



Transparency, Trust, and Security Needs for the Design of Digital News Authentication Tools

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Americans' trust in news is declining, and authenticity and transparency challenges in digital publishing contexts pose unique challenges to the ability to effectively gratify their information-seeking needs via online media. Cryptographic technologies and web-based provenance indicators have the potential to enhance the trustworthiness and transparency of digital communication, but better understandings of news consumers practices and needs are required to develop practical tools. Through a representative online survey of 400 digital news consumers and 19 follow-up interviews, we investigate how users authenticate and assign trust to news content, and identify specific needs pertaining to news transparency and authentication that could be met by digital news authentication tools. While many users currently rely on political ideology to assess news trustworthiness, we find that users of all political orientations see value in independent provenance and authentication tools for digital news.

CCS Concepts: • **General and reference** → **Surveys and overviews**; • **Security and privacy** → **Authentication**; • **Human-centered computing** → **User studies**.

Additional Key Words and Phrases: Information Authenticity, Usability and Human Interaction

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1 INTRODUCTION

Over the past two decades, an increase in the consumption of online news in both the US [12] and around the world has sparked significant research interest, as scholars attempt to understand how the shift away from printed media has affected the way in which the public uses news information. Understanding the implications of the shift towards digital publishing has taken on new urgency in recent years, as an increase in digital misinformation alongside Americans' declining trust in news media [62] has led to dramatic and ongoing disruptions in key areas of public life, such as politics[76] and public health[92]. While this phenomenon mirrors a broader loss of trust in institutions [27, 76], many questions remain regarding precisely *why* media trust has declined so precipitously in the US and how it might be rebuilt [90].

In this paper, we employ a uses and gratification [41] perspective to examine users' perceptions of news trustworthiness in relation to the affordances of digital news content and to investigate how that trust may be increased. Uses and gratifications theory regards media consumers as active participants in the media ecosystem and highlights key objectives that individuals may have for media use, including: information-seeking, identification with characters represented in media portrayals, simple entertainment, a means of enhancing social interactions or relationships, and/or an escape from everyday life [41, 77]. Supporting users' ability to achieve their information-seeking goals through digital news media requires identifying their current news consumption behaviors [27] and specific mechanisms for enhancing their trust in online news [12]. Many news authentication tools have been proposed or employed to aid news consumers' information seeking, but much research focuses on how effective these tools are at prompting mistrust of questionable news content rather than focusing on their potential to rebuild trust with credible publishers. By news authentication tools, we broadly mean digital applications that have been designed to provide indications of the genuineness or legitimacy of online news through a variety of mechanisms (e.g., fact-checking, bias identification, provenance authentication, etc.). Cryptographic provenance systems, which combine cryptographic protocols with a usable interface to confirm the provenance of digital content and surface this information to end users, are one type of news authentication tool that have the potential to enhance trust in news. These tools have received little research attention compared to fact-checking tools, though. Thus, it is valuable to understand user perceptions of the affordances of these tools, particularly in relationship to their ability to enhance trust when seeking news information online.

To find effective ways to support the information-seeking needs of US news consumers (our target user population), the nuances of this audience must be understood [11]. Prior work has demonstrated that trust in specific news organizations varies based upon a user's political identity (e.g., conservative, moderate, liberal) [84], highlighting the need to identify mechanisms for improving news trust across demographic and political lines. To accomplish this, we investigate how a demographically and politically representative sample of news consumers currently assigns trust to digital news media, as well as their attitudes towards specific technical mechanisms for guaranteeing provenance and accountability in digital news.

Through a representative survey of US digital news consumers and semi-structured interviews with a subset of survey participants, we investigate the following research questions:

- RQ1: What needs drive digital news consumers' digital news use, and to what extent are they being met by current digital news offerings?
- RQ2: What strategies, practices or features (if any) do news consumers employ to determine whether digital news is trustworthy enough to gratify information-seeking needs?
- RQ3: Would adding technical provenance and accountability guarantees to digital media enhance news consumers' trust in online news and information?

By surveying a carefully-constructed sample of digital news consumers and conducting follow-up interviews, this work makes two primary contributions to the existing body of research on the relationship between digital media affordances and trust. First, our findings offer a nuanced portrait of how online news consumers are navigating the current digital media landscape as they try to meet their information-seeking needs, complementing and elaborating on previous work in this area. Second, we identify specific cryptographic mechanisms for providing provenance and accountability guarantees around digital media that a wide cross-section of our politically-diverse participants said would enhance their ability to trust online media. Unlike previous work that focuses solely on the addition of contextual information to increase trust in digital media (e.g. [6]), we investigate how adding a layer of immutable *infrastructure* to the digital publishing process can improve trust in online news across the political spectrum. In doing so, we contribute findings on how users perceive the usefulness of cryptographic provenance systems for facilitating increased trust in digital news through their content transparency and authentication affordances. Taken together, our results offer valuable insight into how users negotiate the current digital news environment and how adding cryptographic guarantees to the provenance and transparency of digital information can effectively support them in using digital media to gratify their information-seeking needs.

To summarize, we make the following contributions:

- characterize the mismatch between the trustworthiness needs of politically-diverse online news consumers and the current technical affordances of digital publishing
- build on prior work about the consumption habits of online news consumers, confirming that these patterns also apply to younger Americans who consume less “traditional” news
- reveal that adding immutable, cryptographically-guaranteed logs of the original provenance (date, content and publisher) of digital information and any subsequent changes would increase the trustworthiness of online news information for news consumers across the political spectrum

2 RELATED WORK

2.1 Digital News Consumption and Lack of Trust in News

A wide body of recent research examines both the extent to which news consumers trust digital news, and what factors contribute to this trust. Kalsnes and Krumsvik [39], for example, investigate the role of media executives’ efforts to build trust in news, while others have explored the relationship between news exposure and media trust [91], political trust [60], and the impact of social media spaces on news consumption [35]. In the United States (US) specifically, much attention has focused on the loss of trust in news [11], with researchers documenting a progressive decline in media trust over the past 15 years [8, 27, 87]. As of 2020, 50% of Americans reported major misgivings about journalists and the news media [11]. While this shift corresponds with a broader loss of trust in institutions [27, 76], we note that the recent increase in manipulated media [24] has shifted the way that online news is consumed and shared [48, 57].

Previous attempts have been made to understand the problems of lack of trust in news [11, 89], but many fail to identify specific factors associated with distrust in media, instead addressing distrust in general terms. Recently, work examining factors including various types of transparency (e.g. [27, 90]), audience engagement (e.g. [90, 97]), and racial and ideological diversity in newsrooms (e.g. [26]) have attempted to more precisely locate specific news characteristics and publisher actions that can influence consumers’ trust in news media. Somewhat discouragingly, the most reliable predictor of US news consumers’ trust in a given media outlet over the past 20 years has been the media organization’s brand and the political identity of the individual [25, 31, 86].

At the same time, relatively little work has addressed the way in which the technical affordances – and limits – of digital media may influence media trust, even as research (e.g. [31]) has indicated that it remains difficult for consumers to efficiently detect deception and properly assign credibility to online news. While some work has explored the impact of presenting additional context within the user interfaces for news (e.g. [6, 100]) the effectiveness of these measures was not robust across the political spectrum. By contrast, our work focuses on improving the trustworthiness of the *infrastructure* used to deliver digital news.

2.2 Types of Transparency in Digital News

While “transparency” as a key value in American journalism can be traced back to the 1920s [51, 52], the nature and extent of news publishers’ transparency has been a subject of debate for more than two decades [8, 59, 69, 82], in part because research has identified several *types* of transparency that have different degrees and types of influence on e.g. consumers’ trust in news [27, 90].

Among the types of transparency investigated by researchers are transparency around both what news producers *do* know about a story, but also what they did/do *not* know and how they vet information [8, 69]. In [59], transparency was characterized as allowing news consumers to observe the practices, protocols, and workflow of the newsroom, as well as interact directly with the writers to gain more insight into their personal perspectives. In [82], transparency is about the perceived quality of intentionally shared information from the producer.

In digital journalism and online news specifically, investigations of news “transparency” mechanisms tend to center on providing additional context to reported information. In [69], for example, researchers examined the role of hyperlinks to data sources and providing a list of donors on a nonprofit news site. More recently, researchers identified the importance of transparency around issues such as story framing and the number and nature of corrections to an article[6]. Although there is some research on consumers’ interest in such tools [17, 36, 37, 79], their overarching focus on fact-checking news and “fake news” identification [17, 36, 37] may limit their efficacy across a heterogeneous public. While some of these systems show promise, they fundamentally operate at the *interface* rather than the *infrastructure* level: while news consumers may be reassured by additional contextual information, current systems offer no guarantees that such information has not been changed since publication – or that it might not change without notice or record in the future.

This points to a persistent challenge of authenticating digital news and information: at present, manipulated content can be circulated online with no easy or reliable way for consumers to confirm the provenance of the article [83], in part because, by its digital nature, online news content can be changed or deleted by the publisher without leaving any evidence of the change [71] (e.g. Figure 1). It is also possible for online news publishers to edit digital articles to hide mistakes and neglect to inform their readers about these changes or “ghost edits” [28]. Issues such as these complicate the consumers’ abilities to authenticate and evaluate news, contributing to distrust in digital news and the spread of misinformation [28, 83].

While some novel technical systems have been proposed for evaluating the credibility online content (e.g. [20, 43, 61, 95]), many of these rely on cues such as page rank, popularity, and linguistic structures to assess the “objectivity” or “truthiness” of news content – characteristics that more recent work has found to be relatively manipulable[42]. Of the few tools that prioritize transparency, most require the journalist to provide additional information or perform additional tasks [58, 81] adding additional burdens to a heavy workload[19]. Moreover, a large proportion of prior work was conducted outside of the United States [17, 36, 37, 79].

Because of this, this work specifically assesses how a system that provides immutable, cryptographically-guaranteed transparency around the provenance of digital news could meet the needs of US news

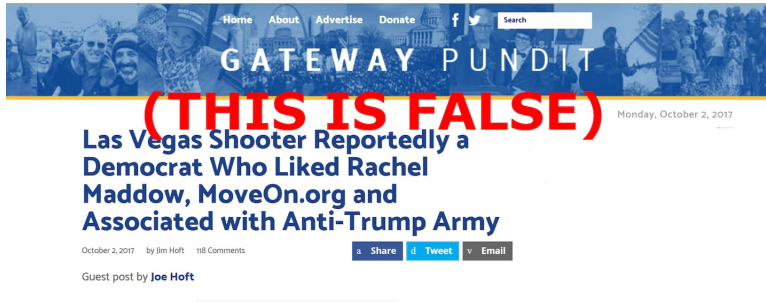


Fig. 1. Screen capture of a Gateway Pundit article published shortly after the 2017 Las Vegas shooting. The original article link now resolves to a 404 error page and images like this one, published with a "THIS IS FALSE" annotation by The Washington Post[67], are the only remaining evidence of its publication.

consumers. First, by addressing existing constraints and leveraging affordances of current digital publishing infrastructure, this study examines the efficacy and affect of capturing provenance data in cryptographically secured logs and displaying them to news consumers. Second, with its survey sample focusing on U.S. news consumers, we are able to focus this study's attention to a politically diverse population. Finally, with younger age groups robustly represented in our sample, we are able to confirm existing news consumption habits in this specific demographic and test whether new tools leveraging provenance information are equipped to serve one of the most rapidly growing age groups of news consumers.

