When Pull Turns to Shove

Modeling how tribalism and biased environments give rise to ideological distributions

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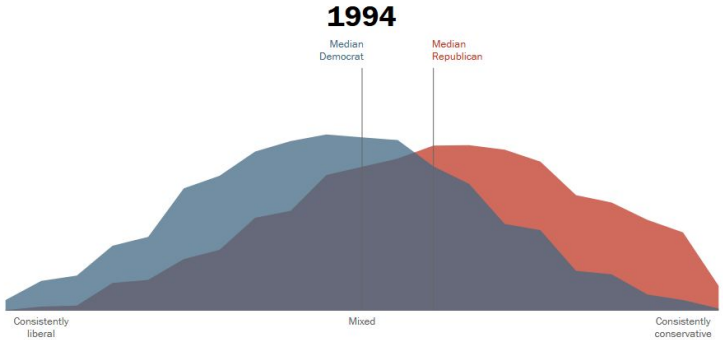
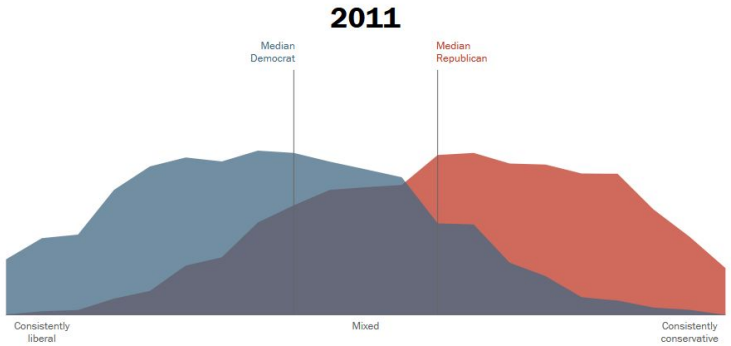
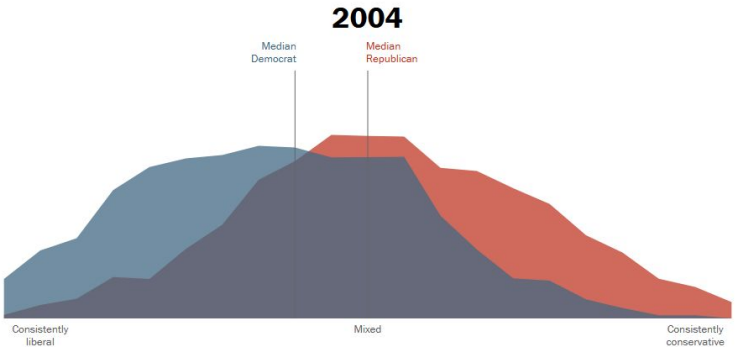
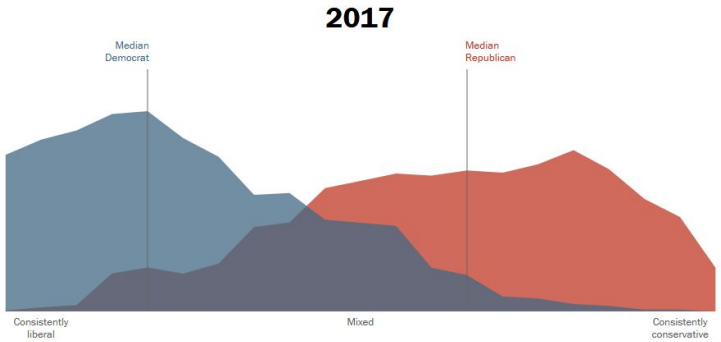
Motivation









Source: Pew Research (2017)

Overview

Political influence/polarization is extremely important, can we approach it mathematically?

