

A COMPARISON OF THREE TECHNIQUES FOR ELICITING  
ANSWERS TO SENSITIVE QUESTIONS

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Abstract

Eliciting answers to "sensitive" questions, that is questions which the respondent may find embarrassing or incriminating, has recently received increasing attention. Two methods, the Warner randomized response technique and the Raghavarao-Federer block total response technique, have been proposed to obtain more truthful answers to sensitive questions than would be possible with direct questioning. In this paper, a third technique, a randomized form of the block total response technique, has been proposed, and the three methods have been compared in an experiment involving  $84 = N = 7n$  subjects. Seven =  $v$  questions were asked in groups of three =  $k$ , with three of the seven being considered of the sensitive type. A set of  $n = 12$  persons responded to each of seven groups of three questions. A symmetrical balanced incomplete block design with parameters  $v = b = 7$ ,  $k = r = 3$ , and  $\lambda = 1$  was used to obtain the seven groups of size three each. Each of the three methods appeared an equal number of times in the first, second, and third order of presentation to the respondent in order to assure that order of presentation was equally represented.

The experiment served to provide factual information and experience and to provide a comparison of the three methods. Relative efficiencies of the three techniques are obtained from the variances for each question as well as with the actual data.

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## 1. Introduction

In the past few years, the problem of obtaining truthful answers to sensitive questions has been given an increasing amount of attention. Three techniques have been proposed for dealing with this problem -- Warner's randomized response, Raghavarao-Federer's block total response, and a randomized form of the block total. This paper will compare these three methods using seven different questions and a total of  $84 = 7(12)$  individuals answering subsets of these seven questions.

First, let us present a brief description and history of each of the three techniques, starting with the oldest one of the three, randomized response. Using the randomized response technique, the respondent answers one of two questions which have been randomly selected. He gives either a yes or no response and does not tell the interviewer which of the two questions he is answering. One of the questions is of the sensitive type, while the other is unrelated and not at all sensitive. For example, the first question might be, "Have you ever cheated on a college exam?" and the unrelated question might be, "Is the last digit of your social security number either 7 or 8?". The interviewer would record only a yes or no answer and because the interviewer did not know which question the response was to, the respondent should feel confident in giving a truthful response.

In order to estimate the number of yeses or noes to the sensitive question, one needs to know the proportion of respondents answering each question. This is very easily done, for example, by asking the individual to answer the first question if the last digit of his social security number is 0, 1, 2, 3, 4, 5 or 6 and answer the second question if the last digit is 7, 8, or 9. Using the

second question stated above, one would also know the proportion of individuals answering "yes" to that question, assuming, of course, that last digits of social security numbers are randomly and uniformly distributed. An estimate, then, of the proportion of people answering "yes" to the sensitive question could be obtained as follows:

$$\begin{aligned} P(\text{Yes answer}) &= P(\text{Yes on first question}) \\ &\quad + P(\text{Yes on second question}) \\ &= P(\text{first question is chosen}) \\ &\quad \cdot P(\text{Yes/first question}) \\ &\quad + P(\text{second question is chosen}) \\ &\quad \cdot P(\text{Yes/second question}) \end{aligned}$$

Rewriting this, we obtain:

$$\begin{aligned} P(\text{Yes/first question}) \\ = \left[ P(\text{Yes answer}) - \frac{P(\text{second question chosen}) \cdot P(\text{Yes/second question})}{P(\text{first question chosen})} \right] \end{aligned}$$

After substituting in all known quantities, we are left with simply solving for  $P(\text{Yes/first question})$ , which is what we were interested in. In our survey, we set up the questions so that the  $P(\text{first question chosen})$  was always equal to 0.7 and the  $P(\text{Yes/second is chosen})$  was always equal to  $\frac{2}{3}$ . Note that it was assumed that birthdates were uniformly distributed throughout the year. This assumption probably is not true. Hence, it would have been better to use a certain number of days, say nine, each month to achieve the desired ratio.

Further discussion and a history of the randomized response technique may

be found in How To Get The Answer Without Being Sure You've Asked The Question, Campbell and Joiner [1973] and in the references cited therein.

Next it seems appropriate to discuss the two most recent techniques, block total response procedure and an extension of this, randomized form of the block total. With the block total response technique we use a balanced incomplete block design and obtain a total response for a set of k questions. For example, an interviewer might set up seven questions and ask each of  $N = 7n$  individuals to give a total response for his answers to the three questions in the  $T_i$  ( $i=1,2,3,\dots,7$ ) that he received. A set of n individuals receive, without replacement, a given  $T_i$ .

From these totals for the different sets of questions, where each set of questions and each question appears an equal number of times, estimates for each particular question can be obtained. First assume

$$(1) \quad \left\{ \begin{array}{l} X_{1i} = \bar{X}_1 + e_{1i}, \quad X_{2i} = \bar{X}_2 + e_{2i}, \quad X_{3i} = \bar{X}_3 + e_{3i} \\ X_{4i} = \bar{X}_4 + e_{4i}, \quad X_{5i} = \bar{X}_5 + e_{5i}, \quad X_{6i} = \bar{X}_6 + e_{6i} \\ X_{7i} = \bar{X}_7 + e_{7i} \end{array} \right.$$

where  $X_{1i}, X_{2i}, X_{3i}, \dots, X_{7i}$  are answers to 1,2,3, $\dots$ ,7 respectively, and  $\bar{X}_1, \bar{X}_2, \bar{X}_3, \dots, \bar{X}_7$  are population means for questions 1,2,3, $\dots$ ,7. Let  $Y_{ij}$  be the total of the answers for the  $j^{\text{th}}$  respondent answering the  $i^{\text{th}}$  set of questions

$$Y_{1j} = X_{1j} + X_{2j} + X_{4j}$$

$$Y_{2j} = X_{2j} + X_{3j} + X_{5j}$$

$$Y_{3j} = X_{3j} + X_{4j} + X_{6j}$$

$$(2) \quad Y_{4j} = X_{4j} + X_{5j} + X_{7j}$$

$$Y_{5j} = X_{5j} + X_{6j} + X_{1j}$$

$$Y_{6j} = X_{6j} + X_{7j} + X_{2j}$$

$$Y_{7j} = X_{7j} + X_{1j} + X_{3j}$$

Using (1) in (2), and omitting the  $e_{hi}$  terms we obtain estimates for individual questions as follows:

$$(3) \quad \left\{ \begin{aligned} \hat{X}_1 &= [Y_{1.} + Y_{5.} + Y_{7.} - (Y_{2.} + Y_{3.} + Y_{4.} + Y_{6.})] / 2 / 3n \\ \hat{X}_2 &= [Y_{1.} + Y_{2.} + Y_{6.} - (Y_{3.} + Y_{4.} + Y_{5.} + Y_{7.})] / 2 / 3n \\ \hat{X}_3 &= [Y_{2.} + Y_{3.} + Y_{7.} - (Y_{1.} + Y_{4.} + Y_{5.} + Y_{6.})] / 2 / 3n \\ \hat{X}_4 &= [Y_{1.} + Y_{3.} + Y_{4.} - (Y_{2.} + Y_{5.} + Y_{6.} + Y_{7.})] / 2 / 3n \\ \hat{X}_5 &= [Y_{2.} + Y_{4.} + Y_{5.} - (Y_{1.} + Y_{3.} + Y_{6.} + Y_{7.})] / 2 / 3n \\ \hat{X}_6 &= [Y_{3.} + Y_{5.} + Y_{6.} - (Y_{1.} + Y_{2.} + Y_{4.} + Y_{7.})] / 2 / 3n \\ \hat{X}_7 &= [Y_{4.} + Y_{6.} + Y_{7.} - (Y_{1.} + Y_{2.} + Y_{3.} + Y_{5.})] / 2 / 3n \end{aligned} \right.$$

where n is the number of people answering a given set of questions.