We also note that while US news consumers want more transparency from publishers, if this transparency requires too much effort on the part of the consumer, its value is lost [59]. The typical news consumer needs a straightforward method to understand the decisions and criteria used by journalists when reporting news - the easier the method is to understand, the better [69]. Thus, even a system that provides technical guarantees around news provenance and corrections must be truly usable by news consumers in order to offer real value.

2.3 Uses and Gratifications of Digital News

Research indicates that individuals use news to gratify a range of needs, including escape, boredom, entertainment, information, and habits [16, 49, 94]. People can be motivated by multiple gratifications when consuming online news, but the emphasis on various motivations correlates with different usage patterns [49]. For example, news sharing on social media has been found to be motivated by interpersonal expression [34], status-seeking, sociality, and informativeness [50, 53], while specifically sharing *fact-checks* of news content on social media is predicted by a need for orientation [4]. Similarly, [50] found that differences in the strength of reported motivations predicted variations in individuals' *intentions* with respect to sharing news.

U&G theory posits that people are purposeful in their media use and choose between competing media options based on their perceived ability to gratify various needs[41]. U&G research explains and predicts the usage of media and communication technologies, identifying users' motivations and the related gratifications (i.e., need-fulfilling outcomes) they associate with specific media or technologies. U&G has proved useful not only to explain and predict general engagement with digital communication and media technologies, but also more granular interactions with those technologies. For example, U&G has been applied to understand motivations for engaging in specific behaviors such as "liking" posts [44] or participating in community groups [40] on social media. U&G has enhanced understandings of the motivations for and patterns of news consumption

since the 1940s [5] and continues to be utilized to effectively explain differences in frequency and variety of news consumption [49]. Past U&G research has identified individual differences, motivations, and gratifications which predict a variety of digital news consumption behavior, including: frequency of news consumption on news websites [16], click-throughs on digital news headlines [63], political newsletter usage [38], news sharing and fact-checking behaviors on social media [4, 50, 53], decisions to follow news personalities on social media [32], and watching and sharing news content on YouTube [34].

In this work, we draw on a U&G perspective to investigate the potential for a cryptographic provenance system for digital news in supporting digital news consumers in using online news for gratifying information-seeking needs by increasing their trust and confidence.

2.4 Cryptographic Systems and Interfaces for Online Information

Research on providing in-browser security warnings to protect users from insecure connections, malware, or phishing sites – which draw on the cryptographic infrastructure of the web – date back to at least 2007 [80]. However, this work consistently indicates that warning messages are widely ignored and misunderstood, with most users either ignoring or clicking through such warning indicators [1, 18, 22, 23]. Because passive indicators are easy to overlook [1, 80], attention has turned to the deployment of more intrusive modal (full-screen) warning messages [1] which present the user with choices and recommendations on how to proceed [18]. Large-scale studies have found that user behavior with respect to such warnings varies considerably, even between the same user on different days [3], and multiple factors account for users ignoring warning messages [74]. Recent design efforts have focused on simple and consistent security indicators [23, 85].

Underlying these indicators and warning systems are a range of cryptographic protocols – most prominently the Certificate Transparency (CT) protocol [46, 47], launched in 2013. The goal of Certificate Transparency is to improve public trust in certificate authorities (CAs), who issue x.509 certificates for use by TLS servers on the web. Under CT, all certificates issued are permanently recorded in a public log which anybody can monitor, so improperly issued certificates can be detected. Unlike many previous cryptographic designs, CT does not directly prevent “misbehavior” by CAs (which lacks a precise technical definition); rather, it ensures that their behavior is observable and non-repudiable.

Similar transparency systems have been proposed for monitoring several other types of authority, including user-key mappings in secure communication systems [55, 78], cryptographic key usage [101], and distribution of software [2, 21, 64]. Recent research proposes general-purpose transparency protocols [15, 54, 93] which can be adapted to any authority regularly publishing and updating information.

We note that within the field of cryptography, transparency has a specific technical definition [14] that is narrower than general usage of the term. Cryptographic transparency systems only guarantee that any actions taken (such as issuing a certificate) are permanently and publicly visible, and are consistent to all observers.

In this work, we explore the possibility of adapting these types of tools to news, by proposing that news publishers cryptographically sign all news content published and enter those signatures in an immutable (e.g. blockchain) log. This practice can be automated and integrated into existing publishing pipelines, meaning this type of authentication infrastructure could seamlessly integrate with journalists’ current practices. Furthermore, it would provide news consumers with unique transparency guarantees. By integrating cryptographic protocols with a usable interface, cryptographic provenance systems have the potential to serve as effective tools for news authentication. There is some evidence that news users would value added transparency indicators for digital news [6]; yet, little is known about what features news consumers would value in a news authentication

tool or whether users perceive the types of transparency indicators afforded by a cryptographic provenance system as useful for enhancing trust in digital content.

3 METHOD

Our study consists of an online survey and a set of semi-structured follow-up interviews, allowing us to obtain comprehensive quantitative data on U.S. adults' behaviors and preferences with respect to online news consumption, trust, and authentication while also gaining rich qualitative insights. Mixed method studies provide an integrative approach that is important for understanding the multi-dimensional nature of online news consumption [56]. To support a representative sample and to protect participant safety during the COVID-19 pandemic, both the survey and interviews were conducted remotely. Participants were recruited through Prolific Academic, an online research recruitment platform which has been shown to produce diverse, quality samples [68, 70].

3.1 Study Procedures

All of our study procedures were approved by our university's institutional review board. To ensure the quality of our research instruments, both the survey and interview design processes were approached iteratively, combining several rounds of feedback from a team of user research experts and subject matter experts on digital news and journalism. We also conducted several cognitive walkthroughs of the survey and interview instruments with a lay audience. Finally, we conducted a survey pilot with 20 Prolific participants to assess its clarity and usability, and to set a fair compensation rate.

Survey Instrument. The final survey instrument, including a detailed breakdown of item sourcing and modifications, can be found in Appendix A. The survey consisted of 46 questions which varied among Likert scales, multiple-choice questions, drop-down questions, and free-response text. Questions corresponded to four main categories: how participants consume news, how they authenticate the news they consume, how they assign trust to different news sources, and how they perceive the usefulness of specific hypothetical news authentication tool features. Where possible, questions were taken from existing surveys (e.g. [12], [11], [84], [45] and [10]). We also developed original items as necessary.

Interview Materials. The interview script covered three main topics: perceptions of news trustworthiness and transparency, news authentication or evaluation practices, and perceptions of/preferences for different features of a hypothetical news authentication tool. These queries were designed to help us better understand how participants define news transparency, what different factors influence their trust in news, and how they would prefer to receive alerts and notifications when reading news online. Since we used a semi-structured approach, questions were adapted and added throughout the interview process. The final interview script can be found in Appendix B.

3.2 Recruitment, Screening and Data Collection

Data collection occurred in the summer of 2021. Throughout the recruitment and data collection process, we implemented several strategies to promote a representative sample and quality data.

Recruitment Our pilot sample of 20 participants showed a good age and gender balance, but skewed liberal. Since political ideology and race correlate with news consumption and trust in news ([84], [12]), we used the Prolific pre-screener tool to stratify participants across these dimensions. Given that a representative sample of the U.S. population can be constructed with approximately 370 participants [88], our target sample size for the survey was 400 participants. Data from the US census [9] and Gallup [30], [29] were used to create quotas to stratify across race (simplified to majority/minority race categories) and political ideology (conservative, moderate, or liberal). Six Prolific studies were created to recruit participants from each race and political ideology category

based on their pre-recorded answers to the “Political Spectrum (US)” (i.e., “Where would you place yourself along the political spectrum? Conservative, Moderate, Liberal, Other, N/A”) and “Ethnicity (Simplified)” (i.e., “What ethnic group do you belong to? White, Black, Asian, Mixed, Other”) Prolific pre-screener questions. Pre-screensers for “Current Country of Residence”, “Age”, “Fluent Languages”, and “Approval Rate” were used to ensure that only participants who resided in the U.S., were over 18, fluent in English, and have a study approval rating of 95 percent or higher were shown our study. Prolific participants who responded to the pilot survey were also excluded using a pre-screener. Pre-screening participants allowed us to promote a more representative sample while avoiding the need to ask questions about race and political ideology as screeners, discouraging priming. Halfway through data collection we found that females were over-represented in our sample, so an additional screener was added (e.g., “Gender Identity”) to collect male participants from each recruitment category in response to this imbalance. At the end of the Qualtrics survey, the 90 respondents who reported being interested in participating in an interview were recruited for follow-up interviews.

Screening and Data Collection Survey participants were given a definition of online news and asked to indicate which of four scenarios was *not* an example of online news based on this definition; participants who answered this question correctly within five (5) attempts were allowed to proceed with the survey. Eligible participants proceeded to answer questions on their news consumption, perceptions of news trustworthiness and transparency, their news authentication practices and preferences, and, lastly, their political ideology and other demographics. Upon completing the survey, participants were automatically redirected back to the Prolific platform and provided with a survey completion code. After their submission was approved, participants received 3.17 USD in compensation through the Prolific platform. (This amount was set per Prolific’s suggested compensation for a 20-minute survey, which was the average completion time of a previous pilot survey). On average, the questionnaire took 17 minutes and 24 seconds to complete.

As part of the survey procedure, participants whether they would be interested in participating in a follow-up interview; those who answered “Yes,” “Maybe,” or “I’d Like More Information” were invited to join the interview portion of the study three weeks after completing the survey. To ensure confidentiality, participants were given instructions on how to change their Zoom name to their Prolific ID to protect their privacy, and they were sent a Zoom link 24 hours before their interview. Participants engaged in 60-minute Zoom interviews with our research team. The interviewer began by explaining the purpose of the study and reviewing the consent form with the participant. After receiving verbal consent, the interviewer began audio recording. The discussions followed a semi-structured format. Participants were asked questions about their beliefs about news transparency, trust in news, and their needs and preferences surrounding news authentication tools. Upon completing the interview, participants were compensated 20 USD through the Prolific system.

3.3 Participant Demographics

Overall Sample Characteristics. Originally, a total of 422 survey submissions were received through Prolific, of which 400 were retained for analysis (17 were returned because participants did not meet the survey criteria or they chose to stop the study; 4 surveys timed-out; 1 was rejected because it lacked a completion code).

