

# Adaptive Survey Design Development and Evaluation for US PIAAC

Minsun Riddles, Tom Krenzke (Westat), Natalie Shlomo  
(University of Manchester)

6th International Workshop for Advances in Adaptive and Responsive Survey  
Designs Census Bureau  
November 5, 2019

# Outline

Challenge

PIAAC Background

PIAAC ASD Goals

PIAAC ASD Strategies

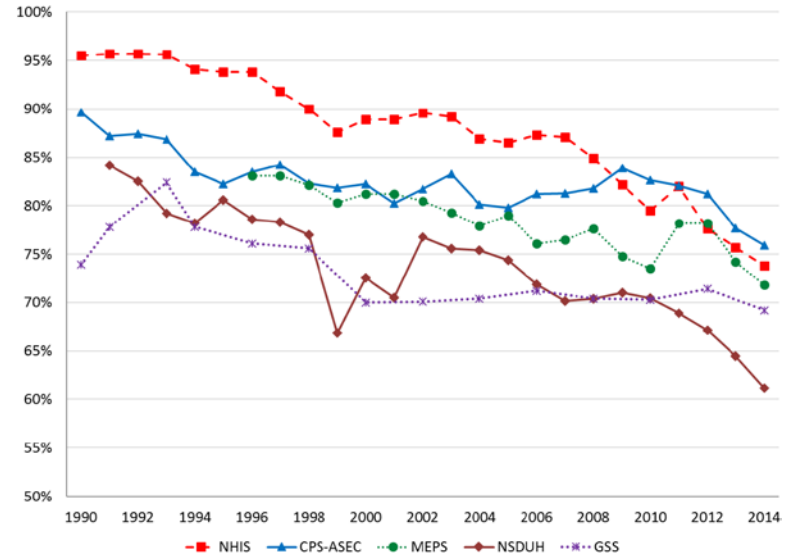
Simulation

Experiment

Summary

# Challenge

- › Declining response rates
  - Susceptibility to higher potential for nonresponse bias
- › Bias is not reduced by continuing to gain completes from the easiest cases
- › Targeting the most difficult cases can be costly and ineffective



(Williams and Brick, 2018)

## PIAAC US 2017 Round 3

- › Program for the International Assessment of Adult Competencies
- › International survey with close to 40 countries participating in Round 1
- › US 2017 sample (sponsored by the National Center for Education Statistics)
  - Non-institutionalized U.S. population of 16 to 74 year olds
  - Nationally representative four-stage area probability sample

PSU	SSU	DU	Person	Completes
80	≈700	8,500+	≈5,000	3,500+

- In-person household survey with 4 data collection instruments
  - Screener, Background Questionnaire (BQ), Assessment

### › **Minimize nonresponse bias** while

- Achieving target sample yield
- Achieving target response rate
- Staying under budget

- › **Sample yield projections** – for timely reaction to potential shortfalls
- › **Sample refreshment** – to increase # of completes without introducing bias at fixed cost
  - Close out very low propensity cases, then release a random group with size that is equal to spending the same expected number of attempts as closed out cases
- › **Subsample** of low priority cases – to reduce efforts on such cases without introducing bias
  - Select 1/3 of low priority cases from among initial released cases
- › **Case prioritization** – to minimize bias subject to constraints
  - More effort and extra postcard to high priority cases

## Case Prioritization: Objective function

### › Minimize nonresponse bias while

- Achieving target sample yield
- Achieving target response rate
- Staying under budget -- Keeping a certain level of contact attempts (CA)

$$\begin{aligned} & \text{Minimize } \left( \frac{\sum_i r_i w_i y_i}{\sum_i r_i w_i} - \bar{Y} \right)^2 \\ & \text{s.t. } \sum_i r_i \geq SY^*, \quad \frac{\sum_i r_i w_i}{\sum_i w_i} \geq RR^*, \quad \text{and } \sum_i c_i \leq C^* \end{aligned}$$