The method for obtaining the estimates using the randomized form of the block total is the same as given above for the block total response. The only difference with this technique is in the manner in which an individual receives the set of three questions to be answered. With this method he chooses a number at random (without replacement) and answers a set of questions corresponding to that number. Thus, the interviewer not only does not know what the respondee had answered for a particular set of questions, but he does not even know which set of questions the respondee has answered.

Further discussion of the block total response technique may be found in Raghavarao and Federer [1973].

## 2. Procedure

First, it was decided to use as the sample the students in the Statistics and Biometry 200 course because of the ease in reaching them and also because the number in the course was close to the number we planned on working with. Then the following seven questions, only 2, 4 and 6 of which are sensitive, were chosen (questions 3 and 5 may also be partially sensitive):

Q<sub>1</sub>: Are you under 21 years of age?  
yes (0) no (1)

Q<sub>2</sub>: Did you cheat in any way on the Statistics 200 prelim that you took last week?  
yes (2) no (3)

Q<sub>3</sub>: In general, are you happy with your decision to come to Cornell?  
yes (1) no (0)

Q<sub>4</sub>: While at Cornell, have you ever stolen money or any other article worth over \$5.00 from a friend, roommate, employer or anyone else?  
yes (3) no (2)

Q<sub>5</sub>: Does your parent earn more than \$25,000 a year?  
yes (0) no (1)

Q<sub>6</sub>: Have you smoked any marijuana during the past two weeks?  
yes (2) no (3)

Q<sub>7</sub>: Are you enrolled in the College of Agriculture and Life Sciences?  
yes (1) no (0)

A copy of one questionnaire used is given in Appendix A. The complete set of T<sub>i</sub> is given in Appendix B.

A primary problem here was in deciding on a good procedure for coding the answers, yes or no. Because in the block total procedures only a total is given, the coding must be such that there are at least two ways of getting any total. Although the above coding procedure is not perfect, it is a much better method than simply coding all "yes" answers 0, and all "no" answers 1, for example. More work is needed on this aspect of the block total technique.

The seven questions were then broken up into seven subsets of three questions each with:

$$(4) \left\{ \begin{array}{l} T_1 = Q_5, Q_6, Q_1 \\ T_2 = Q_4, Q_5, Q_7 \\ T_3 = Q_3, Q_4, Q_6 \\ T_4 = Q_7, Q_1, Q_3 \\ T_5 = Q_6, Q_7, Q_2 \\ T_6 = Q_1, Q_2, Q_4 \\ T_7 = Q_2, Q_3, Q_5 \end{array} \right.$$

The three procedures were coded as follows:

I = Randomized Response Procedure

II = Block Total Response Procedure

III = Randomized Form of Block Total Response Procedure

Each person answered a set of questions using each of the three methods. Since the order in which the techniques were presented might somehow affect the result, the following set of six sequences of the techniques was used.

$$S_1 = I, II, III$$

$$S_4 = II, III, I$$

$$S_2 = I, III, II$$

$$S_5 = III, I, II$$

$$S_3 = II, I, III$$

$$S_6 = III, II, I$$

Then for 42 respondees we used the following setup:

Sets of Seven People

	1	2	3	4	5	6	7
$S_1(I, II, III)$	$T_7 T_6$	$T_1 T_7$	$T_2 T_1$	$T_3 T_2$	$T_4 T_3$	$T_5 T_4$	$T_6 T_5$
$S_2(I, III, II)$	$T_2 T_3$	$T_3 T_4$	$T_4 T_5$	$T_5 T_6$	$T_6 T_7$	$T_7 T_1$	$T_1 T_2$
$S_3(II, I, III)$	$T_3 T_5$	$T_4 T_6$	$T_5 T_7$	$T_6 T_1$	$T_7 T_2$	$T_1 T_3$	$T_2 T_4$
$S_4(II, III, I)$	$T_4 T_7$	$T_5 T_1$	$T_6 T_2$	$T_7 T_3$	$T_1 T_4$	$T_2 T_5$	$T_3 T_6$
$S_5(III, I, II)$	$T_5 T_2$	$T_6 T_3$	$T_7 T_4$	$T_1 T_5$	$T_2 T_6$	$T_3 T_7$	$T_4 T_1$
$S_6(III, II, I)$	$T_6 T_4$	$T_7 T_5$	$T_1 T_6$	$T_2 T_7$	$T_3 T_1$	$T_4 T_2$	$T_5 T_3$

where the first T in each pair corresponds to procedure I and the second T corresponds to procedure II.

Each person received four pages stapled together (see Appendix A). On the first page was a brief introduction and general instructions. The next three pages were stapled together in the order they were to be done. When the student reached the page with procedure III on it, he was instructed to choose a cork without replacement from a jar of corks numbered 1 through 7, and answer the set of questions corresponding to that number. After completing this page he tore off the page and placed it in a big box; this further helped to secure his anonymity. In the other two procedures, instructions and questions to be answered were indicated.

After the first six blocks of seven had been completed by the 42 respondees, another 42 students followed the same set up to obtain the 84 responses.

In general survey practice, a plastic jar with  $n$  corks numbered 1,  $n$  corks numbered 2,  $n$  corks numbered 3, ...,  $n$  corks numbered 7, could be used. Then when one gets down to the last few corks, a check could be made to determine which numbers remained. If only one or two numbers remain, several corks with the same number could be added to give a sense of anonymity to the respondee. It was found that students felt much more secure about their anonymity with procedure III than with the other two procedures. This appears to show up in their answers to question number 2, where the percentage by procedure III was much higher than for procedures I and II.

### 3. Summarized Data and Calculations

The total number of "yes" responses for each  $S_j$  ( $j=1,2,\dots$ ), and for each question for the randomized response technique is:

Question	Number "Yes"	
	I.1	I.2
1	12	13
2	3	5
3	15	13
4	3	4
5	4	6
6	6	7
7	12	15

Sequence	I.1	I.2
1	10	10
2	8	13
3	9	7
4	8	13
5	11	12
6	9	7

The total for each  $T_i$  over all  $S_j$  over Block Total I and II and for Randomized form of Block Total I and II is:

	II	III
$\Sigma T_1$	51	42
$\Sigma T_2$	43	44
$\Sigma T_3$	65	65
$\Sigma T_4$	22	21
$\Sigma T_5$	77	75
$\Sigma T_6$	67	65
$\Sigma T_7$	55	57

The calculations for the randomized response technique are:

$$\begin{aligned} P(\text{Yes answer}) &= P(\text{Yes on first question}) \\ &\quad + P(\text{Yes on second question}) \\ &= P(\text{first question chosen}) \cdot P(\text{Yes/first question}) \\ &\quad + P(\text{second question chosen}) \cdot P(\text{Yes/second question}) \end{aligned}$$

In computational form:

$$P(\text{Yes/first question}) = [P(\text{Yes answer}) - P(\text{second question is chosen}) \cdot P(\text{Yes/second question})] / P(\text{first question is chosen}) .$$

Substituting in the known values we have

$$\begin{aligned} P(\text{Yes/first question}) &= \frac{P(\text{Yes answer}) - (.3)(\frac{2}{3})}{0.7} \\ &= \frac{P(\text{Yes answer}) - .20}{0.7} \end{aligned}$$

where  $P(\text{Yes answer})$  is the proportion of "Yes" responses for a particular question.

