Adoption of Critical Health Practices in Rural India

Aaron Schecter

Introduction

The state of Bihar in India is incredibly poor, despite having a population near the hundred million mark. Health in Bihar reflects the economic status; malnutrition and hunger, diseases such as polio, and neonatal health risks plague the residents (Bihar, 2014). As a result, it is of critical importance that all relevant officials in the region move towards the adoption of more advanced health practices. In particular, the governmental decision makers need to enact policy that implements these changes.

This agent based model is based on the premise that over time, each individual will adapt his/her opinions and perceptions regarding health care change. As these internal mechanisms shift, the agents may become more or less like to actually implement the health policies needed within the province. Given the complexities of the interactions between human emotions and perceptions, agent based modeling is the ideal tool to model change in the network of government officials.

The agent behaviors in the model are based on the Theory of Planned Behavior, which is a psychological framework for the factors leading to decision-making in rational agents (Ajzen, 1991). In addition to individual motivations, a network aspect is incorporated; each actor has both an advice and influence network from whom they derive normative influences. Given these two psychological forces, the rate of adoption and implementation by government officials can be modeled as a function of competing influences. This project aims to explore the impact of each factor as well as determine potential interventions which could improve the overall adoption rates of those in Bihar.

Theory

Psychological Model

The underlying model driving agent rules in this model is the Theory of Planned Behavior, a psychological framework which relates various forces to the intention of action and to the action itself (Ajzen, 1991). This framework is supported by notions of human agency, or the control over one's life and actions (Bandura, 1989, 2001). There are several components to the model, each of which are interrelated; they include attitude, subjective norms, perceived behavioral control, intentions, and behavior (see Figure 1).

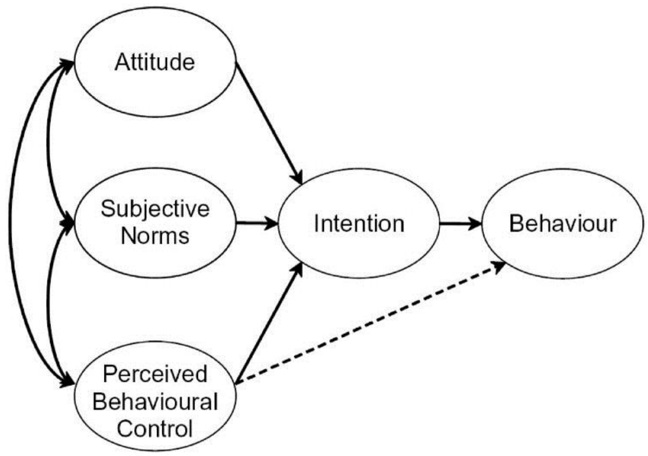

Figure 1. *A schematic of the Theory of Planned Behavior*

Attitudes

The attitude of an individual represents the mindset, opinions, and beliefs of that particular agent. In particular, each agent has internally formed feelings towards any given potential behavior. These could be positive, negative, or neutral and generally range in the degree of their influence. The theory of planned behavior posits that attitudes have a positive relationship with both subjective norms and perceived behavioral control. In other words, if an agent believes that others have a favorable opinion of a behavior, they may be more inclined to have a favorable opinion themselves. Additionally, if an agent believes that they have a high degree of ability to enact a behavior, they are more likely to have a positive attitude towards it.

Subjective Norms

The subjective norms possessed by an individual represent their perception of the attitudes of others toward the behavior of interest. This psychological force encompasses all social pressures, both real and perceived, faced by the agent. The theory of planned behavior suggests that subjective norms are positively influenced by both attitudes and perceived behavioral control. Thus, an agent with an extremely strong personal opinion may have a positively biased perception of the attitudes of those around them. In addition, if an agent believes they can do something, they may be more likely to believe others would support their decision.

Perceived Behavior Control

The perceived behavioral control of an individual is the degree to which they believe they have the ability to actually carry out the behavior. The notion of perceived behavioral control is derived from research in self-efficacy and agency (Bandura, 1977, 1989). In this prior work, the authors suggest that an agent's belief in their own ability to control their situation is colored by perceptions of skill and ability. Thus, feelings of control are largely personal, and do not necessarily match reality. The theory of planned behavior posits that perceived behavioral control is positively influenced by both attitudes and subjective norms. Consequently, if an agent has a favorable opinion of a behavior, and/or they believe others around them have a positive opinion of a behavior, they may have a stronger sense of ability to actually carry out the action.

Intention

The intention of an individual agent is the actual desire to carry out the intended behavior. In other words, intention measures the intensity with which an agent desires to carry out some action. As a result, strong and positive intentions should generally lead to performance of the behavior. Intention is derived from a positive combination of attitudes, subjective norms, and perceived behavioral control. An agent with a strong positive attitude towards a behavior will have a stronger desire to actually carry it out. Additionally, if an agent believes other agents support an action, they will be more motivated to pursue the behavior. Finally, a strong feeling of control may produce a higher willingness to act.

