Knowledge Persists, Opinions Drift:
Learning and Opinion Change in a Three-Wave Panel Experiment

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Abstract
Considerable evidence exists that Americans possess not only low levels of political knowledge, but also relatively uninformed—and sometimes misinformed—opinions on policy matters. Many recent studies focus on whether informational treatments have immediate effects on citizens’ factual beliefs and opinions about policy, but less is known about whether such treatments have enduring effects. Using a three-wave panel experiment, we assess the immediate and enduring effects of factual information provision on factual beliefs and opinion of the Affordable Care Act. We find a relatively persistent effect of information provision on accuracy of factual beliefs, but only an ephemeral shift in opinion, which typically drifts back to its pre-treatment state within a few weeks. Our findings have implications for the understanding of citizen learning and opinion change, as well as ongoing scholarly debates about how long-lasting the effects of (experimental) interventions are.

Keywords: political knowledge; public opinion; survey experiment; learning; opinion change
In general, theories of representative democracy demand that citizens bring at least a modicum of knowledge about public affairs to their political decisions (e.g., Dahl, 1989). Decades of public opinion research, however, highlight a clear problem for normative theory: The public often simply does not know the facts about political topics (Delli Carpini & Keeter, 1996) or even has inaccurate factual beliefs; that is, people may believe things to be true that are actually false (Kuklinski et al., 1998; Kuklinski et al., 2000; Kull et al., 2003; Nyhan & Reifler, 2010). There is considerable evidence that being uninformed or misinformed about specific policy topics matters for opinions on those topics. For example, experimental studies show that accurate information shapes opposition to foreign aid and support for prison spending (Gilens, 2001), attitudes toward immigrants (Barabas & Jerit, 2010), support for teacher pay raises (Schueler & West, 2016), and support for the estate tax (Sides 2016). Observational studies similarly show that the belief that the Affordable Care Act (ACA) established “death panels” correlates with opposition to the law (Pasek et al., 2015), lack of knowledge about the 2001 federal income tax cuts inflated their support (Bartels, 2008), and beliefs about which demographic groups make up the largest share of welfare beneficiaries correlate with attitudes toward these programs (Gilens, 1999). In short, people with accurate factual beliefs about policy often demonstrate a willingness to make different choices than those who have inaccurate (or no) factual beliefs about a given topic.

Scholarly attention has increasingly focused on whether providing accurate policy information causes individuals to update their factual beliefs and opinions about the topic. However, this research has mostly focused on *immediate* effects (e.g., Garrett et al., 2013; Gilens, 2001; Hart & Nisbet, 2012; Kuklinski et al., 2000; Nyhan & Reifler, 2010; Schueler & West, 2016; Sides, 2016; Thorson, 2016; Wood & Porter, 2018). Much less is known about
whether the provision of information—in particular, factual information related to policy matters—can lead to *enduring* effects. For exposure to information designed to educate individuals about public policies to “work,” the effects should persist over a period of time. An emerging literature (e.g., Berinsky, 2017; Swire et al., 2017) has examined the persistence of informational effects on factual beliefs, but few previous studies have considered whether information affects factual beliefs and opinion differently, especially over a period of time extending several weeks beyond treatment. It is therefore imperative to further explore the linkages between information, factual beliefs, and opinion shifts—both immediately following exposure to new information and over a longer period of time.

Using a three-wave online survey experiment, we assess whether the effects of informational treatments about the ACA are successful at shifting either factual beliefs or opinion of the policy, both immediately after the informational treatment and after a period of one to four weeks. We find both an immediate and relatively persistent effect of information provision on accuracy of factual beliefs; although there is some evidence of decay, we observe an enduring ability of many respondents to report correct information about the ACA after exposure to information about the policy. Shifts in opinion are ephemeral, however. Information about the ACA positively shifted opinion about the policy immediately following exposure, but respondent opinions typically drifted back to their pre-treatment states within a few weeks of treatment—even though respondents for the most part retained their corrected factual beliefs.

Our findings have implications for the understanding of citizen learning and opinion change, as well as ongoing scholarly debates about how long-lasting the effects of (experimental) interventions are. With respect to the former, our results suggest that opinions may return to “pre-treatment” states even if factual beliefs remain updated. With respect to the latter, our
results are in-line with work in other (non-policy) areas that suggests opinions may be difficult to shift over the long-term (see, for example, Gerber et al., 2011 on candidate choice), but that knowledge gains may persist for some, but not all, of the mass public (see, for example, Dowling & Miller, 2015 on perceptions of women’s chances of winning office). Our results therefore suggest that educating people about the contents of policies may not be enough to win their long-term support.

The Challenges for Learning and Opinion Change

Evidence demonstrating that factual beliefs shape opinions not only resonates with normative democratic theory, but also fits well with the most prominent empirical models of opinion formation, in which the bits of information that individuals receive from their environment form the basis of their opinions (e.g., Bartels, 2002; Lodge, Steenbergen, & Brau, 1995; Zaller, 1992). There are, of course, important differences among these models—for example, whether a factual belief must persist in order to leave a long-running imprint on opinion, but at their core they share three basic elements. First, individuals must encounter the information. Second, they must accept the information—that is, it becomes their factual belief about the topic. Third, either this factual belief or some aspect of it (such as the affect attached to it) is integrated into the set of factors from which opinions are drawn. In short, there is widespread recognition that what people know about political topics—or, what they believe they know about political topics—plays a fundamental role in shaping their preferences.