Estimates for each question using the Randomized Response Procedure are:

$$\hat{X}_1 = 0.71$$

$$\hat{X}_2 = 0.03$$

$$\hat{X}_3 = 0.83$$

$$\hat{X}_4 = 0.01$$

$$\hat{X}_5 = 0.11$$

$$\hat{X}_6 = 0.23$$

$$\hat{X}_7 = 0.79$$

In the Block Total Response Procedure,

Question 1 appears in T<sub>1</sub>, T<sub>4</sub>, and T<sub>6</sub>;

Question 2 appears in T<sub>5</sub>, T<sub>6</sub>, and T<sub>7</sub>;

Question 3 appears in T<sub>3</sub>, T<sub>4</sub>, and T<sub>7</sub>;

Question 4 appears in T<sub>2</sub>, T<sub>3</sub>, and T<sub>6</sub>;

Question 5 appears in T<sub>1</sub>, T<sub>2</sub>, and T<sub>7</sub>;

Question 6 appears in T<sub>1</sub>, T<sub>3</sub>, and T<sub>5</sub>;

Question 7 appears in T<sub>2</sub>, T<sub>4</sub>, and T<sub>5</sub>.

The estimate for question 1 is, for Y<sub>i.</sub> = response to T<sub>i</sub> for n individuals answering set T<sub>i</sub>:

$$\begin{aligned}\hat{\bar{x}}_1 &= \frac{Y_{1.} + Y_{4.} + Y_{6.} - \frac{1}{2}(Y_{2.} + Y_{3.} + Y_{5.} + Y_{7.})}{3n} \\ &= \frac{51 + 22 + 67 - \frac{1}{2}(43 + 65 + 77 + 55)}{36} = 0.56.\end{aligned}$$

The estimates for the other questions were obtained in the same manner. For questions that were not coded 0 - 1, after the estimate was obtained, the digit to the left of the decimal point was subtracted so that estimates could be more easily compared. The estimated proportions are:

$$\hat{\bar{x}}_2 = 3.0138 - 3 = 0.01,$$

$$\hat{\bar{x}}_3 = 0.64,$$

$$\hat{\bar{x}}_4 = 2.0138 - 2 = 0.01,$$

$$\hat{\bar{x}}_5 = 0.93,$$

$$\hat{\bar{x}}_6 = 2.7638 - 2 = 0.76, \text{ and}$$

$$\hat{\bar{x}}_7 = 0.64.$$

In the randomized form of block total, the estimated proportions are obtained in the same manner as the block total response procedure above, and are:

$$\hat{\bar{X}}_1 = 0.21 ,$$

$$\hat{\bar{X}}_2 = 3.0833 - 3 = 0.08 ,$$

$$\hat{\bar{X}}_3 = 0.83 ,$$

$$\hat{\bar{X}}_4 = 2.1250 - 2 = 0.12 ,$$

$$\hat{\bar{X}}_5 = 0.83 ,$$

$$\hat{\bar{X}}_6 = 2.4583 - 2 = 0.46 , \text{ and}$$

$$\hat{\bar{X}}_7 = 0.71 .$$

The estimates are summarized below:

	I. Randomized Response	II. Block Total	III. Randomized Block Total
$\hat{\bar{X}}_1$	0.71	0.56	0.21
$\hat{\bar{X}}_2$	0.03	0.01	0.08
$\hat{\bar{X}}_3$	0.83	0.64	0.83
$\hat{\bar{X}}_4$	0.01	0.01	0.12
$\hat{\bar{X}}_5$	0.11	0.93	0.83
$\hat{\bar{X}}_6$	0.23	0.76	0.46
$\hat{\bar{X}}_7$	0.79	0.64	0.71

From the class roster, we could check to find out the number of students who were actually enrolled in the College of Agriculture and Life Sciences (question 7 from the survey). Out of the 97 students enrolled in the course, 71 of them were in the College; this is 73%. This value of 0.73 corresponds closely

to the estimates obtained by using our three techniques. The discrepancies are 0.06, -0.09, and -0.02 for methods I, II, and III respectively. The graphical representation of the above results is given in Figure 1.

Considerable discrepancies were obtained for question 5 by the randomized response technique and the other two procedures. From discussions with students it would appear that a figure of 11% of parents with income over \$25,000 is an unusually low figure, but that a figure of 93% by the block total response method is somewhat high. Likewise, it is doubtful if 76% of the students smoked marijuana during the past week (question 6 and the block total response technique).

The data are presented in Appendix C.

