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Randomized Response Versus Direct Questioning: Two Data-Collection Methods for Sensitive Information

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Two nonoverlapping random samples of 200 sorority women reported stigmatizing behaviors differentially, according to survey technique. The two survey methods were direct questioning and randomized response. The randomized response technique guaranteed privacy of confidential information via a randomizing device and hence reduced respondents' inclination to refuse to respond or to lie. Survey items varied in degrees of sensitivity. For each item, a *t* test compared proportions of respondents admitting to the stigmatizing characteristic when queried directly and when queried via a randomizing device. Less sensitive questions showed no difference between the two data-collection methods. More sensitive questions showed a greater proportion of women reporting stigmatizing behaviors when guaranteed privacy of information with the randomized response technique. This field test confirmed the utility of the randomized response technique as a versatile method of collecting more accurate confidential information.

Typically, surveys of sensitive or stigmatizing information have been contaminated by an unknown amount of error due to evasive or incorrect responses. To reduce this bias, Warner (1965) originated the randomized response technique, which provided obvious privacy or confidentiality for respondents. Warner assumed that guaranteed privacy of confidential information will alleviate respondents' desires to refuse questioning or to answer erroneously. Hence, two large sources of response bias, refusals and incorrect replies, can be greatly reduced via the randomized response technique. More importantly, the remaining response bias can be controlled by the researcher. This ingenious technique has the potential to make available additional research possibilities that had heretofore been largely untapped because of the complexities of gaining access to accurate information on sensitive issues or stigmatizing behaviors.

Privacy of confidential information and control of response bias are achieved at once through the use of a randomizing device. For example, in Warner's (1965) original design a spinner randomly selected between dichotomous statements of a sensitive characteristic:

I have had an abortion.
I have NOT had an abortion.

Out of the researcher's sight, the respondent used the randomizing device to select one statement for response. Regardless of which statement the device selected, the response was either "Yes" or "No." Given that the researcher had not witnessed statement selection via the device, there was no possible way to interpret the response. Therefore, the respondent's right of privacy was protected and truthful responses were less threatening. Yet, because the model was based on Bayesian probability theory, population parameters could be estimated from the survey data. To estimate a proportion it is sufficient to know the total number of yes responses; it is unnecessary to know how each particular respondent answered. Hence, eliminating unnecessary information guaranteed additional confidentiality for respondents and, in turn, reduced the amount of response bias due to

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evasion. Remaining response bias induced by the randomizing process was under the researcher's control. Within the randomizing device, the researcher predetermined the selection probability between the dichotomous statements, The negative form of the dichotomous statement both camouflaged the respondent's true situation and incorporated response bias into the design. The amount of this incorporated response error was determined by the value of P, the probability of selecting the first statement by the randomizing device, and the value of $1 - P$, the probability of selecting the second statement. Thus, the researcher controlled the amount of contamination by determining P and $1 - P$ within the randomizing device.

The original Warner (1965) model obtained qualitative data on a sensitive question. Later variations improved statistical efficiency and provided greater control of response error. Subsequent refinements included the unrelated question models (Folsom, Greenberg, Horvitz, & Abernathy, 1973; Greenberg, Abernathy, & Horvitz, 1970; Greenberg, Abul-Ela, Simmons, & Horvitz, 1969; Moors, 1971), a multiple trials model (Liu & Chow, Note 1), and a contamination model (Boruch, 1972). Additional models have been designed to collect quantitative data (Greenberg, Kuebler, Abernathy, & Horvitz, 1971; Liu & Chow, 1976). In an overview, Horvitz, Greenberg, and Abernathy (1975) evaluated several randomized response designs and reported field tests that obtained higher estimates of sensitive behaviors with the randomized response technique than had previously been documented by official records. These field studies were conducted within the discipline of public health. The potential of the randomized response technique has been largely untapped by psychologists (Levy, 1976, 1977).

The present study compared two methods of collecting survey data: (a) direct questioning and (b) a randomized response technique. The survey questionnaire contained items of varying degrees of sensitivity. It was predicted that for the more sensitive questions, the randomized response technique would indicate a larger percentage of respondents reporting the stigmatizing characteristic. In other words, when privacy of highly sensitive information was guaranteed via the randomized response technique, a greater proportion of respondents were expected to admit to the stigmatizing characteristic.

Method

Two nonoverlapping random samples of white sorority members were administered identical questionnaires, shown in Table 1. All respondents in both samples were interviewed individually and privately by a female researcher. The study was presented as a follow-up of an earlier campus-wide survey on sexual attitudes among college students. After completion of data collection, debriefing took place at a Panhellenic meeting, and each sorority received a permanent copy of the results.

