

Online Appendix for:

Assessing (In)accuracy and Cognitive Biases in Self-reported Measure of Exposure to Disagreement: Evidence from Digital Trace Data

1. Timeline of data collection

The first wave of the panel survey was administered between Nov 27th to Nov 29th, 2012, which was shortly after the beginning of the study. The second wave of the panel survey was administered between Dec 11th to Dec 13th, 2012. Based on the starting date of the second survey, we take the log data between Nov 27th to Dec 10th as the Wave 1 exposure (i.e., behavioral measure), and compare this against the self-reported exposure measured at the second wave of the study. We again follow this approach for the third wave, yet the digital log data were recorded only until the Dec 19th, therefore the Wave 2 exposure is based on log data between Dec 7th (two weeks prior to the 3rd survey) to Dec 19th.

Panel Survey	W1			W2		W3
Log data	Wave 1 Exposure (vs. W2 self-report)					
Log data			Wave 2 Exposure (vs. W3 self-report)			
	November 2012	1	6	11	16	21
		December 2012				

Figure A1. Timeline of data collection.

2. Measurement details

Candidate support

1 = favors the liberal candidate, Moon vs. 0 = favors the conservative candidate, Park

(Wave 1 = 58.06%, Wave 2 = 68.03%, Wave 3 = 62.75%, based on liberal candidate support)

Self-reported measures of exposure to disagreement

What percentage of posts (out of 100%) you have read during the last two weeks in this forum can be classified as conservative vs. moderate vs. liberal in your opinion?

(Wave 2: M = .58, SD = .21, range = 0 to 1; Wave 3: M = .59, SD = .21, range = 0 to 1)

Social desirability: Normative indorsement for disagreement (5 items, 7-point scale)

Those who oppose my opinion also have the right to participate in discussions.

It is worth reading the opposite opinion.

There is also something to be considered, even if someone's opinion is different from mine.

We must respect the other participants who hold different opinions.

I respect the opinion of others and treat them appropriately.

(Wave 2: $\alpha = .89$, $M = 5.59$, $SD = .90$; Wave 3: $\alpha = .89$, $M = 5.60$, $SD = .93$)

Social desirability: Need for social approval (3 items, 7-point scale)

I am disappointed if others do not accept my arguments.

I feel ashamed when others do not accept my opinion.

I am sensitive to the evaluation of others on my writings in this forum.

(W2: $\alpha = .87$, $M = 3.86$, $SD = 1.30$; W3: $\alpha = .87$, $M = 3.82$, $SD = 1.28$)

Political interest (2 items, 7-point scale)

I am always interested in politics.

I often look for the latest articles and information about politics.

(W2: Spearman-Brown = .94, $M = 5.05$, $SD = 1.05$; W3: SB = .95, $M = 5.03$, $SD = 1.05$)

Political knowledge (10 items, 1 = "correct" vs. 0 = "incorrect/DK")

Which election is going to be held in December 19th, 2012?

Which of the following pairs of presidential candidates – their endorser is wrong?

Which of the following is not the campaign pledges made by the candidate Park?

Which of the following is not the organizations/institutions the candidate Moon had taken part before?

What is the title of the presidential election campaign announced by the candidate Ahn?

Which of the following is true for the opening time of voting ballot places under the current law?

What is the sum of the term of a president and the term of a member of Parliament?

Who is the current Majority leader in the Parliament?

Who is the current Minority leader in the Parliament?

How many MPs are there in South Korea?

(only measured at once at the beginning of the survey, $M = 5.74$, $SD = 2.15$)

Opinion Climate Perception (single-item, 7-point scale)

Within the forum, my opinion is largely in agreement with the majority opinion.

(W2: $M = 4.41$, $SD = 1.15$; W3: $M = 4.48$, $SD = 1.27$)

Demographics

Gender (0 = male, 1 = female; 48% female)

Age (in years, $M = 35.72$, $SD = 9.86$)

Education (1 = "less than elementary, to 9 = "post-graduate or more", $M = 7.68$, $SD = 1.04$)

Household Income (per month, 1 = "less than 1000" to 8 = "more than 7000", $M = 4.99$, $SD = 1.88$)

Media Exposure

Ideology strengths

3. Detailed results reported in the main manuscript

Table A1. The full results of Table 2 in the main manuscript, predicting reporting inaccuracy.

