Modeling the Theory of Planned Behavior from Survey Data for Action Choice in Social Simulations

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ABSTRACT: *Current dialogues across a variety of disciplines from the social, behavioral and computer sciences have made clear the need for authentic, repeatable and actionable social simulations. Understanding how the individuals that comprise various populations (and segments of society) might respond to a given set of conditions provides the potential to better inform analysts and decision makers in a wide variety of settings. Here we examine the implications of applying a well-documented behavioral prediction theory, Icek Ajzen's Theory of Planned Behavior (TPB), within a social simulation in the context of public policy decision making. We provide brief overviews of both TPB and the construction of artificial societies, a full description of the TPB implementation within an artificial society, and develop an argument for the benefits of informing action choice models such as TPB from representative survey data.*

1. Introduction

Icek Ajzen's Theory of Planned Behavior (TPB) is a predictive paradigm for human behavior that connects attitudes with actions (I. Ajzen, 1991). Specifically, TPB accesses an individual's 1) belief towards a particular behavior, 2) belief about the social norms associated with a particular behavior, and 3) belief regarding the ability to control the outcome of a particular behavior. These are referred to as "behavioral beliefs", "normative beliefs", and "control beliefs", respectively, and together yield the individual's level of intention to carry out a particular action. This "behavioral intention" is assumed to be a direct precursor to actual action, and is empirically well-supported in literature across many behavioral and social domains, including social and cognitive psychology, advertising, marketing, healthcare, and communications (Chang, 1998; Hagger et al., 2007; Mathieson, 1991; Walker, Courneya, & Deng, 2006). TPB was also used as the theoretical basis for examination in over 800 studies in two prominent medically-related scholarly databases between 1985 and 2004 (Francis & Eccles, 2004).

In order to obtain the required information about individual beliefs, TPB surveys are generally used that address specific questions within a particular field of study (Icek Ajzen, 2006). For instance, a healthcare TPB questionnaire would be used to assess individual beliefs related to the use of treadmill exercise for the purposes of weight loss. Once these beliefs are assessed, the model can generate predictions about whether individuals will use treadmills to lose weight. Previous studies have discussed the use of surveys to inform the cognitive state models (e.g., internal beliefs and interests), and a social structures of multi-agent systems. Here we explore the use of survey data to inform the theory of planned behavior (TPB) as a means of ascertaining and describing an actor's intention to carry out specific behaviors within an artificial society.

2. Social Simulations

Social simulations represent large human groups (such as societies) as complex adaptive systems at varying levels of granularity. One of the key goals in the field of social simulation is the representation and analysis of changes in the beliefs, values, and interests (BVIs) of individuals in a population across a range of possible perturbing events (Alt, Jackson, Hudak, & Steven Lieberman, 2010). Data to instantiate these simulation models can be derived from a number of sources, including subject matter expert (SME) input, such as the development of narrative ethnographies, and quantitative survey and polling data, such as the U.S. General Social Survey[1], and World Values Survey[2].

Simulated societies provide tools for analysts and researchers from multiple disciplines to conduct experimentation and gain insight into the complex domain described by a society. The endeavor to understand and analyze complex adaptive systems, including societies, has been described as a "wicked problem" (Roberts, 2000). One defining characteristic of these problems is

[1] http://www.norc.org/GSS+Website/
[2] http://www.worldvaluessurvey.org/

that traction is typically only gained through iteration. One cannot experiment with public policies, for instance, without altering the public—namely the target group of the policies. If a trial policy does not have the intended consequences, new policy must be developed not based on the original conditions, but for the newly changed target group. This makes the wicked problems associated with societies ideal candidates for the use of modeling and simulation, where experimentation and "what if" analyses can be performed without changing the target group.