Comprehensive theoretical framework for population ideology, integrating:

- Individual-level psychology
- Society-level media/information environment (systematically biased)
- Tribalism (partisan/identity-based bias)

Goals:

- Reproduces existing data (Pew, Bail et al. 2018)
- Able to incorporate (and inspire?) future data
- As “simple” as possible

Challenge: many different approaches, few compatible with each other

Basic Model Structure

1) Individuals react to what they see

- Function of the dissonance between a percept's ideology and their current ideology

2) What individuals see is systematically biased by their current position and party affiliation

- Probability distribution —> no assumption on influence type or structure

3) Individuals' reactions are modulated by tribalism

- Percepts and individuals have a 'party'. cross-party —> less 'trust'

How do people change ideology?

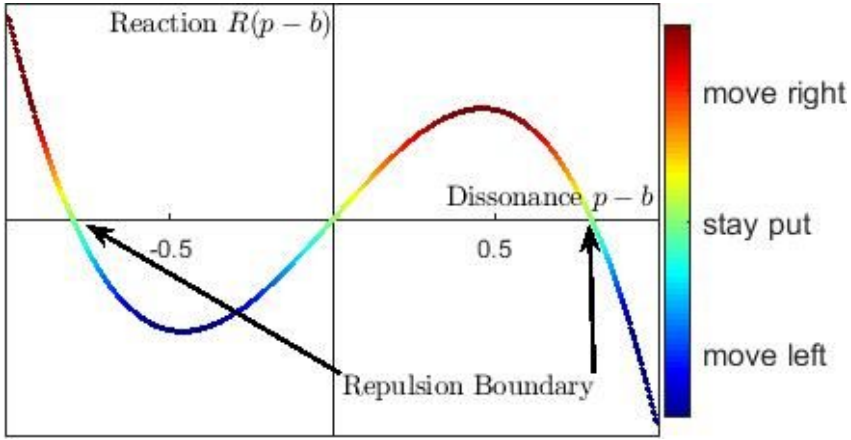
Continuous, finite ideology domain [-1,1]

- Current belief, *b*
- Percepts, *p* (subjectively rated)

"Reaction function":

- local attraction, distal repulsion to ideas.
- "Repulsion Distance" *d* = distance at which percepts shift to being repulsive
  - Allows us to model tribalism: less accepting from out-group sources
- Repulsion is real: Bail et. al (2018)

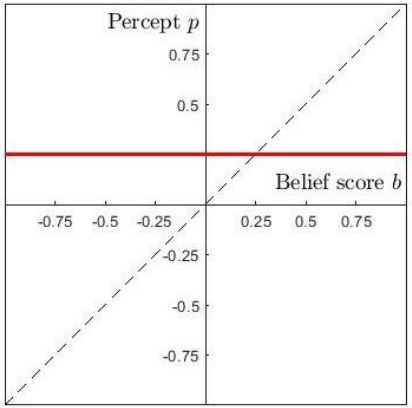
Simple cubic reaction function:



$$R(p-b;d) = (p-b)\left[1 - \frac{(p-b)^2}{d^2}\right]$$

Simplest Case

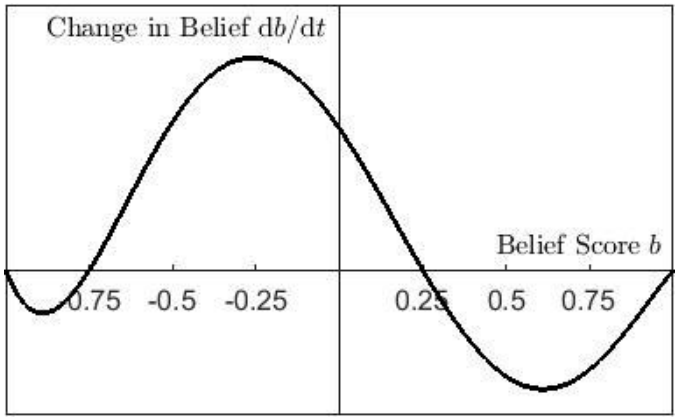
- One repulsion distance *d*
- Constant “party line” percept shown to everyone