Under the right conditions, exposure to accurate information can change opinions. As noted above, previous work has shown that information about the share of the federal budget spent on welfare programs can substantially shift opinions on spending (Kuklinski et al., 2000),
and information about local school districts’ spending can move opinions on education finance (Schueler & West, 2016). There are, of course, limitations to the effectiveness of providing factual information for boosting policy or political knowledge, since the power of corrective information to improve knowledge and change opinions may vary across issues, sources, and format (e.g., Berinsky, 2017; Dixon et al., 2015; Hart & Nisbet, 2012; Nyhan & Reifler, 2013). However, it is worth noting that even studies yielding mixed results highlight the conditions under which learning and persuasion (i.e., opinion change) takes place, rather than demonstrate no causal effect of accurate information. However, whether new information can lead to enduring changes in factual beliefs or opinion, even if it is subsequently forgotten, remains a largely open question in the realm of public policy.

To better understand why the effects of information may fade, it is important to understand why information may fail in the first place. There is strong evidence that it is no easy task to change opinions simply by exposing individuals to accurate information about a political topic. One explanation is that individuals simply reject new facts because they do not passively receive political information; rather, they have both accuracy goals (to get the facts right) and directional goals (to arrive at a particular conclusion). The latter motivate cognitive effort to understand information while reinforcing existing beliefs; information that supports an existing viewpoint is internalized, while contrary facts are often disregarded (Lodge and Taber, 2013; Taber and Lodge, 2006). Individuals may achieve this goal by means such as disparaging the source of the information, identifying logical inconsistencies in it, or questioning the validity of specific elements within the information (Ottati & Wyer, 1990). Individuals’ factual beliefs about specific political topics therefore tend to be consistent with perceptions most congenial to their political predispositions (Bartels, 2002; Jacobson, 2010; Jerit & Barabas, 2012; Kuklinski et
al., 2000; Schaffner & Roche, 2017). Consequently, inaccurate factual beliefs sometimes prove remarkably resilient even when individuals are exposed to correct information (Garret et al., 2013; Nyhan & Reifler, 2010).

That said, there is mounting experimental evidence that individuals can accept correct information and update their factual beliefs (Dowling & Miller, 2015; Wood & Porter, 2018). A second explanation for why information fails to move opinion, therefore, is that its effect on factual beliefs is distinct from its effect on opinion. Studies of impression formation and persuasion, for example, demonstrate how interpretation of facts can lead to instances in which individuals successfully recall facts relevant to a judgment but fail to use those facts in subsequent judgments (Greenwald, 1968; McGuire, 1985; Gaines et al., 2007).

Interpreting information in a manner consistent with political predispositions can allow individuals to update their factual beliefs while maintaining their prior opinions, satisfying both the accuracy goals and the directional goals of their information processing. To the extent that this process of interpretation is dynamic, unfolding over time, it presents an avenue whereby immediate opinion effects may fade without a parallel reversion in factual beliefs.

**Do Information Effects Persist?**

Existing work focuses almost exclusively on the immediate effects of (factual) information. Evidence based on estimating the effect of single-shot treatments shortly after the intervention, however, cannot speak to the question of effect durability. This is an important line of inquiry because there are a number of reasons to expect the effects of information to fade. First, individuals may simply forget new information. In this case, information is not actively rejected so much as it becomes inaccessible. Here, the effect of information on factual beliefs
would recede, but the impact of the expectations for opinion are less clear. Memory-based models of opinion-formation suggest the effect on opinion fades with the loss of the information (Zaller, 1992); as such, the observable implication would be a reversion to prior factual beliefs and opinions over time. However, the online model of information processing suggests that the effect of information on opinion should persist, because learned facts are built into the affective running tally (Lodge, Steenbergen, & Brau, 1995). Therefore, forgetting learned facts would result in a reversion to prior factual belief (or to ignorance) but would not lead to opinion reversion. Either way, forgetting seems especially likely in the context of misperception studies based on single-shot experiments.

Second, individuals can continue to counter-argue against the new information such that they come to reject it even after initially accepting it. If this process of counter-arguing continues over time—either due to internal cognitive activity alone, or to ongoing exposure to contrary messages in the information environment—people may come to reject information they previously accepted. In this case, the observable implications would be reversion toward prior factual belief and reversion to prior opinion.

