Sensitive Questions in Online Surveys: Experimental Results for the Randomized Response Technique (RRT) and the Unmatched Count Technique (UCT)

Elisabeth Coutts Ben Jann

ETH Zürich

Priority Programme on Survey Methodology (PPSM) Meeting

Kassel, September 25–26, 2008

Outline

- Introduction
  - Sensitive Questions in Survey Research
  - Two Techniques: RRT and UCT
  - Our Study
- Method
  - Measurement Techniques
  - The Sensitive Questions
  - Data Collection
- Results
  - Quality Measures
  - Prevalence Estimates
- Conclusions

Sensitive Questions in Survey Research

- Sensitive questions: questions pertaining to private, socially frowned upon or illegal behavior.
- Gaining valid answers to sensitive questions is difficult. People typically underreport sensitive behavior (while overreporting socially desirable behaviors).
- Various techniques have been developed to guarantee anonymity and minimize the respondent's feelings of jeopardy, so that more honest answers can be expected.
- Two such techniques are the randomized response technique (RRT) and the unmatched count technique (UCT; also called item count technique, unmatched block design, or block total response).

The Randomized Response Technique (RRT)

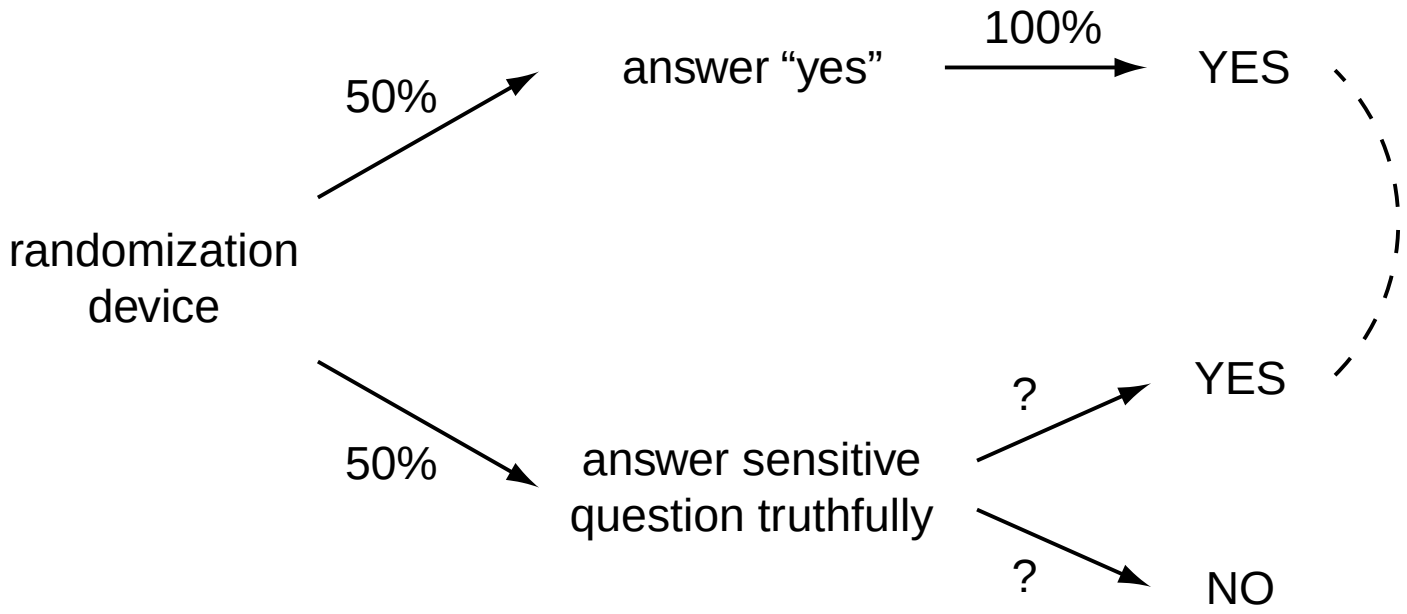
(Warner 1965; also see, e.g., Fox and Tracy 1986)

- Basic idea: anonymity through randomization.
- Depending on the outcome of a randomization device (e.g. roll a dice), the respondent has to answer the sensitive question or give an automatic "yes" or "no" answer (or answer an unthreatening question of which the distribution is known).
- Since only the respondent knows the outcome of the randomization device, a "yes" answer cannot be interpreted as an admission of guilt.
- However, the proportion of the sample that has engaged in the behavior of interest can be calculated with knowledge of the properties of the randomizing device.