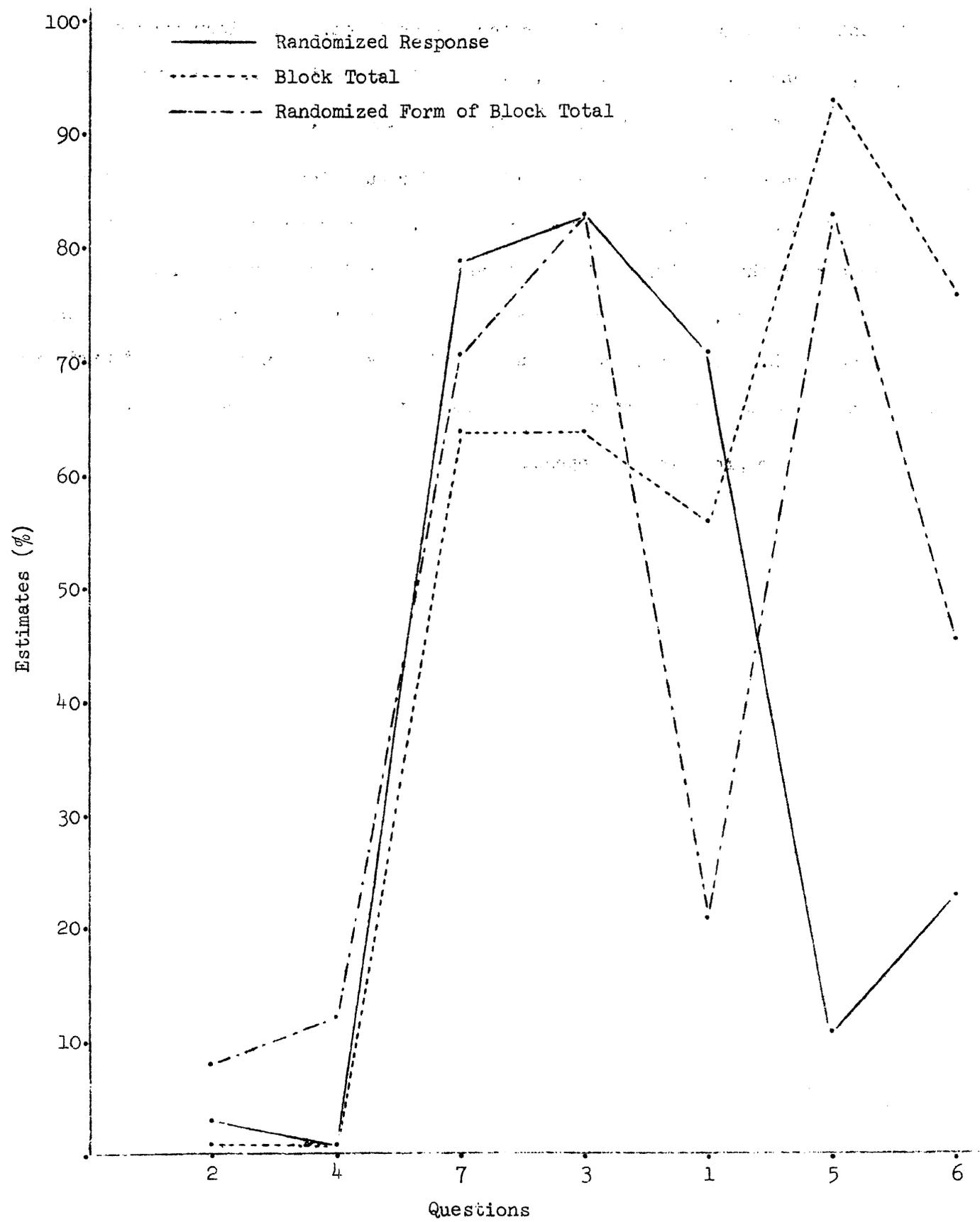


Figure 1. Responses for seven questions from three methods.

#### 4. Variations of Estimators for the Three Methods

The variance of the estimated percentage  $\hat{p}$  by the randomized response procedure, I, is well known, being the estimated variance  $\hat{p}(1-\hat{p})/kn$  divided by  $\Pi^2$  where  $\Pi$  is the fraction answering the sensitive question; in our case  $\Pi = .7$ . Two methods have been devised for estimating the variances of the estimated percentages  $\hat{X}_i$  for the block total response procedure, II. The same procedures may be used for the randomized block total response technique III.

The  $Y_{ij}$ ,  $i=1,2,\dots,7$  and  $j=1,2,\dots,n=12$ , are statistically independent since a simple random sample of  $n$  individuals was selected to answer each  $T_i$  and the  $T_i$  were not used on the same individuals. Hence, we may compute the variance of a given  $\bar{Y}_i$ . as

$$V(\bar{Y}_i) = \left[ \sum_{j=1}^n Y_{ij}^2 - \left( \sum_{j=1}^n Y_{ij} \right)^2 / n \right] / [n(n-1)] .$$

Using the formula the various variances were obtained as:

Question set	Set II	Set III
$T_1$	0.0170	0.0833
$T_2$	0.0827	0.0657
$T_3$	0.0372	0.0221
$T_4$	0.0884	0.0777
$T_5$	0.0221	0.0625
$T_6$	0.0221	0.0372
$T_7$	0.0221	0.0322

Method (i):

Under the assumption of independence of response to the k questions in a block, the variance of  $\hat{X}_i$  is, for k = 3,

$$V(\hat{X}_i) = [\text{sum of variances of } T_h \text{ in three blocks where question } i \text{ occurred plus one-fourth of variances of blocks where } i \text{ did not occur}]/9 .$$

For example, question i occurred in blocks  $T_1$ ,  $T_4$  and  $T_6$ . The estimated variance for question one is

$$\begin{aligned} V(\hat{X}_1) &= [v(\bar{Y}_{1.}) + v(\bar{Y}_{4.}) + v(\bar{Y}_{6.}) + (v(\bar{Y}_{2.}) + v(\bar{Y}_{3.}) + v(\bar{Y}_{5.}) + v(\bar{Y}_{7.}))]/4]/9 \\ &= [0.0170 + 0.0884 + 0.0221 + (0.0827 + 0.0372 + 0.0221 \\ &\quad + 0.0221)/4]/9 = 0.0187 . \end{aligned}$$

The remaining variances for both sets II and III are computed similarly and are given in Table 4.1.

Method (ii):

The second method for computing the variances of the  $\hat{X}_i$  is more akin to the variance component procedure. Here we obtain negative estimates for  $V(\hat{X}_i)$ .

The method is as follows. Use the same procedure for estimating the variance as was used for the mean  $\hat{X}_i$  with the variances of the  $\bar{Y}_i$  being used in place of the  $\sum_{j=1}^n Y_{ij}$ . For example, for the first question, the variance is

$$\begin{aligned} V(\hat{X}_1) &= [v(\bar{Y}_{1.}) + v(\bar{Y}_{4.}) + v(\bar{Y}_{6.}) - (v(\bar{Y}_{2.}) + v(\bar{Y}_{3.}) + v(\bar{Y}_{5.}) + v(\bar{Y}_{7.}))]/2]/3 \\ &= [0.0170 + 0.0884 + 0.0221 - (0.0827 + 0.0372 + 0.0221 \\ &\quad + 0.0221)/2]/3 = 0.0152 . \end{aligned}$$

The estimated variances of the  $\hat{X}_i$  for both sets II and III are obtained as above and are presented in Table 4.1.

Owing to the relatively small sample size,  $n = 12$ , individual comparisons for the  $\hat{X}_i$  are of little value. The average variance over all  $\hat{X}_i$  is of value, however. We note that the average variance for the block total response, set II plus III, by method (i) is about three times larger than the variance for the randomized response. For method (ii), the average variance for the block total response is about twice as large.

Suppose that the variance of all  $\hat{X}_i$  is the same, say  $\sigma^2$ , and further suppose that all responses to questions in each block are independent. Then for  $k = 3$ ,  $V(\hat{X}_i) = 12\sigma^2/9n = 4\sigma^2/3n$  by method (i). Since the randomized response is obtained on each of three individuals the variance by the randomized response procedure is  $\sigma^2/3n\pi^2 = \sigma^2/3(.7)^2n = \sigma^2/1.47n$ . Thus, the ratio of the variances of the block total response to the randomized response procedure is  $4\sigma^2/3n/\sigma^2/1.47n$  which is approximately equal to two. The average estimated variance for the randomized response technique is probably too low, since two of the  $\hat{X}_i$  are near zero.

The time required to conduct three randomized response questions is more than three,  $k$  in general, times longer than for the block total response technique. Hence, the fact that the variance of the former is smaller than for the block total response must be interpreted in light of cost of interviewing. When cost is considered it is not at all certain that the efficiency of the randomized response procedure will be higher.

Table 4.1. Estimated variances for the three procedures.

Variance	I	Method (i)		Method (ii)	
		II	III	II	III
$v(\hat{\bar{X}}_1)$	0.0117	0.0187	0.0271	0.0152	0.0356
$v(\hat{\bar{X}}_2)$	0.0016	0.0136	0.0216	-0.0154	0.0025
$v(\hat{\bar{X}}_3)$	0.0080	0.0204	0.0216	0.0252	0.0026
$v(\hat{\bar{X}}_4)$	0.0006	0.0199	0.0210	0.0224	-0.0010
$v(\hat{\bar{X}}_5)$	0.0055	0.0182	0.0257	0.0123	0.0272
$v(\hat{\bar{X}}_6)$	0.0100	0.0145	0.0246	-0.0104	0.0205
$v(\hat{\bar{X}}_7)$	0.0094	0.0235	0.0277	0.0480	0.0395
Average	0.0067	0.0184	0.0241	0.0139	0.0181

## 5. Conclusions

The estimates that were obtained using each of the three methods seem to correspond fairly closely on questions 2, 3, 4 and 7, but a poor correspondence occurs on questions 1, 5 and 6. Looking back in the summarized data and calculations, Section 2, and also at the graph in Figure 1, we see that the totals here for block total and the randomized block total are all fairly close, except for  $T_1$  which corresponds to questions 5, 6 and 1. The total for Method II is 51, while that for III is 42. Sampling error seems to be the only cause of this discrepancy. The other  $T_i$  agree much more closely. With each  $T_i$  being answered only 12 times under each technique by different people, and each question being answered 36 times under each, sampling error is a likely possibility. With a much larger sample this discrepancy would probably not occur.

