

Stochastic vs. Deterministic Attitudes

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Attitude formation and reporting has been a vexing problem to study. Following Converse (1964)'s characterization of public attitudes as ever shifting and inconsistent, scholars have struggled to answer why individuals provide *different answers to the same question* over time. Are attitudes formed in advance or do they materialize out of the maelstrom of a survey respondent's mind? Are attitude reports deterministic or is there a stochastic component? One difficulty with testing various theories explaining inconsistency has been that consistency, by definition, requires multiple measurements of the same unit over time. Panel studies would be a natural solution, but individuals exist in ever changing information environments, which confounds repeated measures. In this paper, I discuss the fundamental difficulties associated with investigating attitude formation and propose a novel research design to gain leverage on confounding factors in previous studies.

1 Attitude reports

On the literature concerning attitudes, two different positions emerge regarding attitude reporting: the first, I label as deterministic reporting; the second, I label as stochastic reporting. In the deterministic sense, citizens produce their answers to prompts without any random component¹. The changes in reports by a single individual over time indicate that underlying schema changes. The exact method of updating is not of concern. It could

¹I would be indebted to anyone who can point me to a concrete source arguing this position.

be a Bayesian style learning process, online processing, or complete storage of information. Additionally, the process used to retrieve the answer is also unimportant for this research. The individual might check an affective “running score,” search an exhaustive catalog of information, or use a heuristic. The important aspect of deterministic reporting is that there is *no random component* to the response. By contrast, stochastic reporting posits that individuals draw from a distribution of possible answers when reporting (Zaller and Feldman, 1992; Zaller, 1992). Change over time, under the stochastic model, may be the result of schema updates, but it might also represent repeated draws from a distribution where the answers have non-zero probabilities.

To differentiate the two models, the most obvious method would be to ask subjects the same question, repeatedly. In other words, take a sample from the distribution the subject uses to report his answers. If subjects always present the same answer, we could conclude they answer deterministically. If they presented different answers, we could conclude that stochastic reporting was at work. The difficulty in implementing such a plan is that under both models, observed changes over time can be attributed changing information flows in addition to the different mechanisms. Subjects come into contact with new information from social contacts, news sources, and life experience. Changes in answers to prompts may be the result of the reporting mechanism or the result of updated schemas, confounding our ability to differentiate the models using repeated questioning over time.

The obvious solution of asking the sample question over a very short period of time (say over the course of a subject’s participation in a lab environment) also falls short. Remembering the earlier prompt, subjects are likely to repeat their earlier answers. Such short-term repeated questioning would clearly violate the “independent, identically distributed” assumption necessary to statistically analyze the responses.

Anterograde amnesiacs present an unique opportunity to disentangle learning and reporting. This form of amnesia, often the result of trauma to the brain, manifests as a decreased

ability to recall recent events, though long term memory prior to the trauma remains accessible (Mayes, 1991). Having limited ability to recall recent events, this population could conceivably be repeatedly sampled while holding the information environment constant. Over the course of a day (say while serving as subjects in more involved neurological research), subjects can be asked the same questions several times. I assume that it is unlikely during this time subjects will significantly update their schemas on a set of political questions. These questioning sessions are then independent draws from the subjects' reporting distributions. Highly consistent responses indicate deterministic reporting; inconsistent responses indicate stochastic reporting. The next section details the precise statistical method that will be used to differentiate the two theories.

2 Quantifying Error

If attitudes are reported deterministically, we would expect subject answers to be completely consistent, absent error. Of course, a certain amount of error will be present. Subjects may misread the question, be distracted by chance events, or press the wrong key, intending an different response. The primary difficulty with natural error is that it mimics the alternative explanation of stochastic responses. In a simple "agree/disagree" question format with ten questions, a subject's nine agreeing answers might represent a single instance of error or that the subject selects the "agree" response with an internal probability of $p = 1 - e = 0.9$. Error rates of 10% and stochastic probabilities of $p = 0.9$ are difficult to differentiate, but it is quite unlikely that a 10% error rate would lead to 6 or fewer "agree" answers. If we were to observe 6 out of 10 responses, we could be quite confident in rejecting the position that the subject is giving deterministic responses with at most 10% error rate.

The following power analyses develop on the intuition in the previous paragraph: assuming a given error rate, how many responses must we see in order to reject the null hypothesis

of deterministic responses? In order to define the null distribution, I assume that all questions are binary (e.g. “Do you agree or disagree with the following statement: ...”). Given n repetitions of the same question with p probability of “correctly” answering any given question (responses being independent), the null distribution of observing x agreeing responses is Binomial:

$$P(x) = \binom{n}{x} p^x (1 - p)^{n-x} \quad (1)$$

Under the deterministic model, every subject has a single preferred answer, what we might call “success” in a Bernoulli trial. Any deviations from the preferred position represent error, e . To test the hypothesis of deterministic voting with a given level of error, we can compute the probability of seeing the number of successes observed (or fewer) given the null distribution defined using $p = 1 - e$.