Finally, individuals may re-interpret the information. Similar to the previous outcome, in this scenario individuals continue to engage in counter-arguing, but their counter-arguing has to do with the relevance or salience of the information they have already accepted. Instead of coming to reject the new information, they reject its connection to their opinion. The observable implications in this case are that factual beliefs persist as corrected, but opinion reverts to prior status over time. This last case may be especially likely, given that individuals who initially accepted correction may have stronger accuracy motivations. Reinterpretation of factual beliefs would allow them to satisfy both these accuracy goals as well as their directional goals.
The literature on the duration of effects from exposure to accurate factual information on factual beliefs and policy opinions is sparse but compelling. Berinsky (2017) shows that exposure to accurate information about the Affordable Care Act changed factual beliefs about the rumors surrounding so-called “death panels,” and this learning effect persisted one month after treatment.

The long-term effect of exposure to correction on opinions is less clear, however. Correcting misleading or inaccurate claims made by Donald Trump during the 2016 campaign reduced belief in those claims—even among Trump supporters—and this effect on factual beliefs persisted (with some decay) in follow-up interviews (Swire et al., 2017). Yet the corrections had neither short- nor long-term impacts on evaluations of Trump himself.

This emerging literature on the long-term effects of information on factual beliefs and opinions remains limited in two important ways. First, it has yet to identify the long-term effects of exposure to accurate information on specific policy opinions. Indeed, the only studies simultaneously examining effects on both factual beliefs and opinions over time have focused exclusively on candidate evaluations rather than specific policy opinions (Swire et al., 2017). Second, even the studies that have measured both factual beliefs and opinions rely on a relatively short time horizon of approximately one week between treatment and follow-up interviews. Thus, two questions remain open. First, can the effects of factual information on factual belief and policy opinion persist beyond the moments following treatment? Second, to what extent does a lasting effect on opinion require a lasting effect on factual belief(s)?

**Three-Wave Panel Survey Design**

We designed a survey experiment embedded in a three-wave panel to assess respondent
knowledge and opinion of the ACA, and also whether an external informational stimulus affects those views. The study was conducted online using Amazon.com’s Mechanical Turk (MTurk) interface and subject population. The study was in the field in late 2014 and early 2015, after many of the provisions of the ACA went into effect.

The use of the ACA offers three advantages for this study. First, there were well-documented deficiencies in accurate factual beliefs about the law after its passage, including not only many who were uninformed, but also many who were misinformed (Pasek et al., 2015). Second, factual beliefs and opinion about the ACA are highly polarized across party identification (Berinsky, 2017; Henderson & Hillygus, 2011). This pattern is, of course, closely linked to the prevalence of misperception, thus increasing the difficulty of 1) correcting factual beliefs and changing opinions, as well as 2) sustaining these changes over time. Examining these patterns in the case of the ACA—a high-profile issue at the time of the study in which individuals face strong directional goals in processing of information—increases confidence that the results are robust to other policy issues with similarly polarized factual beliefs and opinions. Third, despite the highly polarized views of the law, factual beliefs about the ACA have proven susceptible to short-term correction (Berinsky, 2017). The scope of our study requires initiating such correction in order to measure its duration. The key contribution of our analysis is not whether short-term factual correction occurs—which existing studies already demonstrate—but rather whether corrections persist and/or have long-term effects on opinions.

Wave 1

We first recruited 1,790 participants to take a short survey (Wave 1) of approximately six to eight minutes in length (additional subject recruitment details are included in the Online
Appendix). Among those recruited into the study, 1,649 individuals completed the first wave interview. Participants completed Wave 1 from December 4 to December 9, 2014. We did not employ randomized treatment in Wave 1. Rather, we captured pre-treatment knowledge and opinion of the ACA. Upon completing an informed consent page, participants answered some questions to ascertain demographic and political characteristics.\(^4\)

Next, respondents answered questions about the ACA. We began by soliciting respondent approval of the ACA overall by indicating a number on a slider between 0 and 100.\(^5\) We then posed a set of questions measuring factual beliefs about the content of the law. Respondents were presented with a single grid (row order was randomized across respondents) containing five statements and asked whether the policies in these statements were legal or illegal at the time of the survey.\(^6\) Specifically, participants were asked whether it was legal for (1) the federal government to charge a financial penalty to people who are unable to prove that they have a health insurance policy; (2) insurers to deny health coverage to an individual based on a pre-existing condition; (3) insurers to impose lifetime limits on the amount of coverage a customer can receive; (4) insurers to charge a deductible, co-pay, or coinsurance for preventative services such as mammograms and colonoscopies; and (5) insurers to deny coverage to children of parents who have purchased insurance before the children turn 26 years old. At the time of the survey, the ACA allowed for the first of these, but prohibited the remaining four. Wave 1 questions therefore captured opinion of the ACA as a whole, as well as factual beliefs about the content of the ACA. This initial assessment therefore allows us to gauge the extent to which subsequent factual information facilitated both learning and opinion change.

\textit{Wave 2}
Each respondent who participated in Wave 1 was re-contacted (through MTurk) to participate in a second survey (Wave 2). Approximately 56 percent of our initial respondents completed the second wave of the study (923 of 1,649), which is in-line with other work that has used panel designs on online samples (Berinsky 2017; Berinsky, Huber & Lenz, 2012; Buhrmester, Kwang & Gosling, 2011; Dowling & Miller, 2015). We fielded Wave 2 one week after the end of Wave 1, and respondents completed it between seven and 14 days after taking the initial survey, from December 16 to December 20, 2014.