where

$r$ : response indicator,  $w$ : weight,  $y$ : outcome,  $c$ : # CAs

$SY^*$ : target sample yield,  $RR^*$ : response rate goal,

$C^*$ : maximum number of contact attempts allowed

## Case Prioritization: In practice

- › Predict test score for each sampled case,  $\hat{y}_i$
- › Obtain potential influence of open case  $j$  on outcome

$$I_j = \left( \frac{\sum_{\text{Closed}} r_i w_i \hat{y}_i}{\sum_{\text{Closed}} r_i w_i} - \frac{\sum_i w_i \hat{y}_i}{\sum_i w_i} \right)^2 - \left( \frac{\sum_{\text{Closed}} r_i w_i \hat{y}_i + \hat{\rho}_j w_j \hat{y}_j}{\sum_{\text{Closed}} r_i w_i + \hat{\rho}_j w_j} - \frac{\sum_i w_i \hat{y}_i}{\sum_i w_i} \right)^2$$

Monotonically increasing w.r.t.

$$\hat{\rho}_j w_j (\hat{y}_j - \bar{y}_r)(\bar{y}_s - \bar{y}_r),$$

where  $\hat{\rho}_j$  is response propensity,  $\bar{y}_r = \sum_{\text{Closed}} r_i w_i \hat{y}_i / \sum_{\text{Closed}} r_i w_i$  and  $\bar{y}_s = \sum w_i \hat{y}_i / \sum w_i$

- › Prioritize by decreasing  $I_j$



# Case Prioritization Simulation Setting

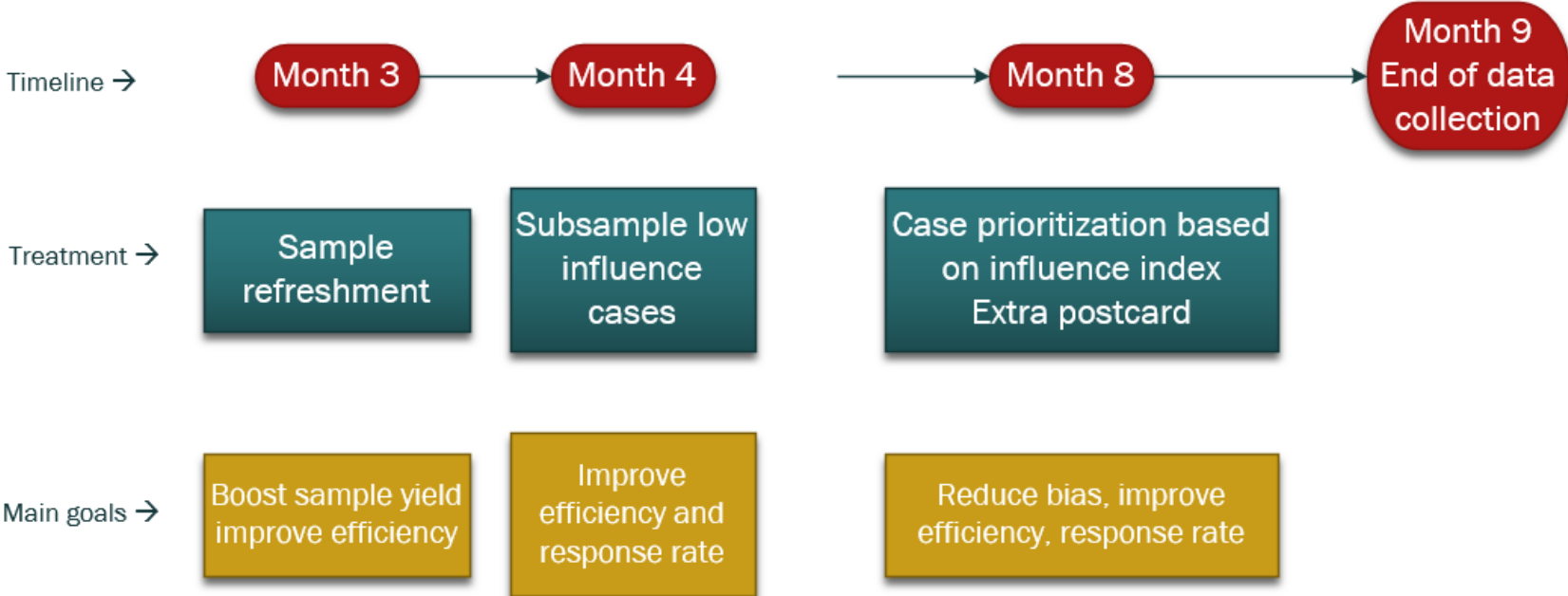
- › 8,488 previous PIAAC US respondents with literacy score
- › 1,000 samples of size 3,500
- › Response mechanism for no prioritization scenario (avg RR = 75%)
  - MAR: race, age, HH size, child in HH, poverty (area), foreign born (area), education (area)
  - NMAR: race, age, HH size, child in HH, poverty (area), foreign born (area), education (area), test score
- › Prioritization at 2.5 months after release
  - Constant (C) no prioritization
  - Low response propensity cases (LR)
  - High influence cases (HI)