As shown in Table 1, the demographic characteristics of our survey respondents reflect trends in the US population [66], including political orientation [29]. Our sample was 51% men (US $\approx$ 49%) and 48% women (US $\approx$ 51%), and also reflects the 70-30 split in the United States between majority and minority racial populations [66]. Politically, 40% of men in our sample identified as conservative (US $\approx$ 38%) in their Prolific pre-screener, 37% as moderate (US $\approx$ 36%), and 23% as liberal (US $\approx$

22%). For women, 35% identified as conservative (US $\approx$ 31%) in their Prolific pre-screener, 36% as moderate US ($\approx$ 35%), and 29% as liberal US ($\approx$ 30%). Our participant sample does, however, skew young, with 60% of respondents in the 18-24 age bracket, though the mean participant age was 26.57 (SD = 9.66, Min. = 18, Max. = 77).

The average participant follows the news some of the time ($M = 1.83$, $SE = .04$). In most instances, these consumers get news because they happen to come across it ($M = 0.30$, $SE = .02$). As shown in Table 2, participants consume news through a range of devices. Participants report they "often" got news from a smartphone, computer, or tablet ($M = 2.74$, $SE = .03$). Participants preferred to get news on a mobile device ($M = 1.14$, $SE = .02$) rather than a laptop or computer. For mobile devices, 93% of participants consume news on their smartphone, and only 22% consume news on a tablet. In order of frequency, over the course of a typical week, participants get their online news from websites or apps ($M = 4.12$, $SE = .11$), search engines ($M = 3.53$, $SE = .11$), and news aggregators such as Apple News, Flipboard, Pocket, Google News ($M = 3.18$, $SE = .13$). The two least common venues for consuming online news were podcasts ($M = 2.33$, $SE = .14$) and YouTube ($M = 2.33$, $SE = .14$).

Demographics of Interview Participants. Seventeen participants from the original survey sample were recruited for follow up interviews. Five participants did not attend their scheduled interview, resulting in a total of 12 interview participants from the initial study. Table 1 shows the demographic characteristics for these 12 interviewees. These participants represented a range of ages (Min. = 20, Max. = 66, $M = 37.09$, $SD = 17.29$), genders, races/ethnicities, political ideologies education levels, and technology knowledge.

To increase the number of interview participants, a second recruitment phase was launched. In this phase, participants were tasked with completing the questionnaire under the stipulation they then participate in an interview. Otherwise, the same Prolific pre-screener and survey material were used. A total of 19 submissions were received through Prolific, of which 11 were retained for analysis (3 were returned because participants chose to stop the study and 5 surveys timed-out). Table 3 displays the demographic characteristics of the survey respondents from our second recruitment.

Although 11 participants completed the initial survey, only seven participants went on to participate in an interview. These participants varied by age (Min. = 22, Max. = 58, $M = 36.29$, $SD = 12.84$), gender (2 female, 5 male), races/ethnicities (1 Hispanic and White, 6 White alone), political ideologies (2 conservative, 3 moderate, 2 liberal), education levels (2 high school diploma, 2 some college, and 3 postgraduate degree) and technology knowledge (7 intermediate).

3.4 Analytical Approach

The survey data were analyzed using the R [73] statistical environment and the pastecs [33], psych [75], and ggplot2 [98] packages. Descriptive statistics and data plots were obtained for the survey items and t-tests and ANOVA were run to test relationships between relevant variables.

Thematic Analysis (TA) was used to analyze the interview data. TA uses recursive data analysis to identify patterns of meaning in data and was chosen for its usefulness in generating contextually-grounded insights [7]. First, Zoom's transcriptions of the audio recordings were cleaned and converted to Google sheets for collaborative coding. Four guiding questions were used to focus the analysis on concepts relevant to the research questions: (1) What factors impact participants' trust in news content?; (2) What criteria or terms do participants use to define transparency? In particular, what do participants believe news producers are least transparent about, and what do participants believe news producers are/should be most transparent about?; (3) What resources and practices do participants currently use to authenticate news?; and (4) What features do participants seek in a news authentication tool?. Three researchers independently conducted line-by-line coding and then met to collate, sort, and identify themes and sub-themes that properly represented trends

across participants; these themes were compared to the raw interview data to ensure they were grounded in the data [65].

4 RESULTS

We present results on participants' perceptions of the authenticity and trustworthiness of available digital news sources, and how they believe current practices of authenticating digital news succeed or fail. In addition, participants shared the factors likely to affect their usage of a tool that could to support them in filling their desires to be informed and/or educated with authenticated news.

4.1 Digital News Consumers Needs and Digital News Offerings

The following sections outline survey and interview findings relevant to RQ1, which explores digital news consumers' information-seeking needs when engaging digital news and the extent to which the gratifications they seek are obtained.

4.1.1 Needs and Gratifications Motivating Digital News Use. In the interviews, participants indicated being motivated to engage digital news content to meet needs for entertainment, information-seeking, social connection and status-seeking, self-expression, and habitual use. These needs were often implicitly stated. For example, P6 indicated that they gratified needs for social connection and group belonging through their news use when they stated:

"Sometimes my friends tend to retweet a lot of stuff that's happening. So I'll be like, 'oh this, let me read about it.' Or if they send it to me that I'm like, 'Okay, let me read about it because they sent it to me. They want me to read it.'" —**Participant 6** (Female, 20, Hispanic, Liberal)

Others indicated their news use was associated with multiple motivations and gratifications. For example, P15 describes a typical day of reading the news:

"Typically, I start the day once I'm up and ready then I'll usually log into the computer. I have kind of a few sites I like to check, including CNN and Fox and BBC. That's kind of one of the first things I do in the morning. Then, throughout the day at work, as I think of it I'll click on usually Fox and CNN. I just want to look at both because I think they're kind of both sides of the spectrum, so I try to look at both of those throughout the day. Then in the evening when I come home from work, I typically watch the local news channel, whatever is playing at the time that's convenient. And then, in the evening, if I'm on the computer again, I'll check periodically just CNN and Fox primarily." —**Participant 15** (Male, 58, White, Conservative)

This description implies that the participant's news consumption is motivated by habit, information-seeking, self-expression, and likely group belonging. In addition to indicating a variety of motivations for consuming digital news in general, participants also revealed they have specific needs and expectations regarding the trustworthiness and authenticity of digital news. Our findings on the gratifications sought are outlined in detail in the following sections.

4.1.2 News Consumers' Trust in News. For the average news consumer, how often they trust the information they receive online depends on the source of news. If the information is coming from a local news organization, they are likely to trust it most of the time ($M = 2.57$, $SE = .05$). If the news is instead provided by a national news organization ($M = 2.44$, $SE = .05$), or received through friends, family and acquaintances ($M = 1.84$, $SE = .05$), consumers trust it about half the time. Information gathered through social media is the least likely to be trusted, with participants only sometimes trusting this news ($M = 1.43$, $SE = .05$).

Table 4 shows trust in news source types broken down by political ideology. Political ideology had a significant effect on how often participants put trust in news from national news organizations ($F(1, 398) = 17.59$ $p < .001$, $\omega = 0.34$), local news organizations ($F(1, 398) = 6.917$ $p = .009$, $\omega = 0.17$) and family and friends ($F(1, 397) = 9.70$ $p < .001$, $\omega = 0.26$). Liberal news consumers trusted information provided by national and local news organizations more often than Moderate and Conservative consumers. Conservative news consumers trusted information provided by family and friends more often than Liberal and Moderate consumers.

In the interviews, many participants reflected that their trust in news was low or had declined in recent years. For P2, recent reporting on the billionaire space race causes her unease:

“What they choose to report on is pretty disturbing. I don’t know why we all needed to hear about Jeff Bezos’ rocket into space for hours and hours and we’re not hearing anything about the climate summit.” —**Participant 2** (Female, 33, White, Liberal)

P5 quickly traced her distrust in news to the 2016 election:

“You know I didn’t feel this cynical about the news until Trump. And it’s almost like he shone a light on things.” —**Participant 5** (Female, 64, White, Conservative)

P4 on the other hand could not point to a specific event that spurred his distrust in news:

“Generally, I don’t really trust most of what I read a news article...I don’t really, like, feel like anything that I read is 100% of the truth, as there’s probably something missing.” —**Participant 4** (Female, 30, White, Liberal)

4.1.3 Consumer’s Concerns About News Publisher Practices and Lack of Transparency.

In the survey, participants were asked how often various bad practices occur on the part of news publishers (See Figure 2). For all of the listed bad practices, consumers reported they happened at least “sometimes.” Consumers believed three things happened “often” in news: two or more different versions of the same article are circulated online ($M = 3.11$, $SE = .05$), fake news articles appear online ($M = 2.89$, $SE = .05$), and changes are made to news articles without being documented ($M = 2.54$, $SE = .04$).

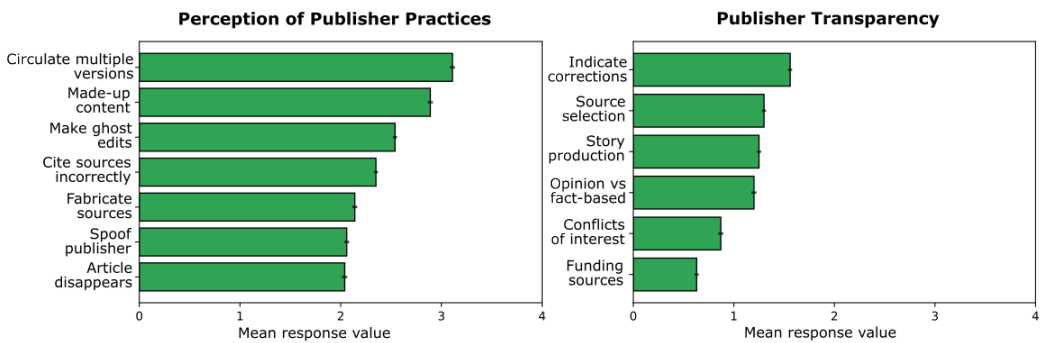


Fig. 2. (a) Bar chart showing mean perceived frequency of the seven bad habits practiced by news publishers for all participants, measured based on a 5-point Likert Scale where 0 represents “This Never Happens” and 4 represents “This Happens All The Time”. (b) Bar chart showing mean perceived level of communication for six aspects of publisher transparency for all participants, measured based on a 4-point Likert Scale where 0 represents “Not At All Well” and 4 represents “Very Well”. It is important to note that all error bars included on the chart are standard error bars.