In Wave 2, participants were randomly assigned (with equal probability) to either a treatment condition in which they received textual information about some of the features of the ACA, or to a control group in which they did not receive any additional information. Respondents who were assigned to receive the information about the ACA viewed five specific pieces of information (displayed in Box 1) about changes to the health insurance system that resulted (or would ultimately result) from the policy on a range of issues: mandating insurance coverage, prohibiting the denial of coverage due to pre-existing conditions, the elimination of lifetime coverage limits, the provision of cost-free preventative care, and the mandatory coverage of children on their parents’ plan through the age of 25. After exposure to the ACA informational treatment (or not, for participants assigned to the control condition), we repeated the grid of questions measuring factual beliefs about the law from Wave 1. Additionally, we repeated both the questions measuring opinion of the specific elements included in the factual belief questions and the question measuring overall opinion of the ACA.

{Box 1 about here}

One critical feature of the study’s design is the ability to identify within-subject effects of information on changes in factual beliefs and changes in opinion while minimizing the threat of
consistency bias, which is a concern when survey participants answer related questions in a similar manner in order to appear consistent to the researcher or themselves (Weisberg et al., 1996). Consistency bias is of particular concern for within-subject analysis because participants’ recall of pre-treatment responses could shape their post-treatment responses. We reduce this threat by asking pre-treatment factual beliefs and opinion in the first wave, a week prior to treatment assignment in the second wave. Upon completion of Wave 2, we are therefore able to assess whether exposure to information affected respondents’ factual beliefs and opinions about the ACA immediately after respondents were exposed.

Wave 3

Using the same recruitment methods as we did for Wave 2, we invited all respondents who completed Wave 2 to a final survey (Wave 3). Participants completed Wave 3 at least one week after completion of Wave 2. Importantly, we assigned all Wave 2 respondents (with equal probability) to receive an invitation to Wave 3 one, two, or four weeks after the opening of Wave 2. During Wave 3, we once again presented the factual belief and opinion questions to respondents. As we randomize length of time between the second and third wave, but do not repeat treatment in Wave 3, we are able to ascertain in Wave 3 how much the immediate effects of the informational interventions administered in Wave 2 decayed over a meaningful period of time. More importantly, this approach allows us to determine whether any decay in the information effect on opinion depends on a similar decay in effect on factual beliefs. We are able to identify whether effects on both factual beliefs and opinions remain, whether both effects fade together, or whether opinion effects fade despite persistence of effects on factual beliefs.
Results

We begin by examining initial factual beliefs about elements of the ACA from Wave 1 of our survey, restricted to participants who completed all three waves of the study. Table 1 contains the percent of participants with correct factual beliefs, incorrect factual beliefs, and who are unsure (i.e., responded “don’t know”) for each of the five elements of the law. The table also includes the average for each of those response categories across all five questions. Although the results vary from item to item, they are generally consistent with past research showing significant numbers of individuals are either uninformed (unsure) or misinformed (incorrect) about specific components of the ACA (Pasek et al., 2015).

The Immediate Effect of Informational Interventions on Factual Beliefs and Opinions

Exposure to factually correct information about the content of the ACA had an immediate, positive impact on the accuracy of factual beliefs. On average, participants in the control condition showed no increase in the number of accurate factual beliefs (out of the five items) from Wave 1 to Wave 2 (a difference of 0.09 items with a standard error of 0.06). In contrast, the number of accurate factual beliefs about the ACA among the five items included in the study grew by 1.34 for participants in the treatment condition (with a standard error of 0.08)—the 1.26 difference in the trend between the two groups has a standard error of 0.10 and is statistically significant at customary thresholds. This effect is driven both by a greater decrease in the number of unsure responses (-0.58 with standard error of 0.09) and a greater decrease in the number of inaccurate factual beliefs (-0.68 with a standard error of 0.09) for respondents in the treatment condition, relative to those in the control condition.
To assess accuracy of factual beliefs about each specific element of the ACA, we first regress a binary indicator for correct factual belief about that element at Wave 2 on an indicator for assignment to the treatment condition and an indicator for correct factual belief about that element at Wave 1 (i.e., the binary indicators take a value of 1 if the participant has a correct factual belief about the element or a value of 0 if the participant is either unsure or incorrect). The coefficients for the treatment indicators in these models capture the effect of exposure to information on changes in factual beliefs controlling for initial factual beliefs (Finkel 1995). Additionally, we divide the sample by initial factual belief about each element of the ACA (incorrect, unsure, or correct) and estimate the effect of treatment on subsequent accuracy of factual belief within each subgroup. Figure 1 displays the differences between participants in the treatment and control conditions for factual beliefs about the ACA, both overall and by respondents’ initial responses. Considering responses overall (denoted by the open diamonds in Figure 1), while the magnitude of the effect of information on factual beliefs varies across the specific questions, in each case accuracy improves more among treatment group subjects compared to control group subjects.\textsuperscript{10}