# Case Prioritization Simulation Results

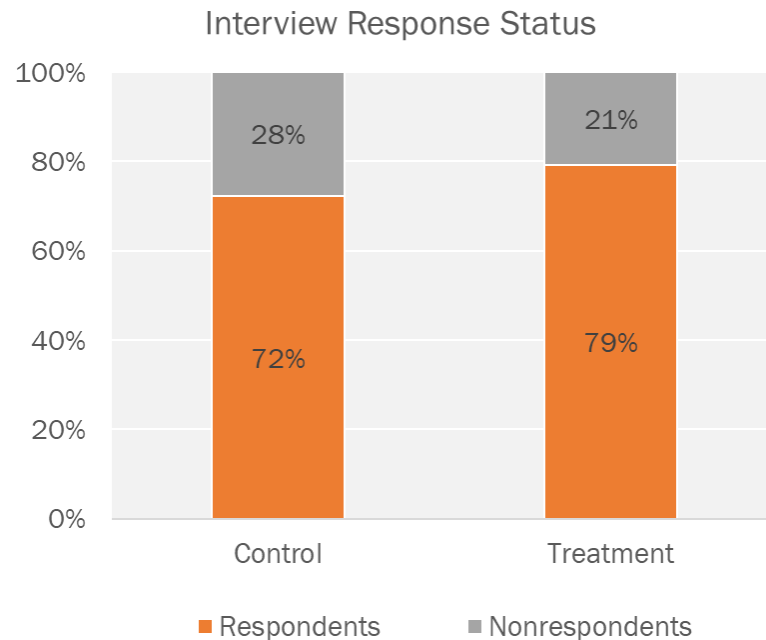
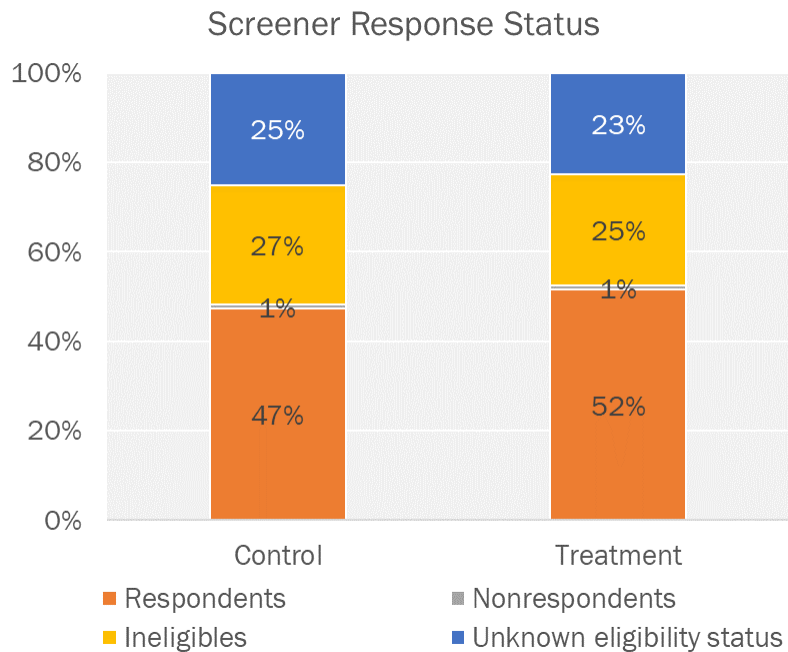
Response Mechanism	Prioritization	Bias	Std Error	MSE	Overall response rate
MAR	C	-1.285	0.552	1.956	75%
	LR	-0.800	0.405	0.804	78%
	HI	-0.515	0.378	0.408	77%
Not MAR	C	-2.465	0.514	6.342	76%
	LR	-2.527	0.368	6.519	77%
	HI	-0.851	0.351	0.840	79%