The interview procedure differed for Samples 1 and 2. Respondents in Sample 1 (direct questioning) completed the questionnaire silently in the presence of the researcher. Anonymity was promised but could not be guaranteed. In contrast, respondents in Sample 2 completed the questionnaire via the randomized response technique, with a randomizing device to provide privacy of information. The device was a transparent plastic globe used to select numbers in bingo games. The globe contained a total of 16 wooden pellets (10 red pellets, 3 non-red pellets imprinted "Yes," and 3 non-red pellets imprinted "No").

Respondents in Sample 2 were individually trained to use the randomizing device with practice questions such as "Do you own a dog?" The researcher gave the following instructions during practice sessions:

> Turn the globe in order to draw a pellet before reading the first question. If you draw a red pellet, read and answer Question 1 truthfully. If you draw a "Yes" pellet, do not answer the question; merely circle the word "Yes" on the questionnaire beside Question 1. Likewise, if you draw a "No" pellet, merely circle the word "No" on the questionnaire beside Question 1.

These instructions were repeated with additional practice questions until the respondent could perform the correct procedure without prompting. Then the researcher continued:

> If I did not see which pellets you drew from the globe, I would not be able to interpret your responses. You might have drawn a red pellet and answered truthfully, or you might have drawn a non-red pellet and answered according to the pellet. Therefore, I will leave the room now. Since I will not see which pellets you draw as you complete the questionnaire, your privacy of information will be guaranteed. Do you understand?

Table 1
Survey Questionnaire

1. Are you a Protestant?	Yes	No
2. Do you approve of premarital sex for engaged couples?	Yes	No
3. Have you ever been raped?	Yes	No
4. Do you approve of kissing on the first date?	Yes	No
5. Have you ever masturbated?	Yes	No
6. Have you ever had a homosexual experience?	Yes	No
7. Are you a virgin?	Yes	No
8. Have you ever touched a male's genitals with your mouth (fellatio); or have you ever had a male touch your genitals with his mouth (cunnilingus)?	Yes	No
9. Do you think junior high school students should have a course in sex education?	Yes	No

After each respondent in Sample 2 agreed that the technique did indeed assure privacy of information, the researcher provided her with the questionnaire and immediately left the room. Thus, privacy of information was assured to the respondents in Sample 2.

The 6 non-red pellets in the randomizing device served two purposes. By camouflaging responses the non-red pellets assured privacy of information in order to reduce the need for evasive or incorrect responses. The proportion of non-red pellets also specified the error component induced by the randomizing device. Amount of error was preset by the experimenter through manipulation of the ratio of red pellets (truthful responses) to non-red pellets questionnaire.

The Model

We assume that a population is specified and that the purpose of the investigation is to obtain an estimate of the proportion of members in that population having the given sensitive trait. It is further assumed that a suitable randomizing device directs the respondent to answer the question in one of three possible ways: (a) truthfully, (b) automatically yes, or (c) automatically no. Let

- π = population proportion having the sensitive trait,
- P = probability that the randomizing device will direct respondent to answer truthfully,
- θ = probability that the randomizing device will direct respondent to answer "yes,"
- λ = sample proportion of yes responses,
- N = total sample size,
- n_y = total number of yes responses in the sample.

The probabilities of yes and no responses are

$$P_{(\text{yes})} = P\pi + \theta,$$
$$P_{(\text{no})} = P(1 - \pi) + (1 - P - \theta).$$

The likelihood function for the sample is given by

$$L = [P\pi + \theta]^{n_y}[P(1 - \pi) + (1 - P - \theta)]^{N-n_y}.$$

The maximum likelihood estimator, $\hat{\pi}$, for the population proportion (π) having the sensitive trait is

$$\hat{\pi} = \frac{\lambda - \theta}{P}.$$

The estimate of the variance of $\hat{\pi}$ is given by

$$\text{Var}(\hat{\pi}) = \frac{\lambda(1 - \lambda)}{NP^2}.$$

Thus, an estimate of π, as well as of its variance, may be obtained for each item in the questionnaire.

Testing

The intent is to compare the proportion estimates obtained from the two samples for all questions. Although it would be preferable to use a multivariate test statistic (Hotelling's T^2), this approch is not possible. Clearly, all proportions within a sample are not independent, but the guarantee of anonymity provided by the model also prohibits an estimate of the degree of dependence. Therefore, it is not possible to estimate a covariance matrix.

For any particular question, the two sample estimates of π are independent, although the variances of the two estimators are different. The two-sample t test used in this study may be found in Welch (1937) or Brownlee (1965).