{Figure 1 about here}

Figure 1 also presents results from the same analysis conditioning on participants’ initial factual beliefs, separating the initially incorrect (denoted by the triangles) and the initially unsure (denoted by the squares) from those who provided a correct response in Wave 1 (denoted by the circles). The initially unsure (uninformed) and the initially incorrect (misinformed) both exhibit stronger accuracy gains as a result of exposure to the treatment for all five items, with the only effect not significantly different from zero being for the misinformed on the “uninsured penalty” item. Moreover, the learning effects in both groups are statistically and substantively similar for
four of the five items; the exception is the “pre-existing conditions” item where the misinformed have larger accuracy gains than the uninformed. This suggests that the informational treatment both corrects inaccurate factual beliefs and instructs the unsure.11

To estimate the effect of information exposure on opinion of the ACA, we regress approval of the law at Wave 2 on an indicator for assignment to the treatment condition and the measure of approval at Wave 1. Once again, we divide the sample by initial factual belief about each of the five elements of the ACA (incorrect, unsure, or correct). We estimate the effect of treatment on subsequent approval of the ACA within each subgroup while controlling for initial (i.e., Wave 1) overall approval of the ACA.

Figure 2 displays the treatment effects of information on opinion of the ACA. The dashed vertical line represents the overall treatment effect of the factual information about the ACA on opinion of it. This effect—a 3.44-point increase on the 0 to 100 approval scale in the treatment group compared to the control group—indicates that exposure to information about policies contained in the ACA increased approval of the law overall.12

{Figure 2 about here}

The estimates presented in Figure 2 display changes in opinion concerning the ACA by initial factual beliefs about the content of the law, separated by initially incorrect (triangles), initially unsure (squares), and initially correct (circles). Consistent with the positive effect on opinion of the ACA overall, the three groups exhibit increased approval of the ACA across all five factual items. Not all of the opinion shifts are significantly different from zero, but within each item the three groups of subjects are statistically indistinguishable from one another. In short, there is little evidence that subjects’ initial condition (especially being either initially misinformed or uninformed) affects the likelihood that they update their opinions of the ACA
when confronted with correction, but the correction does increase approval of the law overall. It is worth noting that exposure to information about the contents of the ACA is especially effective at boosting approval of the law among those who are the most misinformed about it. When, we regress Wave 2 ACA approval on an indicator for treatment condition, the count of the number of elements about the law a participant held incorrect factual beliefs about at Wave 1 (0 to 5), and the interaction of these two variables while controlling for Wave 1 ACA approval, the results indicate that the treatment was increasingly effective among those most mistaken about the contents of the law. Analyses of treatment effectiveness by the number of unsure responses or the number of correct responses to the Wave 1 factual belief items, however, do not yield a similar pattern. This suggests that information about the law is particularly effective at improving opinions among the misinformed. Results appear in Online Appendix Table A8.

The Persistent Effect of Informational Interventions on Factual Beliefs and Opinion

We next address the question of how persistent the effect of information is, with respect to both factual beliefs and opinion change. In this section, we analyze Wave 3 responses in the same ways we examined Wave 2 responses. The diamonds in the left pane of Figure 3 display the overall difference between treatment and control conditions in factual beliefs controlling for Wave 1 factual beliefs, while the right pane does the same for the opinion trend controlling for Wave 1 ACA approval. For both factual beliefs and opinion, we also break out the treatment effect by timing of the Wave 3 interview—one, two, or four weeks after Wave 2.

With respect to factual beliefs, we do observe some decay in effects over time. This is consistent with previous work that found that the effect of efforts to correct misperceptions
and/or rumors fade as treatment recedes into the past, generally decreasing by ten to fifteen percentage points within about a week (e.g. Berinsky, 2017; Swire et al., 2017). Depending on the size of the initial effect, this decay in some cases can return effects to pre-treatment levels (Berinsky, 2017). However, the information effects in our experiment retain statistical significance after a relatively long period of time. This suggests that in most instances participants in the treatment condition lose some (but not nearly all) of the relative gains they made at Wave 2—the magnitude of these losses is generally about one third to one half the size of the difference in the trend at Wave 2.15 In addition, of the five items that exhibited an effect on factual beliefs in Wave 2 among the sample overall, three continue to exhibit this effect even among respondents interviewed for Wave 3 four weeks later (the exceptions being “coverage to 26” and “uninsured penalty”). So, while the size of the treatment effect does diminish over time, some of the effect of information exposure endures in both a substantive and statistical sense for many topics for nearly a month. Thus, our experiment suggests that information can engender learning—in both the immediate sense and for some subjects over a longer period of time. But, at the same time they also indicate that treatment effects estimated at only one time point—presumably, immediately after treatment—are likely to somewhat overstate the actual impact of information on factual beliefs in the longer term.