We can analytically determine how the whole population moves:

$$\tau \frac{\mathrm{d}b_j}{\mathrm{d}t} = (1-b_j^2)\left\{(p_0 - b_j)\left[1 - \frac{(p_0-b_j)^2}{d^2}\right]\right\}$$

Note: damped motion at edges to confine movement and represent “entrenchment”



Perception Curve

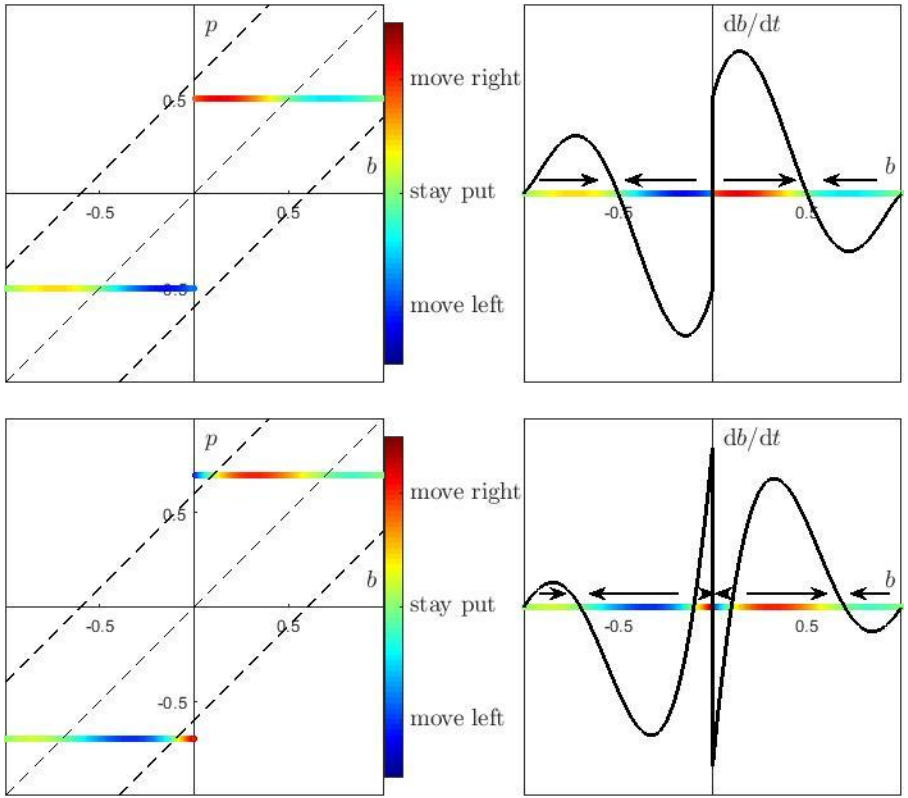
p = p(b)

- Current position determines percept diet

Graphical analysis technique

- 45° lines for *p=b*, *p=b±d*
- Crossings are fixed points
- Slope determines stability

—> Easy qualitative dynamics for ANY perception curve!



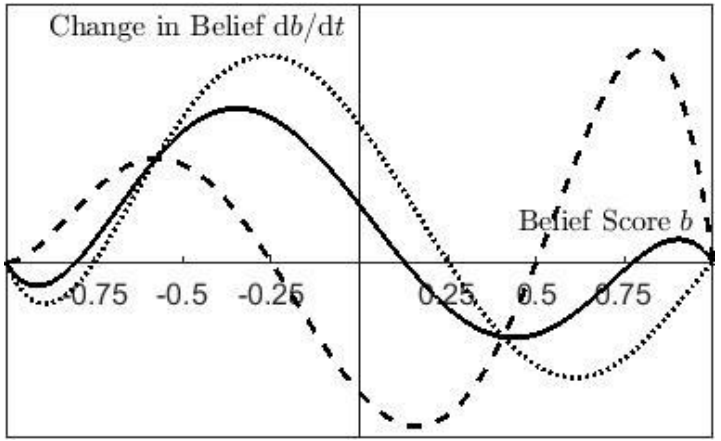
Inter-group Bias (Tribalism)

