Using Screeners to Measure Respondent Attention on Self-Administered Surveys: Which Items and How Many?

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Abstract

Inattentive respondents introduce noise into data sets, weakening correlations between items and increasing the likelihood of null findings. "Screeners" have been proposed as a way to identify inattentive respondents, but questions remain regarding their implementation. First, what is the optimal number of Screeners for identifying inattentive respondents? Second, what types of Screener questions best capture inattention? In this paper, we address both of these questions. Using item-response theory to aggregate individual Screeners we find that four Screeners are sufficient to identify inattentive respondents. Moreover, two grid and two multiple choice questions work well. Our findings have relevance for applied survey research in political science and other disciplines. Most importantly, our recommendations enable the standardization of Screeners on future surveys.

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1 Introduction

In order to ensure that respondents pay attention on self-administered surveys, researchers frequently use "Screener" questions to identify inattentive respondents (Oppenheimer, Meyvis, and Davidenko, 2009; Berinsky, Margolis, and Sances, 2014; Meade and Craig, 2012). By instructing respondents to select a specific, otherwise atypical response to demonstrate their attention, these questions effectively reveal the proportion of respondents who do not read questions carefully. Using this method, Berinsky, Margolis, and Sances (2014) show that as many as 40% of respondents will fail Screener questions, and that attentive and inattentive individuals respond to the same stimuli in very different ways.[1]

While Screeners hold great potential for identifying inattentive respondents, questions remain regarding their implementation. First, what is the optimal number of Screeners for identifying inattentive respondents? Berinsky, Margolis, and Sances (2014) present evidence that a single Screener measures attention with error, and ultimately argue for an "additive scale based on multiple measures" (747). Thus, multiple questions are needed. However, it is currently unclear just how many questions are necessary – and thus how much survey time researchers should allocate – for a useful scale.

Second, what types of Screener questions best capture inattention? Existing work offers a plethora of potential Screeners that vary both in content – for instance, questions about a respondent's favorite color, current mood, or interest in politics – and form – such as stand-alone questions that instruct respondents to choose a given option or perform a specific task (Oppenheimer, Meyvis, and Davidenko, 2009; Berinsky, Margolis, and Sances, 2016) or attention checks that appear within a grid or among a battery of questions (Kung, Kwok, and Brown, 2017). The dozens of political science articles that have been published since 2014 that use Screeners have employed screeners in an *ad hoc* way, raising concerns about generalizability and replicability.

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[1]While others refer to these sorts of questions as Instructional Manipulation Checks, or IMCs (Openheimer, Meyvis, and Davidenko 2009; Hauser and Schwarz 2015), we will refer to questions that measure attentiveness as Screeners.

In this paper, we examine how to best capture survey attentiveness using a relatively small set of survey questions. We provide general guidance for the kinds of 10-20 minute self-administered Internet surveys now common in political science research. We show it is possible to accurately capture survey attentiveness using only two stand-alone multiple choice Screener questions and two simpler true/false questions within a grid. Moreover, our results highlight that while stand-alone Screeners are well equipped to distinguish between respondents at the top of the attentiveness spectrum, grid Screeners are better able to do so among respondents with low levels of attention. Finally, we make general recommendations for applied researchers interested in using a standard attentiveness scale. Though this advice is primarily aimed at scholars using a 10-20 minute online survey, these guidelines can be adapted to other surveys as well. Our purpose here is to advance a measurement approach to gauge attentiveness reliable in as short a scale as is feasible.