{Figure 3 about here}

The evidence for opinion change, however, follows a different pattern (see the right pane of Figure 3). The roughly 3.44-point positive shift in opinion of the ACA at Wave 2 (again denoted by the vertical dashed line) nearly completely dissipated by Wave 3. Moreover, examining Wave 3 ACA approval separately for the participants whose responses we solicited one, two, and four weeks after treatment indicates that the erosion of the opinion shift occurred
quickly. The treatment effect on opinion of the ACA disappeared one week after treatment (the earliest possible time of the third interview), and there are no statistically distinguishable differences across the three time of interview conditions. Thus, while respondents retained much of their knowledge gains over a long period of time, their favorability toward the ACA reverted to pre-treatment levels soon after exposure to the information.

**Discussion**

We examined the conditions under which informational treatments affect factual beliefs and opinion about public policies (here, the Affordable Care Act). We found that providing individuals with informational treatments was an effective means of stimulating immediate knowledge gains. This is consistent with previous findings from both observational and experimental studies that information can stimulate political learning across a range of topics (e.g., Barabas & Jerit, 2010; Berinsky, 2017; Dixon et al., 2015; Dowling & Miller, 2015; Jerit et al., 2006; Nyhan & Reifler, 2015; Thorson, 2016). We also found that information led to immediate shifts in opinion about the ACA; again, this is consistent with much existing experimental work (Barabas & Jerit, 2010; Cobb et al., 2013; Gilens, 2001; Schueler & West, 2016; Sides, 2016).

Yet, if information can truly move opinion about a given policy domain in a meaningful fashion, we should expect its effects to last well beyond the moments following exposure, as a given individual must first receive and then internalize new information. Few studies, however, have examined the durability of shifts in factual beliefs or opinion that result from information provision. Indeed, an inability to measure effect duration has been a long-standing criticism of survey experiments (e.g. Gaines, Kuklinski & Quirk, 2007), and is an area of growing scholarly
concern in the area of survey experiment research (see: Chong & Druckman, 2010; Druckman, Fein & Leeper, 2012), and experimental (see: Gerber et al., 2011) and survey (see: Hill et al., 2013) research more generally. We attempted to address this shortcoming by conducting our experiment on a panel of survey respondents, which affords us the ability to measure the decay of treatment effects over a period of time randomly assigned to range between one and four weeks.

We found that shifts in factual beliefs are fairly enduring; while some of the effect decays, a significant portion of the treatment effect appears to linger over a period of time. Yet, the changes in opinion of the ACA that stem from information exposure appear to be more ephemeral. Shifts in opinion among our panel exhibited total decay during the duration of our experiment, returning to their pre-treatment levels. Thus, it appears to be more difficult for information to shift opinions in an enduring fashion, even though people do demonstrate a propensity for “long-term” learning. Put another way, although knowledge shifts and persists, opinions drift.

These results make three contributions to the understanding of citizen learning and opinion change, as well as ongoing scholarly debates about how long-lasting the effects of experimental interventions are. First, our findings offer some good news about mass knowledge in a democratic setting. Though low information levels among the voting public has been long-lamented in political science scholarship (e.g., Delli Carpini & Keeter, 1996), our findings suggest that focused educational efforts may be an effective means of boosting knowledge over a fairly meaningful period of time. Future work should consider whether and how the information source might affect learning. It remains to be seen, for instance, whether information can impact
knowledge in the same way across contexts, issues, or source objectivity (e.g., Berinsky, 2017; Nyhan & Reifler, 2010; 2013).

Second, we speak to the theoretical question about whether knowledge gains necessarily lead to opinion change. Specifically, our findings suggest that remembering facts is not a sufficient condition for sustaining shifts in individual-level opinion about policies. We view this as less normatively promising. In short, if sustained knowledge does not beget sustained opinion change, the democracy problem continues. Future work could determine whether and in what conditions information can spur enduring shifts in public opinion.

Last, our findings reinforce the idea that single-shot survey experiments, which cannot capture an ongoing political discourse over a period of time, are probably not the most valid tool by which to measure “meaningful” informational effects on political knowledge and/or opinion. Learning and opinion change occur over a period of time in a noisy world. We encourage subsequent research in this area to account for this, and to make further inroads toward an understanding of the manner in which information can shape knowledge and opinion over a period of time.

Although we believe our results make several important contributions, our findings are not without limitations. For instance, we examine a single policy area that is at once highly salient and complex. It could be that the there is something about the ACA itself that contributed to our findings. We might expect both factual claims and opinion to be most susceptible to change in complex, hard-to-understand policy areas, as opposed to “easier” questions on which individuals have well-formed beliefs (e.g., Carmines & Stimson, 1980).

Similarly, it is worth noting that with the exception of the mandated requirement for individuals to buy health insurance, the items in the Affordable Care Act that we include as
treatments are generally popular among the portion of people who know about them. It could be that the effects we report—especially with respect to duration—are particularly likely for policies like the ACA because individuals pay special attention to information that they believe may benefit them later. In contrast, people might be more likely to forget information that is negative or distressing, or that they decide is not useful. Thus, it is possible that our findings could be constrained to positive/popular issues. With these points in mind, future work could therefore extend our panel design to a range of other policy areas that vary in complexity, salience, and/or the extent to which people can classify them as positive and/or clearly partisan.