	OLS W2	GLM W2	OLS W3	GLM W3
<u>Social desirability</u>				
Discussion norm W2/W3	.016 [-.012; .044]	.379 [-.023; .835]	.017 [-.012; .047]	.234 [-.059; .582]
Need for social approval W2/W3	-.003 [-.019; .014]	-.084 [-.370; .176]	-.017 [-.037; .005]	-.076 [-.320; .157]
<u>Cognitive burdens</u>				
Interest W2/W3	.019 [-.002; .040]	.066 [-.256; .417]	.007 [-.019; .034]	.017 [-.279; .317]
Knowledge	-.003 [-.013; .008]	.041 [-.103; .197]	.002 [-.009; .013]	.123 [-.005; .275]
<u>Opinion Climates</u>				
Perceived Opinion Climate W2/W3	-.021 [-.042; -.001]*	-.304 [-.645; -.033]*	-.031 [-.052; -.009]*	-.284 [-.585; -.021]*
<u>Controls</u>				
Candidate preference W2/W3	.283 [.234; .331]*	2.108 [1.552; 2.991]*	.113 [.060; .165]*	.642 [-.012; 1.330]
Ideology Strength W2/W3	-.059 [-.085; -.033]*	-.347 [-.739; .001]	-.045 [-.075; -.016]*	-.214 [-.544; .106]
Total Exposure W1/W2 (log)	-.012 [-.029; .005]	-.005 [-.245; .235]	-.015 [-.035; .006]	.024 [-.175; .243]
Media Exposure	.002 [-.011; .014]	-.040 [-.201; .116]	-.000 [-.015; .014]	-.158 [-.329; -.013]*
<u>Demographics</u>				
Age (in years)	.001 [-.001; .003]	.016 [-.013; .050]	.002 [-.001; .004]	.021 [-.008; .054]
Female	-.002 [-.046; .042]	.106 [-.531; .807]	-.013 [-.059; .035]	.105 [-.447; .693]
Education	-.009 [-.031; .015]	.302 [.041; .621]*	-.002 [-.022; .017]	-.052 [-.397; .242]
HH income	.006 [-.006; .018]	-.061 [-.234; .095]	-.006 [-.018; .006]	-.108 [-.271; .042]
R ² /Adj. R ² (or AIC / BIC)	0.340 (0.313)	339.957 / 393.604	0.127 (0.093)	387.246 / 440.892
Log Likelihood / Deviance		-155.979 / 311.957		-179.623 / 359.246

Note: * = 0 outside the 95% percentile confidence interval based on 10000 bootstrapped replications.

Table A2. Predictors of perceived exposure to disagreement (in self-reported measure) as a function of social desirability bias, cognitive burden, and public opinion perception, controlling for the actual exposure to disagreement ($N = 341$).

	Perceived Exp to Dis W2	Perceived Exp to Dis W3
<u>Actual Exposure</u>		
Actual Exp to Dis (in %) W1/W2	.059 [-.157; .283]	-.096 [-.257; .051]
<u>Social desirability</u>		
Discussion norm W2/W3	.014 [-.012; .039]	.025 [.001; .048]*
Need for socl approval W2/W3	-.007 [-.022; .008]	-.013 [-.029; .004]
<u>Cognitive burden</u>		
Interest W2/W3	.015 [-.005; .034]	.005 [-.014; .024]
Knowledge	-.002 [-.011; .007]	.004 [-.005; .013]
<u>Opinion Climate</u>		
Prvcd Op Climate W2/W3	-.023 [-.041; -.005]*	-.027 [-.045; -.008]*
<u>Controls</u>		
Candidate pref W2/W3	-.164 [-.278; -.050]*	-.251 [-.324; -.187]*
Ideo Strength W2/W3	-.044 [-.068; -.021]*	-.033 [-.056; -.010]*
Total Exp W1/W2 (log)	-.013 [-.028; .003]	-.003 [-.015; .010]
Media Exposure	-.001 [-.012; .009]	-.000 [-.012; .011]
<u>Demographics</u>		
Age (in years)	.001 [-.001; .003]	.001 [-.001; .003]
Female	.003 [-.037; .042]	-.023 [-.062; .017]
Education	-.005 [-.025; .017]	-.008 [-.027; .009]
HH income	.004 [-.006; .015]	-.004 [-.014; .005]
R ²	0.302	0.405
Adj. R ²	0.272	0.379
Num. obs.	341	341
RMSE	0.177	0.167

Note: * = 0 outside the 95% percentile confidence interval based on 10000 bootstrapped replications outside the confidence interval.