Social simulations must consist of actors, representations of individuals from population subgroups within the real population under study, as well as a representation of the social environment within which these actors interact (National Research Council, 2008). When developing social simulation scenarios, data must be obtained to inform 1) the internal states of each entity on issues relevant within the society, 2) the interaction rules of the social environment (i.e., how entities interact), and 3) the formation of the intention to carry out certain actions (Alt et al., 2010). We demonstrate through case study how TPB can be implemented in one artificial society, the Cultural Geography (CG) model.

2.1 Cultural Geography Model

The social simulation used in this paper is the CG model, a government owned, open-source, agent based multi-agent system (MAS), composed of actors, objects and laws, implemented in Java (Ferber, Gutknecht, & Michel, 2004). The CG model is intended to serve as a reusable framework to facilitate analysis of social theories and their interaction in the context of a particular geographic area and time period under study (Alt, Jackson, & Stephen Lieberman, 2009). The model is based on theoretical and empirical work from cognitive psychology, social psychology, and structural sociology. The model emulates a conflict ecosystem and the process of scenario development mirrors Mansoor's counter-insurgency intelligence preparation of the battlefield (IPB) process (F. Mansoor, Zaidi, Wagenhals, & Levis, 2009; P. Mansoor, 2007). The two main components of the model are the cognitive module, which manages the internal states of each agent, and the social structure module, which manages the interaction of agents in the artificial society.

The cognitive module instantiates and controls an entity's stance on a given issue, such as "Are you satisfied with security in your neighborhood?" within the model. Walter Fisher's narrative paradigm theory (Fisher, 1989; Jackson, 2009) describes each human as a collection of stories, gained from first and second person observations, that shape the individual's perception of the world and events. The beliefs, values, and interests (BVIs) contained in each population subgroup's unique narrative are implemented within the model in the form of a Bayesian belief network (BBN). A Bayesian approach to the representation of human decision making is well supported by literature from cognitive psychology (Beppu & T. L Griffiths, n.d.; T. L Griffiths & J. B Tenenbaum, 2001; J Tenenbaum, T Griffiths, & Kemp, 2006), allows for transparency within the model, and ease of subject matter expert input.

Social structure module controls the interaction between entities within the model, which primarily consists of the exchange of information. The likelihood of interaction for every pair of agents in the artificial society corresponds to their similarity across social factors, including socio-economic, socio-demographic, and socio-cultural attributes, as well as BVIs (Blau, 1994; Blau & Schwartz, 1997; M. McPherson, Smith-Lovin, & Cook, 2001; Miller McPherson, Popielarz, & Drobnic, n.d.; Miller McPherson & Ranger-Moore, 1991).

2.2 Modeling TPB in Social Simulations

Action choice models provide methods to control the intention to take actions within an artificial society. TPB is one such action choice model that holds that individuals within a group form an intention execute a behavior based on 1) their individual attitude toward the behavior, 2) their perception of group or subjective norms associated with that behavior, and 3) their perceived level of behavioral control (i.e., chances of success) in regard to that behavior. The TPB is widely used in empirical studies for the forecasting of human behavior (I. Ajzen, 1991; Mathieson, 1991; Sparks & Shepherd, 1992; Walker et al., 2006). Accordingly, the empirical data used to drive the majority of these studies is derived from survey or questionnaire data, making TPB attractive for use in social simulations using multi-agent systems where agents are representative of the actual individuals or groups that comprise the society under consideration.

Our goal here is not to gather information on behavioral intentions through a new survey, but rather to model the workings of TPB inside of an artificial society of representative agents. The path to instantiate social simulations with traceable data is tractable given that the area to be modeled can be accessed by survey or polling teams. Each of the three components of the TPB can be calculated via item responses:

The attitude, *A*, toward a given behavior, *B*, can be expressed as an expected value model where the strength of belief, *b*, is expressed as a likelihood and the outcome evaluation, *e*, is an evaluation of the value of the potential outcome (Icek Ajzen, 2006; Mathieson, 1991). Thus, if the behavior outcome is beneficial, and this outcome is highly likely, the attitude towards a behavior will be correspondingly favorable. The attitude *A* is the sum product of these two terms across the salient observations, *i*, out of the possible, *n*.