A priori, researchers cannot know which of “agree” or “disagree” the subject prefers, and therefore we cannot arbitrarily label one or the other “success” in advance. For example, if we arbitrarily labeled “agree” as success condition, we might be tempted to reject a 10% error rate if we observe 10 out of 10 “disagree” statements. Of course, this pattern is completely consistent with deterministic reporting with “disagree” as the preferred position. To avoid this pitfall, the null hypothesis must be slightly amended to consider two possibilities: $H_0 : p = (1 - e)$ or $p = e$. To test this more complex hypothesis, I compute the two sided confidence interval for p using the method of Clopper and Pearson (1934). If the interval includes either e or $1 - e$, I reject the null hypothesis of deterministic responses. This test is conservative as the interval computed may be wider than necessary to ensure coverage.

This design provides two degrees of freedom: the number of questions asked and the hypothesized error rate of deterministic reporting. These two values are not independent. The larger the error rate, the more questions are needed to generate at least one possible response set that has a confidence interval that excludes the hypothesized error rates. Table 1

shows the minimum number of questions necessary to have the possibility of rejecting the null hypothesis for a series of plausible error rates.

	Error Rates	Minimum Required Questions
1	0.010	2
2	0.025	4
3	0.050	4
4	0.100	6
5	0.200	12

Table 1: Comparison of error rates with minimum number of questions required for rejection of null

This analysis shows a rapid increase in the number of questions as the error rate increases. Given the constraints of working with anterograde amnesiac subjects, error rates greater than 0.10 may be impossible to differentiate from stochastic responses. So far this analysis has only considered asking a single individual a series of repeated questions. Future work will consider spreading the questioning over more subjects (e.g. sampling from 4 subjects 6 times) and asking multiple questions of the same subject (e.g. a question pertaining to education policy and a question pertaining to Congress). Spreading the load over more subjects may open up opportunities differentiate higher levels of error.

It may also be possible to more precisely quantify error in a general sense. As subjects begin question sessions at a computer terminal, a series of prompts could be used to assess their overall abilities to properly press “agree” and “disagree” on command. Errors, for example pressing “agree” when the prompt indicates “Please press ‘agree,’” could be recorded to provide an estimate of the subject’s baseline error rate. A reasonable case could be made for setting e to this value in the previous analysis.

Error could also be minimized by providing a secondary screen for subjects to confirm their answers. Confirmation would reduce the opportunities for momentary lapses in attention, mispressed keys, and other random error. Confirmed responses are more likely to be

the subject’s “correct” response.

3 Gone but not forgotten

Implicit in this design is the assumption that subjects’s lack of explicit memory implies in the inability to update any memory structures related to attitude formation. Previous research does indicate that anterograde amnesiacs have the ability to learn skills and can be primed to recall certain words more quickly (Mayes, 1991). Ongoing research tests the online model of attitude formation, which does not require explicit retention of information (Coronel n.d.). If subjects do update memory structures in the course of this study, we no longer are able to assume that questioning sessions are independent. Subjects may unconsciously attempt to appear consistent, even they do not recall earlier questioning sessions. Alternatively, accessing attitudes in an earlier questioning sessions may make later retrieval easier².

There is no way to guarantee that subjects are not violating the independence assumption. There are, however, checks that can put in place to assess whether the assumptions are failing. First, if answering questions earlier makes later retrieval easier for subjects (“priming”), response times for later questioning sessions should be shorter than earlier sessions. By soliciting responses via computer interface that records response times, we are able to observe if responses in later sessions appear more accessible (Huckfeldt et al., 1999). Secondly, if subjects are internalizing earlier responses and storing that information in memory, if unconsciously, they may be using different neurological structures to answer novel questions compared to questions they have been asked before. To test this condition, an neural imaging technique, such as ERP or fMRI, can identify structures active during question response

²Both cases, responses will tend to enhance consistency, which favors the deterministic model. Even though the first result might be generated stochastically, storing the result may shift later probabilities of response close to a value of 1 for making the same answer.

(Rorden and Karnath, 2004; Bentin et al., 1985). During each questioning session, subjects can be asked a set of novel questions after responding the repeated questions. These novel questions provide a baseline for both response times to novel stimuli and a stimulus to neurological structures involved in processing and responding to novel questions. If the independence assumption holds, the response times and activation patterns of the novel questions should be identical to the repeated questions. This strategy allows us to detect violations. Though identical response times and activation patterns cannot guarantee that the independence assumption is holding, they do provide checks of two paths that would violate the core assumption of this design.

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