2   Data and Methods

We use the two-parameter item response theory (IRT) model (Clinton, Jackman, and Rivers, 2004; Van der Linden, 2005) to measure respondents' latent attentiveness on surveys.[2] This model characterizes each screener response $y_{ij} \in \{0,1\}$ as a function of subject i's latent *attentiveness* (θ_i), the *difficulty* (α_j) and *discrimination* (β_j) of item j, where

$$\Pr[y_{ij} = 1] = \Phi(\beta_j \theta_i - \alpha_j) \tag{1}$$

where Φ is the standard normal CDF (Jackman, 2009; Fox, 2010). β_j is referred to as the "discrimination" parameter because it captures the degree to which the latent trait affects the probability of a yes answer. If β_j is 0, then question j tells us nothing about the latent

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[2]Following past literature, our IRT model measures attentiveness on a uni-dimensional scale. We evaluated the validity of this model using exploratory factor analysis. We found that there is a clear drop-off in explanatory power between the first principal component and higher-order ones. This suggests that it is reasonable to summarize attentiveness with a single latent trait.

variable being measured. The difficulty parameter, α_j, tells us hard an item is to get right.

While a greater number of screener items facilitate more accurate measures of attentiveness, (Ansolabehere, Rodden, and Snyder, 2008; Berinsky, Margolis, and Sances, 2014), researchers are rarely able to include a large number of screeners in their surveys. In order to evaluate an optimal set of screener items to measure attentiveness, we draw from optimal test theory (van der Linden, 1998; Tausanovitch and Warshaw, 2011; Montgomery and Cutler, 2013). Specifically, we seek to maximize Fisher's Information for a given scale. Under this framework, the contribution of a given item to our level of certainty at a particular value of attentiveness, θ_i, can be determined by evaluating Fisher's Information for the item at that value (Bimbaum, 1968; Van der Linden, 2005):

$$IIF_j(\theta) = \beta_j^2 * p * q \tag{2}$$

where $p = \Phi(\beta_j\theta - \alpha_j)$ and $q = 1 - p$. This is referred to as the Item Information Function (IIF). The Test Information Function (TIF) for a set of items is simply the sum of the individual IIF's (Van der Linden, 2005, 16-17). We use the IIF as means of selecting items, and the TIF as a way of comparing sets of items.

Scholars may want to maximize information across the entire range of attentiveness. Van der Linden (2005) shows that this can be done by maximizing the TIF for a small set of uniformly distributed points in the range of attentiveness, θ. Since the TIF is an additive function of the IIFs, this requires only that we calculate the values of the IIF at each of these points, and choose the items with the highest sum of these values.

Alternatively, we may also want to discriminate between low and medium/high attention respondents – that is, between shirkers and workers (see Van der Linden, 2005, 21-22). For example, we might want to just separate respondents in the bottom quartile of the range of attentiveness from the rest of the respondents. To do this, we can maximize the TIF at a value in the lower end of the attentiveness spectrum. This gives the optimal set of items to separate low attentiveness respondents – aka, shirkers – from the rest of the respondents.

To examine how to best capture attentiveness using a small set of survey questions, we conducted a nationally diverse online survey of 2,526 Americans public via Survey Sampling International (SSI) in August 2016. The survey included eight Screeners. Following Berinsky, Margolis, and Sances (2014), four of these items were Screeners asking about favorite colors, the most important problem facing the country, news web sites, and newspaper sections. Each of these Screeners are stand-alone–the Screener question is the only question to appear on the page–which has been the traditional way of asking Screener questions to date. We show screenshots of these questions in the Appendix.

We embedded the four remaining Screeners in question grids alongside other questions. The purpose of these grid Screeners was to explore the feasibility of increasing the total number of Screeners asked while taking up less space. We presented subjects with two grids of questions over the course of the survey. For each row in the grid, a respondent was presented with a (randomly ordered) statement with which they could agree strongly, agree, neither agree nor disagree, disagree, or disagree strongly. Along with sincere attitudinal questions such as whether the federal government should guarantee health insurance and whether gays and lesbians should have the right to marry, the first grid included two Screener statements that have a single right answer: that World War 1 came after World War 2; and an instruction to "Please check 'neither agree nor disagree' ". The second grid similarly contained two Screener statements–"Obama was the first president" and "Two is greater than one"–amid the sincere attitudinal statements.