$$A_B = \sum_i^n b_i e_i \quad (1)$$

A similar approach is applied to determine the subjective norms, *SN*, associated with the behavior, *B*. The components of *SN* are similar to those of *A*: the normative belief strength, *nb*, takes the place of strength of belief, *b*, and motivation to comply with the *nb*, *m*, takes the place of outcome evaluation, *e* (Icek Ajzen, 2006; Mathieson, 1991). In this case however, the terms are summed across the relevant others, *n*, opinions are valued by the individual.

$$SN_B = \sum_i^n nb_i m_i \quad (2)$$

Perceived behavioral control, *PBC*, also follows a similar pattern. Control beliefs, *cb*, serve as the likelihood estimate, while perceived facilitation, *pf*, provides the value estimate (Icek Ajzen, 2006; Mathieson, 1991). The summation for *PBC* is over each, *i*, of the perceived skills, resources or opportunities, *n*, associated with the behavior.

$$PBC_B = \sum_i^n cb_i pf_i \quad (3)$$

Finally, the sum of these three components yields a behavioral intention score for each of the behaviors, *B*, under study, completing the TPB model.

$$BI_B = A_B + SN_B + PBC_B \quad (4)$$

The TPB survey methodology uses questions (response items) about behavioral beliefs to yield *A*, normative beliefs to yield *SN*, and control beliefs (or self-efficacy) to yield *PBC* (Icek Ajzen, 2006). Through the rest of this article, we discuss techniques to leverage existing social survey data to measure these beliefs, embed intelligent agents with these beliefs, and implement TPB within a full scale social simulation.

3. Techniques for Leveraging Survey Data

The identification of relevant existing survey data from populations of interest to construct social simulation models is an ongoing effort across disciplines. In the experience of the authors, there are currently no survey instruments that are executed on a recurring basis in a manner to explicitly inform social simulation development. As such, social simulations seeking to leverage these existing data sources must be flexible in their application and techniques. Previous work has explored techniques to leverage existing survey data to inform cognitive models regarding issue stance and to construct authentic social structures within simulation societies (Alt et al., 2009). Here we extend this work by exploring techniques to inform representations of the TPB within the model using a relevant social survey.

3.1 General Strengths and Limitations of Survey Use

Since direct observation of a large population's behavior choices over the time scale of interest is not tenable, our model must be informed by either sample observations, or self-report. Even for small populations, where sample observations of very specific behavior choices in precise contexts may be possible (e.g., employees using the treadmill at the company gym), self-report methods are more easily conducted. In general, TPB methodologies use self-reports in the form of TPB questionnaires to inform the behavior choices of populations large and small.

While self-report methods, TPB questionnaires or social surveys, are the plainly preferred technique, it is necessary to clearly state the caveats associated with their use. Self-report prone to direct errors such as memory inaccuracies and misunderstandings of question phrasing that are particularly germane to TPB models. Likewise, they are also susceptible to direct deception on the part of the respondent. Although deception and intentional disinformation can be minimized with appropriate research methodologies that ensure anonymity and confidentiality, the variance in all types of error rates between subjects is difficult to establish. Moreover, ascertaining causal relationships is often difficult with self-report methodologies (Icek Ajzen, 2006)National Research Council, 2008).

3.2 World Value Survey

The World Values Survey (WVS) is an enduring social and behavioral research project that seeks to assess and describe longitudinal and cross-cultural values across 62 different countries with detailed questionnaires of approximately 250 items[3]. Survey items predominantly reflect the current sociocultural, moral, religious, and political views of the respondent. Questionnaires are administered in face-to-face interviews in each country by local (or indigenous) members of the society where local academics can "opt-in" to the decentralized WVS network. The WVS has been repeated in waves (longitudinal slices) from 1981 through 2006, and the

[3] WVS data for all countries from all survey waves, along with a description of WVS methodology and analysis, is freely available at www.worldvaluessurvey.org.

number of countries included in the sample has grown from 22 to the current 62 through the iterations.