In Table A2, we directly predict the perceived exposure to disagreement controlling the actual exposure. Results show that a favorable opinion climate perception (i.e., perceiving one's opinion to be more in line with the overall opinion) makes an individual to less likely to report the perceived disagreement independent of actual exposure, therefore being more "accurate" in terms of discrepancy between actual exposure and perceived exposure to disagreement.

Table A3. Predictors of inaccuracy in self-reported exposure to disagreement, when the three most recent days are used as a benchmark against the self-reported measures ($N = 341$).

	OLS W2	OLS W2 RECENT	OLS W3	OLS W3 RECENT
<u>Social desirability</u>				
Discussion norm W2/W3	.016 [-.012; .044]	.025 [-.006; .056]	.017 [-.013; .047]	.020 [-.013; .052]
Need for social approval W2/W3	-.003 [-.019; .014]	.005 [-.012; .023]	-.017 [-.037; .005]	-.011 [-.031; .011]
<u>Cognitive burdens</u>				
Interest W2/W3	.019 [-.002; .040]	.018 [-.004; .041]	.007 [-.019; .034]	-.004 [-.030; .023]
Knowledge	-.003 [-.013; .008]	-.003 [-.015; .008]	.002 [-.009; .013]	.002 [-.010; .014]
<u>Opinion Climates</u>				
Perceived Opinion Climate W2/W3	-.021 [-.042; -.001]*	-.023 [-.046; -.001]*	-.031 [-.052; -.008]*	-.033 [-.055; -.010]*
<u>Controls</u>				
Candidate preference W2/W3	.283 [.234; .331]*	.251 [.196; .306]*	.113 [.060; .167]*	.161 [.107; .214]*
Ideology Strength W2/W3	-.059 [-.085; -.033]*	-.064 [-.092; -.036]*	-.045 [-.074; -.016]*	-.044 [-.074; -.015]*
Total Exposure W1/W2 (log)	-.012 [-.029; .005]	-.016 [-.039; .006]	-.015 [-.035; .006]	.005 [-.016; .025]
Media Exposure	.002 [-.011; .014]	-.001 [-.017; .012]	-.000 [-.015; .014]	-.002 [-.016; .009]
<u>Demographics</u>				
Age (in years)	.001 [-.001; .003]	.002 [-.001; .004]	.002 [-.001; .004]	.001 [-.002; .003]
Female	-.002 [-.046; .042]	-.003 [-.051; .044]	-.013 [-.059; .035]	-.011 [-.061; .039]
Education	-.009 [-.031; .015]	-.002 [-.026; .023]	-.002 [-.023; .017]	-.006 [-.028; .016]
HH income	.006 [-.006; .018]	.002 [-.011; .015]	-.006 [-.018; .006]	-.007 [-.020; .006]
R ²	0.340 (0.313)	0.263 (0.234)	0.127 (0.093)	0.154 (0.120)
RMSE	0.196	0.218	0.207	0.216

Note: * = 0 outside the 95% percentile confidence interval based on 10000 bootstrapped replications outside the confidence interval.

** For RECENT columns, DV is the actual exposure during three most recent days *minus* reported exposure to disagreement.

Table A4. Lagged DV regression models predicting attitude certainty as a function of exposure to disagreement, $N = 320$ (Table 4 in the main manuscript).

	Preference Certainty W3	
<u>Lagged DV</u>		
Preference Certainty W2	.517 (.046) ^{***}	.523 (.046) ^{***}
<u>Focal predictor</u>		
Exposure to Disagreement (Self-report)	-.520 (.266)	
Exposure to Disagreement (Behavioral)		-.769 (.340) [*]
<u>Correlates</u>		
Total Exposure W2 (log)	.009 (.035)	.015 (.035)
Candidate preference W2	-.198 (.118)	-.301 (.140) [*]
Interest W2	-.007 (.052)	.006 (.052)
Knowledge	.059 (.025) [*]	.056 (.025) [*]
Ideological Strength	.074 (.060)	.077 (.060)
Efficacy	.091 (.044) [*]	.083 (.044)
Media Exposure	-.011 (.029)	-.009 (.029)
<u>Demographics</u>		
Age (in years)	-.007 (.005)	-.008 (.005)
Female	.175 (.099)	.185 (.098)
Education	.066 (.053)	.063 (.053)
HH income	-.015 (.028)	-.013 (.028)
Intercept	2.193 (.575) ^{***}	2.273 (.575) ^{***}
R ²	0.412	0.414
Adj. R ²	0.387	0.389
Num. obs.	320	320
RMSE	0.858	0.856