3   Results

As a benchmark, we first measure attentiveness using all 8 items. Based on this "full attentiveness scale", we evaluate how much information each individual Screener item provides about the latent scale of attentiveness. The top four survey items in Table 1 are traditional, stand-alone Screeners. These questions all discriminate well on the latent scale, and they

Table 1: Item Parameters

Type	Item	Pass Rate	Difficulty Param.	Discrim. Param.	IIF (Full Dist.)	IIF (High Atten.)	IIF (Low Atten.)
Stand-alone	Websites	0.39	0.69	2.05	4.6	0.30	0.01
Stand-alone	Most Important Problem	0.30	0.92	1.47	3.1	0.44	0.02
Stand-alone	Favorite Color	0.58	-0.28	1.48	3.3	0.08	0.24
Stand-alone	Section of Newspaper	0.25	1.67	2.18	4.8	1.00	0.00
Grid	World War 1 came after World War 2	0.61	-0.35	0.94	1.9	0.07	0.17
Grid	Please check 'neither agree nor disagree'	0.90	-1.92	1.14	1.2	0.00	0.25
Grid	Obama was the first president	0.71	-0.78	1.09	2.1	0.03	0.28
Grid	Two is greater than one	0.76	-0.85	0.78	1.2	0.03	0.13

each contribute a good deal of information to the full scale. However, these items have relatively low passage rates, ranging from 25-58%. The high difficulty parameter values for these questions suggest even relatively attentive respondents failed some of these Screeners. The difficulty of stand-alone Screeners means they do a good job of discriminating between those with moderate and high levels of attention but are unable to distinguish among respondents at the bottom range of attentiveness.[3]

In contrast, the four grid items all have relatively high passage rates – ranging from 61-90%. The low difficulty parameters confirm that only inattentive people failed many of these Screeners. While these items do not contribute as much information to the full attentiveness scale (or at the top end of the range of attentiveness) as the stand-alone Screeners, they do discriminate very well between people at the low end of the scale (since these are the people that tend to fail the grid items). Examining the IIF for the low-attention sample in the last column, we see that all four grid Screeners contribute more information at the low end of the scale than the website, most important problem, and section of the newspaper stand-alone Screeners.[4]

Next we evaluate the validity of various scales that combine multiple screener items. In Figure 1, we follow the model of Berinsky, Margolis, and Sances (2014) and evaluate how

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[3]We maximize information for low-attention respondents for levels of attentiveness one standard deviation below the mean, and we maximize information for high-attention respondents for levels of attentiveness one standard deviation above the mean.

[4]A concern could be that these grid Screeners are capturing cognitive ability rather than engagement with a survey. Indeed, both Berinsky, Margolis, and Sances (2014) and Alvarez et al. (2019) find Screeners sometimes correlate with education. However, we show in the Online Appendix that none of our attentiveness scales are strongly predicted by demographics such as education or age. Moreover, exploratory factor analysis indicates that a single latent factor (attentiveness) characterizes the bulk of the variation in the individual Screeners.

each of four attentiveness scales fares at predicting respondents' performance on Tversky and Kahneman's (1981) unusual disease framing experiment. The y-axis represents the framing treatment effect and the x-axis is the attentiveness scale. Each figure includes points that represent quintiles along the attentiveness scale as well as a loess line and 95% confidence bands, which use 60 binned groups. Following Berinsky, Margolis, and Sances (2014), we expect the treatment effects will be larger among more attentive respondents.

In the top-left panel of Figure 1, we find the full scale with 8 items clearly discriminates the most inattentive from everyone else. Indeed, there is essentially no treatment effect among respondents in the lowest quintile of attentiveness (treatment effect = 0.07, se = 0.04). In contrast, there are clear effects among the remaining 80% of the attentiveness scale. To put these results in context, the magnitude of the experimental treatment effect among those who fall in the 20-40th percentile are the same as those who passed any stand-alone Screener.[5] In other words, the traditional, stand-alone Screeners not only require researchers to drop substantial portions of the sample, but the results look virtually identical to those with only moderate levels of attentiveness.