(back to constant "party line" for each)

$p_i = 0.25,\ p_o = -0.25 \qquad d_i = 1,\ d_o = 0.75 \qquad f = 0.7$

Adding another group ("party")

- In-group perceptions p_i, repel distance d_i
- Out-group perceptions p_o, repel distance d_o
- Some fraction from in-group, $0 \le f \le 1$



Movement = weighted average:

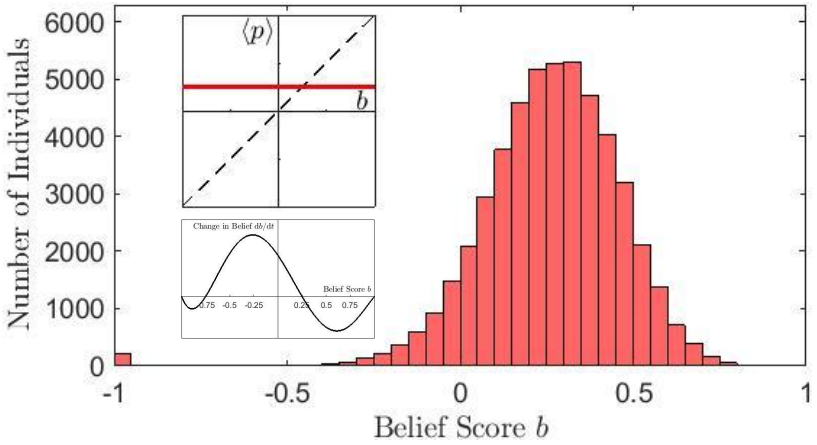
$$\tau \frac{\mathrm{d}b}{\mathrm{d}t} = (1-b^2)\left\{ f\ (p_i - b)\left[1 - \frac{(p_i-b)^2}{d_i^2}\right] + (1-f)(p_o-b)\left[1-\frac{(p_o-b)^2}{d_o^2}\right]\right\}$$

Looks complicated, but just linearly interpolated between results for each party independently

Adding Heterogeneity: Reactions

Reaction noise: differing impacts/reactions

- Normal noise —> Itô SDE
- Attracting fixed points —>stable distributions
- This noise is also edge-damped, to preserve asymptotic, entrenched extremes



'Simplest example', plus reaction noise:

$$\tau \mathrm{d}b = \left(1 - b^2\right) \left\{ (p - b) \left[1 - \frac{(p-b)^2}{d^2} \right] \mathrm{d}t + \sigma_r \mathrm{d}W \right\}$$

($\sigma_r = 0.25$)

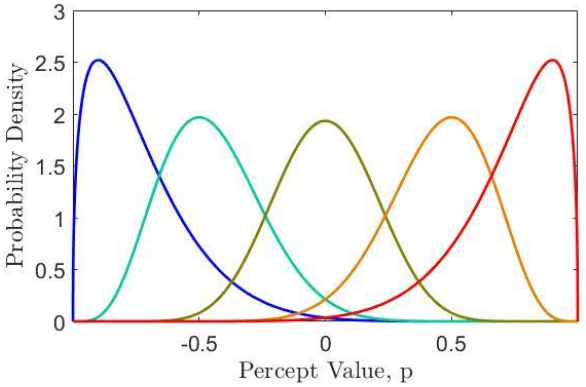
Adding Heterogeneity: Perceptions

Perception ‘noise’: distribution of sources/experiences

How to systematically parametrize?