- › Randomly split selected areas into control and treatment groups, where assignment was based on
  - SSUs for certainty PSUs
  - PSUs for noncertainty PSUs
- › There were about 1,800 respondents in each group
  - Control group – standard contact protocols were used
  - Treatment group...

# Timeline for Treatments and Their Goals

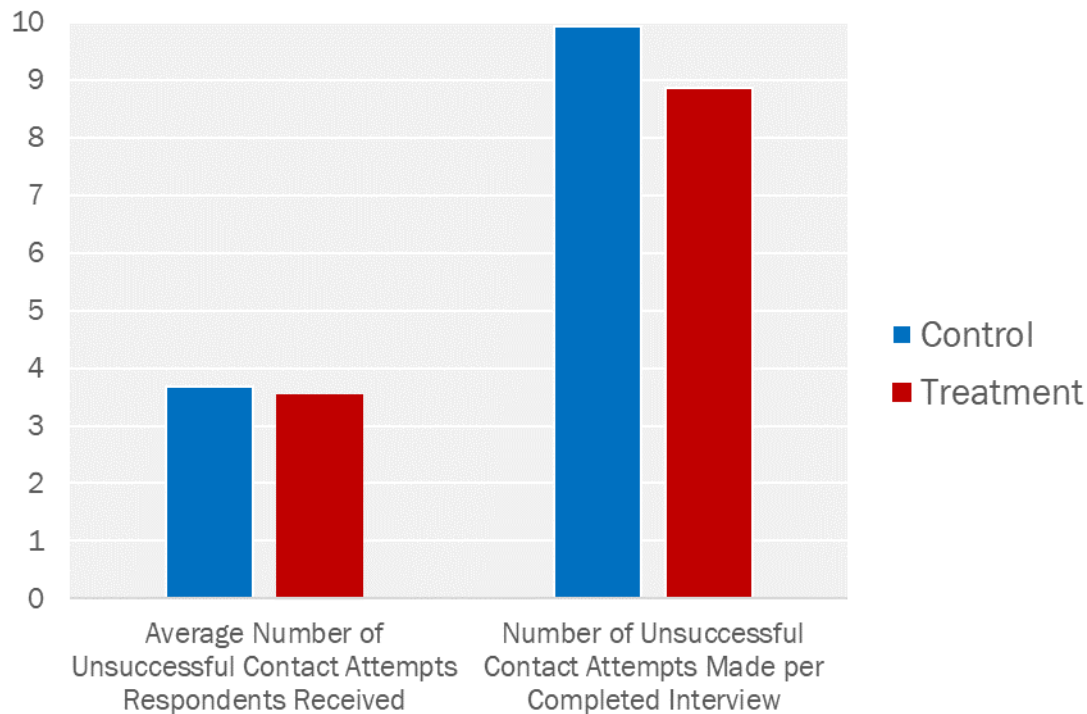


# Indication of Positive Response Status



# Indication of Improved Efficiency/Productivity

## Unsuccessful contact attempts by group



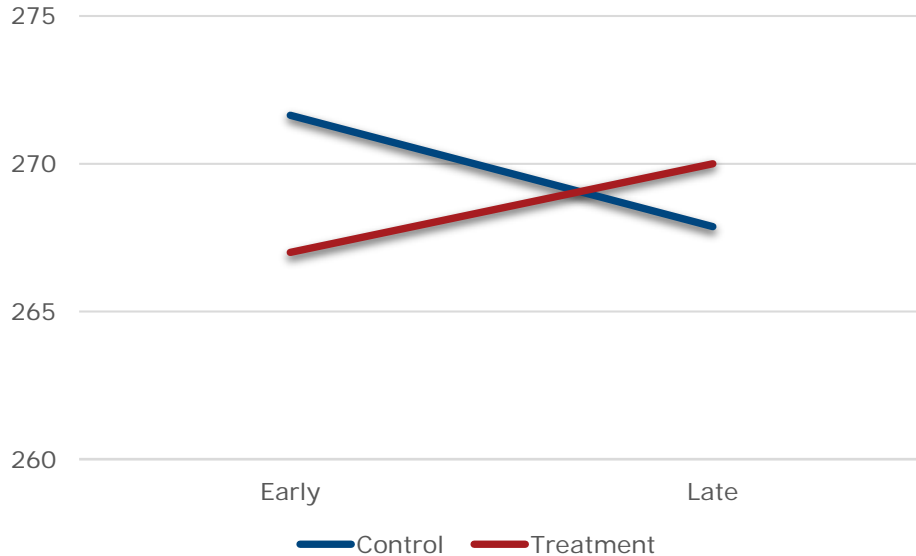
About 1 fewer  