In contrast, scales that use all traditional Screeners (top-right panel) or all grid Screeners (bottom-left panel) do much worse at discriminating shirkers from workers in this experiment. For the scale that employs only traditional Screeners, there are smaller, but non-null treatment effects in the lowest two quintiles. This result occurs because the stand-alone Screeners do not do a good job distinguishing between those with low and moderate levels of attention. As a result, moderately attentive respondents, who responded to the framing treatment, end up in the bottom quintile of attention. Moreover, only in the top 40% of attentiveness on this scale do the treatment effects reach the same strength as using the top 80% of attentiveness on the full scale. For the scale with all grid Screeners, the top three quintiles have similar average scores of attentiveness because many respondents answered almost or all the grid screeners correctly. While the grid screener scale can certainly iden-

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[5]The treatment effect among the second quintile is 0.35 and ranges between 0.34 and 0.35 among passers of each of the stand-alone Screeners.

Figure 1: Attentiveness plays a role in detecting experimental treatment effects
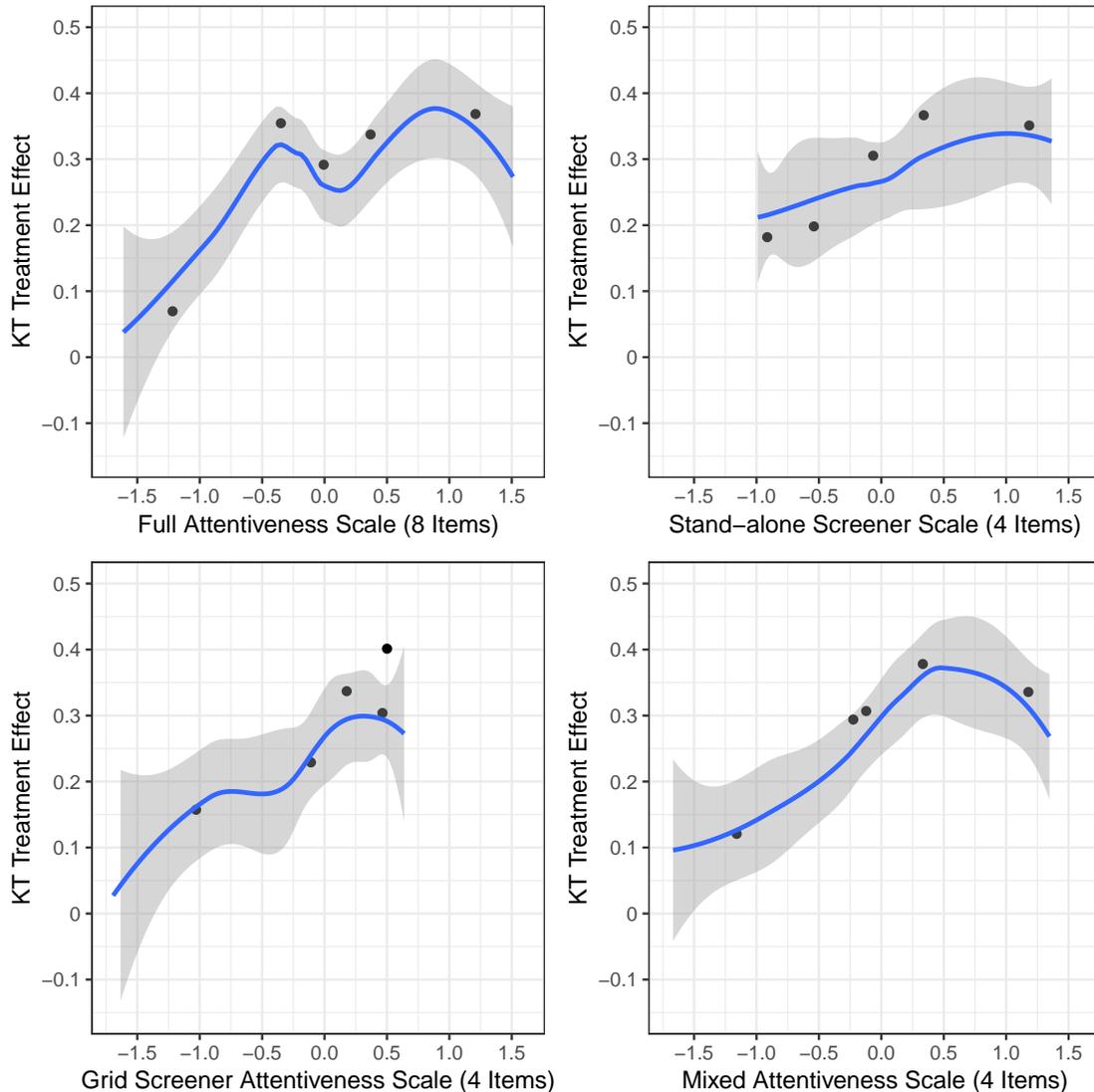
tify true shirkers, it has a more difficult time separating individuals at the higher end of attentiveness. Crucially, however, on both of these scales analysts would have to drop at least 40% of the sample in order to clearly separate shirkers from workers, whereas the full eight-item scale can distinguish between shirkers and workers by dropping only the bottom quintile of attentiveness.