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

4. Detailed setups for Monte Carlo Simulations

Data Generation Stage

In this stage of simulation, we first simulate the data frame of size $N = (341, 1000, 5000)$ conditional on observed means, standard deviations, and a correlation matrix of all independent variables in the Table 4 in the main manuscript (including both of the exposure to disagreement variables). During this stage, we systematically vary the zero-order correlation between two measures of disagreement ($r =$ from 0.00 to 0.95 by 0.05 interval, so 20 zero-order correlations to be evaluated), yet residual correlations of two exposure

variables with other covariates were kept constant as to our observed data. This effectively enable us to simulate the dataset we can observe hypothetical, counterfactual scenarios within which the correlation of two “exposure to disagreement” variables systematically vary across range of plausible values. Based on a given sample size and a covariance matrix (that is converted from the modified correlation matrix), the “new” data frame that contains all independent variables were randomly sampled from the multivariate normal distribution, using *nvrnorm* function in R (from the MASS library).

Based on the simulated “new” data frame, then we further simulate (or newly “predict”) our focal dependent variable, *candidate preference certainty* at Wave 3, based on the regression coefficients of the model involving behavioral exposure measurement as in Table 4 of the main ms,¹ but using the newly simulated observations for values of independent variables. Once we “predict” the dependent variable conditional on the model and the new data, we then added a Gaussian random noise to each of the dependent variable observation, which ensured that each simulation run is not completely deterministic. This effectively creates new dataset that reflects the (revised) covariational structure yet with a sufficient randomness in data generating process.

Prediction Stage

Given above simulated data and dependent variable observations, we re-fit the two regression models (as reported in Table 4 in the main ms.) on this simulated data. We expect that the regression coefficients of the behavioral exposure measure in these re-fitted regressions on the simulated data would on average converge to the original correlation coefficient, since, effectively, the simulated dependent variable is regressed to the very same model that has generated the dependent variable itself. However, the regression coefficient for the self-reported exposure measure would be systematically affected by the revised correlational structure behind the simulated data, therefore we can observe how the regression coefficient of self-reported exposure measure would behave under different correlational structure assumed in the data generation stage.

Having re-fitted the regression models on the simulated data, we compare two (newly created) unstandardized coefficients of “exposure to disagreement” variables (one based on the self-reported vs. the other based on the behavioral benchmark), and observe (1) their relative size (i.e., the ratio of two coefficients), (2) their absolute bias (i.e., the absolute difference of two coefficients), and (3) whether the statistical significance of two coefficients agree with each other. In determining statistical significance, we assumed $\alpha = .05$ level for scenarios with $N = 341$, $\alpha = .01$ level for scenarios with $N = 1000$, and $\alpha = .001$ level for scenarios $N = 5000$ (which is determined by a priori MC power simulation).

¹ Therefore, for the data generating process of DV, we assumed that the regression model reported in Table 4 in the main manuscript – especially the one involving behavioral measure of exposure to disagreement – would reflects the true model specification generating candidate preference certainty.

5. Using alternative behavioral benchmark and public opinion perception measurement

Here, we perform several robustness checks regarding our measurements of behavioral benchmark and public opinion perception measurement. First, we replicate our main results reported in Table 2 (using OLS models) based on the alternative behavioral benchmark (i.e., mean of daily average proportion). Second, we employ alternative measure of public opinion perception.

First, in our main manuscript, we have referred another construction of behavioral benchmark measure based on average of daily proportions (i.e., a daily proportions of disagreement exposure per day, and daily proportions for 14 days were then averaged, W1: $M = .22$, $SD = .17$; W2: $M = .24$, $SD = .15$). Using this alternative benchmark as a comparison, the first two columns of below Table A5 replicates the main findings in Table 2 of the main manuscript.

