placebo effect modeling

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Goal of simulation: to evaluate the adoption and fixation of technological variants with different efficacy rates, in the presence of placebo effect and conformist transmission

Each agent is represented as a list $[T, p]$ where T denotes the technological variant that the agent possesses (either T1 or T2), and p denotes the agent's subjective belief about the efficacy (a value between 0 and 1) of the technological variant that he possesses.

For any given agent, "realized efficacy" E_r is a function of baseline efficacy E_b and his subjective belief p. Assuming the function takes the following form: $E_r = E_b + \beta \cdot p + \beta_1 \cdot E_b \cdot p$, where E_b represents the baseline efficacy of a particular technology, and β coefficients represents the magnitude of placebo effect.

Now we set up the simulation:

1. Create a starting population of N F1 agents, with 90% agents possessing technology 1 (T1) and the rest 10% possessing technology 2. Those who have T1 have belief $p = \frac{E_{b1}}{1-E_{b1}\cdot\beta_1-\beta}$ where E_{b1} represents the baseline efficacy of technology 1, and those agents with T2 have belief 0, meaning that because it is the new technology and they have no prior experience with it, these agents don't believe it will work at all.

2. Each F1 agents will then "use" the technology and generates either a "positive" or "negative" outcome problematically based on the realized efficacy.

3. Now we create a F2 generation of naive agents of the same size N (no population growth). Each F2 agents will sample a number of F1 agents as their models. Note that these models could all have T1, all have T2, or a mixture of the two technologies, and the models will also have an "outcome" associated with them. The focal F2 agent will then construct their belief regarding the

efficacy of T1 and T2 using the following formula:

$$p_1 = \frac{n_1 \cdot w_o + T_{1pos} \cdot w_a}{(n_1+n_2) \cdot w_o + (T_{1pos}+T_{1neg}) \cdot w_a}$$

$$p_2 = \frac{n_2 \cdot w_o + T_{2pos} \cdot w_a}{(n_1+n_2) \cdot w_o + (T_{2pos}+T_{2neg}) \cdot w_a}$$

where n_1 and n_2 represent the number of models in the sample that have T1 and T2 respectively, T_{1pos} and T_{1neg}represents the number of positive and negative outcomes of technology 1, and w_o and w_a represent the weights associated with observed technological practice and observed outcomes. Essentially, p_1 is just the mean of beta distribution $beta(n_1 + T_{1pos}, n_1 + n_2 + T_{1pos} + T_{1neg})$.

4. If all models possess T1 or T2, then the focal F2 agent will adopt T1 or T2 with the aforementioned belief. If the models possess a mixture of T1 and T2, the focal F2 agent will adopt T1 with probability $\frac{p_1}{p_1+p_2}$, and T2 with probability $\frac{p_2}{p_1+p_2}$

5. After all agents in F2 have adopted a technology and constructed the corresponding belief, they become the parent generation and the cycle continues.