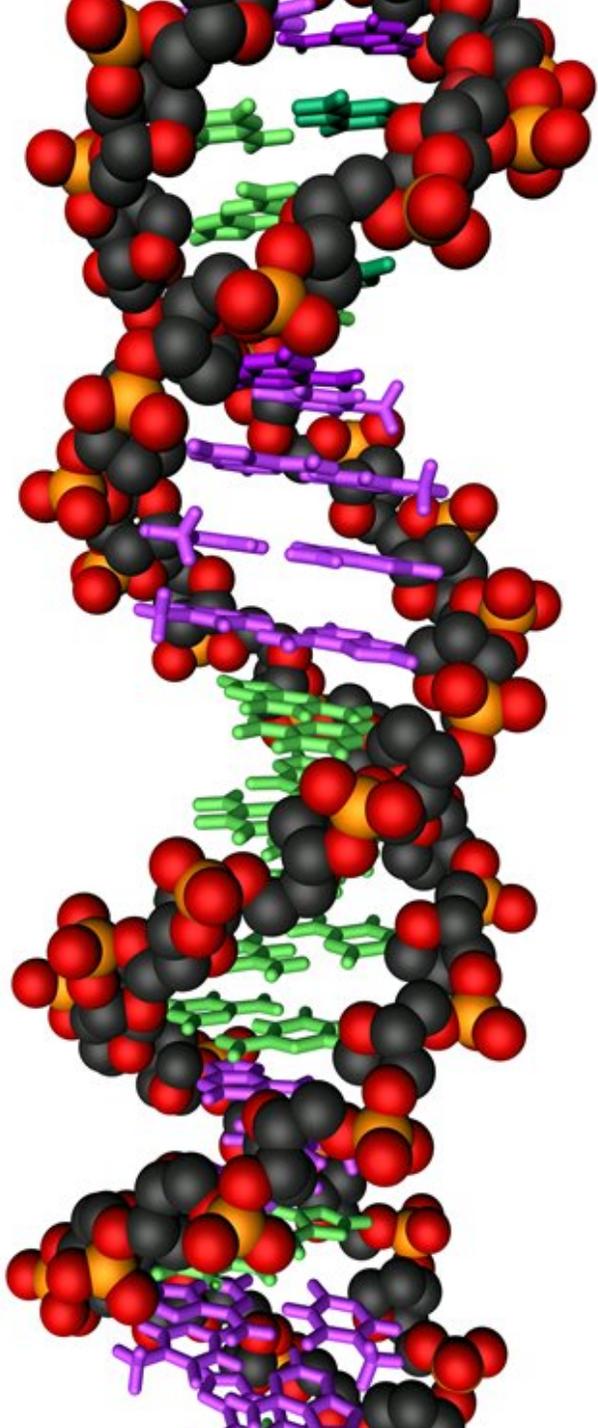
DFOV: 25.6 x 25.6cm



- Helpful inventory of currently available biomedical measurement technologies
 - Functional Magnetic Resonance Imaging (fMRI)
 - e.g. work on choice behavior by UO Ph.D candidate Dan Burghart, his co-chair Bill Harbaugh (pictured here) and Ulrich Mayr (UO Psych dept);

Other technologies

- PET; EEG; MEG, SPECT, fNIR, single-unit neuronal recording, cyclic voltammetry, lesion studies, drug/dietary manipulation, EBS, TMS
- Methods allow researchers to measure processes (or at least “follow a trail of footprints”) inside the brain
- Different methods more suitable for:
 - Different regions of the brain
 - Different temporal resolutions



DNA?