- Beta distributions: bounded, 2 parameters
  - Perception curve *P(b)* dictates *peak*
- One for each party, weighted by in-group fraction

σ_p =0.2:



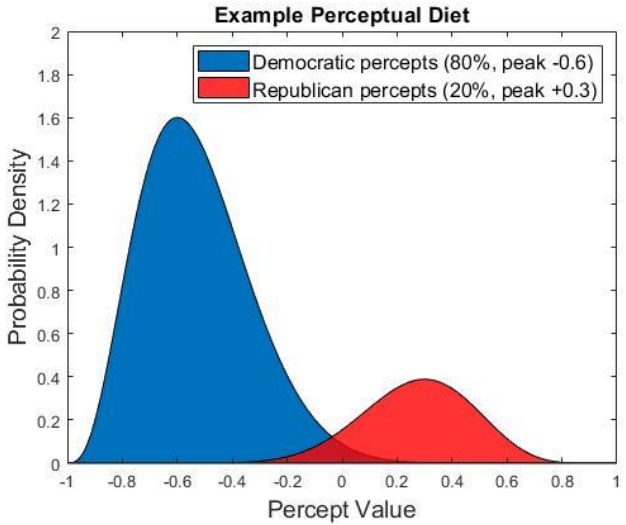
Adding Heterogeneity: Perceptions

Perception ‘noise’: distribution of sources/experiences

How to systematically parametrize?

- Beta distributions: bounded, 2 parameters
  - Perception curve *P(b)* dictates *peak*
- One for each party, weighted by in-group fraction
- Total reaction = integral of these perception distributions against the (tribally-biased) reaction functions
  - Integral reflects assumption that percepts change on faster time scale than ideology

σ_p =0.2:



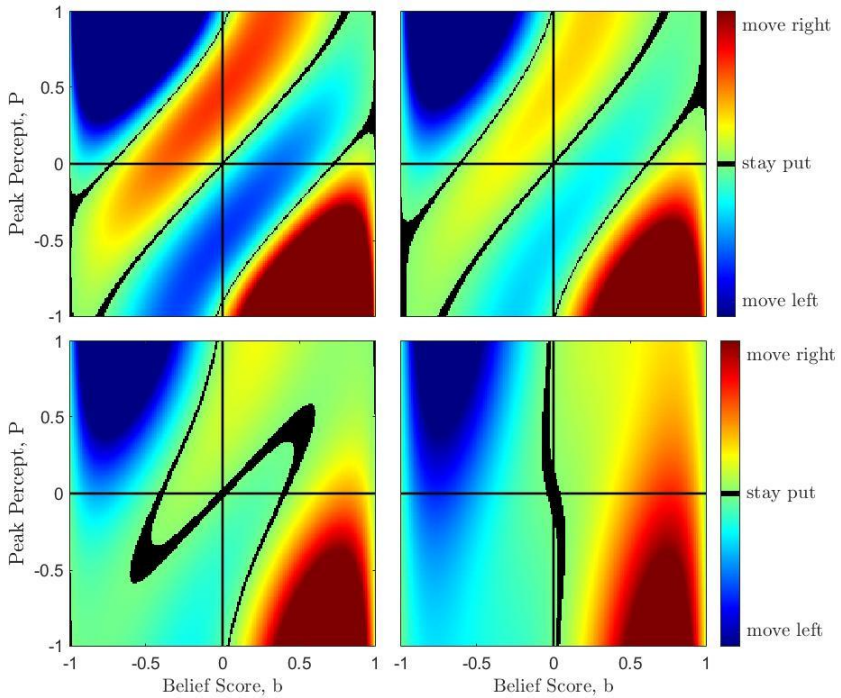
Reaction Maps

For any (global) repulsion distance *d* and percept distribution breadth σ_p, we can compute:

- Value at (b, P) = integral of reaction over percept distribution with peak (mode) P.
- Can use this for graphical analysis technique!