We examined whether participants from different ideological groups differ on their beliefs on how often these problems occur (See Table 5). Political ideology had a significant effect on how often participants thought sources were incorrectly cited in news stories, $F(1, 397) = 14.6191$ $p < .001$, $\omega = 0.298$ and on how often participants thought a news story they previously read online becomes inaccessible on its original website, $F(1, 394) = 8.008$, $p < .001$, $\omega = 0.214$. Conservatives believe that sources are made up for news and news stories become inaccessible online more frequently than Moderates and Liberals believe these things occur (see Table 5).

In regard to news transparency practices, participants believed news organizations did not do well at communicating with their audience about key aspects of the publishing process, including how they produce their stories, where their funding comes from, whether conflicts of interest exist, whether a story is opinion-based or fact-driven, and how sources for stories are selected (Figure 2). At best, participants believed producers did "somewhat well" when it came to communicating that a correction had been made to a news story ($M = 1.56$, $SE = .04$). Participants also believed that, in general, news organizations try to cover up their mistakes ($M = 0.27$, $SE = .02$). They maintained that it is better for society if Americans are skeptical of the news media ($M = 0.28$, $SE = .02$).

In the interviews, participants reported specific expectations when it comes to what news transparency should look like. P1 (Female, 20, White, Asian, Moderate) was one of many to say transparency involves "getting both sides of the argument" as well as "being truthful in general" and telling the news "as is". Transparency also involves making timely, informative corrections that are easy for the reader to find. P3 (Male, 36, Hispanic, Liberal) said he wanted publishers to "Make just as big of a deal about corrections as they did about the actual story." Many participants reported that citing sources and disclosing personal bias or possible incentives are crucial to news transparency.

4.2 Digital News Consumers Authentication Strategies

The following section outlines survey and interview findings relevant to RQ2, which explores how digital news consumers assess authenticity and trustworthiness of available digital news sources.

4.2.1 Digital News Consumers Current Authentication Practices. Figure 3 depicts survey participants' self reflection of their critical news consumption skills. In all areas, they acknowledged that they could accomplish tasks such as distinguishing different functions of digital news media, determining the accuracy of the content they consume, and assessing credibility, reliability, and objectivity of online news. Participants agreed that they give a good deal of thought to where they get their news ($M = 2.94$, $SE = .05$). They also agreed that they usually turn to the same place in order to get their news ($M = 2.88$, $SE = .05$). Even though they often rely on the same publishers, participants only sometimes paid attention to the news source a link will take them to when reading online content ($M = 2.07$, $SE = .04$). Although the average consumer had not seen a news organization make an official correction to a story in the past few months ($M = 0.41$, $SE = .03$), they agreed that when they do see a news organization issue an official correction, it typically makes them feel less confident in the organization ($M = 1.16$, $SE = .04$). Participants typically go into a news story expecting that it will be moderately accurate ($M = 0.79$, $SE = .02$). In the occasions when they come across something that they believe is inaccurate, the consumer will sometimes take it upon themselves to figure out if the content is true or not ($M = 2.41$, $SE = .05$).

In the interviews, participants reported several types of news authentication and assessment behaviors when reading news online. These included: looking at the news publisher, looking at who shared the article, looking at the date of the article, reading corrections in a current article, clicking through to embedded content, Googling article content to compare with other content

online, and checking the article's sources. Most participants reported they do not check the URL of articles after clicking on an article link.

When evaluating the news publisher or the sharer of a news article, participants reported making trust evaluations based on whether the news publisher aligned with their political ideology. For example, P14 admitted:

"I have to say, from my experience, [untrustworthy news] almost always seems to come from, again, like republican type sources; because I follow politicians from both sides, as well, and I've been fooled by that in the past." —**Participant 14** (Male, 34, White, Liberal)

For the majority of participants, news published or shared by an entity from an opposing political party was considered less trustworthy. Participants also used the perceived trustworthiness of their social contacts or news organizations/aggregators as a proxy for the trustworthiness of a shared or curated article. This was especially true when consumers used news aggregators like Apple News and Google News to get information. P7 explains why she does not double-check that an article is coming from the stated publisher:

"I think it's because I'm linking from Apple News, I'm thinking I'll just trust that. All those links are real." —**Participant 7** (Female, 48, White, Moderate)

In regard to checking the date of an article and scanning for correction statements, users reported assessing these indicators on metrics of timeliness and appropriateness. For example, when asked if he pays attention to the dates on news stories, P4 responded:

"That I do look at, to make sure I understand if I'm reading something like actually new or from like years ago that someone's trying to sell as new." —**Participant 4** (Female, 30, White, Liberal)

Other participants reported similar associations between article recency and trust, with more recent articles being perceived as more likely to be trustworthy or accurate. Additionally, although participants indicated that they expect trustworthy publishers to identify corrections, the existence of a correction statement did not translate directly into an indicator of trustworthiness. Several participants indicated the frequency, timing, and magnitude/nature of the correction are important to consider. Frequent corrections were considered an indicator the publisher was not trustworthy. Trustworthy publishers were expected to provide timely corrections that were provided in a way appropriate to the magnitude of the mistake and importance of the corrected information. For example, P3 stated that when it comes to corrections:

"I'd like to see it addressed as soon as possible. I'd like to see it be made a kind of a big deal, like, 'Hey, we made a mistake, and we want to make sure that you know we made this mistake'." —**Participant 3** (Male, 36, Hispanic, Liberal)

4.3 Perceived Need and Desired Features for a News Authentication Tool

The following section outlines survey and interview findings relevant to RQ3, which explores how a news authentication tool that provides technical provenance and accountability guarantees to digital media might enhance news consumers' trust in online news and information. In the survey, we asked participants a series of questions on whether they would use four authentication features (all which could be afforded by a cryptographic provenance system) and whether having access to a tool that provided these features would increase their trust in news. In the interviews, we also explored additional features users would prefer in a news authentication tool. Our survey findings suggest that the four features (i.e., authenticating article provenance and embedded material, identifying equivocation, creating a record of changes) all gratify needs of online news consumers.

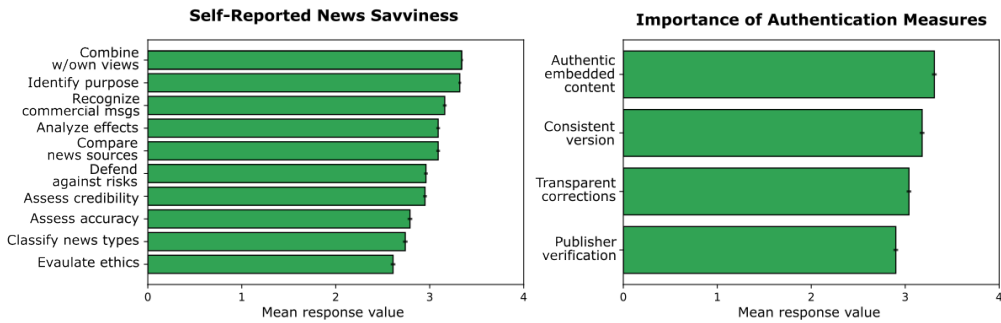


Fig. 3. (a) Bar chart showing mean self-rating in ten areas of critical news consumption for all participants, measured based on a 5-point Likert Scale where 0 represents "Strongly Disagree" and 4 represents "Strongly Agree". It is important to note that all error bars included on the chart are standard error bars. (b) Bar chart showing the mean level of importance of four authentication measures for all participants, measured based on a 5-point Likert Scale where 0 represents "Not Important" and 4 represents "Very Important". It is important to note that all error bars included on the chart are standard error bars.

The interviews also illustrate that creators of news authentication tools must implement these features in a way that meets users' specific preferences if they hope to achieve the desired effect.

Across the survey and interview results, participants showed a strong interest in authenticating their digital news. In the survey, to assess whether users are interested in receiving information about common issues related to news transparency and authenticity (e.g., incorrect source attribution, equivocation, ghost edits, and fabricated news), participants were asked to rate how important it was for them to know that their news (1) is coming from the stated source, (2) they are seeing the same version of a news story that other people are seeing, (3) that changes have been made to the story since it was first published, and (4) that embedded material in a story is authentic. Participants indicated they were interested in being informed about all four categories, with most averages falling between "3 = important" and "4 = very important" (Figure 3). We investigated whether ideological groups differed in their preferences. We found there were no statistically significant differences ($p > .05$) in preferences between ideological groups (Table 6); all though it was important to know this information when reading news online.

Next, we investigated whether participants perceived that having news authentication tools that provided these four features would impact their trust and confidence in news:

- Showed every change to an article since it was published
- Confirmed a news article was coming from the stated publisher
- Indicated whether or not a publisher shows two different versions of the same article to different users
- Confirmed that embedded material in a news article was authentic

The average participant agreed that all four features - authenticating embedded content ($M = 3.32$, $SE = .04$), authenticating the original publisher ($M = 3.20$, $SE = .04$), showing all edits ($M = 3.13$, $SE = .05$), and acknowledging article versions ($M = 2.77$, $SE = .06$) - would enhance their trust and confidence in the news they read (Figure 4). Participants were also asked to rank these features on a 1 to 4 Likert scale representing most likely to use to least likely to use. The typical news consumer indicated they were most likely to use the feature that tracked changes to a news article ($M = 2.19$, $SE = .05$). The feature that makes readers aware when two different version of the same article are

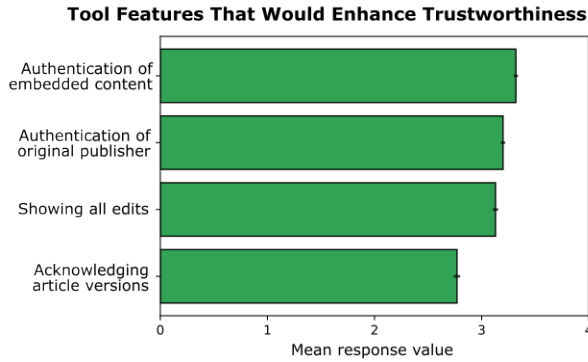


Fig. 4. Bar chart showing mean enhancement of trust for all participants if each of the four proposed tool features could be used, measured based on a 5-point Likert Scale where 0 represents "Strongly Disagree" and 4 represents "Strongly Agree". It is important to note that all error bars included on the chart are standard error bars.

being shown to different users was second most likely to be used ($M = 2.38$, $SE = .05$). Third most likely to be used was the feature that confirms embedded material in a news article is authentic ($M = 2.44$, $SE = .06$). Least likely to be used was the feature that confirms a news article is coming from the stated publisher ($M = 2.99$, $SE = .05$).