The Randomized Response Technique (RRT)

(Warner 1965; also see, e.g., Fox and Tracy 1986)

- Example (forced-response design): Toss a coin and, if heads, answer the sensitive question, else answer "yes".



$$\widehat{\text{prevalence}} = \frac{\text{observed yes} - E(\text{automatic yes})}{E(\text{sensitive question})} = \frac{\text{observed yes} - 0.5N}{0.5N}$$

- Critical assumption: Respondents closely follow the instructions.

The Unmatched Count Technique (UCT)

(see, e.g., Dalton et al. 1994, Raghavarao and Federer 1979)

- Given a list of statements, respondents report how many of them are true, but not which ones. For some respondents the list contains the sensitive item, for others not (randomized).
- Example: "How many of the following statements apply to you?"

Group A (short list)	Group B (long list)
I have a cat.	I have a cat.
I have blue eyes.	I have blue eyes.
I like country music.	I like country music.
	I use drugs.

- Prevalence estimate = mean difference
- Advantage: Requires no randomization device.
- BTW: Analysis of effects of covariates on prevalence is possible for both RRT and UCT.

Our Study

- Many open issues about the use of RRTs in self-administered modes (and computer-assisted modes in particular).
- Our study is an exploration of the effectiveness of different implementations of RRT in the setting of an online survey.
- We also compare the use of the RRT to that of the UCT.

Measurement Techniques in our Study

1. Direct questioning (DQ).
2. Five variants of the randomized response technique (RRT).
   - All variants employ a forced-response design (answer truthfully or simply say "yes" depending on the outcome of the randomization device).
   - Different randomization devices.
3. Unmatched count technique (UCT).

The Five RRT Variants

1. Manual coin toss: Respondents were instructed to get a coin, toss the coin six times, and note the results on a sheet of paper.
2. Electronic coin toss: A "Toss Coin" button was displayed next to each of the sensitive questions.
3. Banknotes: Respondents were instructed to get two Euro bills and write down the last three digits of their serial numbers.
4. Phone numbers: Respondents were instructed write down the last three digits of two telephone numbers of their choice.
5. Banknotes or phone numbers: Similar to (3), but with the option to use telephone numbers if no banknote were available.

- With all variants but the second, the random numbers had to be generated before seeing the questions.

The Sensitive Questions

1. Keeping too much change: "Have you ever received too much change and knowingly kept it?"
2. Freeriding: "Have you ever knowingly used public transportation without buying a ticket?"
3. Shoplifting: "Have you ever deliberately taken an article from a store without paying for it?"
4. Marihuana use: "Have you used marihuana in the past month?"
5. Driving under influence (DUI): "Have you ever driven a car although your blood alcohol was almost certainly over the legal limit?"
6. Infidelity: "Have you ever cheated on your partner?"

Data Collection I

- Online survey implemented using the Unipark platform by Globalpark GmbH.
- Respondents recruited from the German "Sozioland" access panel by Respondi AG ($N = 2075$).
- Data collection: August/September 2007
- Compared to the general population, female respondents are overrepresented and the respondents are relatively young and well educated.
- Questionnaire structure: (1) basic demographic questions, (2) living conditions and neighborhoods, (3) item battery measuring personality trait, (4) sensitive questions, (5) attitudes towards the sensitive behaviors, (6) perception of the used technique (RRT/UCT).