After administering the survey on the 84 students and listening to their comments and then tabulating and calculating results, a few conclusions can be made. The primary point is that the third technique, randomized form of block total, is most likely the best of the three methods studied. Students seemed to be the most satisfied with this method as to their anonymity. The interviewer did not know who had chosen which cork number, and after the student placed his paper in the box the interviewer could not tell whose paper was whose. This additional level of anonymity seemed to leave the students most satisfied.

After explaining the three techniques to the students and trying to make them believe that their answers would truly be anonymous, some students still lacked confidence. Some said that no matter what an interviewer told them, they still would not answer a "sensitive" question honestly if an honest answer could incriminate or embarrass them. They felt that there must be some way the interviewer could find out an individual's answers if he wanted to. This seems to be

the biggest problem facing users of these three techniques. An interviewer is going to have to be trained so that his introductory remarks will instill a high level of confidence in the respondent, and this will not be an easy task.

To get an even better insight into the randomized response, block total, and randomized block total as methods for obtaining truthful answers to sensitive questions a much larger sample will have to be taken. Although 84 seems like a fairly large number, it really is not when each question is answered only 36 times. Further research is needed in this whole area.

### References

1. Campbell, C. and Joiner, B. L. (1973). How to get the answer without being sure you've asked the question. The American Statistician,
2. Raghavarao, D. and Federer, W. T. (1973). Application of BIB designs as an alternative to the randomized response method in survey sampling. BU-490-M in the Mimeo Series of the Biometrics Unit, Cornell University.

Appendix A -- Sample questionnaire given to a single interviewee.

This survey is designed for the purpose of comparing three methods of obtaining truthful answers to questions that an individual might feel are embarrassing, incriminating, or both. All three methods are aimed at keeping the individual's answers completely anonymous. We are not interested in how particular individuals answer specific questions, but rather in estimating the number of individuals responding in a certain way (either yes or no).

Results of this survey will be summarized and analyzed and then presented to you at a later date.

After finishing this survey, some of you may want to construct a similar survey using one or more of these three methods and your own questions for your term project.

When you have completed all three sections, please write down any comments you have concerning the three procedures. Did you feel as though your answers were really anonymous? Why or why not? Write comments on back of this page.

I. Randomized Response Procedure

In this method you are to answer one of two questions according to the procedure indicated. You give only one answer in each pair of questions, and because of the way this method is designed the interviewer cannot tell which question you have answered. The interviewer knows only the proportion of times the question is answered.

1. Answer question A if the last digit of your social security number is 0, 1, 2, 3, 4, 5 or 6. Answer question B if the last digit is 7, 8 or 9.

Question A: Does your parent earn more than \$25,000 a year?

Question B: Is your number 7 or 8 (as opposed to 9)?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

2. Answer question A if your birthday falls between January 1 and September 12. Answer B if your birthday falls between September 13 and December 31.

Question A: Have you smoked any marijuana during the past two weeks?

Question B: Is your birthday between September 13 and November 25?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

3. Draw a cork and note its color, and if it is white, also note its number. Answer question A if it is red and question B if it is white.

Question A: Are you under 21 years of age?

Question B: Was the number on your cork 1?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

## II. Block Total Response Procedure

For this procedure you are asked to give only a total of your answers to the three questions. Please do not, unless you wish to, indicate what you answer for individual questions, but rather a total for all three. Because you give just the total, the interviewer cannot tell how you have answered individual questions. For example if your total was 4 you could have answered in any of the following ways:

1. 0 (1)  
2. (2) 3  
3. (1) 0  
= 4

1. 0 (1)  
2. 2 (3)  
3. 1 (0)  
= 4

1. (0) 1  
2. 2 (3)  
3. (1) 0  
= 4

### Possible Answers

3. In general, are you happy with your decision to come to Cornell?

Yes (1) No (0)

4. While at Cornell, have you ever stolen money or any other article worth more than \$5.00 from a roommate, friend, employer, or anyone else?

Yes (3) No (2)

6. Have you smoked any marijuana during the past two weeks?

Yes (2) No (3)

Total for the three questions:

III. Randomized Form of Block Total Response

Without looking, select a cork from the jar. Observe the number on the cork. This number will correspond to a certain set of questions that you will answer. The seven questions are:

1. Are you under 21 years of age?

Yes (0) No (1)

2. Did you cheat in any way on the Stat 200 prelim that you took last week?

Yes (2) No (3)

3. In general, are you happy with your decision to come to Cornell?

Yes (1) No (0)

4. While at Cornell, have you ever stolen money or any other article worth over \$5.00 from a roommate, friend, employer, or anyone else?

Yes (3) No (2)

5. Does your parent earn more than \$25,000 a year?

Yes (0) No (1)

6. Have you smoked any marijuana during the past two weeks?

Yes (2) No (3)

7. Are you enrolled in the College of Agriculture and Life Sciences?

Yes (1) No (0)

Do not give answers to individual questions but rather a total of your three answers.

If the number on your cork was 1, give a total for questions 1, 2, 4

Answer \_\_\_\_\_

If number was 2, give total for 2, 3, 5

Answer \_\_\_\_\_

If number was 3, give total for 3, 4, 6

Answer \_\_\_\_\_

If number was 4, give total for 4, 5, 7

Answer \_\_\_\_\_

If number was 5, give total for 5, 6, 1

Answer \_\_\_\_\_

If number was 6, give total for 6, 7, 2

Answer \_\_\_\_\_

If number was 7, give total for 7, 1, 3

Answer \_\_\_\_\_

Now fold this page in half and place in the box provided. This is to insure that your answers remain anonymous.

Appendix B -- Complete set of all questionnaire forms for three techniques.

This survey is designed for the purpose of comparing three methods of obtaining truthful answers to questions that an individual might feel are embarrassing, incriminating, or both. All three methods are aimed at keeping the individual's answers completely anonymous. We are not interested in how particular individuals answer specific questions, but rather in estimating the number of individuals responding in a certain way (either yes or no).

Results of this survey will be summarized and analyzed and then presented to you at a later date.

After finishing this survey, some of you may want to construct a similar survey using one or more of these three methods and your own questions for your term project.

When you have completed all three sections, please write down any comments you have concerning the three procedures. Did you feel as though your answers were really anonymous? Why or why not? Write comments on back of this page.

T<sub>1</sub> --

I. Randomized Response Procedure

In this method you are to answer one of two questions according to the procedure indicated. You give only one answer in each pair of questions, and because of the way this method is designed the interviewer cannot tell which question you have answered. The interviewer knows only the proportion of times the question is answered.

1. Answer question A if the last digit of your social security number is 0, 1, 2, 3, 4, 5 or 6. Answer question B if the last digit is 7, 8 or 9.

Question A: Does your parent earn more than \$25,000 a year?