While intention has a positive relationship with each of the three components of internal influence, Ajzen (1991) posits that the impact of intention on the performance of a behavior is moderated by perceived behavioral control. In other words, even the strongest of intentions can be dampened if the agent has no control over his/her situation. Thus, the actual ability of an agent to act is a combination of both intention and control.

Network Model

While the Theory of Planned Behavior provides a framework for the internal mechanisms driving an agent's decision-making process, external forces cannot be ignored. In particular, the social network in which an individual is embedded will directly impact the beliefs and opinions of that person. The Bihar government official survey collected information on two types of network ties, advice and influence. Each official was asked to list all the individuals from whom they receive advice on a number of topics, and was also asked who they believed to be the most influential people in their network.

The advice and influence network of each agent provides the source of external opinions that help shape an individual's perception of society norms. In particular, simply by reporting the presence of a relation, an agent is revealing their implicit perceptions of their network (Krackhardt, 1987). As a consequence, it is likely that those individuals reported to be in the ego network will strongly influence an agent's subjective norms. Thus, the attitudes of those in the advice and influence networks of each agent will have some positive influence on the norms of each actor.

Methodology

Model Setup

The agent based model representing the Bihar government officials is setup in two main steps. First, the agents – represented by turtles – need to be initialized with values for each of the four behavioral attributes. To carry out this task, a multinomial distribution was generated from the collected survey data; attitudes, subjective norms, perceived behavioral control, and intent all were measured on a Likert scale from 1 to 7. The distribution of each of these factors is presented in Table 1.

	Attitudes	Subjective Norms	Perceived Behavioral Control	Intent
Value				
1	0.002	0.02	0.11	0.09
2	0.006	0.02	0.08	0.02
3	0.022	0.04	0.08	0.07
4	0.07	0.10	0.13	0.06
5	0.15	0.16	0.17	0.12
6	0.29	0.29	0.23	0.24
7	0.46	0.37	0.20	0.40

Table 1. *Probability distribution of initial agent values, based on survey data. Numbers based on 9799 survey responses.*

It is interesting to note that the attitudes, subjective norms, and reported intent are all so heavily skewed positive, while control is more evenly dispersed. Thus, while a majority of respondents had favorable opinions of change, they did not necessarily feel they had control over their ability to implement new policies.

In addition to initializing the values of each agent, the setup also partitioned the turtles into "implementers" (indicated by a green color) and "non-implementers" (indicated by a blue color). This categorical assignment was based on the survey data in which respondents indicated whether or not they would be the individual responsible for making decisions. The dataset contained 47% affirmative responses. Therefore, only 47% of all turtles would even by capable of changing their behavior, regardless of opinion.

Second, the model setup generates advice and influence ties between the model agents. These ties are represented by two types of link breeds, advice (yellow color) and influence (pink color). In the dataset, there were on average 10.52/9799 advice ties per turtle and 2.12/9799 influence ties per individual. Thus, each turtle was asked to create a number of links equal to a Poisson random number generated based on the appropriate mean. A Poisson random number generator is used so that the degree distribution of each turtle roughly follows a power-law distribution, which is common in many naturally occurring networks (Barabási & Albert, 1999). For both link breeds, the connections are directed; the creating turtle generates a link to a number of other turtles. This action represents the survey setup, which asks respondents to point to who they receive advice from or vice versa.