- Discussion of genetic methods
 - Not discussed much elsewhere in neuroecon
 - But, over time, organisms may compensate for their genetic differences
 - Environmental factors influence gene expression
 - Zillion dummy variables

Highlights of Paper (2)

- “Ventral Valuation Network”
 - Dopamine system:
 - Concrete rewards – Juice, Cookie, \$\$, etc.
 - Abstract rewards –Altruism, Punishment
 - “Utility” in the brain?
 - More likely a conditioning system
 - Reward prediction errors, Gains vs. Losses

Brain Regions Frequently Implicated in Decision Making/Reward Processing

- Thorough inventory provided...
- Ventral Striatum & V. Tegmental Area
 - Neurotransmitter: Dopamine
 - “Pleasure/reward centers” (food, love, drugs)
 - Amygdala, Caudate, Nucleus Accumbens, Putamen, SN-PC
- Lateral & Orbital Pre-Frontal Cortex
 - Volitional/Goal Directed behavior
- Anterior Cingulate Cortex
 - (Executive) “Monitoring” system

Highlights of Paper (3)

- Neuro methods have things to say about challenges to standard economic models
 - Remembered vs. Anticipated vs. Choice (RP) vs. Experienced Utility; “Wanting vs. Liking”?
 - Hypothetical bias, RP/SP
 - Money only indirectly, or directly rewarding; brain utility depends on source of income (earned, unearned)
 - Context-dependent preferences, discounting
 - Risk and ambiguity, social preferences
 - Plastic preferences
 - Advertising
 - “Nature vs. Nurture” versus “Nature via Nurture”
 - Induced preferences

Theory vs. Empirics/Policy

- Neuroeconomics has already made, and will continue to make, huge contributions to economic *theories of individual behavior*....
“microeconomics”
- We are a little further away from neuroeconomics making a difference to *practical empirical measurement of aggregate environmental net social benefits* for policy-making
- Why?

Empirically expedient fictions

- A representative consumer
- Linearity and additive separability of preferences as a function of net income and quantity/quality of the environmental good
 - Estimated model yields (average) marginal utility of income, (average) marginal utility of environmental good, and (average) WTP for good
- Problem? If policy affects only a non-random subset of the population sampled for estimation, models will not reflect average WTP in the affected group