While the eight-item scale performs better than using four stand-alone Screeners or four grid Screeners, implementing a survey with eight Screeners is costly. A mixed attention scale with two grid and two stand-alone Screeners performs nearly as well as the full scale

(bottom-right panel). The experiment yields small treatment effects among respondents in the lowest quintile of attentiveness (0.12). Once again, however, there is a clear jump in the size of the treatment effects between the bottom and second quintiles, with relatively modest differences across quintiles.[6] Similar to the full eight-item scale, the four-item mixed scale improves upon the strategy of using a single stand-alone Screener by showing that researchers can improve data quality while maintaining a larger proportion of the sample.

These results further show that the framing experiment is not one that requires extreme levels of attentiveness. Respondents need to pay some attention to the treatment–choosing response options randomly will not suffice. But even those individuals who may have only skimmed the experimental stimulus responded to the difference in language between the conditions.

Next, we examine how well the different attentiveness scales do at reducing noise in a non-experimental setting when question wordings require close reading, again following Berinsky, Margolis, and Sances (2014). For the last four decades, the ANES has asked a series of three questions on economic liberalism. For two of the questions, a low response (1) represents a liberal position while a high response indicates a position position (7). On the third question, the scale is reversed.

In Figure 2, we examine the difference in a) the correlation between the reverse-item scale and the one of the two like-coded scales (which should be negative) and b) the correlation between the two like-coded scales (which should be positive). If respondents are paying attention, the correlation between the same-coded scales should be around .5 and the correlation between the reversed scale should be around -0.5, producing a difference of -1. This is exactly what we observe in the upper left panel of the graph. Using the attentiveness scale with all eight items, there is virtually no difference in the correlations of flipped and non-flipped ANES scales among respondents in the lowest quintile of attentiveness. After a large difference between the bottom and second quintiles of attentiveness (0.01 versus -0.52),

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[6]The magnitude of the treatment effects varies between 0.29 (second quintile) and 0.38 (fourth quintile).