Interview participants agree there is perceived need for a tool to authenticate digital news. Participants expounded on why they believe it is important to authenticate digital news content. P15 stated:

"I think because a lot of [news] can be manipulated, I think it's important to know that something is authentic and that the source that it's coming from is accurate."
—Participant 15 (Male, 58, White, Conservative)

P17 also explained why verifying the source of a quote is imperative:

"If it's not coming from the stated source, it could be inaccurate, or they could be trying to hide from something from you. There's a number of reasons for that. Like why claim you're coming from this source when you're not?" **—Participant 17** (Male, 24, White, Moderate)

Although they recognize the importance of authentication, consumers simply do not have time to conduct in-depth verification of every news source they come across. P2 underscores this point:

"I mean, I feel like I've tried to dig up articles in the archives that have disappeared. It's really frustrating how like things just become like lore...it's just happens so much where stories just are silenced." **—Participant 2** (Female, 33, White, Liberal)

P1 agreed it should not be the reader's job to hunt down information:

"If they just give me a hint towards what's wrong, I don't want to, I don't really want to have to go and find out myself. I feel like that's their responsibility as the news source."
—Participant 1 (Female, 20, White, Asian, Moderate)

Participants want an easy-to-use, integrated tool that provides information on news authenticity. Some interviewees prefer a mobile-based tool. P3 compared a potential tool to his current Smart News app:

“For me, again, as I stated earlier, I use an app called Smart News, where it has, you know, a lot of different articles from tons of different news sources and stuff. So something that would have something similar, you know, where there’s different articles from several different sources.” —**Participant 3** (Male, 36, Hispanic, Liberal)

P7 agrees that she prefers a tool for mobile devices:

“If there was an app on the phone it would be nice, I guess that things get opened up via that app. Even if it’s just again that I’m copying the URL and going into the app and putting it in there and letting it tell me what’s right or wrong, would be good. I only use a laptop for Prolific. My kids use it for school. Everything else is on my phone so if it were desktop or laptop specific, it would be very difficult for me to utilize it.” —**Participant 7** (Female, 48, White, Moderate)

Other participants prefer a web-based authentication tool. Specifically, they want integrated alerts that automatically activate when they open news online. P11 refers to the Honey extension for Google Chrome when considering a web-based tool:

“I like the idea of it, add it to your browser and it works. . . In Chrome if I open it up and check the news and it had that, like I said, the built-in browser like the Honey thing that would be spectacular.” —**Participant 11** (Female, 49, White, Conservative)

P1 also voices interest in integrated alerts:

“You know, like extensions the browser that if I pull up an article. . . ideally like something that pops up and says, you know, “be careful about who this person is” or like you know, “be careful about the wording in this article” or you anything like that that would kind of warn you.” —**Participant 1** (Female, 20, White, Asian, Moderate)

However, participants indicated it is important that an authentication tool does not make judgements on behalf of the reader. P1 says:

“I would still want it to let me read the article just know like I wouldn’t want it to block out the whole thing.” —**Participant 1** (Female, 20, White, Asian, Moderate)

P6 agreed that a suggestion from the tool would be better than an outright decision on her behalf:

“I want to go with the first one way to say, ‘if you want to know more about the topic.’ They’re not being as, I would say, aggressive. They’re just like if your interest in why it is wrong and you want to know more information, then go to this website. I think the first option would make more people go to that website to like check why it’s wrong or why it’s correct.” —**Participant 6** (Female, 20, Hispanic, Liberal)

A common theme in the interviews was that consumers prefer a news authentication tool to be customizable. P3 articulates his desired level of customization:

“If I clicked on a story, it just might be the regular story of the pops up, but if I wanted to see if it was, you know, the actual publisher I could click on the publisher tool or the drop-down box. Just click on you whatever icon and give me the information.” —**Participant 3** (Male, 36, Hispanic, Liberal)

P9 envisions similar customization:

“Having some customization, in some sort of way so that like, if you wanted to turn off like having both sides of an article or not. Just kind of like, depending on what kinds of filters you want to put on for what kind of news you’re like exposing or verifying. So just like some sort of customization.” —**Participant 9** (Male, 21, White, Conservative)

Most importantly, participants indicated that news organizations should not be able to edit information published by a news authentication tool. Every interviewee agreed they would gain

confidence in the tool if news producers had no affiliation with or control over the tool. P6 (Female, 20, Hispanic, Liberal) thought, while publishers should not be able to change information published by a news authentication tool, they should be able to “see what [the tool] is saying” and make comments to “update what [the tool] is saying” and acknowledge their mistakes. Consumers, like P2 (Female, 33, White, Liberal), also want to know who is funding the tool and if it is partnered with any news organizations in order “to assess potential bias.”

5 DISCUSSION

Guided by a U&G perspective, we performed a multifaceted investigation of digital news users’ needs and behaviors. Our survey and interview findings offer nuanced, representative insights into U.S. adults’ needs around digital news (RQ1), as well as the strategies they employ in determining whether online news is sufficiently trustworthy to gratify their information-seeking (as opposed to e.g. their entertainment or escapism) needs (RQ2). We also evaluated how cryptographic transparency guarantees around digital news’ provenance could increase trust in news (RQ3). We discuss these findings and their implications in the following sections.

5.1 A gap in transparency indicators

As in prior work (e.g., [16, 49, 50]), our interview participants’ motivations for consuming news aligned with those described by the uses and gratification (U&G) framework – specifically, entertainment, information-seeking, social connection and status-seeking, self-expression, and habitual use.

Uniquely, however, our findings indicate that digital news consumers’ desire for transparent and trustworthy information is unmet by current offerings (RQ1), with digital news interfaces lacking satisfying trust and authentication indicators. In light of this, our participants indicated that their political values play a strong role in the selection and use of news (RQ2).

5.2 Consumers employ a limited array of authentication strategies

In probing consumers’ use of digital news, participants reported six main strategies for evaluating the for transparency and trustworthiness of online content. Specifically, participants reported:

- Noting the apparent news publisher
- Noting who shared the article (when encountered on social media)
- Registering any corrections statements in the article
- Clicking through to embedded content (e.g. Tweets)
- Comparing article content to other published content via web search
- Checking an article’s sources

While these strategies reveal an interest in authenticating the publisher, embedded content, and corrections to an article, our participants did not report employing any specific practices related to verifying the provenance of digital content, such as verifying the URL they are redirected to after clicking on an article link. Our findings suggest consumers only employ a limited range of authentication behaviors that mostly focus on verifying the facts of an article or identifying ideological bias. This content-based focus on assessing legitimacy and trustworthiness reflects the popular “fact-checking” approach of many news authentication tools. This approach may be useful in helping open-minded consumers assess the content of a particular news article, but its scalability and ability to communicate the trustworthiness of legitimate digital news publishers is limited.

5.3 Users' stated needs, usage patterns, and gratifications obtained display misalignment

When we compare our findings on consumers' needs and behaviors, we find that consumers' needs explain their digital news consumption and authentication practices, but that there are also disconnects between users' stated needs, their behaviors, and the outcomes of their digital media usage. The U&G framework is useful for making sense of these findings. U&G explains that people use media technologies purposively to meet a variety of needs; understanding the gratifications people seek from a particular communication technology, including its content or components, can explain and predict media usage [77]. Additionally, while people are aware of some of their motivations and gratifications from their media usage, their stated motivations do not always align perfectly with their media usage, and the gratifications sought are not necessarily the gratifications obtained (e.g., [96]). Gaps between gratifications sought and those obtained can lead to dissatisfaction [72].

Our findings suggest consumers desire transparent and trustworthy news media to meet their information needs. Still, these gratifications often go unmet since they lack the tools to identify authentic and reliable digital news quickly. The lack of effective trust indicators leads participants to use several heuristics to assess news quality. However, these heuristics can also be problematic regarding their ability to provide reliable authentication. For example, participants reported evaluating the trustworthiness of articles based on whether the news publisher/sharer aligned with their political ideology, whether a trusted contact approved the article, or whether they trusted the news organization or aggregator. An unintended consequence of turning to these proxies is that when consumers think these indicators can gratify their information needs, they are less likely to evaluate the related news content critically.

5.4 Users identify specific needs and expectations for usable news authentication tools

By examining consumers' existing needs and behaviors, we find consumers have specific expectations of and needs for transparent, trustworthy news media, but they believe these needs are often not gratified. The lack of effective tools for authenticating digital news often leads people to utilize unreliable heuristics for assigning trust to digital content. We investigated whether a news authentication tool, specifically a cryptographic provenance system, could gratify needs related to news trust, transparency, and authentication. Based on our knowledge of existing problems related to the provenance, transparency, and security of digital news content, we identified authentication features that a cryptographic provenance system could afford to address these issues and surveyed whether news consumers perceived these as meeting important information needs (4.3). When presented with features of a cryptographic provenance system for news, participants indicated these features would meet their needs to evaluate news content confidently.

We acknowledge that the options provided as news authentication tool features in our survey are not the only possible solutions to help online news consumers authenticate news and promote trust-building with digital publishers. These findings provide a starting point to gauge participants' authentication preferences, specifically providing needed context on how users perceive the usefulness of features afforded by cryptographic guarantees. By adopting a mixed-method approach to our study and interviewing participants, we could explore the potential of specific news authentication features and also give participants the opportunity to voice their preferred solutions for authentication beyond these features. The interview data revealed digital news users report specific needs and expectations for a usable news authentication tool. Consumers believe a news authentication tool could help meet needs related to obtaining trustworthy information. But, just as news consumption is motivated by multiple needs, we find consumers' have competing

needs and expectations pertaining to an authentication tool. For example, users desire authenticated content, but if too much authentication information is provided, this could interfere with ease of use gratifications sought from digital content. Similarly, if a person's consumption of specific media is motivated by social or entertainment needs, then pop-ups from an authentication tool could interfere with the sought gratifications. Additionally, although almost all interview participants reported that they read their news on their mobile phones, there were mixed reactions to a mobile news authentication tool. Some participants thought they would not want another app to clutter their phone, so they preferred the tool on their laptops instead. Others preferred a desktop-based interface because it would be easier to digest information. From our interaction with participants two things are clear: users would prefer an authentication tool that can be used on a mobile device, but they do not want it in application form.

Previous literature shows a consumer's political affiliation can affect their perceived trustworthiness of both the news and its producer [25, 31, 86]. Although we discovered similar findings in our research, we also identified that the proposed features of a cryptographic provenance system would increase the trustworthiness of news for all participants, regardless of partisanship. This demonstrates a shared need for news authentication across party lines. This suggests cryptographic provenance systems which verify the provenance of an article or embedded content, surface edits, and make the user aware of different versions of an article could mitigate skepticism towards digital news and promote trust-building with digital publishers. A tool such as this, robust against partisan differences, would ensure all consumers have their news authentication needs met.

5.5 Implications for designing usable news authentication tools

Having identified several ways in which consumers manually authenticate online news, we believe a digital news provenance system that cryptographically guarantees the publisher, publication date and any changes (corrections or other updates) to an article can significantly streamline news consumers' authentication processes. Building on existing web infrastructure, such a tool could likewise label valid website addresses, since consumers often fail to independently confirm the correctness of online news URLs.