Note: *d*-dependent —> separate maps for in-group content and out-group content

Bifurcation as noise increases —> repulsion dominates



d = 0.8 σ_p = 0.2, 0.3, 0.4, and 0.5

Full Model Structure

$$R(p-b;d) = (p-b)\left[1 - \frac{(p-b)^2}{d^2}\right]$$

$$v_{in} = \int_{-1}^{1} R(p-b;d_{in})\ \rho_{in}(p;b,\sigma_p)\mathrm{d}p$$

$$v_{out} = \int_{-1}^{1} R(p-b;d_{out})\ \rho_{out}(p;b,\sigma_p)\mathrm{d}p$$

$$\tau\ \mathrm{d}b = (1-b^2)\left\{[f v_{in} + (1-f)v_{out}]\,\mathrm{d}t + \sigma_r \mathrm{d}W\right\}$$

Parameters: d_{in}, d_{out}, σ_p, σ_r, f : arbitrary (chosen reasonably)

Perception curves P_{in}, P_{out}: arbitrary (fit)

ϱ_{in}, ϱ_{out}: beta distributions with peaks P_{in}, P_{out} and variance σ_p^2

Or use data!

Full Model: Matching Real-World Distributions

Perception curves

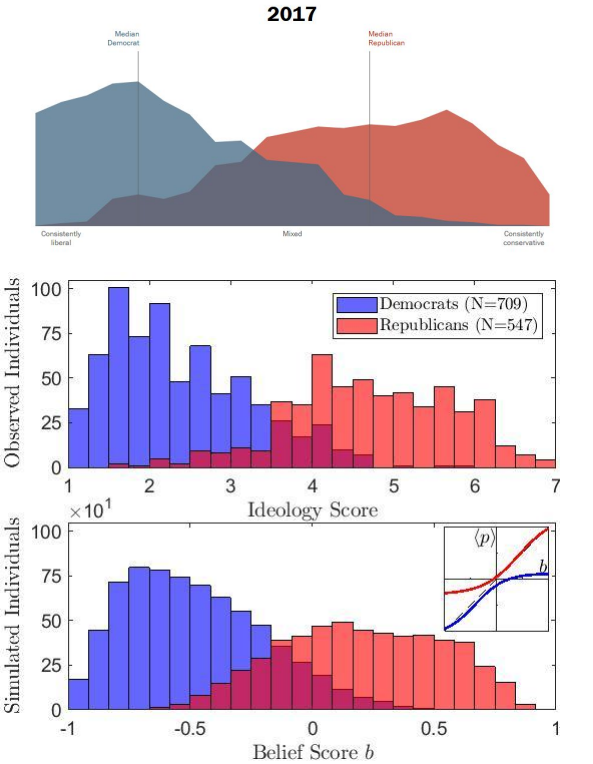
- P(b) = sigmoid, one for each party

In-group fraction

- Rough “media bubble” effect:
  - $f_R(b) = 0.7 + 0.2b$ (Republicans)
  - $f_D(b) = 0.7 - 0.2b$ (Democrats)

Results:

- Equilibrium population distribution(s) matching real-world data
- Also reproduces *dynamics* results of Bail et. al (2018)!



Source: Pew Research (2017) (top), Bail et. al (2018) (middle)