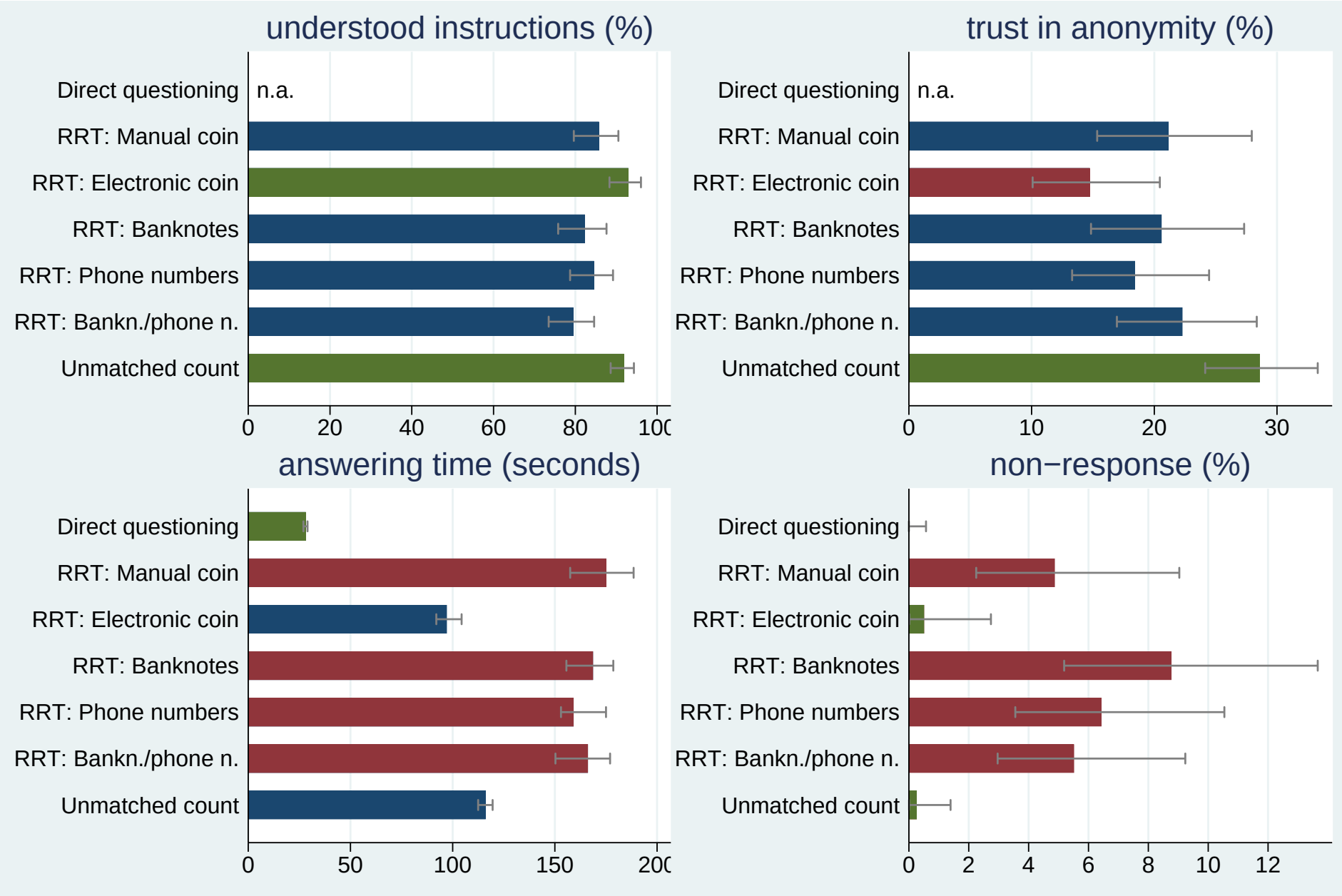
Data Collection II

- Respondents were randomly assigned to one of ten experimental groups

Group	Count	Percent
Direct questioning 1	193	9.30
Direct questioning 2	232	11.18
Direct questioning 3	218	10.51
RRT: Manual coin toss	185	8.92
RRT: Electronic coin toss	201	9.69
RRT: Banknotes	194	9.35
RRT: Phone numbers	218	10.51
RRT: Banknotes or phone numbers	236	11.37
Unmatched count 1	210	10.12
Unmatched count 2	188	9.06
Total	2075	100.00