5.5.1 Offer alternatives to partisan bias. Numerous interview participants divulged they were biased toward news outlets whose perceived political leanings matched their own. Our results indicate, however, that a tool providing cryptographic assurances around e.g. the news publisher's identity and transparency around corrections and updates was welcomed by participants across the political spectrum as a mechanism for enhancing their trust in online news. As such, we posit that a cryptographic provenance system for digital news could offer a more nuanced and robust alternative to partisan affiliation in supporting new consumers' identification of trustworthy information.

At the same time, we note that any implementation of such a tool must follow best-practices learned from previous cryptographic transparency systems. In particular, we note that participants wanted the option to close or ignore the indicators of any news authentication tool. We note that allowing users to e.g. toggle the visibility of such indicators aligns with U&G, because not all news consumption is intended to support information-seeking – and therefore the authenticity of news is not always its most important characteristic to users. Providing simple, optional, indicators, however, is consistent with current best practices in the interface design of other online cryptographic provenance systems (such as CT, discussed above), which has evolved from “roadblock” warnings to a collection of much simpler indicators.

5.5.2 Not all transparency is created equal. While survey participants reported that it was important to see corrections, interview participants indicated they only wanted to be notified of corrections that changed the overall meaning of the article or altered the accuracy of statements and claims

made in the article. Both a failure to acknowledge significant changes and, possibly, the presence of too many changes, had a negative effect on participants' trust in the information. Likewise, corrections made long after publishing also adversely affected consumer trust.

Because consumers deem some corrections more important than others, interfaces for online news transparency should be designed such that visual emphasis matches the perceived impact on the story. At the same time, because news consumers and news producers may have different assessments of what constitutes an "important" edit, a cryptographic provenance system that captures *every* edit provides the necessary infrastructure for designing interfaces and options that can better meet news consumers' needs in this regard.

5.5.3 Users need to be made aware of their implicit security needs and expectations. Although our participants never talked about their desire for news authentication in the context of security needs, each of the features of news authentication the consumers mentioned has an associated security component. For example, consumers want secure and guaranteed ways to ensure the information they interact with comes from the stated publisher. This seemingly simple feature requires the application cryptographic protocols to secure an unalterable record of digital content and its provenance. Indicators that help users determine that the stated publisher is the source need to be backed by cryptographic evidence to be reliable. Additionally, users already have many notions of what transparency means, many of which are not captured by the cryptographic notion of transparency. An important challenge will be to design interfaces for cryptographic provenance systems which accurately convey technical limitations while also communicating the guarantees provided by these systems.

Making users' implicit needs explicit could improve the perceived usefulness of and intent to use a cryptographic provenance system. As reported in 4.3, survey respondents claimed they cared about equivocation, but in our interviews, participants admitted they were unaware that equivocation happens, specifically in the journalism space. The fact that equivocation occurs unbeknownst to online news consumers indicates that online news producers have failed to be transparent with their readers on this issue. Despite being unaware of the frequent occurrences of equivocation, participants were emphatic they want to know if other versions of a news story exist. Applying cryptographic techniques, this assurance can be accomplished through consensus protocols that establish a consistent global view of committed information and that can back indicators that ensure all parties see the same digital content [99]. Making implicit needs for cryptographically-guaranteed transparency explicit will be a challenge for designers of cryptographic provenance systems, but making users aware of how these assurances could meet existing needs for authentication that cannot be altered or tampered is promising for facilitating trust between news consumers and digital publishers.

5.5.4 Authentication tools must seamlessly integrate with users' existing news practices and adjust to varying needs. We found that, ultimately, consumers want established authentication methods that mitigate the guesswork of finding trustworthy news while also taking the onus of verifying the information off the consumer. Our interview results reveal consumers perceive that an automated news authentication tool could gratify this need, but it needs specific features to be useful. In particular, we identified two significant design implications: first, the tool must be usable on mobile devices and integrate seamlessly with the places where people get their digital news; second, the tool must be customizable and allow for user autonomy. In particular, the consumer's platform preference is an important implication for future news authentication tools. Although some participants stated a preference for a desktop-based tool, most online news consumption happens via mobile phone [10]. In truth, consumers want the convenience of a desktop browser extension but the accessibility of a mobile app. They want the news to be easily verifiable in one setting without additional steps

but want to be able to do so on the go as they read the information in real-time. This presents an exciting challenge for future developers as they must find alternatives to the traditional mobile app to satisfy the consumer's needs. To be effective, tools for news authentication must integrate seamlessly with the places where users consume digital news.

5.6 Implications for Research and Future Directions

This research examines the needs and behaviors relevant to how consumers choose and evaluate digital news content and investigates the potential of cryptographic provenance systems for improving trust in news. We discover consumers have specific standards for transparent, trustworthy news media, and they often report that available news content does not meet their desired needs for determining the trustworthiness of online information. Although consumers employ a select set of authentication behaviors mainly focused on verifying facts or ideological biases in an article, there is often a disconnect between their stated needs, authentication behaviors, and digital media usage. Some consumers even revealed they were aware their stated motivations to obtain trustworthy, verified news do not correlate with their actual media usage, leading to unmet gratifications and dissatisfaction.

Unlike news authentication systems that focus on fact-checking content, we found that a majority of our politically-diverse, US-representative participant sample of digital news users perceived that authentication features afforded by a cryptographic provenance system could meet their needs for identifying trustworthy information online. While there was variation in the features participants felt would make such a system usable, we note that most, if not all, of their preferred options could be implemented on top of the cryptographic features we proposed. Developers of future news authentication tools face the unique challenge of satiating varying consumer needs within a single provenance system, but in doing so can help offer a tool that meets the trustworthiness needs of news consumers across the political spectrum – something no prior system that we are aware of has managed to achieve.

It is worth noting that our interview participants did not explicitly identify security needs as an important aspect of authentication and often used "authentication" synonymously with fact-checking. This suggests that the provenance authentication afforded by cryptographic protocols and the implications of these technical assurances will need to be clearly communicated to end users and distinguished from other forms of verification. Yet, it is important to note that, without being provided an explanation that the proposed authentication features would need to be backed by cryptographic guarantees to be reliable, the majority of users indicated that having access to these types of transparency assurances was important to them. This suggests users do not necessarily need to understand the technology behind a cryptographic provenance system to value it; instead, the assurances provided by the system need to be clearly communicated. In particular, considering the interview feedback that users desire a tool that does not appear to be subject to manipulation or bias, the system should clearly communicate that the information surfaced from the cryptographic record cannot be altered. Future research should investigate how to design usable indicators of cryptographic assurances.

Our findings suggest that digital news users perceive a need for cryptographic provenance systems that 1) authenticate the provenance of published news content, 2) authenticate embedded materials, 3) generate immutable records of digital news articles and edits made to the content, and 4) verify all users are viewing consistent versions of an article. Future research should prototype and perform usability tests of the interfaces of such systems and delve deeper into how to balance users' competing needs and preferences. Researchers can draw upon work exploring how consumers respond to flagged content (e.g., misinformation warnings) to inform the design of transparency indicators that successfully communicate information transparency and trustworthiness to news

consumers [92]. Similarly, observational work on user responses to HTTPS warnings can help researchers design news authentication indicators to which users are likely to attend [1]. Additionally, future research could also perform interviews with journalists and online news publishers in order to gain their insight on effective transparency indicators and to gauge these stakeholders' openness to opting in to a cryptographic provenance system by cryptographically signing all the content they publish. Lastly, future research should use experimental designs to test how effective the proposed news authentication features are at helping users evaluate digital news content and whether they indeed improve trust and confidence in credible digital news publishers.

6 LIMITATIONS

The empirical results reported in this paper should be considered in light of multiple limitations. We discuss those limitations here and how they can be addressed in future research.

6.1 Prolific Went Viral On TikTok Resulting in More Women and Younger Respondents

During the survey pilot conducted prior to releasing the full survey study, the research team noticed that about 70% of the respondents were women. The spike in women respondents was due to Prolific 'going viral' on the social media platform TikTok at the same time as the study pilot. This in turn generated a large number of new young and female users for the Prolific platform [13]. To adjust for the larger than expected number of female respondents from the surge of new users from TikTok, we stratified the survey recruitment by gender as reported in the methods section. This resulted in the gender balance of our sample being fairly representative with 48% of participants identifying themselves as male, 51% as female, and the other 2% choosing to self-describe. Importantly, we were able to recruit a sample that was representative across racial and ideological groups, as well.

We were not able to counteract the skew toward younger participants; our final sample displays a mean age of 26.57 which is less than the average age in the United States, which is 38.5 years old [9]. While the younger mean age is not in line with the United States population at large, it is more in line with our target population of U.S. digital news consumers, which skews younger than the broader population [10]. While we were able to gather data from adults up to age 77, future work could more closely investigate the authentication preferences and the effectiveness of authentication tools for older users who consume digital news.

6.2 Political Ideology

When examining our data, we observed discrepancies between the participants' answers to the Prolific pre-screener question and our survey question on political ideology. Prolific's pre-screener question is, "Where would you place yourself along the political spectrum? Conservative, Moderate, Liberal, Other, N/A" whereas the question we used in the survey is, "In general, do you consider yourself as [1=very liberal, 2=somewhat liberal, 3=moderate, 4=somewhat conservative, 5=very conservative]". When using the more granular political ideology question sourced from previous research [84], about half of the participants who originally reported being "Moderate" on the Prolific pre-screener (a 3-item measure) refined their response to indicate a slightly more partisan position (i.e., "somewhat conservative" or "somewhat liberal") when answering the 5-item ideology measure. We considered adding a pre-screener to collect more "Moderate" participants but this would have required we move the political ideology question to the beginning of the survey, potentially priming participants' responses. Thus, when binning the participants' responses from the survey into "Conservative", "Moderate", and "Liberal" categories for the analyses, there are less participants in the "Moderate" category compared to the pre-screener stratification. Future research should note that providing three versus five item Likert scales for political ideology may prompt different responses from participants near the middle of the ideological scale.

7 CONCLUSION

This work provides insight into how U.S. users value, perceive, and struggle with the authentication of online news. Survey data provided a broad understanding of the current news consumption habits of online news consumers, their perceptions of news authentication and trustworthiness, and their desires for specific facets of a news authentication tool. The interviews helped us gain a deeper understanding of user perceptions surrounding news authentication and the practices employed by users to authenticate their own news. Additionally, the interviews addressed and explored specific possibilities of a news authentication tool. Together these results lead us to conclude that online news consumers care a great deal about being able to detect fabricated news, equivocation, ghost edits, and incorrect source attribution in online news. A cryptographic provenance system would provide the cryptographic infrastructure to detect these negative publishing practices and to provide assurances when publishers do not engage in these practices. Our findings identified several design considerations for the user interfaces of such tools and identified challenges to navigate in their implementation (e.g., partisanship, competing user needs surrounding corrections). This work contributes understandings of authentication needs that expand beyond the limits of fact-checking and the fake news identification and consider affordances of technologies that enhance the transparency of digital publishing and improve consumers' trust in credible online publishers.