Question B: Is your number 7 or 8 (as opposed to 9)?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

2. Answer question A if your birthday falls between January 1 and September 12. Answer B if your birthday falls between September 13 and December 31.

Question A: Have you smoked any marijuana during the past two weeks?

Question B: Is your birthday between September 13 and November 25?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

3. Draw a cork and note its color, and if it is white, also note its number. Answer question A if it is red and question B if it is white.

Question A: Are you under 21 years of age?

Question B: Was the number on your cork 1?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

T<sub>2</sub> --

I. Randomized Response Procedure

In this method you are to answer one of two questions according to the procedure indicated. You give only one answer in each pair of questions, and because of the way this method is designed the interviewer cannot tell which question you have answered. The interviewer knows only the proportion of times the question is answered.

1. Answer question A if the last digit of your social security number is 0, 1, 2, 3, 4, 5 or 6. Answer question B if the last digit is 7, 8 or 9.

Question A: While at Cornell, have you stolen money or any other article worth over \$5 from a roommate, friend, employer, or anyone else?

Question B: Is your number 7 or 8 (as opposed to 9)?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

2. Answer question A if your birthday falls between January 1 and September 12. Answer B if your birthday falls between September 13 and December 31.

Question A: Does your parent earn more than \$25,000 a year?

Question B: Is your birthday between September 13 and November 25?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

3. Draw a cork and note its color, and if it is white, also note its number. Answer question A if it is red and question B if it is white.

Question A: Are you enrolled in the College of Agriculture and Life Sciences?

Question B: Was the number on your cork 1?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

T<sub>3</sub> --

I. Randomized Response Procedure

In this method you are to answer one of two questions according to the procedure indicated. You give only one answer in each pair of questions, and because of the way this method is designed the interviewer cannot tell which question you have answered. The interviewer knows only the proportion of times the question is answered.

1. Answer question A if the last digit of your social security number is 0, 1, 2, 3, 4, 5 or 6. Answer question B if the last digit is 7, 8 or 9.

Question A: In general, are you happy with your decision to come to Cornell?

Question B: Is your number 7 or 8 (as opposed to 9)?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

2. Answer question A if your birthday falls between January 1 and September 12. Answer B if your birthday falls between September 13 and December 31.

Question A: While at Cornell, have you ever stolen money or any other article worth over \$5 from a roommate, friend, employer, or anyone else?

Question B: Is your birthday between September 13 and November 25?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

3. Draw a cork and note its color, and if it is white, also note its number. Answer question A if it is red and question B if it is white.

Question A: Have you smoked any marijuana during the past two weeks?

Question B: Was the number on your cork 1?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

T<sub>4</sub> --

I. Randomized Response Procedure

In this method you are to answer one of two questions according to the procedure indicated. You give only one answer in each pair of questions, and because of the way this method is designed the interviewer cannot tell which question you have answered. The interviewer knows only the proportion of times the question is answered.

1. Answer question A if the last digit of your social security number is 0, 1, 2, 3, 4, 5 or 6. Answer question B if the last digit is 7, 8 or 9.

Question A: Are you enrolled in the College of Agriculture and Life Sciences?

Question B: Is your number 7 or 8 (as opposed to 9)?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

2. Answer question A if your birthday falls between January 1 and September 12. Answer B if your birthday falls between September 13 and December 31.

Question A: Are you under 21 years of age?

Question B: Is your birthday between September 13 and November 25?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

3. Draw a cork and note its color, and if it is white, also note its number. Answer question A if it is red and question B if it is white.

Question A: In general, are you happy with your decision to come to Cornell?

Question B: Was the number on your cork 1?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

T<sub>5</sub> --

I. Randomized Response Procedure

In this method you are to answer one of two questions according to the procedure indicated. You give only one answer in each pair of questions, and because of the way this method is designed the interviewer cannot tell which question you have answered. The interviewer knows only the proportion of times the question is answered.

1. Answer question A if the last digit of your social security number is 0, 1, 2, 3, 4, 5 or 6. Answer question B if the last digit is 7, 8 or 9.

Question A: Have you smoked any marijuana during the past two weeks?

Question B: Is your number 7 or 8 (as opposed to 9)?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

2. Answer question A if your birthday falls between January 1 and September 12. Answer B if your birthday falls between September 13 and December 31.

Question A: Are you enrolled in the College of Agriculture and Life Sciences?

Question B: Is your birthday between September 13 and November 25?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

3. Draw a cork and note its color, and if it is white, also note its number. Answer question A if it is red and question B if it is white.

Question A: Did you cheat in any way on the Stat. 20J prelim that you took last week?

Question B: Was the number on your cork 1?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

T<sub>6</sub> --

I. Randomized Response Procedure

In this method you are to answer one of two questions according to the procedure indicated. You give only one answer in each pair of questions, and because of the way this method is designed the interviewer cannot tell which question you have answered. The interviewer knows only the proportion of times the question is answered.

1. Answer question A if the last digit of your social security number is 0, 1, 2, 3, 4, 5 or 6. Answer question B if the last digit is 7, 8 or 9.

Question A: Are you under 21 years of age?

Question B: Is your number 7 or 8 (as opposed to 9)?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

2. Answer question A if your birthday falls between January 1 and September 12. Answer B if your birthday falls between September 13 and December 31.

Question A: Did you cheat in any way on the Stat 200 prelim that you took last week?

Question B: Is your birthday between September 13 and November 25?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

3. Draw a cork and note its color, and if it is white, also note its number. Answer question A if it is red and question B if it is white.

Question A: While at Cornell, have you ever stolen money or any other article worth over \$5 from a roommate, friend, employer, or anyone else?

Question B: Was the number on your cork 1?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

T7 --

I. Randomized Response Procedure

In this method you are to answer one of two questions according to the procedure indicated. You give only one answer in each pair of questions, and because of the way this method is designed the interviewer cannot tell which question you have answered. The interviewer knows only the proportion of times the question is answered.

1. Answer question A if the last digit of your social security number is 0, 1, 2, 3, 4, 5 or 6. Answer question B if the last digit is 7, 8, or 9.

Question A: Did you cheat in any way on the Stat. 200 prelim that you took last week?

Question B: Is your number 7 or 8 (as opposed to 9)?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

2. Answer question A if your birthday falls between January 1 and September 12. Answer B if your birthday falls between September 13 and December 31.

Question A: In general, are you happy with your decision to come to Cornell?

Question B: Is your birthday between Sept. 13 and November 25?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

3. Draw a cork and note its color, and if it is white, also note its number. Answer question A if it is red and question B if it is white.

Question A: Does your parent earn more than \$25,000 a year?

Question B: Was the number on your cork 1?