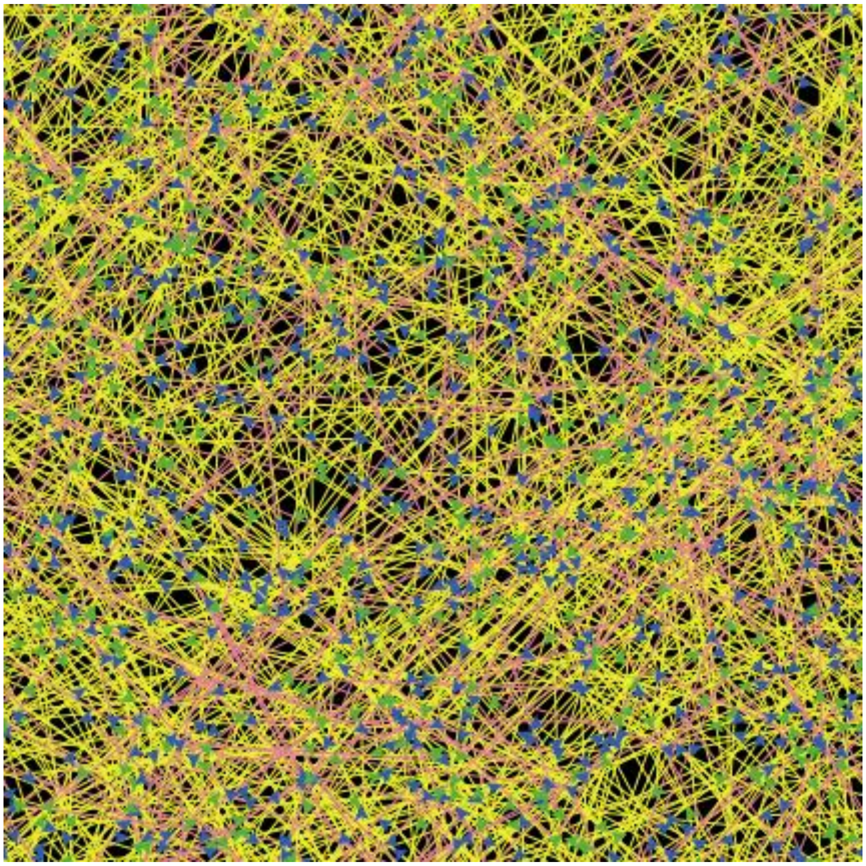

Figure 2. *Model setup with blue non-implementers, green implementers, yellow advice ties, and pink influence ties.*

Model Rules

At each model step, turtles are asked to update their internal variables: attitudes, subjective norms, perceived control, and intent. If a turtle is an implementer, it is asked to potentially perform the behavior of adopting. The model stops if every implementer has adopted, or after a set amount of time.

Because each psychological component is interrelated, the turtles are asked to create a "last-…" set. This command requires each turtle to store the value of all four factors in a separate turtle variable. Additionally, each turtle considers its advice and influence neighborhood, and collects the average attitudes there as well. The purpose of this step is to ensure that all turtle calculations are based on the internal values *at the beginning of the tick*, rather than the values that have been updated already.

The changes in the internal psychological variables can be represented by a series of equations that relate the new value to the previous values. For notational purposes, let A_t, N_t, C_t, and I_t represent the attitudes, subjective norms, perceived control, and intent at time t respectively. Further, let AD_t be equal to the average attitude of a turtle's advice neighborhood at time t and let IN_t be equal to the average attitude of a turtle's influence neighborhood at time t. By default, AD_t and IN_t are zero if there is no neighborhood. Then, each turtle updates their internal variables via the following equations:

$$A_t = A_{t-1} + u_1 \times [\theta_{NC-A}(N_{t-1} - A_{t-1}) + (2 - \theta_{NC-A})(C_{t-1} - A_{t-1})]/12$$

$$N_t = N_{t-1} + u_2 \times [\theta_{AC-N}(A_{t-1} - N_{t-1}) + (2 - \theta_{AC-N})(C_{t-1} - N_{t-1}) + \theta_{AD-IN}(AD_{t-1} - N_{t-1}) + (2 - \theta_{AD-IN})(IN_{t-1} - N_{t-1})\ ]/24$$

$$C_t = C_{t-1} + u_3[\theta_{AN-C}(A_{t-1} - C_{t-1}) + (2 - \theta_{AN-C})(N_{t-1} - C_{t-1})]/12$$

$$I_t = I_{t-1} + u_4[\theta_{A-I}(A_{t-1} - I_{t-1}) + \theta_{N-1}(N_{t-1} - I_{t-1}) + (3 - \theta_{A-I} - \theta_{N-I})(C_{t-1} - I_{t-1})]/18$$

Effectively, the above equations represent the hypothesized inter-relationships among the four components of the Theory of Planned Behavior. In each equation, the difference terms represent the disparity between any given pair of factors. Each parameter θ is positive, and as a result, the value of one factor at time t will move closer to the values of the other factors at time $(t-1)$. The number u is a Uniform(0,1) random variable, meant to inject randomness into the changes in the psychological factors. Finally, the division term is designed so that the maximum change in one time step is 1. This number is derived from the range of difference values, which could be from 0 to 6. Further, the parameters always sum to the number of difference terms (more details in the following section). By default, if any of the four turtle values goes outside the range [1, 7], the value is adjusted to the appropriate limit number.

The second core turtle procedure is actual adoption. This portion of the model asks all implementer turtles to consider their current values of intent and perceived behavioral control. Then, each turtle is asked the following question:

1. If $C_t \geq \beta_C$, go to step 2
2. If $I_t \geq \beta_I$, go to step 3

3. Adopt with probability 0.5 and set your color to red

The parameters β are threshold values which control the ease of adoption from the decision-making turtles. Effectively, the agents must have a minimum level of control and intent simultaneously to be able to perform the behavior. Additionally, a random component is operationalized within the decision process to account for variability in behavior.