Results

Quality Measures for the Different Techniques



Quality Measures for the Different Techniques

Experimental condition	N	Understood (in %)	Trust (in %)	Time (in sec.)	Non-response (in %)
Direct questioning	643	n.a.	n.a.	28	0.0
RRT: Manual coin	185	85.7	21.1	175	4.9
RRT: Electronic coin	201	92.9	14.7	97	0.5
RRT: Banknotes	194	82.3	20.6	169	8.8
RRT: Phone numbers	218	84.5	18.4	159	6.4
RRT: Bankn./phone n.	236	79.5	22.3	166	5.5
Unmatched count	398	91.8	28.6	116	0.3

Understood: completely understood the instructions
Trust: believes that the technique guaranteed the anonymity
Time: total time spent answering the sensitive questions (median)
Non-response: did not answer any of the sensitive questions

Quality Measures: Summary

- The manual RRTs (manual coin toss, banknotes, and telephone numbers) were problematic with respect to several domains. Many respondents did not understand the procedures and both answer times and levels of non-response were considerable.
- The electronic coin toss RRT, although easier to use and better understood by the respondents, is problematic because it induces less trust.
- The unmatched count technique (UCT), however, performed well compared to the RRTs on all of these measures.

Prevalence Estimates (Std. Err. in Parentheses)

	Keeping too much change	Free-riding	Shop-lifting	Mari-huana use	DUI	Infi-delity
Direct questioning	56.1 (2.0)	61.8 (1.9)	23.4 (1.7)	4.7 (0.8)	29.0 (1.8)	26.2 (1.7)
RRT	58.3 (2.6)	56.7 (2.6)	9.2 (3.2)	-31.1 (3.1)	1.9 (3.2)	4.4 (3.2)
RRT: Electronic coin	59.0 (5.7)	67.8 (5.2)	22.0 (6.9)	-7.0 (7.1)	8.0 (7.0)	20.0 (6.9)
Unmatched count	43.5 (11.1)	76.5 (10.1)	17.5 (10.3)	32.5 (11.3)	19.0 (9.3)	35.9 (9.1)
Question sensitivity	20.4	22.0	79.2	42.6	52.7	72.8
RRT: "false no"	0.0	5.1	14.2	35.7	27.0	21.8

Sensitivity: proportions of respondents who think that the behavior is not alright and that admitting it would be uncomfortable for most.
"false no": Estimated proportion of respondents who answered "no" although they were instructed to give an automatic "yes".

Prevalence Estimates: Summary

- The RRT estimates seem unreliable due to strong false "no" biases. Apparently, many respondents were reluctant to give an automatic "yes" answer.
- Interestingly, the electronic coin toss RRT seems to be the least biased. Possibly, the thought that the electronic coin flips could be recorded disciplined the respondents to follow the instructions.
- The unmatched count technique (UCT) provides more reasonable estimates.
- However, standard errors are high for the UCT.

Conclusions

- The UCT is a promising alternative to RRT in self-administered surveys (also see the results by Tsuchiya et al. 2007). It was superior to the (forced-response) RRT in our study along several dimensions.
  - Easier to understand, higher trust rates.
  - Shorter response times, less non-response.
  - UCT does not suffer from the negative biases observed for RRT.
- Respondents are reluctant to give an automatic "yes" answer. This is a strong argument against the forced-response RRT in self-administered settings.

Follow-up study

- How does the unrelated question RRT perform?
- None of the randomization devices worked very well in the online setting. Alternatives?
- How to improve efficiency of UCT?
- Explore alternatives to RRT and UCT (e.g. the "triangular model" by Yu et al. 2008).