Our experiment also cannot speak to the mechanism by which knowledge shifts but opinions drift. It could be that exposure to other information eroded the shift in opinion that we observed; in this scenario, both our informational treatments and the new (unknown to us) information are retained, but the unknown information affected opinion of the ACA. To our knowledge, there was no major news story during our third wave that would be an obvious culprit on this front, but we concede the possibility. Alternatively, perhaps respondents re-interpreted our information over a period of time. Or, perhaps they shared the information in peer groups or other networks and were convinced to revert to prior opinions. Future work could more closely examine these possibilities in an effort to uncover the mechanisms underlying sustained shifts in factual beliefs, opinion, or both.
Endnotes

1 Of course, persistence of prior opinion in the face of updated factual beliefs need not require motivated interpretation of information. A single newly updated factual belief, weighed against all other considerations or affective judgments that shape opinion on a topic, may simply prove too small to shift the balance. Indeed, the affect associated with prior inaccurate factual beliefs can continue to shape opinions on a political topic even after the factual belief has been corrected (Thorson, 2016).

2 Additionally, observational and experimental evidence of the persuasive effects of campaign advertisements show their effects to be short-lived in the absence of sustained exposure (Gerber et al., 2011; Hill et al., 2013).

3 Although this is a convenience sample, the MTurk population appears more representative of the larger US population than student samples and has become a common source of study recruits in social science research (Berinsky, Huber & Lenz, 2012; Buhrmester, Kwang & Gosling, 2007; Paolacci, Chandler & Ipeirotis, 2010). For a more detailed discussion of the pros and cons of using this subject pool for research purposes, particularly in social science research, see, among others: Berinsky, Huber & Lenz, (2012); Buhrmester, Kwang & Gosling, (2007); Coppock, (2018); Huff & Tingley, (2015); Krupnikov & Levine, (2014); Mullinix et al., (2015); and Weinberg, Freese & McElhattan, (2014). For our purposes, the primary advantage of using MTurk was the ability to implement our own three-wave panel in which the timing of the third wave could be randomized across respondents. As is common with MTurk samples, the participants in this study skew Democratic and white; additionally, they skew to higher educational attainment (see Online Appendix Table A1). However, as analyses presented in
Online Appendix Table A7 show, the effects do not vary substantively by education, race, or gender. Differences in effects by party are reported in note 10 below.

4 This research received human subjects approval from [institution redacted]. Question wording for all questions is included in the Online Appendix.

5 Full question wording: “In 2010, Congress passed a large-scale health care bill known as ‘The Affordable Care Act,’ commonly referred to as ‘ObamaCare.’ Please use the slider below to express the extent to which you approve of this reform.”

6 Participants were also allowed an option to indicate whether they were unsure of the answer.

7 Participants completed Wave 3 from December 23 to December 29, 2014 in the first condition, from December 30, 2014 to January 5, 2015 in the second condition, and January 13 to January 19, 2015 in the third condition. The timing at which this study occurred, near the end of the calendar year, may be a particularly busy period for respondents, and they may thus be less likely to retain political information given to them by a survey. This may play a contributing role in the decrease of factual retention among the treatment group from Wave 2 to Wave 3 described below. However, it is also worth noting that such a pattern cannot explain why effects on opinion almost completely disappear by Wave 3, whereas effects on factual beliefs do not.

8 All of our results are restricted to the set of individuals who participated in all three waves of the study and passed an attention screen in Wave 1 (N = 652). The demographics and initial factual belief and opinion responses appear in column 9 of Table A1 in the Online Appendix. The table also displays values of sample characteristics at earlier waves of the study. Because the use of longitudinal data raises concerns about how either attrition or panel conditioning may shape our results, in the Appendix we present a series of diagnostic tests (see Appendix Tables
A1-A4 and their accompanying discussion) to assess the sensitivity of our results and conclude that the findings we present are not due to attrition or conditioning.

9 Mean responses for the individual items are contained in Appendix Table A6 (both overall and separated by party).

10 There is little evidence that either Democrats’ or Republicans’ perceptions of the facts are especially sensitive or impervious to factual information about the ACA. Despite the fact that Democrats are slightly more likely than Republicans to know the facts about the ACA (see Appendix Table A6), Republicans, who are initially more opposed to the ACA and therefore (potentially) more predisposed to reject factual information that might cast the law in a more favorable light (e.g., Nyhan & Reifler, 2010, but see: Guess and Coppock, 2018), exhibit patterns similar to Democrats with regard to their ability to learn about the law. In addition, the decay patterns for learning (presented below) tend to hold regardless of party identification. Results available upon request.

11 The initially correct also exhibit positive treatment effects on the accuracy trend for three of the five items, but these estimates take on a different meaning because they represent greater retention of accurate factual beliefs relative to the control group rather than greater gains in accuracy. Larger positive values of the treatment effect indicate smaller losses of accuracy from Wave 1 to Wave 2 for those exposed to the informational treatment.

12 Factual information especially boosts support for the law among Republicans (6.99), but has no statistically significant effect among Democrats (2.08).