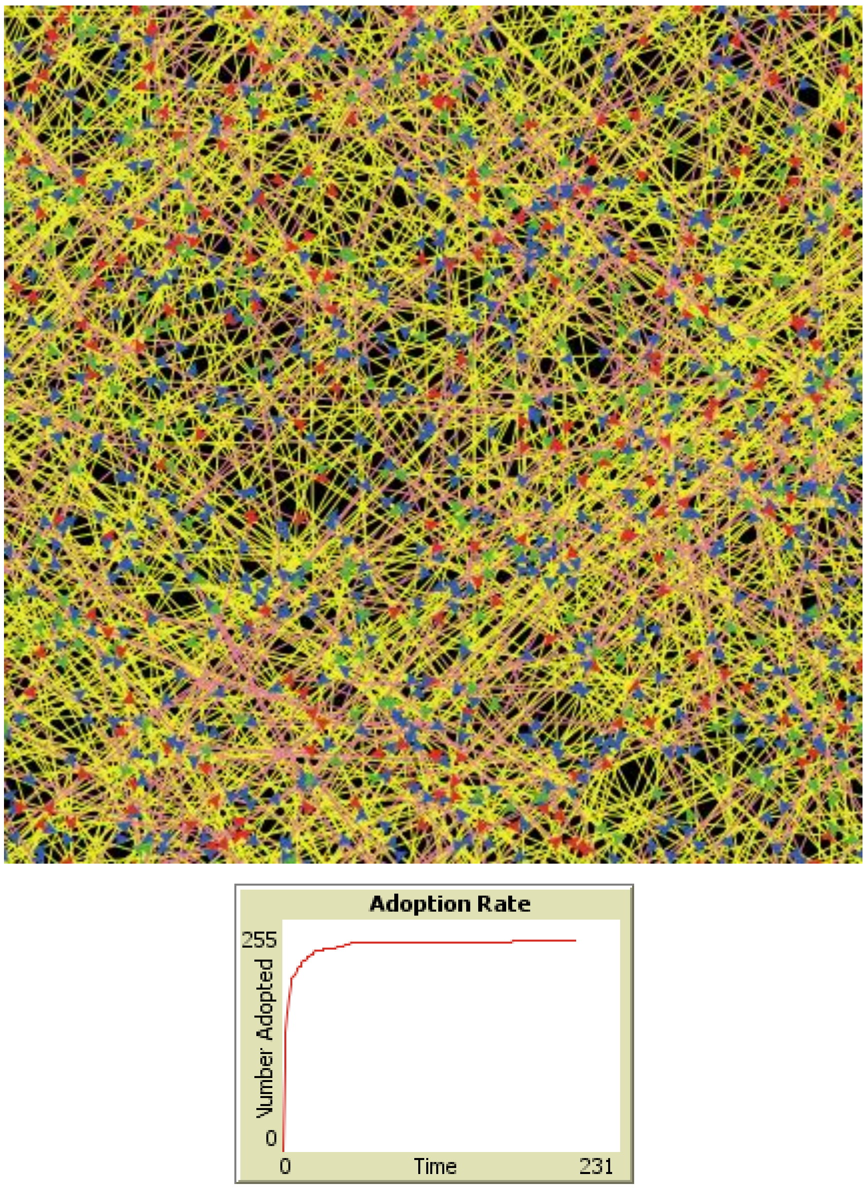

Figure 3. *A model result with 255 adoptees. A plot of the adoption rate over time is included.*

Model Parameters

In the following section, each of the parameters mentioned previously will be defined both qualitatively and quantitatively. First, the psychological change parameters:

- θ_{NC-A}: The influence of norm/control on attitude. This parameter ranges in value from 0 to 2, and controls the impact of norms on attitude. The influence of control on attitude is operationalized as $2 - \theta_{NC-A}$. By construction, there is a direct substitution effect between these factors; if $\theta_{NC-A} > 1$, then norms have a greater influence on attitude than control and vice versa.
- θ_{AC-N}: The influence of attitude/control on subjective norms. This parameter ranges in value from 0 to 2, and controls the impact of attitude on subjective norms. The influence of control on norms is operationalized as $2 - \theta_{AC-N}$. By construction, there is a direct substitution effect between these factors; if $\theta_{AC-N} > 1$, then attitudes have a greater influence on norms than control and vice versa.
- θ_{AD-IN}: The influence of the attitudes of the advice network on subjective norms. This parameter ranges in value from 0 to 2. The impact of influence ties on norms is operationalized as $2 - \theta_{AD-IN}$. By construction, there is a direct substitution effect between these factors; if $\theta_{AD-IN} > 1$, then the attitudes of the agent's advice network have a greater impact than the attitudes of the influence network.
- θ_{AN-C}: The influence of attitude/norms on control. This parameter ranges in value from 0 to 2, and controls the impact of attitude on perceived control. The influence of subjective norms on control is operationalized as $2 - \theta_{AN-C}$. By construction, there is a direct substitution effect between these factors; if $\theta_{AN-C} > 1$, then attitudes have a greater influence on control than subjective norms and vice versa.
- θ_{A-I}, θ_{N-I}: The influence of attitudes and norms on intent. The parameters range in value from 0 to 1.5. The impact of attitude is operationalized by θ_{A-I}, while the impact of norms is captured by θ_{N-I}. The influence of perceived control on intent is then captured by $3 - \theta_{A-I} - \theta_{N-I}$. In this case, there is not a substitution effect between attitudes and norms. However, there is a substitution effect between perceived control and the other two factors. More specifically, if $\theta_{A-I} > 0.75$, then attitudes have more influence on intent than control, and if $\theta_{N-I} > 0.75$, then norms have more influence on intent than control.