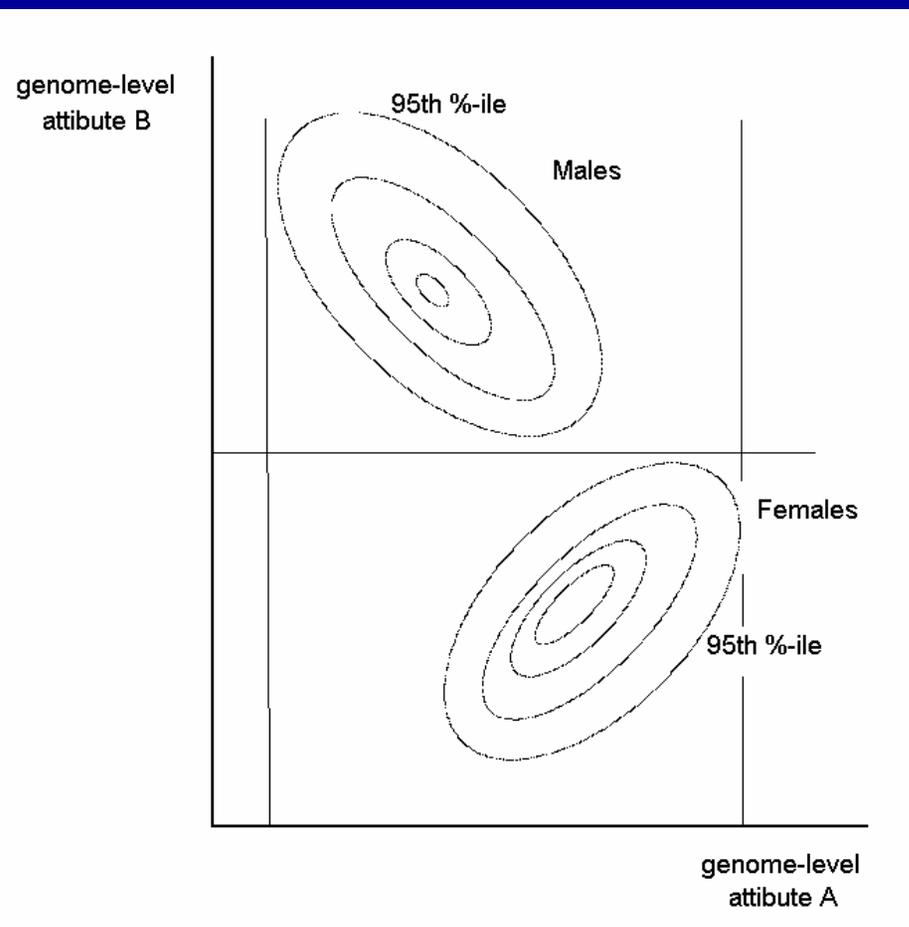
Heterogeneity

- Typical approach – allow preference parameters in “representative consumer” model to vary systematically with *observable* characteristics
 - Relatively exogenous...
 - Age, Gender, Ethnicity
 - Potentially endogenous...
 - Educational attainment, Family structure, Region of residence, Socioeconomic status
- Different characteristics are used to explain why different choices are made by people who face similar sets of alternatives

Observables...merely indicators?

- {Gender, age, ethnicity...} are undoubtedly correlated, to varying extents, with a much larger suite of underlying factors – e.g. differences in individual-specific types of neural responses to similar stimuli, mediated by
 - genetics
 - hormonal effects
 - the biology of aging
 - cumulative life experiences (including prior exposure to similar choices)

Observables probably proxy for “deeper” heterogeneity



- Empirically, we might use **1(female)** as a crude indicator to capture the real reasons why choices differ—say, genome-level or brain-based attributes A and B
 - **1(female)** readily captures differences in underlying attribute B
 - **1(female)** does not cleanly separate differences in attribute A

Potential to remedy shortcomings in the usual observable proxies?

- Improve ability to explain observed choices by measuring more (and deeper) dimensions of heterogeneity
 - Differences in neural mechanisms engaged for different types of choices
 - Phenotype, genotype information?
 - Attitudes, personality measures?
 - Individual histories of prior choices and measures of prior subjective experienced utility?
- Unfortunately, the size of the parameter space will soon get out of hand...

More-fundamental measures of heterogeneity?

- Q: what will we do with these new “biomedically relevant variables” once we have them?
- Q: will biomedical technologies allow us to measure some *sufficiently finite* number of “**deep**” **observables** for individuals that will serve as better predictors of economic choices than the usual “**superficial**” **observables** such as gender, age, ethnicity, etc.?
 - If time-invariant...would panel data suffice to control?
- Neuro tradition seems to think of these measures as dependent variables...

Example: “deeper” characteristics

- Usual approach: simply proxy for differences in unobservable discount rates (r) and risk aversion (a) by controlling for gender, age, etc.
- Better: use separate individual-specific measures of (r) and (a) to explore their structural influence
 - Allow (r) and (a) to be predicted by “superficial observables”
 - Allow choices to depend directly upon (fitted) (r) and (a)
- However, (r) and (a) unobservable, except in very special cases; in practice, will continue to use reduced forms where choices depend directly on superficial observables
- (r) and (a) are especially relevant for the deeper neurological/ biomedical observables and processes we are starting to measure now...mechanisms may help us understand *why* the superficial observables have the effects on choices that they do

Choice context, framing, etc.

- Environmental economists are well aware that myriad contextual and experiential factors affect the real and stated choices of individuals
 - We have been exploring these factors and controlling for them for years in our survey research
 - ...but we are still curious as to *why they matter*
- Easy to demonstrate effects; harder to know what to do about them. Ideally...
 - Find natural choice contexts (or design experimental contexts) covering the range relevant for policy; collect data on prior experiences
 - Estimate implied WTP as an explicit function of contextual variables and prior experiences
 - Simulate predicted WTP under relevant policy context (perhaps for people with particular experiences)

We're trying: public/private SP health-risk reduction studies

- Not just net income and avoided death(s), but variously include contextual/experiential info:
 - Private programs: Baseline and change in risk, avoided illness, latency, duration, prior experience with illnesses, subjective risk of same and other illnesses, household structure, subjective updating of choice scenario... (Cameron and DeShazo)
 - Public policies: Baseline numbers and changes in community illnesses and deaths, number of individuals covered by policy, type of illness/injury, source of risk, type of beneficiary, attitudes toward government provision of risk reductions, evidence of individual-specific discount rates... (Bosworth, Cameron, DeShazo)

Libertarian paternalism?

Regulation for conservatives?