Figure 2: Attentiveness plays a role in non-experimental data collection
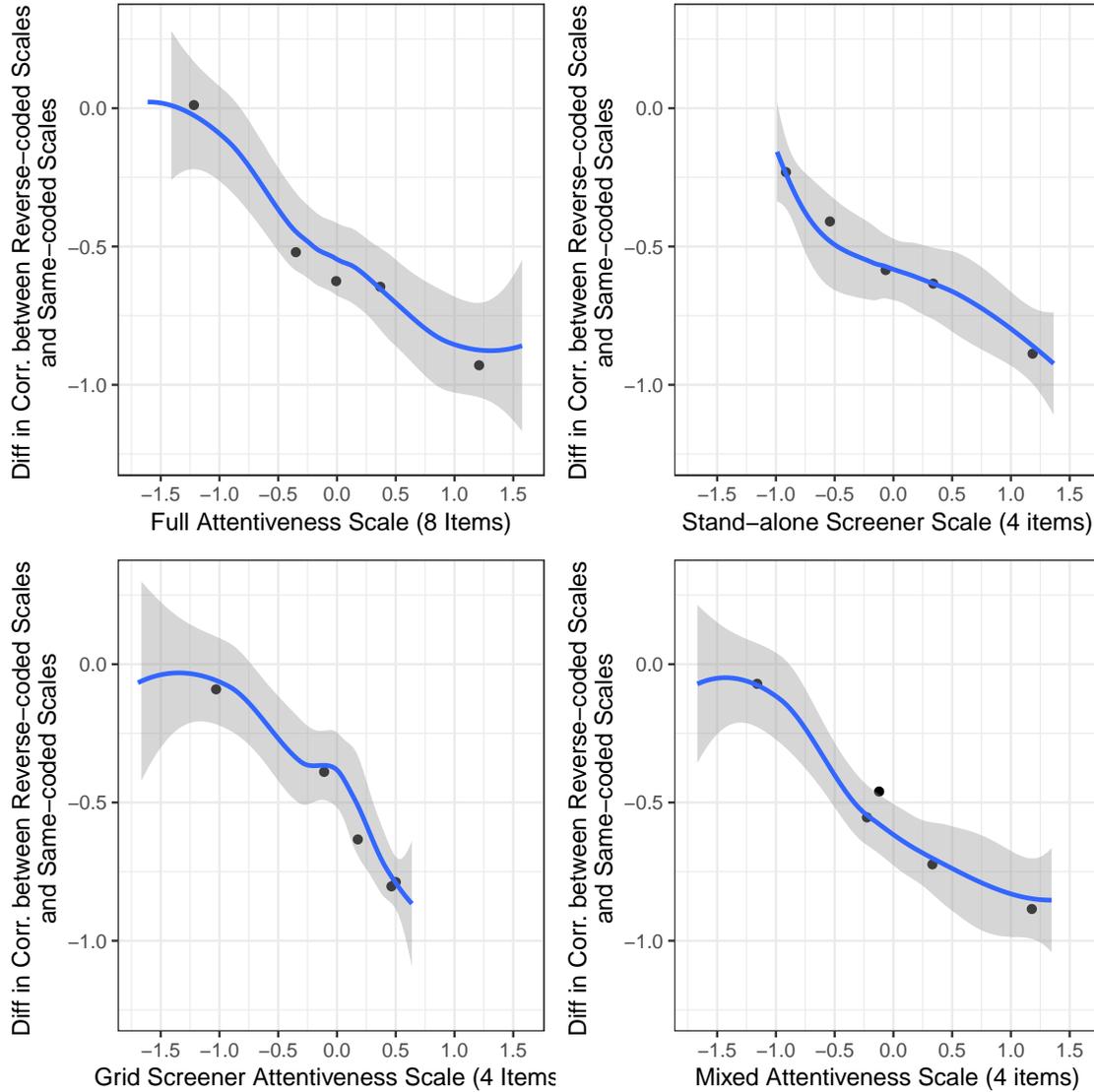
the middle 60% of the attentiveness range looks similar to one another, whereas those in the top 20% in the attentiveness range has a differenced correlation of -0.92. Unlike the framing experiment in which respondents in the top 80% of the sample all responded similarly to the experimental stimulus, the most attentive people in sample were the most responsive to the relatively long survey questions and subtle change in response options. In other words, for the ANES questions attentiveness matters at both the top *and* the bottom of the scale.

Again, the four-item scale made up of only stand-alone Screeners (top right) does a better

job distinguishing among people at the top end of the attentiveness range rather than the bottom, while the four-item scale made up of only grid items (bottom left) does a good job identifying the least attentive respondents but has a more difficult time distinguishing respondents at the top end of the attentiveness spectrum.[7] And, again, the four-item mixed attention scale looks quite similar to the eight-item scale, successfully distinguishing between inattentive respondents in the bottom quintile and the rest of the sample. These results indicate that the mixed scale with only four items performs nearly as well as the full scale at detecting inattentive respondents on the ANES scales.