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A SURVEY MEASURES

Note: The survey measures (all items and response options) are listed below in the order they appeared in the online survey. Notes on the source of the survey item, wording modifications made, etc., can be found in italics after the item wording.

Informed Consent: RESEARCH STUDY KEY INFORMATION

The HATLab, a research group at Clemson University, is inviting you to volunteer for a research study.

Study Purpose: The purpose of this research is to gain insight into how individuals who consume news access and think about the information they receive from various news publishers.

Voluntary Consent: Participation is voluntary. You will not be punished in any way if you decide not to be in the study or at any point decide to stop taking part in the study.

Activities and Procedures: Your part in the study will be to answer questions provided in an online Qualtrics questionnaire.

Participation Time: It should take you approximately 20 minutes to complete the Qualtrics questionnaire. **Risks and Discomforts:** The only risks that you may face are those related to discussing your daily consumption of news and information.

Possible Benefits: You may directly or indirectly benefit from the shared expertise of the researchers, who specialize in user interface design, cryptography, and digital publishing and by furthering these fields with your participation. Moreover, you - as a consumer of online news - may benefit from reflecting on your daily interactions with news and media. There is also monetary compensation for participating in and completing our research survey.

Exclusion/Inclusion Requirements: If you choose to participate in this study, you would be expected to engage in study tasks. Participants should be 18 years or older, currently reside in the United States, and must get news from the internet through a smartphone, computer, or tablet.

Audio/Video Recording and Photographs: There will not be any audio or video recording in our survey. Photographs of survey responses may be used for analytical purposes and will not be shared outside of the research team. **Protection of Privacy and Confidentiality:** The results of this study may be published in scientific journals, professional publications, or educational presentations. Any personally identifiable information will be removed and excluded from any publications.

Contact Information: If you have any questions or concerns about your rights in this research study, please contact the Clemson University Office of Research Compliance (ORC) at 864-656-0636 or irb@clemson.edu. If you are outside of the Upstate South Carolina area, please use the ORC's toll-free number, 866-297-3071. The Clemson IRB will not be able to answer some study-specific questions. However, you may contact the Clemson IRB if the research staff cannot be reached or if you wish to speak with someone other than the research staff. If you have any study-related questions or if any problems arise, please contact The Clemson University HATLab NewsAuth Team at newsauthproject@gmail.com

By clicking the "I consent" button below, you acknowledge: Your participation in the study is voluntary. You get news from the internet through a smartphone, computer, or tablet. You are 18 years of age or older. You currently reside in the United States. You are aware that you may choose to terminate your participation at any time for any reason. You have read the information written above. [I consent, begin the study; I do not consent, I do not wish to participate]

**Note: Participants who did not consent received the following message, per the Prolific guidelines: "As you do not wish to participate in this study, please return your submission on Prolific by selecting the 'Stop without completing' button."*

Prolific ID: Please enter your Prolific ID: _____

Age: What is your age? [Drop-down options: 0 to 100] **Source: Prolific pre-screener wording; Note: Participants who reported being under 18 were screened out and received the following message, per the Prolific guidelines: “You are ineligible for this study, as you have provided information which is inconsistent with your Prolific prescreening responses. Please return your submission on Prolific by selecting the ‘Stop without completing’ button.”*

U.S. Resident Status: In what country do you currently reside? [I currently reside in the United States; I do not reside in the United States] **Source: Prolific pre-screener wording; Note: Participants who did not reside in the US were screened out and received the following message, per the Prolific guidelines: “You are ineligible for this study, as you have provided information which is inconsistent with your Prolific prescreening responses. Please return your submission on Prolific by selecting the ‘Stop without completing’ button.”*

State of Residence: Please select the state where you currently live: [Drop-down with 50 states and “I do not live in the U.S.” / Prefer Not to Answer options] *Source: Prolific pre-screener wording; Note: Participants who did not reside in the US were screened out and received the following message, per the Prolific guidelines: “You are ineligible for this study, as you have provided information which is inconsistent with your Prolific prescreening responses. Please return your submission on Prolific by selecting the ‘Stop without completing’ button.”*

News Platforms: Please select which platforms you get news from at least some of the time. (Select all that apply): [Television; Radio; Print Publications; Smartphone; Computer or laptop; Tablet; Smartwatch (e.g., Apple Watch, Samsung Galaxy); Internet streaming service (e.g., Netflix, Hulu); Smart speaker (e.g., Amazon Alexa, Google Home); Prefer not to answer] **Source: Item created for this survey based on list of news sources found in [11]*

Online News Consumption: How often do you get news from a smartphone, computer, or tablet? [Multiple choice: Often, Sometimes, Rarely, Never, Prefer not to answer] **Source: [12]*

Preferred Device: Do you prefer to get your news: [Multiple choice: On a desktop or laptop computer, On a mobile device (such as a smartphone or tablet), Prefer not to answer] **Source: [10]*

Frequency of News Consumption: Would you say you follow the news... [Multiple choice, All or most of the time, Some of the time, Only now and then, Hardly ever, Prefer not to answer] **Source: [12]*

Intentionality of News Consumption: Which statement best describes how you get news? [Select one: I mostly get news because I’m looking for it; I mostly get news because I happen to come across it; Prefer not to answer] **Source [11]*

Comprehension and Attention Check: The following questions ask about how you interact with online news. We define online news as information you read online about events and issues that involve more than just your friends and family. This includes local, national, or international news you read online. Which of these does not fall under our definition of online news? [Multiple choice: CNN posts a story about the rise of the COVID Delta variant in the U.S. on Instagram; Your coworker Avery shares a posts about a recent promotion on LinkedIn; Fox News posts about the

city council election on Facebook; Yahoo News tweets a story about the effect of climate change around the world] **Source: This item was created for this study based on definitions of news tested in the [12]; Note: If people selected an answer other than “Your coworker Avery...” they received the following message “Unfortunately, the answer you selected did fall under our definition of online news. Please click the next button to reread our definition of online news and try again!” Participants were given up to five attempts to answer correctly. If they answered incorrectly five times, they were given the message: “You are ineligible for this study, as you have failed to identify the incorrect definition of online news five times. Please return your submission on Prolific by selecting the ‘Stop without completing’ button.”*

Preferred Browser for Laptop/Desktop, Phone, and Tablet: Which web browser(s) do you use? Select all that apply. [Participants could select from the following options for Laptop/Desktop, Phone, and Tablet: Google Chrome, Safari, Firefox, Microsoft Edge, DuckDuckGo, Internet Explorer, Other] **Source: Created based on popular browsers*

Online News Sourcing: How often do you get news online from: People that you are close with; People you are not particularly close with; News organizations [Matrix, 5-Point Likert, Never to Almost Always] **Source [10]*

Online News Mediums Used/Frequency: Thinking about the news you got on a smartphone, computer, or tablet, IN THE PAST WEEK, how many days did you get news from. . . : News websites or apps; Search such as through Google or other search engines; YouTube; Podcasts; News Aggregators (e.g., Apple News, Flipboard, Pocket, Google News) [Matrix: Never gets news this way, 0, 1, 2, 3, 4, 5, 6, 7, Prefer not to answer] **Source: [12], wording was adapted slightly to specify news from smartphone, computers or tablets and the News Aggregator and YouTube options were added; deleted the “Social media such as Facebook, Twitter, or Instagram” option since that is asked in a later question*

News Websites Used: In THE PAST WEEK, did you get news from the WEBSITE OR APP of any of these news organizations? That is, did you get news ONLINE from any of these? (Select all that apply). Vox, CNN, Fox News, ABC News, Breitbart, The Guardian, USA Today, The Hill, The New York Times, Time, Univision, HuffPost, Business Insider, The Wall Street Journal, New York Post, BBC **Source: [12], changed from a matrix to a “Select All” to save space/time*

General Social Media Use: How often do you use these social media sites or apps? Facebook, Twitter, Instagram, LinkedIn, Snapchat, WhatsApp, Reddit, TikTok, Other_____ [Never, Rarely, Sometimes, Often, Prefer not to answer] **Source: [12]; TikTok was added for this survey; Note: The display of the next question options was based on these answers*

Frequency of News Consumption on Social Media: You told us that you use each of the following social media. In THE PAST WEEK, how many days did you get news from the following social media sites or apps? Facebook, Twitter, Instagram, LinkedIn, Snapchat, WhatsApp, Reddit, TikTok [Matrix: 0, 1, 2, 3, 4, 5, 6, 7, No answer] **Source: Item adapted from the [12], wording was changed to ask how often “you get news from” versus “use”*

Social Media News Consumption Behaviors: Thinking about when you are on a social networking site, how often, if at all, do you. . . Click on links to news stories; Pay attention to the news publisher the link takes you to; Read the full article on the original website; Post links to news stories; Share or repost links to news stories that were originally posted by someone else; “Like”

news stories; Comment on news stories [Matrix, 5-Point Likert, Never to Almost Always, Prefer not to answer] *Source [10]; deleted the “Post my own photos or videos of a news event” and “Discuss issues in the news with others on that site” options and added “Pay attention to the news publisher the link takes you to” and “Read the full article on the original news site”

Critical Media Consumption Competency: Please indicate how you feel about your knowledge and skills for each of the following statements: I can distinguish different functions of [online news] (communication, entertainment, etc.); I am able to determine whether or not [online news] contents have commercial messages; I manage to classify [online news] messages based on their producers, types, purposes, and so on; I can compare [online news] and information across different media environments; I can combine [online news] messages with my own opinions; It is easy for me to make decisions about the accuracy of [online news] messages; I am able to analyze positive and negative effects of [online news] contents on individuals; I can evaluate [online news] in terms of legal and ethical rules (copyright, human rights, etc.); I can assess [online news] in terms of credibility, reliability, objectivity, and currency; I manage to fend myself from the risks and consequences caused by [online news] contents. [5-point Likert scale ranging from Strongly disagree to Strongly agree] *Source: 10-item Critical Consumption subscale in New Media Literacy Scale from [45]; modified to be “online news” versus “media”; removed the “I consider [online news] rating symbols to choose which media contents to use” item

Importance Attributed to News Sourcing: Thinking about the how you get your online news, indicate how much you agree or disagree with the following statements: I give a good deal of thought to where I get my news from; I usually turn to the same places when I get news; I consider myself to be loyal to the places I get my news from; I often recommend the places I get my news from to others [Matrix, 5-Point Likert, Strongly Disagree to Strongly Agree, Prefer not to answer] *Source [10]; modified to be about “online news”; modified to be Likert scale versus a sliding scale; cut the negatively worded options for each item (e.g., I do not give a good deal of thought to the sources...) and adapted wording to be “where/places” instead of “sources”

Perceived Ability to Recognize Original Reporting: How confident are you that you can tell whether a news organization does its own reporting? [Multiple Choice: Very confident, Pretty confident, Not too confident, Not confident at all, No answer] *Source: [12]