- If we measure/elicit and our models control for...
 - Differences in context
 - Inaccurate subjective perceptions
 - Misinformation, incomplete information
 - Subjective scenario adjustment/tailoring
- We can counterfactually simulate what preferences (and therefore choices) might be under ideal conditions...
 - The desired context
 - Subjective perceptions which match best science
 - Accurate and complete information
 - The choice scenario intended by the researcher

Approaches to heterogeneity

- Problem: “superficial observables” do not fully capture relevant heterogeneity
- Use new “deeper” measures? Choice processing at the neuronal level will be influenced by
 - Myriad genetic differences across individuals
 - Extensive heterogeneity in life experiences
 - But it will remain daunting to measure these for use as empirical controls
- Current refrain: why don't you just use a random parameters model?

Random Parameters Logits for “unobserved heterogeneity”?

- Often stick with linear and additively separable preferences (constant MU). Have strong theoretical reasons to expect (and can enforce)
 - Positive marginal utility for net income
 - Positive marginal utility from more of a “good”
 - Negative marginal utility from more of a “bad”
- Estimate with simulation methods to produce
 - K expected values of MU parameters
 - potentially $K(K+1)/2$ variances/covariances

RPL good, but not a panacea

- Pros:
 - Allows for a continuum of preferences (within the assumed functional form)
 - Can describe sample behavior and confirm the presence and extent of heterogeneity in preferences
- Cons:
 - Cannot predict WTP for an affected population with a different distribution of characteristics than the estimating sample
 - Can be generalized for systematic variation in marginal utilities, but this can complicate the imposition of valuable sign restrictions on marginal utilities

Neat stuff in the Roe/Haab paper

- Will we find “utility” in the brain? = neurological or neurochemical indicators of anticipated (or realized) utility
 - Glimcher et al – neuronal firing levels as “physiological” expected utility?
 - Schultz, Dayan, Montague – dopamine rush: possible DMU in *actual* rewards (but constant MU in *anticipated* rewards?)
 - Other neurotransmitters (serotonin, acetylcholine, norepinephrine, oxytocin) may have roles in choice
- Bernheim and Rangel – choices may maximize *anticipated* utility, but “should” they instead maximize experienced utility?...implications for *prospective* policy evaluation

Continued...

- Knutson et al, Elliot et al – rewarded and unrewarded tasks; analogs to “cheap talk” in stated preference research; consequentiality... Are similar neural pathways implicated in hypothetical and real choices? Will this research help us calibrate differences?
- McClure et al – malleable preferences, advertising; relevant to “constructed preferences” in unfamiliar choice situations
- Caspi et al – implication that genetic makeup can predispose individuals to suffer depression in reaction to major life stressors such as those created by economic recessions; depression changes preferences; feedback further affects the economy?
- And much more...

Thinking ahead, empirically

- Problems with using biomedical measurements and biomechanical/neural models of choice processes in policy analysis?
 - Still need conformable “observables” that we can measure for everyone ...
 - Cheaply
 - From a distance (e.g. in the Census)
 - With due respect for individual privacy
 - Can't feed every citizen through an fMRI machine
 - Will your SS card encode your genetic makeup and all of your life experiences, archived with your Census records, for economic researchers to access?

Value of biomedical/neuro insights?

- Help us better understand the reasons for different choices by “superficially observable” categories of individuals (both across- and within-)
- To highlight attributes of choice contexts that matter, so that we can design our studies appropriately

What now?

- Do we want to
 - Stick to our neoclassical guns? X
 - Jettison our paradigm and start over? X
 - generalize our traditional approach? ?
- Alternatives to B/C for policy-making?
 - Stakeholder representatives at 20 paces (dueling advocates)
 - Voluntary representatives may be a sample, but they are not a random sample

Aggregation problem

- Even with deeper knowledge of what influences individual choices...
 - Still haven't solved the problem of aggregation
 - Ordinary B/C still assumes constant $MU(Y)$
 - Can only use B/C to *advise* policy makers, not to make policy
 - Normative concerns (equity) and politics will still affect policy decisions

Paraphrase Churchill on democracy as a form of government?

- “...[Benefit-cost analysis] is the worst [way to inform policy] except all those others that have been tried from time to time”