4 Discussion and Conclusion

Previous research has already shown that using a single Screener question is problematic. We add to these findings by showing that researchers need variation in the difficulty of Screener items in order to accurately place respondents on an attentiveness scale. Additionally, different stimuli or survey subtleties may require more or less attention on the part of survey respondents.

As a general rule, we recommend using a multi-item scale that includes screeners that vary in difficulty, similar to our four-item mixed scale. This strategy allows one to classify respondents at both the high and low ends of the attentiveness spectrum. Figures such as 1 and 2 make it clear to readers how respondents with different levels of attentiveness behave in the survey. That said, researchers may want to tailor a set of attention checks specific to their research needs. For example, grid Screeners will suffice if researchers want to identify the least attentive respondents. Alternatively, if one has a particularly subtle treatment or complicated experimental design that requires respondents to pay careful attention, stand-

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[7]The difference in correlations among those in the bottom quintile of the traditional, stand-alone scale is -0.23. While still substantially lower than the correlation in the top quintile, it is larger than the full attentiveness scale (which has a correlation of 0.01), indicating that there are people with moderate levels of attention in the bottom quintile. Similarly, the difference in correlations among those in the top two quintiles of the grid scale is -0.80 and -0.79, indicating that there are people with moderate levels of attention in the top quintiles.

alone Screeners would be the best way to distinguish among people at the top end of the attentiveness spectrum.

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Online Appendix

A1   Screener Questions

There are many important issues facing our country today. Research shows that issues people think are important can affect their views on other issues. We also want to know if you are paying attention. Please ignore the question and put "crime" in the top position and "unemployment" in the bottom position. Leave the rest of the issues in the same order.

Please rank the following issues facing the nation from 1 (most important) to 7 (least important). You can change your rankings by dragging and dropping different issues.

- Health care
- Unemployment
- The federal budget deficit
- The Afghanistan war
- Crime
- Education
- Relations with other countries

We would like to get a sense of your general preferences.

Most modern theories of decison making recognize that decisions do not take place in a vacuum. Individual preferences and knowledge, along with situational variables can greatly impact the decision process. To demonstrate that you've read this much, just go ahead and select both red and green among the alternatives below, no matter what your favorite color is. Yes, ignore the question below and select both of those options.

What is your favorite color?

☐ White   ☐ Pink

☐ Black   ☐ Green

☐ Red   ☐ Blue

We are also interested in what sections people like to read in the newspaper. This might affect what they learn from articles and how they feel about the issues discussed in them. We also want to see if people are reading the questions carefully. To show that you've read this much, please mark both the classified and none of the above boxes below. That's right, just select these two options only.

Regardless of how frequently you read the newspaper, what would you say are your favorite newspaper sections to read? (please check all that apply)

☐ National   ☐ Classified   ☐ Science and Technology

☐ Local   ☐ Style   ☐ Opinion

☐ Real Estate   ☐ Sports   ☐ None of the above

☐ Comics   ☐ Business   ☐ All of the above

When a big news story breaks people often go online to get up-to-the-minute details on what is going on. We want to know which websites people trust to get this information. We also want to know if people are paying attention to the question. Please ignore the question and select FoxNews.com and NBC.com as your two answers.

When there is a big news story, which is the one news website you would visit first? (Please only choose one)

☐ New York Times website   ☐ FoxNews.com   ☐ NBC.com

☐ Huffington Post   ☐ Google News   ☐ USA Today website

☐ CNN.com   ☐ Yahoo! News   ☐ Other [_____]

In the grid below, you will see a series of statements. Please tell us whether you agree or disagree with each statement.

	Agree strongly	Agree	Neither agree nor disagree	Disagree	Disagree strongly
People convicted of murder should be given the death penalty	○	○	○	○	○
Please click the "neither agree nor disagree" response	○	○	○	○	○
Gays and lesbians should have the right to legally marry	○	○	○	○	○
World War I came after World War II	○	○	○	○	○
In order to reduce the budget deficit, the federal government should raise taxes on people that make more than $250,000 per year	○	○	○	○	○
The Affordable Care Act passed by Congress in 2010 should be repealed	○	○	○	○	○
The government should require all electricity power plants to significantly reduce their greenhouse gas emissions even if it might increase electricity bills a few dollars a month.	○	○	○	○	○

In the grid below, you will see a series of statements. Please tell us whether you agree or disagree with each statement.