There are a multitude of freely available longitudinal social surveys that may fit our goals of instantiating an action choice model for an artificial society. The European Social Survey[4] and United States General Social Survey[5] provide notable alternatives. We have chosen to use the WVS because of its unique characteristics of global inclusiveness, indigenous administration, and focus on items that bias extrapolation of actions from personal BVIs.

In the examples that follow, we use the World Values Survey's most recent 2006 wave to illuminate the application of TPB to an artificial society on representative agents from the country of Indonesia. Where appropriate, we have noted the WVS item code (e.g., "V92") to aide follow on work and the docking of models and simulations using a common dataset.

3.3 Theory of Planned Behavior Instruments

TPB questionnaire development is straightforward and well-documented (see for instance, (Icek Ajzen, 2006). Given its empirical history, TPB self-reports have addressed issues of sampling methodologies and questionnaire biases across a wide variety of fields. Each behavior is defined by its "target", "action", "context", and "time" elements[6], where all four items build a complete description of the behavior, and the corresponding intention, *BI*, for that behavior. Given space and scope constraints, the descriptions that follow are necessarily incomplete. The reader is directed to Ajzen, 2006 for a more comprehensive treatment.

Describing the *target* of an *action* is relatively straightforward, for instance in the question, "I will donate 10 dollars (action) to Wikipedia (target)". These types of questions are commonplace in self-reports, and while this may suffice for a basic description of a behavior, it does not supply enough information to generate the predictive *Behavioral Intention* estimator. We also need the context and time elements to fully describe the behavior, such as "I will donate 10 dollars to Wikipedia from my home computer (context) within the next week (time)". Each element can be tightly specified, such as "10 dollars", or highly generalized. The target and context elements can overlap somewhat and, clearly, some context items, such as "from my home computer", may not be necessary to gauge a particular *BI*. In this case, the computer used for the action of donation may be irrelevant, whereas the specific action "donate 10 dollars" and time "within the next week", may be highly relevant.

Once the behavior is described in sufficient scope and language for *BI* estimation, questions using this behavior description must be developed to assess the behavioral, normative, and control beliefs associated with actually carrying out the behavior. Thus, the *latent* variables of theoretical analysis must be associated with *salient*, observable behavioral outcomes. Care must be taken during item development since there is a limited subset of behavioral, normative, and control beliefs that are in fact accessible relative to any well-formed TPB behavior description.

Given these requirements, most TPB questionnaires are developed iteratively, with pilot work dedicated to elucidating what beliefs are genuinely accessible (Ajzen, 2006). One prominent goal is to clarify the *model salient beliefs* (MSBs) associated with each belief category. These MSBs are the most frequently stated beliefs for the population, and may be readily available from existing survey sources for specific types of behaviors. In applying TPB to social simulations using existing survey data, we must postulate that the survey designers have identified the equivalent of MSBs for their populations prior to commencing major investigations. As described in the following section, the researcher must determine MSBs for the salient behavioral, normative, and control beliefs that are relevant to the behavior in question.

4. Case Study: Applying TPB to WVS 2005

The application of TPB to an artificial society can be demonstrated using TPB calculations in conjunction with existing data from the 2005 WVS for Indonesia. The applied TPB can then be implemented as a simulation artifact at the instantiation of the simulation. The first step in this process is the selection of a behavior of interest for representation in the simulated society that is feasible to populate from the existing data.

Given that our survey data approach topics in a more generalized fashion, our application of TPB will focus on a more general class of behaviors, rather than an extremely precise behavior. As such, we forgo aspects of exact temporal clarity in favor of wide-ranging applications. It is important to note that, as demonstrated below, many of the survey items in the WVS can be used to temporally-specify TPB results from the broader categorical behavior classes.