13 There is modest evidence that exposure to information about specific elements in the law also increased support for those specific elements. Examining the effect of treatment on Wave 2 opinion on these specific elements while controlling for Wave 1 opinion reveals larger increases
in support for mandating the purchase of health insurance, prohibiting discrimination due to pre-
existing conditions, and providing free preventative care among individuals who were told the
ACA includes these elements but no difference in the trends in support for the two remaining
elements of the law. Furthermore, while these shifts in opinion were concentrated among treated
participants who did not initially express accurate factual beliefs about their existence in the
ACA during the Wave 1 interview (i.e., among those who learned about their relation to the law),
there is no evidence that the shifts were driven by ACA supporters changing their minds on these
elements once they learned they were in the law (i.e., coming to favor particular elements upon
learning that they are included in a favored law).

14 The findings displayed in Figure 3 are robust if they are broken out by respondents’ initial
response condition (incorrect, unsure, correct). See Online Appendix Figure A1.

15 Visually, the magnitude of the estimates in the left pane of Figure 3 is about one-third to one-
half of the magnitude of the estimates for the corresponding entries [open diamonds] in Figure 1.
References


Cobb, M. D., Nyhan, B., & Reifler, J. (2013). Beliefs don’t always persevere: How political figures are punished when positive information about them is discredited. *Political Psychology, 34*, 307-326.


Box 1. Information Treatment

Please take a moment to read the information below about current law related to health care in the United States. On the next page, we will ask you some questions about what you read.

***

“In 2010, the federal government enacted a large-scale piece of health care legislation. The new law, the ‘Affordable Care Act,’ commonly referred to as ‘Obamacare,’ implemented a series of new regulations on health insurance.

As of 2014, some of the major changes in effect as a result of the Affordable Care Act (ACA) include:

**Mandating the Purchase of Health Insurance.**
The ACA includes a requirement that people have health insurance, or else they must pay a financial penalty. In 2014, this penalty is the greater of $95 or 1% of income (up to $2,448) for each single adult without health insurance.

**Prohibiting Discrimination Due to Pre-Existing Conditions.**
The ACA prohibits insurance companies from refusing to sell coverage or renew policies because of an individual's pre-existing medical conditions.

**Eliminating Lifetime Limits on Insurance Coverage.**
Under the ACA, insurance companies are now prohibited from imposing lifetime dollar limits on essential benefits, like hospital stays.

**Providing Free Preventive Care.**
Under the ACA, all new plans must cover certain preventive services such as mammograms and colonoscopies without charging a deductible, co-pay, or coinsurance.

**Extending Coverage for Young Adults.**
Under the ACA, young adults are allowed to stay on their parents' health plan until they turn 26 years old.”
Table 1. Factual Beliefs of the ACA, Wave 1

<table>
<thead>
<tr>
<th></th>
<th>Correct</th>
<th>Incorrect</th>
<th>Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deny coverage based on pre-existing conditions</td>
<td>70.55</td>
<td>19.02</td>
<td>10.43</td>
</tr>
<tr>
<td>Impose lifetime limits</td>
<td>43.10</td>
<td>21.47</td>
<td>35.43</td>
</tr>
<tr>
<td>Charge deductible, etc. for preventative services</td>
<td>26.84</td>
<td>45.86</td>
<td>27.30</td>
</tr>
<tr>
<td>Deny coverage to those under 26 years old</td>
<td>66.56</td>
<td>20.40</td>
<td>13.04</td>
</tr>
<tr>
<td>Charge financial penalty for not having insurance</td>
<td>79.45</td>
<td>8.28</td>
<td>12.27</td>
</tr>
<tr>
<td>Average across five elements</td>
<td>57.30</td>
<td>23.01</td>
<td>19.69</td>
</tr>
</tbody>
</table>

*Note: Table entries are percentages. See Online Appendix Table A5 for comparison of this set of respondents to all respondents who participated and passed the attention screen in Wave 1.*
Figure 1. Immediate Effect of ACA Informational Treatment on Factual Beliefs

Note: The figure displays the difference between treatment and control conditions in the Wave 2 factual beliefs while controlling for initial factual beliefs at Wave 1, both overall and by initial response (at Wave 1) to the factual items about the ACA.
Figure 2. Immediate Effect of ACA Informational Treatment on Opinion

Note: The figure displays the difference between treatment and control conditions in Wave 2 opinion of the ACA while controlling for initial opinion at Wave 1, by initial response (at Wave 1) to the factual items about the ACA. Dashed vertical line denotes overall treatment effect (difference between treatment and control conditions in Wave 2) on opinion of the ACA of 3.44 (p<.01).
**Figure 3.** Persistent Effect of ACA Informational Treatment on Factual Belief and Opinion Change, by Wave 3 Treatment

Note: The figure displays the difference between treatment and control conditions in the Wave 3 factual beliefs (left pane) and opinion of the ACA (right pane) while controlling for initial Wave 1 response, by randomly assigned timing of Wave 3 interview. Dashed vertical line in right pane denotes overall initial treatment effect (difference between treatment and control conditions in Wave 2) on opinions of the ACA of 3.44 (p<.01).