	Agree strongly	Agree	Neither agree nor disagree	Disagree	Disagree strongly
By law, abortion should never be permitted	○	○	○	○	○
In order to reduce the budget deficit, the federal government should eliminate all welfare programs that help poor people	○	○	○	○	○
Two is greater than one	○	○	○	○	○
The federal government should raise the minimum wage to $10	○	○	○	○	○
Obama was the first president of the U.S.	○	○	○	○	○
The federal government should guarantee health insurance for all citizens	○	○	○	○	○
The federal government should pass new rules that protect the right of workers to join labor unions	○	○	○	○	○

A2 Full Text of framing experiment

> Imagine that your country is preparing for the outbreak of an unusual disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows:

Subjects are then randomly assigned to one of the two following conditions:

> Condition 1, Lives Saved Frame: "If Program A is adopted, 200 people will be saved. If Program B is adopted, there is 1/3 probability that 600 people will be saved, and 2/3 probability that no people will be saved."

> Condition 2, Mortality Frame: "If Program A is adopted, 400 people will die. If Program B is adopted there is 1/3 probability that nobody will die, and 2/3 probability that 600 people will die."

A3 ANES economic liberalism question wording

Item 1: Some people feel the government in Washington should see to it that every person has a job and a good standard of living. Suppose these people are on one end of the scale, at point 1. Others think the government should just let each person get ahead on their own. Suppose these people are at the other end, at point 7. And, of course, some other people have opinions somewhere in between. Where would you place YOURSELF on this scale?

Item 2: Some people think that the government in Washington ought to reduce the income differences between the rich and the poor, perhaps by raising taxes of wealthy families or by giving income assistance to the poor. Suppose these people are on one end of the scale, at point 1. Others think that the government should not concern itself with reducing this income difference between the rich and the poor. Suppose these people are at the other end, at point 7. And, of course, some other people have opinions somewhere in between. Where would you place YOURSELF on this scale?

Item 3 (reverse coded): Some people think the government should provide fewer services, even in areas such as health and education, in order to reduce spending. Suppose these

people are on one end of the scale, at point 1. Other people feel that it is important for the government to provide many more services even if it means an increase in spending. Suppose these people are at the other end, at point 7. And, of course, some other people have opinions somewhere in between. Where would you place YOURSELF on this scale?

A4 Relationship Between Scales and Demographics

	(1)	(2)	(3)	(4)
	Full Scale	Traditional	Grid	Mixed
Some College	0.14***	0.06	0.20***	0.11**
	(0.04)	(0.04)	(0.04)	(0.04)
College	0.11**	0.08*	0.12**	0.07
	(0.04)	(0.04)	(0.04)	(0.04)
Age/100	-9.15	-22.18	-2.52	-1.35
	(25.10)	(24.83)	(23.10)	(23.98)
$(\text{Age}/100)^2$	0.26	0.59	0.09	0.06
	(0.64)	(0.64)	(0.59)	(0.62)
Female	0.29***	0.26***	0.15***	0.25***
	(0.04)	(0.03)	(0.03)	(0.03)
White	0.08	0.08	0.03	0.07
	(0.07)	(0.07)	(0.07)	(0.07)
Black	-0.19*	-0.10	-0.23**	-0.15
	(0.09)	(0.08)	(0.08)	(0.08)
Hispanic	-0.12	-0.06	-0.15	-0.14
	(0.09)	(0.08)	(0.08)	(0.08)
Constant	77.87	208.43	12.96	4.05
	(244.46)	(241.66)	(225.05)	(233.47)
Observations	2,524	2,524	2,524	2,524
R^2	0.10	0.06	0.10	0.08

Notes: Cell entries are coefficients from linear regressions of attentiveness scales on covariates. Robust standard errors in parentheses. * $p<0.05$, ** $p<0.01$, *** $p<0.001$