There are a number of social and behavioral themes that are well represented in the WVS, and numerous candidates of behavioral classes that are germane to our investigation. We have chosen *participation in organized religious activities*, broadly defined, as the class of behaviors for this case study as we feel it will be of interest to the greatest variety of readers from different fields and subfields within the behavior representation communities. In the examples that follow,

[4] http://www.europeansocialsurvey.org/
[5] www.norc.org/GSS+Website/
[6] These elements are sometimes abbreviated as "TACT".

we have chosen survey items from the WVS that best correspond to Ajzen's salient observation types (see Ajzen, 2006) to populate the TPB models (equations 1-4).

4.1 Attitude

Recall from equation 1 that an individual's attitude, *A*, toward a behavior, *B*, is a function of the strength of belief, *b*, and the outcome evaluation, *e*. In this case we are trying to determine an individual's attitude toward participation in organized religious activities. The TPB process calls for the aggregation of multiple self-report items to specify the variable of interest.

Several candidate items provide access to salient observations germane to our question. One clear item begins: "FOR EACH OF THE FOLLOWING, INDICATE HOR IMPORTANT IT IS IN YOUR LIFE:", where respondents rank "RELIGION" (V9) from "Very important" to "Not at all important" on a four-point scale. Another candidate to inform *b* exists in the item: "APART FROM WEDDINGS AND FUNERALS, ABOUT HOW OFTEN DO YOU ATTEND RELIGIOUS SERVICES THESE DAYS?" (V186). Another candidate for correlation of *b* is the item: "HOW IMPORTANT IS GOD IN YOUR LIFE?" (V192). V186 is reported on a 7 point Likert anchored with "More than once a week" and "Never, practically never", while V192 utilized a 10 point scale anchored with "Not at all important" and "Very important". A respondent's answer of "4" to V9, "6" to V186, and "10" to V192 thus become b_1, b_2, and b_3, respectively.

Outcome evaluation *e* can be informed by the series of items V188-V191. Each begins with the phrase, "GENERALLY SPEAKING, DO YOU THINK THAT THE [CHURCHES] IN YOUR COUNTRY ARE GIVING ADEQUATE ANSWERS TO:", and concludes with "THE MORAL PROBLEMS AND NEEDS OF THE INIVIDUAL" (V188), "THE PROBLEMS OF FAMILY LIFE" (V198), "PEOPLE'S SPIRITUAL NEEDS" (V190), and "THE SOCIAL PROBLEMS FACING OUR SOCIETY" (V191). These are each answered simply as "yes" or "no", so we take the sum of the responses from each respondent for the total *e*. That is, answering "yes" to all four yields score of 4 for *e*. A respondent answering in the affirmative to all *e* equates to A_B = 80 as demonstrated below:

$$A_B = \sum_i^n b_i e_i = (4+6+10)(1+1+1+1) = 80 \quad (5)$$

4.2 Subjective Norm

The subjective norm, *SN*, (equation 2) regarding participation in organized religious activities can be determined in a similar manner. Recall *SN* is dependent on normative behavior, *nb*, and the motivation to comply with the *nb*, *m*. Several items on the WVS are germane to the social norms experienced by the respondent regarding religious activities.

One series of WVS items begins with: "NOW I AM GOING TO READ OFF A LIST OF VOLUNTARY ORGANIZATIONS. FOR EACH ONE, COULD YOU TELL ME WHETHER YOU ARE AN ACTIVE MEMBER, AN INACTIVE MEMBER OR NOT A MEMBER OF THAT TYPE OF ORGANIZATION:" where respondents reply to "CHURCH OR RELIGIOUS ORGANIZATION" (V24) with one of the three response categories. Another WVS item simply asks: "DO YOU BELOG TO A RELIGION OR RELIGIOUS DENOMINATION" (V185). Where respondents reply with either a "no", or a "yes" selection from a list of religious denominations. In this case, we are not concerned about *what* religion a person belongs to, only *if* they identify with a religion. Thus, this item becomes a binary (yes/no) calculation. A respondent's answers of 2 (active member) to V24, and 1 (yes) to V185 thus become nb_1 and nb_2, respectively.