Finally, there are a set of threshold parameters which dictate the relative difficulty of a turtle actually performing the behavior of adoption.

- β_C: The threshold for the agent's level of control. This parameter ranges from 1 to 7.
- β_I: The threshold for the agent's level of intent. This parameter ranges from 1 to 7.

Model Fitting

In order to determine the values of the above parameters, the tool BehaviorSearch was applied to the agent based model. BehaviorSearch is an application that allows NetLogo to find the optimal set of parameters, as measured by some fitness function (Stonedahl & Wilensky, 2011). Effectively, this search tool performs similar analysis to the BehaviorSpace experimentation platform, without needing to exhaustively search all possible parameter combinations. In this modeling context, there are two specific objective functions of interest:

1. Minimize $\left(0.47 - \frac{\text{\# adopted}}{\text{\# implementers}}\right)^2$
2. Maximize $(\text{\# adopted})$

Fitness function 1 attempts to find the set of behaviors that most closely match the observed dataset; in the survey, 47% of all potential implementers reported the adoption of critical health practices. Fitness function 2 attempts to find the set of behaviors that lead to the highest overall rate of adoption. The contrast between the two models will highlight the differences in hypothetical behavioral patterns and potentially identify future interventions.

Results

Model Testing

Using BehaviorSearch, the NetLogo model was tested through several runs. With each repetition, the BehaviorSearch tool performed 500 model runs; this procedure was repeated 5 times. The reason for this relatively small number was due to the magnitude of the data. There are 9799 agents in the model, and one repetition of the parameter search took multiple hours. However, there was still 2,500 model runs to analyze. In Table 2 the results are presented from fitness function 1, which attempts to match the behavior as closely as possible to the real data. The results are ranked by best fitness function value; the top 20 are collected and averaged.

Parameter:	θ_{NC-A}	θ_{AC-N}	θ_{AD-IN}	θ_{AN-C}	θ_{A-I}	θ_{N-I}	β_C	β_I	Fitness
	1.63	1.22	0.54	1.81	1.39	0.17	5.6	5.9	4.73E-05
	0.69	0.62	0.91	1.24	1.41	0.34	5	5.8	5.29E-05
	1.58	1.98	1.5	0.37	0.73	0.88	6	5.4	7.70E-05
	0.63	1.22	0.51	0.19	0.58	1.29	5.2	5.8	8.88E-05
	0.7	1.62	1.34	0.06	0.53	0.17	5.7	5.8	2.08E-04
	1.05	1.49	0.66	0.58	1.14	1.11	5.8	5.8	2.11E-04
	0.41	0.74	1.92	1.97	1.25	0.91	5.8	5.6	2.29E-04
	0.26	0.11	0.29	0.66	0.33	0.53	5.3	5.7	3.60E-04
	1.68	0.73	0.98	1.61	0.31	0.07	5.9	5.4	4.66E-04
	0.7	1.9	1.7	1.35	0.44	0.14	5.6	5.9	4.90E-04
	1.92	1.74	0.96	0.95	0.88	0.99	5.8	6	9.64E-04
	1.41	0.59	0.17	0.94	1.12	0.29	5.8	5.3	0.001054
	0.44	1.27	1.13	0.32	0.74	0.92	5.7	5.6	0.001151
	0.44	0.28	1.1	1.33	1.14	0.1	5.4	5.8	0.001318
	1.36	1.46	1.64	0.93	1.39	0.6	5.8	5.8	0.002075
	0.66	1.86	0.97	1.2	1.06	1.1	5.8	5.7	0.002259
	0.25	0.16	1.6	0.48	0.42	1.32	5.6	5.4	0.002321
	0.44	0.22	1.78	0.64	1.42	1.28	5.4	5.6	0.002352
	1.63	1.22	0.54	1.81	1.39	0.17	5.6	5.9	0.003401
	0.69	0.62	0.91	1.24	1.41	0.34	5	5.8	0.003911
Mean:	0.903	1.067	1.094	0.924	0.904	0.678	5.622	5.683	
SE:	0.548	0.644	0.527	0.558	0.401	0.458	0.265	0.201	

Table 2. *The results of BehaviorSearch runs on the ABM with N = 9799 turtles. The results presented are the parameter values and fitness function value for the 20 best results across all 2,500 model runs*

From the parameter results in Table 2, a number of qualitative interpretations can be made. First, on average perceived behavioral control has a slightly greater impact on attitudes than subjective norms. Further, attitudes have a greater effect on norms relative to perceived control. Advice ties have, on average, a slightly greater impact on subjective norms than do influence ties. Additionally, norms have a greater influence on perceived control relative to attitudes. It should be noted however that all of these results are relatively small, and there is significant variability. Intent is influenced by all three psychological factors. On average, it can be observed that attitude tends to dominate control with regard to influence on intent. Conversely, the influence of control trumps the influence of subjective norms on intent. Finally, the threshold variables have very similar values when considering the 20 best model instances. On average, turtles whose intent and control are both over 5.6 will have a 50% chance of adopting at any tick.