Proportion of False "No" Answers: Estimation I

The expected proportion of "yes" answers in the RRT design can be written as

$$\lambda = p \cdot \pi_x + (1 - p)(1 - \gamma)\pi_y$$

where

- p: probability of being directed to the sensitive question ($p = 0.5$ in our design)
- π_x: (unknown) probability of answering "yes" to the sensitive question
- π_y: (known) probability of answering "yes" to the innocuous question ($\pi_y = 1$ in our design)
- γ: probability of cheating (i.e. giving a "no" answer although an automatic "yes" would have been indicated by the procedure)

Proportion of False "No" Answers: Estimation II

If we assume that π_x is at least as high as the observed proportion of "yes" answers using direct questioning, the proportion of cheaters (false "no" answers) in the RRT design can be estimated as

$$\hat{\gamma} \geq 1 - \frac{1}{(1-p)\pi_y}(\hat{\lambda} - p \cdot \hat{\pi}_x^{\mathrm{DQ}})$$

where

- $\hat{\lambda}$ observed proportion of "yes" answers in the RRT design
- $\hat{\pi}_x^{\mathrm{DQ}}$ observed proportion of "yes" answers using direct questioning

Note that the boundary of the above solution is equivalent to the maximum-likelihood estimate for the proportion of cheaters proposed by Clark and Desharnais (1998).

UCT Statements I

- Set 1:
  - I have been to Spain.
  - I have read the book “Perfume”.
  - I have one or more cats as pets.
  - I am an active, playing member of a soccer club.
  - I have received too much change and knowingly kept it at least once.
  - I have a brother.
- Set 2:
  - I have a cell phone.
  - I have more than one sister.
  - I read a newspaper every day or nearly every day.
  - I use an electronic planner to schedule my appointments.
  - I own a digital camera.
  - I have knowingly used public transportation without having a valid ticket at least once

UCT Statements II

- Set 3:
  - I have ordered an item online at least once.
  - I own a dog.
  - I have my own car.
  - My shoe size is larger than $10\frac{1}{2}$.
  - I have lived in another country for longer than a month.
  - I have deliberately taken an article from a store without paying for it at least once
- Set 4:
  - I have been to America.
  - I have one or more children.
  - I drink coffee every morning or nearly every morning.
  - I wear glasses to correct my vision..
  - I have used marijuana in the past month.
  - I have a television set in my bedroom.

UCT Statements III

- Set 5:
  - I work on a computer every day or nearly every day.
  - I am self employed.
  - I live in an apartment building.
  - I can drive a motorcycle.
  - I have driven a car although my blood alcohol was almost certainly over the legal limit at least once.
  - In my free time I go jogging at least once a week.
- Set 6:
  - I have a dishwasher in my kitchen.
  - I go shopping more than once a week.
  - In my free time I listen to music at least once a week.
  - I have cheated on a partner at least once.
  - I eat only vegetarian dishes.
  - In winter I go skiing or snowboarding at least once.

References

- Clark, Stephen J., and Robert A. Desharnais (1998). Honest Answers to Embarrassing Questions: Detecting Cheaters in the Randomized Response Model. *Psychological Methods* 3: 160–168.
- Dalton, Dan R., James C. Wimbush, and Catherine M. Daily. 1994. Using the unmatched count technique (UCT) to estimate base rates for sensitive behavior. *Personnel Psychology* 47:817–828.
- Fox, James Alan, and Paul E. Tracy. 1986. *Randomized response: A method for sensitive surveys.* London: Sage
- Raghavarao, Damaraju, and Walter T. Federer. 1979. Block total response as an alternative to the randomized response method in surveys. *Journal of the Royal Statistical Society Series B (Statistical Methodology)* 41:40–45
- Tsuchiya, Takahiro, Yoko Hirai, and Shiguro Ono. 2007. A study of the properties of the item count technique. *Public Opinion Quarterly* 71:253–272.
- Warner, Stanley L. 1965. Randomized-response: A survey technique for eliminating evasive answer bias. *Journal of the American Statistical Association* 60:63–69.
- Yu, Jun-Wu, Guo-Liang Tian, and Man-Lai Tang. 2008. Two new models for survey sampling with sensitive characteristic: design and analysis. *Metrika* 67:251-263.