Illuminating a respondent's motivations to comply with a specific behavior *m* is arguably the most elusive variable to draw from surveys such as the WVS. One viable proxy measure for motivation from social norms can be identified in the WVS items that address the respondent's preferences or aversions of different kinds of neighbors, and their relative level of trust for people occupying different social groups. These items make salient important characteristics of in-group versus out-group behavior. In other words, they should reflect to what extent the respondent associates with his or her religious in-group at the expense of maintaining influencing relationships from outside of that group[7].

The series of items about neighbors begins with "COULD YOU PLEASE MENTION ANY THAT YOU WOULD NOT LIKE TO HAVE AS NEIGHBORS:" where respondents have "mentioned", or "not mentioned" "PEOPLE OF A DIFFERENT RELIGION" (V39). The second salient group measure begins with, "COULD YOU TELL ME FOR EACH WHETHER YOU TRUST PEOPLE FROM THIS GROUP:" where respondents rank "PEOPLE FROM ANOTHER RELIGION" (V129) on a four point scale from "A great deal" to "None at all".

Another series of WVS items proves quite valuable when elucidating *m.* This series of items begin with "PLEASE INDICATE FOR EACH DESCRIPTION WHETHER THAT PERSON IS VERY MUCH LIKE YOU" where respondents chose from a six point scale from "Very much like me" to "Not at all like me" to the prompt "TRADITION IS VERY IMPORTANT TO THIS PERSON; TO FOLLOW THE CUSTOMS HANDED DOWN BY ONE'S RELIGION OR FAMILY" (V89). A

[7] For a review of these theories, as well as supporting research, see Blau & Schwartz (1997).

respondent's answers of 1 (mentioned) to V39, 4 (do not trust at all) to V129, and 1 (very much like me) to V89, thus become m_1, m_2, and m_3, respectively. These values together yield:

$$SN_B = \sum_i^n nb_i m_i = (2+1)(1+4+1) = 18 \quad (6)$$

4.3 Perceived Behavioral Control

The perceived behavioral control, *PBC*, (equation 3) in this case refers to the individual's perception of the ability to participate in organized religious activities successfully if they chose to do so and is based on the control belief, *cb*, and the perceived facilitation, *pf*. The *cb* in this case refers to the individual's opportunity to participate in religious services and can be informed by items V185 andV24 as described above (in section 4.2). That is, we ask 1) whether the person belongs to a religion denomination, and 2) whether the person is an active member of that organization. Similarly to above, a respondent's answers of 2 (active member) to V24, and 1 (yes) to V185 thus become cb_1 and cb_2, respectively.

Correspondingly, *pf* can be informed by items V188-V191, which asks respondents:"GENERALLY SPEAKING, DO YOU THINK THAT THE [CHURCHES] IN YOUR COUNTRY ARE GIVING ADEQUATE ANSWERS TO:" "THE MORAL PROBLEMS AND NEEDS OF THE INDIVIDUAL" (V188), "THE PROBLEMS OF FAMILY LIFE" (V189), "PEOPLE'S SPIRITUAL NEEDS" (V190), "THE SOCIAL PROBLEMS FACING OUR SOCIETY" (V191) where these are all binary (yes/no) responses that are aggregated. Confidence also plays a role in the *pf* values, and a salient observation can be obtained through the item, "FOR EACH ONE, COULD YOU TELL ME HOW MUCH CONFIDENCE YOU HAVE IN THEM:" where respondents chose from a four point scale from "A great deal" to "None at all" to the prompt "THE CHURCHES" (V131). A respondent's answers of 1 (yes) for V188-V191 and 1 (a great deal) for V131 thus become pf_1 through pf_5, generating our PBC measure:

$$PBC_B = \sum_i^n cb_i pf_i = (2+1)(1+1+1+1+1) = 15 \quad (7)$$

4.4 Behavioral Intention

Our goal in obtaining the above calculations is the Behavioral intention, *BI*, which is the linear sum of *A*, *SN*, and *PBC*. Following from our example above the BI regarding participation in organized religious activities for an Indonesia respondent using the method described above is:

$$BI_B = A_B + SN_B + PBC_B = 80+18+15 = 113 \quad (8)$$

In implementation this raw *BI* value can be normalized across the entities within the simulation providing each entity a relative likelihood, as compared to the overall population, of forming the intention to participate in a given behavior.

5.0 Discussion and Conclusion

It is important for researchers applying this type of methodology to be keenly aware of the scales used in the self-report items being used. Since the *BI* is an aggregate measure of the three belief components (*A*, *SN*, and *PBC*), the researcher must make sure that all scales are either ascending or descending values. The calculations used here reflect the most extreme respondent. The *BI* value of 113 is the highest possible *BI* given the WVS items selected for inclusion.

The measures of subjective norms that are intrinsic to the value of TPB are generally not the domain of social surveys. Here we selected individual WVS items based on our informed interpretation of TPB. Another way to approach questions about subjective norms is to aggregate responses across the population of respondents in the form of expected values. Item V186, used previously to determine the individual's *b*, can be used to determine the *nb* across relevant others, *n*. In this case, the WVS does not provide an explicit match for the TPB and it is necessary to use the surrogate *nb* described above with the assumption that the group under study is relevant to the individual by his membership in the group alone.

The mean score across the population subgroup under study can be used. The individual's *m* can be obtained from the item: "...PLEASE INDICATE FOR EACH DESCRIPTION WHEHTER THAT PERSON IS VERY MUCH LIKE YOU, LIKE YOU, SOMEWHAT LIKE YOU, NOT LIKE YOU, OR NOT AT ALL LIKE YOU?...TRADITION IS IMPORTANT TO THIS PERSON; TO FOLLOW THE CUSTOMS HANDED DOWN BY ONE'S RELIGION OR FAMILY" (WVS:V89). This response is on a six point scale anchored with "Very much like me" and "Not at all like me."

Another potential contributor to *nb* is provided in the item "HERE IS A LIST OF QUALITIES THAT CHILDREN CAN BE ENCOURAGED TO LEARN AT HOME. WHICH, IF ANY, DO YOU CONSIDER TO BE ESPECIALLY IMPORTANT:" where respondents have either "Mentioned" or "Not mentioned" "RELIGIOUS FAITH" (V19). It is ultimately up to the researcher, informed of the theory being applied, to select appropriate items for inclusion. Furthermore, automated feature

selection mechanisms, not explored here, can be used to assist the researcher in the clarification and selection of items *if* there is a well-phrased survey item that can be used as a data mining target. A separate publication by the authors reviews this in greater detail (Alt & Stephen Lieberman, 2010).

The use of well documented theories from the social sciences, such as Icek Ajzen's Theory of Planned Behavior, leverages the existing body of knowledge and data to enhance the representation of human cognition and behavior in artificial societies. Existing data collection instruments, protocols and methodologies from the social and behavioral sciences provide solid theoretical bases to human-centered modeling and simulation across a variety of domains, from traditional research and development, to decision support for policy makers, and training for field analysts. Furthermore, as we have demonstrated, well documented survey and polling procedures, such as the TPB questionnaire process, can provide a reasonable foundation for the development of data to populate action choice models in social simulations.

Here we examined the use of these methods when applied to existing data from the WVS and illustrated one potential means of leveraging this data source while maintaining traceability to the TPB. Future work will propose a survey instrument designed to specifically elicit the information required to instantiate action choice models in an artificial society and provide further discussion of the dynamic implementation of the TPB within simulation.

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