The second step in the analysis process is to fit the same models, but with respect to the second fitness function. Thus, the following results are the parameter values that lead to the highest rates of adoption. Similarly, the 20 best model runs are presented and summarized in Table 3. The results of maximizing the overall adoption rate leads to a number of interesting observations. First, a very high overall adoption rate is clearly feasible; given that there are 47% implementers in the network, a value of 4,605 is approximately the max attainable value. Thus, the BehaviorSearch tool was able to create scenarios in which there was 90%+ adoption among the officials.

Second, the two biggest changes in parameter values occurred in the influence of norms/control on attitude and the influence of attitude/control on norms (see Figure 2). In both cases, control has a significantly smaller impact in the maximum adoption case. Further, the thresholds for adoption in the second model are lower (the minimum search value was 5). Clearly, when there is a lower barrier to action the agents will increasingly perform the behavior.

Qualitatively, these results make intuitive sense. The biggest limiting factor in performing a particular behavior was the perceived sense of control; if a government official did not believe he/she had the means to make change, even the best intentions would not overrule this. However, if perceived behavioral control was less of a factor, than the intentions would dominate. This result is a reflection of the overwhelmingly positive support for adoption in the network survey data. Further, there are implications for intervention; if government officials are given increased control over their situation or more resources, they may be significantly more likely to actually adopt the critical health practices.

Parameter:	θ_{NC-A}	θ_{AC-N}	θ_{AD-IN}	θ_{AN-C}	θ_{A-I}	θ_{N-I}	β_C	β_I	Fitness
	1.06	1.36	1.6	0.41	1.5	0.3	5.2	5	4284
	1.06	1.36	1.6	0.41	1.5	0.3	5.2	5	4280
	1.06	1.36	1.6	0.41	1.5	0.3	5.2	5	4272
	1.06	1.36	1.6	0.41	1.5	0.3	5.2	5	4269
	1.06	1.36	1.6	0.41	1.5	0.3	5.2	5	4241
	1.06	1.36	1.6	0.41	1.5	0.3	5.2	5	4227
	1.06	1.36	1.6	0.41	1.5	0.3	5.2	5	4224
	1.06	1.36	1.6	0.41	1.5	0.3	5.2	5	4200
	1.06	1.36	1.6	0.41	1.5	0.3	5.2	5	4200
	1.06	1.36	1.6	0.41	1.5	0.3	5.2	5	4177
	1.31	1.17	0.15	1.71	0.85	1.22	5	5	4171
	1.31	1.17	0.15	1.71	0.85	1.22	5	5	4137
	1.31	1.17	0.15	1.71	0.85	1.22	5	5	4133
	1.31	1.17	0.15	1.71	0.85	1.22	5	5	4089
	1.31	1.17	0.15	1.71	0.85	1.22	5	5	4087
	1.31	1.17	0.15	1.71	0.85	1.22	5	5	4065
	1.31	1.17	0.15	1.71	0.85	1.22	5	5	4035
	1.31	1.17	0.15	1.71	0.85	1.22	5	5	4018
	1.97	1.6	0.11	1.88	0.82	0.33	5	5.4	4008
	1.97	1.6	0.11	1.88	0.82	0.33	5	5.4	4000
Mean:	1.251	1.308	0.871	1.077	1.172	0.671	5.1	5.04	
SE:	0.2740	0.1357	0.7480	0.6861	0.3366	0.4599	0.1025	0.1231	

Table 3. *The results of BehaviorSearch runs on the ABM with N = 9799 turtles. The results presented are the parameter values and fitness function value for the 20 best results across all 2,500 model runs*