unsuccessful attempt  
per completed interview

Potential for saving about  
3,600 attempts in PIAAC

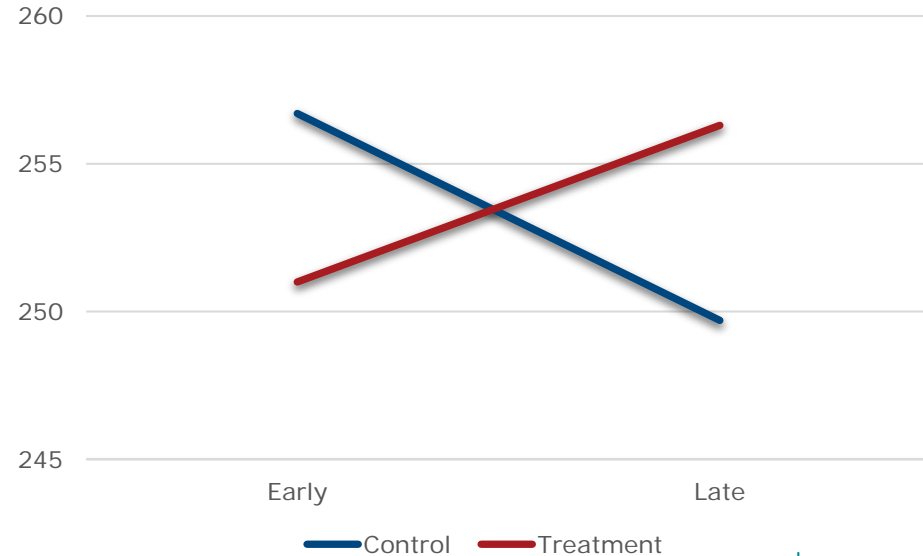
# Indication of Potential for Reduced Bias

## › Interaction of Group and Timing of Response

Literacy (p-value = 0.08)



Numeracy (p-value < 0.05)



## Summary

- › Addressing more challenging data collection environment by
  - Timely monitoring
  - Strategies tailored/optimized for goals
- › Tested potential through a simulation study
- › Evaluated through an experiment
- › Implementation in the next cycle



# Thank You