Answer: Yes \_\_\_\_\_ No \_\_\_\_\_

## II. Block Total Response Procedure

For this procedure you are asked to give only a total of your answers to the three questions. Please do not, unless you wish to, indicate what you answer for individual questions, but rather a total for all three. Because you give just the total, the interviewer cannot tell how you have answered individual questions. For example if your total was 4 you could have answered in any of the following ways:

$$\begin{array}{rcl} 1. & 0 & \textcircled{1} \\ 2. & \textcircled{2} & 3 \\ 3. & \textcircled{1} & 0 \\ & = & 4 \end{array}$$

$$\begin{array}{rcl} 1. & 0 & \textcircled{1} \\ 2. & 2 & \textcircled{3} \\ 3. & 1 & \textcircled{0} \\ & = & 4 \end{array}$$

$$\begin{array}{rcl} 1. & \textcircled{0} & 1 \\ 2. & 2 & \textcircled{3} \\ 3. & \textcircled{1} & 0 \\ & = & 4 \end{array}$$

### Possible Answers

5. Does your parent earn more than \$25,000 a year?

Yes (0) No (1)

6. Have you smoked any marijuana during the past two weeks?

Yes (2) No (3)

1. Are you under 21 years of age?

Yes (0) No (1)

Total for the three questions:

## II. Block Total Response Procedure

For this procedure you are asked to give only a total of your answers to the three questions. Please do not, unless you wish to, indicate what you answer for individual questions, but rather a total for all three. Because you give just the total, the interviewer cannot tell how you have answered individual questions. For example if your total was 4 you could have answered in any of the following ways:

$$\begin{array}{r} 1. \quad 0 \quad \textcircled{1} \\ 2. \quad \textcircled{2} \quad 3 \\ 3. \quad \textcircled{1} \quad 0 \\ \quad \quad = \quad 4 \end{array}$$

$$\begin{array}{r} 1. \quad 0 \quad \textcircled{1} \\ 2. \quad 2 \quad \textcircled{3} \\ 3. \quad 1 \quad \textcircled{0} \\ \quad \quad = \quad 4 \end{array}$$

$$\begin{array}{r} 1. \quad \textcircled{0} \quad 1 \\ 2. \quad 2 \quad \textcircled{3} \\ 3. \quad \textcircled{1} \quad 0 \\ \quad \quad = \quad 4 \end{array}$$

	Possible Answers
4. While at Cornell, have you ever stolen money or any other article worth more than \$5.00 from a roommate, friend, employer, or anyone else?	Yes (3) No (2)
5. Does your parent earn more than \$25,000 a year?	Yes (0) No (1)
7. Are you enrolled in the College of Agriculture and Life Sciences?	Yes (1) No (0)

Total for the three questions:

## II. Block Total Response Procedure

For this procedure you are asked to give only a total of your answers to the three questions. Please do not, unless you wish to, indicate what you answer for individual questions, but rather a total for all three. Because you give just the total, the interviewer cannot tell how you have answered individual questions. For example if your total was 4 you could have answered in any of the following ways:

$$\begin{array}{r} 1. \quad 0 \quad \textcircled{1} \\ 2. \quad \textcircled{2} \quad 3 \\ 3. \quad \textcircled{1} \quad 0 \\ \quad \quad = \quad 4 \end{array}$$

$$\begin{array}{r} 1. \quad 0 \quad \textcircled{1} \\ 2. \quad 2 \quad \textcircled{3} \\ 3. \quad 1 \quad \textcircled{0} \\ \quad \quad = \quad 4 \end{array}$$

$$\begin{array}{r} 1. \quad \textcircled{0} \quad 1 \\ 2. \quad 2 \quad \textcircled{3} \\ 3. \quad \textcircled{1} \quad 0 \\ \quad \quad = \quad 4 \end{array}$$

### Possible Answers

- |  |         |        |
|--|---------|--------|
| 3. In general, are you happy with your decision to come to Cornell?  | Yes (1) | No (0) |
| 4. While at Cornell, have you ever stolen money or any other article worth more than \$5.00 from a roommate, friend, employer, or anyone else? | Yes (3) | No (2) |
| 6. Have you smoked any marijuana during the past two weeks?  | Yes (2) | No (3) |

Total for the three questions:

## II. Block Total Response Procedure

For this procedure you are asked to give only a total of your answers to the three questions. Please do not, unless you wish to, indicate what you answer for individual questions, but rather a total for all three. Because you give just the total, the interviewer cannot tell how you have answered individual questions. For example if your total was 4 you could have answered in any of the following ways:

$$\begin{array}{r} 1. \quad 0 \quad \textcircled{1} \\ 2. \quad \textcircled{2} \quad 3 \\ 3. \quad \textcircled{1} \quad 0 \\ \quad \quad = \quad 4 \end{array}$$

$$\begin{array}{r} 1. \quad 0 \quad \textcircled{1} \\ 2. \quad 2 \quad \textcircled{3} \\ 3. \quad 1 \quad \textcircled{0} \\ \quad \quad = \quad 4 \end{array}$$

$$\begin{array}{r} 1. \quad \textcircled{0} \quad 1 \\ 2. \quad 2 \quad \textcircled{3} \\ 3. \quad \textcircled{1} \quad 0 \\ \quad \quad = \quad 4 \end{array}$$

	Possible Answers	
7. Are you enrolled in the College of Agriculture and Life Sciences?	Yes (1)	No (0)
1. Are you under 21 years of age?	Yes (0)	No (1)
3. In general, are you happy with your decision to come to Cornell?	Yes (1)	No (0)

Total for the three questions:

## II. Block Total Response Procedure

For this procedure you are asked to give only a total of your answers to the three questions. Please do not, unless you wish to, indicate what you answer for individual questions, but rather a total for all three. Because you give just the total, the interviewer cannot tell how you have answered individual questions. For example if your total was 4 you could have answered in any of the following ways:

$$\begin{array}{r} 1. \quad 0 \quad \textcircled{1} \\ 2. \quad \textcircled{2} \quad 3 \\ 3. \quad \textcircled{1} \quad 0 \\ \quad \quad = \quad 4 \end{array}$$

$$\begin{array}{r} 1. \quad 0 \quad \textcircled{1} \\ 2. \quad 2 \quad \textcircled{3} \\ 3. \quad 1 \quad \textcircled{0} \\ \quad \quad = \quad 4 \end{array}$$

$$\begin{array}{r} 1. \quad \textcircled{0} \quad 1 \\ 2. \quad 2 \quad \textcircled{3} \\ 3. \quad \textcircled{1} \quad 0 \\ \quad \quad = \quad 4 \end{array}$$

	Possible Answers
6. Have you smoked any marijuana in the past two weeks?	Yes (2) No (3)
7. Are you enrolled in the College of Agriculture and Life Sciences?	Yes (1) No (0)
2. Did you cheat in any way on the Stat 200 prelim that you took last week?	Yes (2) No (3)

Total for the three questions:

## II. Block Total Response Procedure

For this procedure you are asked to give only a total of your answers to the three questions. Please do not, unless you wish to, indicate what you answer for individual questions, but rather a total for all three. Because you give just the total, the interviewer cannot tell how you have answered individual questions. For example if your total was 4 you could have answered in any of the following ways:

$$\begin{array}{r} 1. \quad 0 \quad \textcircled{1} \\ 2. \quad \textcircled{2} \quad 3 \\ 3. \quad \textcircled{1} \quad 0 \\ \quad \quad = \quad 4 \end{array}$$

$$\begin{array}{r} 1. \quad 0 \quad \textcircled{1} \\ 2. \quad 2 \quad \textcircled{3} \\ 3. \quad 1 \quad \textcircled{0} \\ \quad \quad = \quad 4 \end{array}$$

$$\begin{array}{r} 1. \quad \textcircled{0} \quad 1 \\ 2. \quad 2 \quad \textcircled{3} \\ 3. \quad \textcircled{1} \quad 0 \\ \quad \quad = \quad 4 \end{array}$$

### Possible Answers

1. Are you under 21 years of age?

Yes (0) No (1)

2. Did you cheat in any way on the Stats 200  
prelim that you took last week?

Yes (2) No (3)

4. While at Cornell, have you ever stolen money  
or any other article worth over \$5.00 from a  
roommate, friend, employer, or anyone else?