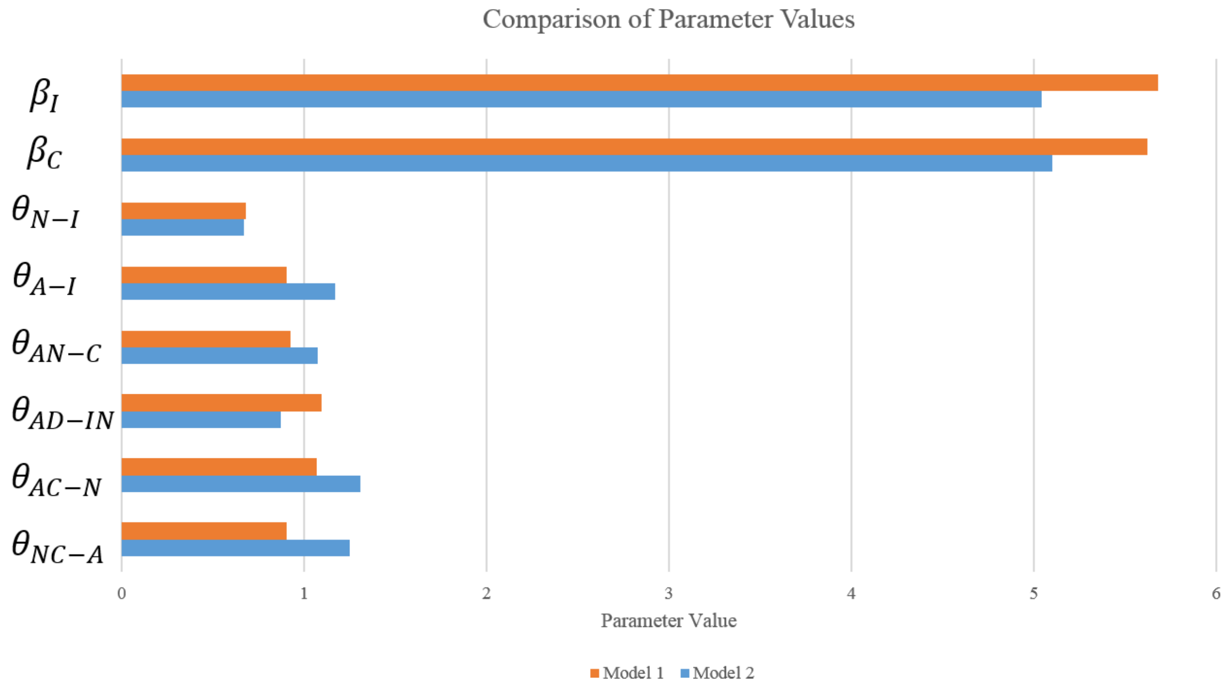

Figure 4. *Comparison of parameter values across both fitness functions*

Model Extension

As an extension to the basic agent based model, an additional layer of complexity was added in order to more accurately represent possible interventions available. The context of the extension is the notion of an "intervener," which is an agent that attempts to persuade or coerce existing agents into performing the desired behavior. In other words, can we introduce a new set of agents and have them significantly improve the adoption rates?

Model Rules

The setup for this agent based model is identical to the basic model, with the exception of the new set of agents, the interveners (colored purple). These turtles own the variable power, which also varies randomly from 1 to 7. Power represents the relative influence of that intervener, i.e. its inherent ability to affect change. Each intervener creates a tie to a set number of other turtles in the network; only implementer turtles can be targets, since it is their opinion which truly drives change. It is possible that interveners may simultaneously choose to influence the same implementer turtle. Finally, the number of ties assigned to each intervener is variable, from 1 to 5.

The influence of the intervener turtles is included in both the "control" and "intent" equations for the non-intervener turtles in the network. This addition represents the ability of an intervention to improve feelings of control and to improve a turtle's intrinsic motivation to act. For a given turtle, define P as the average persuasive power of all the turtles that have chosen to intervene on that turtle's behalf. The changes to the equations are:

$$C_t = C_{t-1} + \cdots + u_5(\theta_{INT-C} \times P)/7$$
$$I_t = I_{t-1} + \cdots + u_6((2 - \theta_{INT-C}) \times P)/7$$

The values u_5 and u_6 are Uniform(0,1) random variables added to represent the randomness of individual effects. The parameter θ_{INT-C} represents the influence of interveners on a turtle's perceived control. This variable ranges from 0 to 2, with values greater than 1 indicating the intervener has a greater relative influence on control than intent. The division by 7 guarantees that the maximum increase in intent or control at any tick is 2 – this increased value is meant to represent the power of an intervener, relative to self-change. Additionally, it should be noted that this will always add a positive value to intent and control; while this may not always be realistic, it signifies a strictly positive effect of intervention. Future work may adjust this.

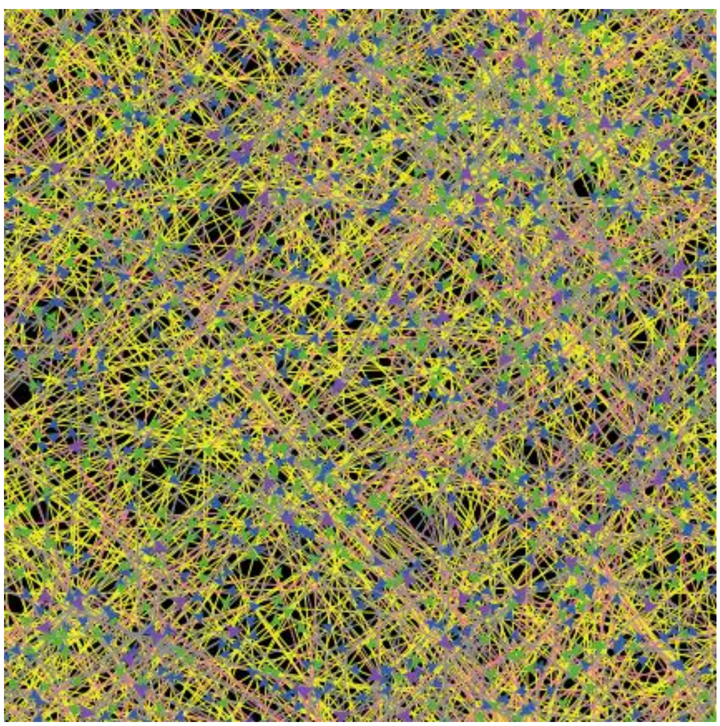

Figure 5. *Setup for interveners model. Additional purple turtles are interveners with grey influence ties.*

Model Testing

As a test case, the intervention model was run against a basic model using 100 replications of the BehaviorSearch tool. In these models, only 1000 turtles were simulated for run-time reasons. The fitness function used was fitness function 2, which was the maximum adoption rule. Both the final objective function value and the parameter values are compared in Table 4.