Second, we employ another measure of one's public opinion perception based on more direct measure of perceived opinion distribution. During our survey, we have also asked "overall what percentage of other participants of the online forum would be in-party vs. out-party supporters" in terms of their political orientations. The alternative measure of perceived opinion climate was thus operationalized as the perceived prevalence of in-party supporters vis-a-vis out-party supporters, again using their reported candidate support at the time of exposure. The measure therefore runs from -100 to +100, but for the ease of interpretation, we rescaled this measure to 0 to 100 range (Wave 2: $M = 56.97$, $SD = 16.43$; Wave 3: $M = 55.40$, $SD = 19.80$), effectively expressing the perceived prevalence of in-party supporters away from even-split (50%) of the opinion climate. The third and the fourth column of below Table A5 uses this alternative measure of public opinion perception (yet using the original DV construction, *not* based on average of daily proportions). Due to the more fine-grained scale used for this construct, the unstandardized coefficient is much smaller than our original results. Yet

Lastly, the last two columns both use alternative behavioral benchmark and public opinion perception measurement instead of their original measurements. All of the results reveal that no matter how we operationalize the key variables, the influence of public opinion perception is extremely stable and consistent.

Table A5. Results of alternative measurements

	Alt DV W2	Alt DV W3	Alt OP W2	Alt OP W3	Alt ALL W2	Alt ALL W3
<u>Social desirability</u>						
Discussion norm W2/W3	.009 [-.019; .036]	.002 [-.024; .028]	.008 [-.018; .036]	.007 [-.021; .036]	.001 [-.025; .028]	.002 [-.024; .028]
Need for socl approval W2/W3	-.004 [-.020; .012]	-.015 [-.032; .002]	-.004 [-.019; .011]	-.019 [-.039; .001]	-.005 [-.021; .010]	-.015 [-.032; .002]
<u>Cognitive burden</u>						
Interest W2/W3	.011 [-.011; .031]	.000 [-.022; .023]	.017 [-.004; .038]	.004 [-.021; .030]	.009 [-.013; .030]	.000 [-.022; .023]
Knowledge	.004 [-.007; .016]	.008 [-.002; .018]	-.006 [-.015; .004]	-.001 [-.011; .010]	.001 [-.009; .012]	.008 [-.002; .018]
<u>Opinion Climate</u>						
Prevcd Op Climate W2/W3	-.020 [-.040; .000]	-.004 [-.005; -.003]*	-.004 [-.005; -.002]*	-.002 [-.003; -.001]*	-.004 [-.005; -.002]*	-.002 [-.003; -.001]*
<u>Controls</u>						
Candidate pref W2/W3	.063 [.010; .117]*	.033 [-.020; .086]	.333 [.283; .383]*	.189 [.126; .253]*	.110 [.054; .167]*	.033 [-.021; .086]
Ideo Strength W2/W3	-.044 [-.071; -.018]*	-.025 [-.050; -.000]*	-.052 [-.077; -.028]*	-.041 [-.069; -.013]*	-.038 [-.064; -.012]*	-.025 [-.050; -.000]*
Total Exp W1/W2 (log)	-.072 [-.089; -.055]*	-.068 [-.081; -.055]*	-.013 [-.029; .002]	-.015 [-.035; .007]	-.073 [-.090; -.058]*	-.068 [-.081; -.054]*
Media Exposure	-.006 [-.019; .006]	-.007 [-.018; .004]	.004 [-.008; .016]	.000 [-.014; .015]	-.004 [-.017; .008]	-.007 [-.018; .004]
<u>Demographics</u>						
Age (in years)	-.000 [-.003; .002]	-.000 [-.003; .002]	.001 [-.001; .003]	.002 [-.000; .004]	-.001 [-.003; .001]	-.000 [-.003; .002]
Female	.021 [-.023; .065]	-.003 [-.044; .039]	.008 [-.033; .049]	-.011 [-.054; .034]	.030 [-.012; .073]	-.003 [-.045; .039]

Education	-.009 [-.034; .017]	-.013 [-.036; .008]	-.010 [-.031; .012]	-.005 [-.025; .015]	-.011 [-.034; .013]	-.013 [-.037; .009]
HH income	.008 [-.004; .020]	-.001 [-.012; .009]	.005 [-.006; .016]	-.006 [-.018; .005]	.007 [-.004; .019]	-.001 [-.011; .009]
R ²	0.251	0.348	0.398	0.184	0.307	0.348
Adj. R ²	0.222	0.322	0.374	0.152	0.279	0.322
Num. obs.	341	341	341	341	341	341
RMSE	0.202	0.184	0.187	0.200	0.194	0.184

* 0 outside the confidence interval based on 10,000 replications.

Note: *Alt DV* = Alternative dependent variable only (using different behavioral benchmark). *Alt OP* = Alternative opinion climate variable only (using different behavioral benchmark). *Alt ALL* = Alternative dependent variable *and* alternative opinion climate variable.