Overview

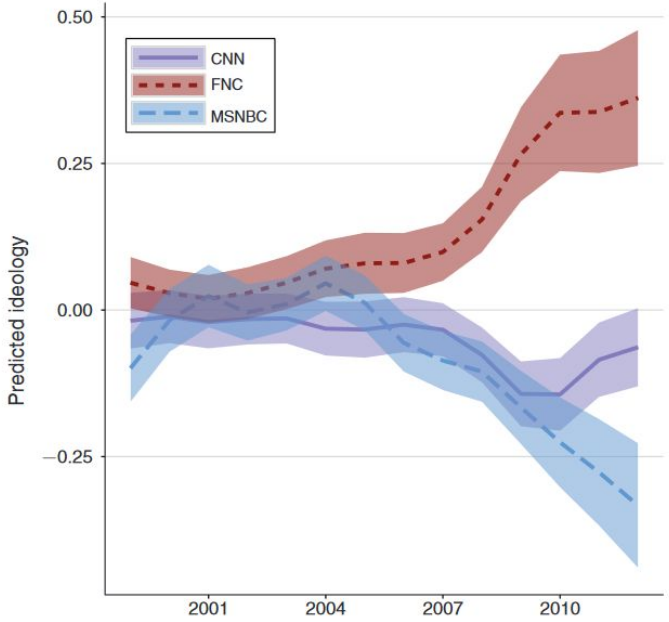
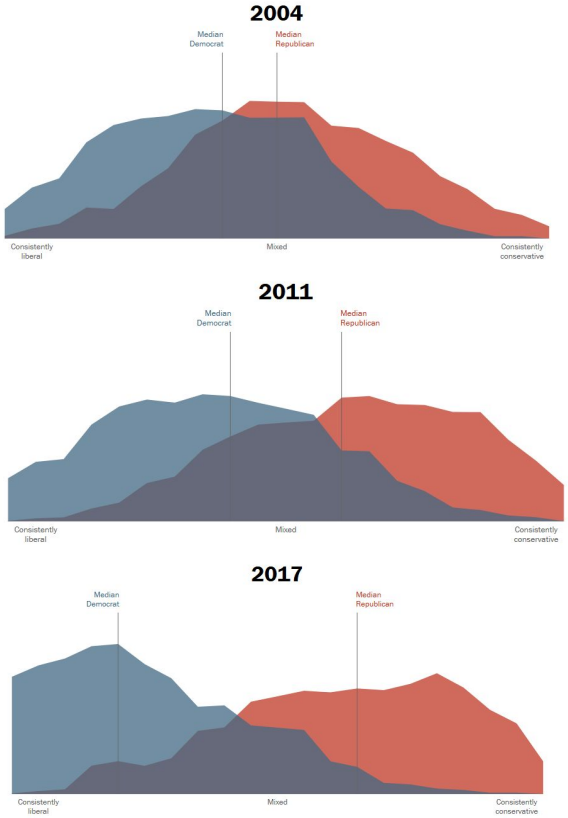


FIGURE 3. ESTIMATED IDEOLOGY BY CHANNEL YEAR

Martin/Yurukoglu (2017)



Overview

Reactions

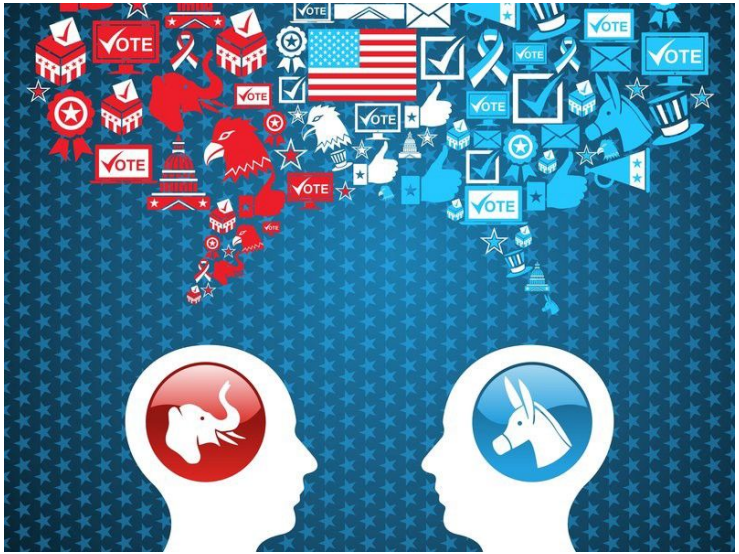
- Highly nonlinear psychological response

Perceptions

- Individuals coupled to systematically biased probabilistic environment
- Analogue for self-selecting, algorithmically-enabled, many-modal influence environments

Tribalism

- Identity mediates reaction
- Implies observed negative-campaigning, straw-manning persuasive tactics



Moving Forward

Data Gathering/Incorporation

- Experiments can explore/inform reaction function, perceptual distributions, tribalism effect

Goals

- Gain understanding of how people are influenced
- Identification of large-scale causes of polarization
- Suggest strategies for effective communication

Meta-Goals

- Theory/Experiment feedback loop!
- Benefits of probabilistic framing