	Basic Model	Interveners Model
Fitness Value	146.457	145.604
Parameters		
θ_{NC-A}	1.1548	1.2142
θ_{AC-N}	1.1581	1.1527
θ_{AD-IN}	1.7654	1.8135
θ_{AN-C}	1.511	1.4113
θ_{A-I}	0.7072	0.7604
θ_{N-I}	0.4529	0.4991
Number Intervener Ties		2.73
θ_{INT-C}		0.9499

Table 4. *Parameter values and fitness function values for base model and extension*

Interestingly, the addition of interveners into the model completely failed to improve the adoption rate in the network. There was no significant change in any of the core model parameters. On average, interveners made 2.73 ties in the most successful model scenarios. Additionally, there is no significant difference between the impacts of intervention on control, relative to intent.

Preliminary testing was done on the interveners model with 9,799 total government official turtles, and 100 intervention agents. However, the best possible outcome found only yielded 3,831 adopted turtles. This result is significantly less than the best model with no intervention.

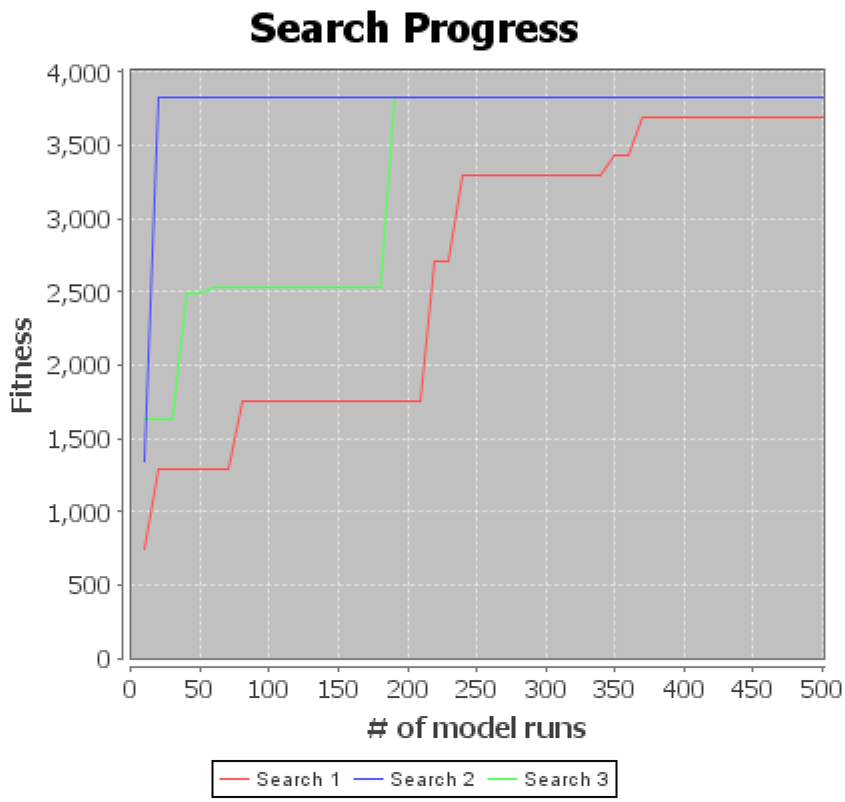

Figure 6. *Preliminary BehaviorSearch results for intervention model*

The key takeaway from this modeling experiment is that interventions into the model do not provide a guaranteed improvement in adoption. This result conflicts to some degree with common sense assumptions about human behavior. However, is possible that intervention does have an effect, but the combination of network size and action threshold do not necessitate additional motivation. An area of future research is to expand this model and more thoroughly reveal the relationship between external influences and the basic model behaviors.

Conclusions

This modeling project has highlighted the underlying psychological mechanisms that lead to different outcomes with respect to adoption of critical health practices. Given the urgent need for improved use of modern medicine, spurring change is of the utmost importance. The agent based models presented here take a first step towards providing insight into what drives people, and also what should drive people. Finally, a naïve approach at incorporating intervention did not yield positive results; however, this merely encourages future thought and research.

Future work on this project revolves around adding complexity and randomness to the model, as well as incorporating more aspects of the original dataset. Other psychological and network forces may be at play that have currently not been accounted for. Additional model extensions should also be considered, particularly those with immediate practical implications.

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