Table 2
Comparing Results of Two Survey Methods

Survey question	Sample 1 (direct questioning)[a]		Sample 2 (randomized response)[b]	t test for $\hat{p}$ and $\hat{\pi}$
	n_d[c]	$\hat{p}$[d]	$\hat{\pi}$[e]	
1	2	.82	.89	*ns*
2	3	.85	.84	*ns*
3	2	.02	−.04	*ns*
4	3	.99	.74	−3.61***
5	7	.20	.51	3.63***
6	3	.02	.01	*ns*
7	3	.45	.47	*ns*
8	8	.43	.67	2.56*
9	2	.96	1.07	2.05**

[a] $N = 68$.
[b] $N = 132$.
[c] n_d = number of respondents declining to respond to particular questions in Sample 1. (Two women declined all questions in Sample 2.)
[d] $\hat{p}$ = population proportion of yes respondents questioned directly.
[e] $\hat{\pi}$ = population proportion of yes respondents corrected for response error in the randomizing device in Sample 2.
* $p < .01$.
** $p < .05$.
*** $p < .001$.

Results and Discussion

The predictions were substantiated by the results. For less sensitive questions, the two data-collection methods obtained approximately equivalent estimates of population proportions; however, for more sensitive questions the randomized response technique generally revealed larger estimates of proportions of respondents who reported stigmatizing characteristics. This expected finding indicated that privacy of information allowed respondents in the randomized-response sample to answer sensitive questions more honestly than those in the direct-questioning sample. For example, Questions 5 and 8 showed significantly greater proportions of women who answered "Yes" to questions of masturbation and specific sex acts when assured privacy of information.

The data presented in Table 2 revealed interesting incidental information on sexual values and activities among sorority women. On Question 4, almost all respondents in the direct-questioning sample approved of kissing on the first date. In contrast, respondents in the randomized-response sample reported much less approval. The negative t value indicated more unexpected conservative responses via the randomizing device. Perhaps there was some social pressure among sorority women to approve publicly of more lenient behavior for this item. The results of Questions 3 and 6 showed that regardless of data-collection methods, very small proportions of respondents had experienced homosexuality or rape. In Question 7 sexual intercourse was readily reported by direct questioning, and both samples revealed about the same percentage of virgins. Therefore, loss of virginity was not perceived to be a stigmatizing characteristic in this population.

On Questions 3 and 9, $\hat{\pi}$ fell outside the limits for the normal 0-to-1 distribution of a proportion. These two items were unique because of the almost universal agreement among respondents (i.e., for Question 3 virtually no rapes were reported, and for Question 9 everyone agreed to sex education in junior high school). Since the mean proportions for these items were at the extremes of a normal distribution, additional yes and no responses due to non-red pellets in the randomizing device caused the highly skewed distributions to exceed the normal limits. A larger sample size should yield $\hat{\pi}$s within the normal range of 0 to 1 on these items. Truncating the distribution so that $\hat{\pi} = 1.00$ for Question 9 yielded a t value of .71. Thus, the higher t value shown in Table 2 was an artifact of the randomizing device. There was no significant difference between the two data-collection methods for Question 9. Remaining items on the questionnaire were not distorted by such severely skewed distributions and therefore provided more reliable results. This artifact of the randomizing technique should not be a problem for field studies with larger samples or less extreme population proportions.

Because the original Warner (1965) design had a very large variance component from the randomizing device, sample sizes ranging from 400 to 2,000 have been the rule in previous field tests. Refinements of the technique

reduced the variance for estimates from smaller samples. Unique to this study was the easily obtainable, inexpensive randomizing device with excellent error control for greater statistical efficiency. In addition, respondents accepted it readily, perhaps because it was recognized as part of a familiar game. Hence, with the randomizing device to guarantee privacy of information, only two interviewees in Sample 2 declined to participate; whereas with direct questioning in Sample 1, seven and eight interviewees declined to respond to the more highly sensitive items (Questions 5 and 8, respectively), and two interviewees declined to answer any items. In other words, within Sample 1 a larger number of interviewees declined the more sensitive questions. Analysis of both samples revealed that a higher proportion of interviewees refused to respond when questioned directly than when questioned via the randomizing device. Clearly, the randomizing device's guarantee of privacy of information reduced the proportion of refusals and simultaneously increased the willingness of respondents to provide more accurate information regarding stigmatizing characteristics.

In summary, no significant difference was found between population proportions queried about less sensitive information, regardless of survey method. Both methods, randomized response and direct questioning, resulted in approximately equivalent population estimates for less sensitive data. However, on more sensitive questions the two survey methods resulted in significantly different population proportions with the sensitive characteristic. When privacy of information was assured with the randomizing device, respondents reported higher instances of socially unacceptable behaviors. This study confirmed the utility of the randomized response technique as a versatile method for gaining access to more accurate information on sensitive social problems.

Reference Note

1. Liu, P. T., & Chow, L. P. *The efficiency of the multiple trial randomized response technique.* Unpublished manuscript, Department of Population Dynamics, School of Hygiene and Public Health, Johns Hopkins University, 1975.

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