Yes (3) No (2)

Total for the three questions:

## II. Block Total Response Procedure

For this procedure you are asked to give only a total of your answers to the three questions. Please do not, unless you wish to, indicate what you answer for individual questions, but rather a total for all three. Because you give just the total, the interviewer cannot tell how you have answered individual questions. For example if your total was 4 you could have answered in any of the following ways:

$$\begin{array}{r} 1. \quad 0 \quad \textcircled{1} \\ 2. \quad \textcircled{2} \quad 3 \\ 3. \quad \textcircled{1} \quad 0 \\ \quad \quad = \quad 4 \end{array}$$

$$\begin{array}{r} 1. \quad 0 \quad \textcircled{1} \\ 2. \quad 2 \quad \textcircled{3} \\ 3. \quad 1 \quad \textcircled{0} \\ \quad \quad = \quad 4 \end{array}$$

$$\begin{array}{r} 1. \quad \textcircled{0} \quad 1 \\ 2. \quad 2 \quad \textcircled{3} \\ 3. \quad \textcircled{1} \quad 0 \\ \quad \quad = \quad 4 \end{array}$$

	Possible Answers
2. Did you cheat in any way on the Stat 200 prelim that you took last week?	Yes (2) No (3)
3. In general are you happy with your decision to come to Cornell?	Yes (1) No (0)
5. Does your parent earn more than \$25,000 a year?	Yes (0) No (1)

Total for the three questions:

III. Randomized form of Block Total Response

Without looking, select a cork from the jar. Observe the number on the cork. This number will correspond to a certain set of questions that you will answer. The seven questions are:

1. Are you under 21 years of age?  
Yes (0) No (1)
2. Did you cheat in any way on the Stat 200 prelim that you took last week?  
Yes (2) No (3)
3. In general, are you happy with your decision to come to Cornell?  
Yes (1) No (0)
4. While at Cornell, have you ever stolen money or any other article worth over \$5.00 from a roommate, friend, employer, or anyone else?  
Yes (3) No (2)
5. Does your parent earn more than \$25,000 a year?  
Yes (0) No (1)
6. Have you smoked any marijuana during the past two weeks?  
Yes (2) No (3)
7. Are you enrolled in the College of Agriculture and Life Sciences?  
Yes (1) No (0)

Do not give answers to individual questions but rather a total of your three answers.

- |  |              |
|--|--------------|
| If the number on your cork was 1, give a total for questions 1, 2, 4 | Answer _____ |
| If number was 2, give total for 2, 3, 5                              | Answer _____ |
| If number was 3, give total for 3, 4, 6                              | Answer _____ |
| If number was 4, give total for 4, 5, 7                              | Answer _____ |
| If number was 5, give total for 5, 6, 1                              | Answer _____ |
| If number was 6, give total for 6, 7, 2                              | Answer _____ |
| If number was 7, give total for 7, 1, 3                              | Answer _____ |

Now fold this page in half and place in the box provided. This is to insure that your answers remain anonymous.

Appendix C -- Original data from 84 interviews.

Randomized Response (I) -- Number of people answering either "Yes" or "No" for each question in each  $S_j$ .

Question	I.1		I.2			
	Yes	No	Yes	No		
$S_1$	1	2	1	2	2	1
	2	0	3	1	2	2
	3	3	0	2	1	1
	4	1	2	1	2	2
	5	1	2	1	2	2
	6	2	1	1	2	2
	7	1	2	2	1	1
$S_2$	1	2	1	2	2	1
	2	0	3	2	1	1
	3	2	1	3	0	0
	4	1	2	0	3	3
	6	1	2	2	1	1
	7	2	1	3	0	0
	$S_3$	1	3	0	2	1
2		0	3	0	3	3
3		3	0	2	1	1
4		1	2	1	2	2
5		0	3	0	3	3
6		0	3	0	3	3
7		2	1	2	1	1
$S_4$	1	1	2	2	1	1
	2	0	3	1	2	2
	3	3	0	2	1	1
	4	0	3	1	2	2
	5	1	2	3	0	0
	6	1	2	2	1	1
	7	2	1	2	1	1
$S_5$	1	3	0	3	0	0
	2	1	2	1	2	2
	3	2	1	2	1	1
	4	0	3	1	2	2
	5	1	2	1	2	2
	6	1	2	1	2	2
	7	0	3	3	0	0
$S_6$	1	1	2	2	1	1
	2	2	1	0	3	3
	3	2	1	2	1	1
	4	0	3	0	3	3
	5	1	2	0	3	3
	6	1	2	1	2	2
	7	2	1	2	1	1

Block Total Response (II) and Randomized Form of Block Total (III) -- Total responses for each  $T_i$  in each  $S_j$  and in each set of  $N = 42$ .

		II.1	II.2	III.1	III.2
S <sub>1</sub>	T <sub>1</sub>	4	5	4	3
	T <sub>2</sub>	3	5	4	5
	T <sub>3</sub>	6	5	6	5
	T <sub>4</sub>	2	0	0	1
	T <sub>5</sub>	6	7	7	5
	T <sub>6</sub>	6	6	5	5
	T <sub>7</sub>	5	4	5	5
	ΣT	32	32	31	29
S <sub>2</sub>	T <sub>1</sub>	4	4	2	4
	T <sub>2</sub>	4	5	3	4
	T <sub>3</sub>	5	6	6	5
	T <sub>4</sub>	3	2	3	2
	T <sub>5</sub>	6	7	5	6
	T <sub>6</sub>	5	6	6	5
	T <sub>7</sub>	4	5	5	5
	ΣT	31	35	30	31
S <sub>3</sub>	T <sub>1</sub>	4	4	5	2
	T <sub>2</sub>	3	3	3	5
	T <sub>3</sub>	6	6	5	6
	T <sub>4</sub>	2	2	3	2
	T <sub>5</sub>	7	6	7	5
	T <sub>6</sub>	6	5	5	5
	T <sub>7</sub>	5	4	4	5
	ΣT	33	30	32	30
S <sub>4</sub>	T <sub>1</sub>	4	5	3	5
	T <sub>2</sub>	2	4	4	4
	T <sub>3</sub>	5	5	5	6
	T <sub>4</sub>	2	3	1	2
	T <sub>5</sub>	7	6	7	6
	T <sub>6</sub>	6	6	7	5
	T <sub>7</sub>	5	4	5	5
	ΣT	31	33	32	33
S <sub>5</sub>	T <sub>1</sub>	4	4	4	3
	T <sub>2</sub>	2	4	4	2
	T <sub>3</sub>	4	5	5	6
	T <sub>4</sub>	1	3	1	2
	T <sub>5</sub>	6	7	6	7
	T <sub>6</sub>	6	5	6	6
	T <sub>7</sub>	5	4	5	3
	ΣT	28	32	31	29
S <sub>6</sub>	T <sub>1</sub>	5	4	3	4
	T <sub>2</sub>	4	4	3	3
	T <sub>3</sub>	6	6	5	5
	T <sub>4</sub>	2	0	3	1
	T <sub>5</sub>	6	6	7	7
	T <sub>6</sub>	5	5	5	5
	T <sub>7</sub>	5	5	5	5
	ΣT	33	30	31	30