Actual Ability to Recognize Original Reporting: Do you believe that each of the following does its own news reporting? Google News, Facebook , ABC News , HuffPost, The Wall Street Journal , Apple News [Matrix Yes, does its own reporting, No, does not do its own reporting, Not sure, No answer] *Source: [12]

Awareness of Corrections: In the PAST FEW MONTHS, have you seen a news organization make an official correction to a story? [Select: Yes, No, I’m Not Sure] *Source [11]; added the “I’m not sure” option

Impact of Corrections: When a news organization issues an official correction to a story, do you tend to feel... [Select: More confident in that organization, Less confident in that organization, No difference in confidence in that organization, Prefer not to answer] *Source [11]

Frequency of News Authentication Behaviors: When you are online and come across information in a news story that you think is inaccurate how often do you take it upon yourself to

figure out whether it is true? [Multiple choice: Almost Always; Often; Sometimes; Rarely; Never]
**Source [10]*

Personal Trust in Online News Publishers: When reading news online, how much, if at all, do you trust the information you get from: National news organizations, Local news organizations, Friends, family, and acquaintances, Social networking sites, such as Facebook and Twitter [Matrix, 5-point Likert, Never to Almost Always] **Source [10]; modified to include "When reading news online"*

Perception of Americans' Trust in News: Overall, how much confidence would you say Americans have in the news media? [Select one: A great deal, A fair amount, Not too much, No confidence at all, No answer] **Source [11]*

Perception of Appropriateness of Confidence in News: When you think about the amount of confidence Americans have in the news media, do you think they have... [Select one: Too much confidence, Too little confidence, The right amount of confidence, No answer] **Source [11]*

Perception of Ability to Improve Trust: Do you think it is possible to improve the level of confidence Americans have in the news media or is that not possible to do? [Select one: Yes, it is possible, No, it is not possible, No answer] **Source [11]*

Perception of Appropriateness of Trust in News: Ideally, do you think it's better for society if Americans are... [Select one: Trusting of the news media, Skeptical of the news media, No answer] **Source [11]*

Perceptions of Source Accuracy: How accurate, do you think, is the news posted online by: People that you are close with, People you are not particularly close with, News organizations [Matrix, 5-point Likert, Not At All Accurate to Extremely Accurate] **Source [10]*

General Expectations of News Accuracy: Which of the following best describes how you approach news stories, even if neither is exactly right? I typically go into a news story expecting that it will... [Select one: Largely be accurate, largely be inaccurate, No answer] **Source [11]*

Perception of Source of Mistakes in News Stories from Trusted Publishers: For the next set of questions, think about news stories from publishers you trust. (By publishers we mean organizations that distribute journalistic content like newspapers or news content for free or for profit). When significant mistakes make their way into news stories, how much, if at all, do you think each of the following is a reason why they occur? Careless reporting; A source gave incorrect information; Desire to mislead; Lack of expertise on the topic; The news is breaking too quickly [Matrix: A major reason, A minor reason, Not a reason, No answer] **Source [11]; Adapted to be about trusted publishers*

Perception of Source of Mistakes in News Stories from Publishers in General: Now that you've answered this set of questions while thinking about publishers you trust, answer this set of questions again with regards to publishers in general. When significant mistakes make their way into news stories from other publishers, how much, if at all, do you think each of the following is a reason why they occur? Careless reporting; A source gave incorrect information; Desire to mislead; Lack of expertise on the topic; The news is breaking too quickly [Matrix: A major reason, A minor reason, Not a reason, No answer] **Source [11]; Adapted to be about "general" publishers*

Perceptions of Cover-Ups: Which of the following statements comes closer to your view? In general... [Select: News organizations are willing to admit their mistakes, News organizations try to cover up their mistakes, No answer] *Source [11]

Perceptions of Transparency in News Organizations: Thinking about news organizations generally, how well do they do at telling their audiences about each of the following? How they produce their news stories; Where their money comes from; When there are potential conflicts of interest with other corporations or individuals; Whether a news story is opinion or factual reporting; When a correction has been made to a news story; How they find and choose sources for their stories [Matrix: Very well, Somewhat well, Not too well, Not at all well, No answer] *Source [11]

Awareness of Fabricated news, Equivocation, Ghost edits & Incorrect attribution: How often, if at all, do you think the following things happen?: There are two or more different versions of the same article circulating online; Changes are made to news articles without being documented; Sources are made up for news stories; Sources are incorrectly cited in news stories; There are articles that pretend to be from one publisher but they are from another publisher; There are fake news articles online (e.g., the content of the news is intentionally made-up); A news story that I read will become inaccessible from its original website [5-point Likert scale: This never happens, This rarely happens, This sometimes happens, This often happens, This happens all the time; I'm not sure] *Source: Items created for this study to capture whether users perceive that Fabricated news, Equivocation, Ghost edits, Incorrect attribution occur (Fake News also included for comparison)

Perceived Need for a Tool that Authenticates the Publisher: When reading news online, how important is it for you to know that your news is actually coming from the stated publisher? [5-point Likert: Not Important to Very Important] *Source: Item created for study; captures users' perceived need for indicators to flag fabricated news/capture provenance

Perceived Need for a Tool that Traces Different Versions of a Story: When reading news online, how important is it for you to know that you are seeing the same version of a news story that other people are seeing? [5-point Likert: Not Important to Very Important] *Source: Item created for study; captures users' perceived need for indicators to flag equivocation

Perceived Need for a Tool that Traces Changes to a Story: When reading news online, how important is it for you to know that changes have been made to the story since it was first published? [5-point Likert: Not Important to Very Important] *Source: Item created for study; captures users' perceived need for indicators to flag corrections/ghost edits

Perceived Need for a Tool that Authenticates Embedded Content: When reading news online, how important is it for you to know that embedded material in a story was authentic (e.g. a social media post or image)? [5-point Likert: Not Important to Very Important] *Source: Item created for study; captures users' perceived need for indicators to flag incorrect attribution

Perceived Impact on Trust - Tracing Changes: Please indicate your level of disagreement or agreement with the following statement: If there was a tool that showed every change to an article since it was published, it would enhance my trust and confidence in the news I was reading. [5-point Likert: Strongly Disagree to Strongly Agree] *Source: Item created for study

Perceived Impact on Trust - Flagging Equivocation: Please indicate your level of disagreement or agreement with the following statement: If there was a tool that indicated whether or not a publisher shows two different versions of the same article to different users, it would enhance my trust and confidence in the news I was reading. [5-point Likert: Strongly Disagree to Strongly Agree] *Source: *Item created for study*

Perceived Impact on Trust - Authenticating Publisher: Please indicate your level of disagreement or agreement with the following statement: If there was a tool that confirmed a news article was coming from the stated publisher, it would enhance my trust and confidence in the news I was reading. [5-point Likert: Strongly Disagree to Strongly Agree] *Source: *Item created for study*

Perceived Impact on Trust - Authenticating Embedded Material: Please indicate your level of disagreement or agreement with the following statement: If there was a tool that confirmed that embedded material in a news article was authentic (e.g. a social media post or image), it would enhance my trust and confidence in the news I was reading. [5-point Likert: Strongly Disagree to Strongly Agree] *Source: *Item created for study*

Preferred Trust Indicators: Rank the following in terms of which tool you would use the most: A tool that shows every change to an article since it was published; A tool that indicates whether or not a publisher shows two different versions of the same article to different users; A tool that confirms a news article is coming from the stated publisher; A tool that confirms that embedded material in a news article is authentic (e.g. a social media post or image) *Source: *Item created for study*

Political Ideology: In general, do you consider yourself as. . . [Likert: 1=very liberal, 2=somewhat liberal, 3=moderate, 4=somewhat conservative, 5=very conservative] *Source: [84]

Interview Participant Recruitment: Would you be willing to participate in an online interview study about your digital news consumption? [Yes, No, Maybe, I'd like more information] *Source: *Item created for study*

Gender: What is your gender identity? [Multiple Choice: Male, Female, Prefer to self-describe ____, I prefer not to say] *Source: *Item created based on the HCI Guidelines for Gender Equity and Inclusivity*

Ethnicity: Are you of Hispanic, Latino, or Spanish origin, such as Mexican, Puerto Rican or Cuban? [Yes, No, Prefer not to answer] *Source: [12]

Race/Ethnicity: What is your race/ethnicity? (Check all that apply) [White, Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, Other] *Source: *[anonymized] demographic questionnaire*

Education: What is the highest level of school you have completed or the highest degree you have received? [High school incomplete or less; High school graduate or GED (includes technical/vocational training that doesn't count towards college credit); Some college (some community college, associates degree); Four year college degree/bachelor's degree; Some postgraduate or professional schooling, no postgraduate degree; Postgraduate or professional degree, including master's doctorate, medical or law degree; I prefer not to answer] *Source: *[anonymized] demographic questionnaire*

Technology Knowledge: Which of the following best describes your technology knowledge? [Basic; Intermediate; Advanced; Professional; None] *Source: [anonymized] demographic questionnaire

Social Desirability: Thinking about what it means to be a good citizen, how important is it to follow what is happening in the news [Multiple Choice: Very important, Somewhat important, Not too important, Not at all important, No answer] *Source: [12] (deleted the Vote in elections, Serve jury duty if called, Volunteer to help others options)

Feedback: Thank you for taking this survey. If there is anything you would like to add about these topics or if you would like to share feedback, please enter it below. (To complete the survey and be redirected to Prolific, click the next button.) _____

B INTERVIEW SCRIPT

Good [morning/afternoon], my name is [researcher name]. It is a pleasure to meet you! I want to thank you for taking the time to meet with me. First, I want to give you a quick overview of our project then discuss how we will conduct the interview today. A few weeks ago, you completed a questionnaire through Prolific regarding your news consumption habits. At the end of the survey, you indicated that you would be open to participating in an online interview with our research team. This interview is a follow up to the questionnaire you previously completed. The goal of this session is to better understand how you choose and use news information. During the interview you will be asked a series of questions. There are no right answers to these questions, rather we would like you to answer openly and honestly about your personal experience. If a question is confusing or you need the question to be restated, please do not hesitate to ask for clarification. If at any point you become uncomfortable you are free to choose to pause, not answer a question fully, or to discontinue the interview.

Prior to our meeting you should have received a consent form for your review. I would like to read a portion of that consent form to you know and receive a verbal confirmation that you are still willing to participate in this interview. Before I read this, do you have any questions for me?

CONSENT:

By participating in the study, you indicate that you have read the information provided to you on the interview consent form, been allowed to ask any questions, and you are voluntarily choosing to take part in this research. You do not give up any legal rights by taking part in this research study. Do you consent to participating in this interview?

Thank you for your verbal confirmation! Before we begin the interview, I would like to take an audio recording of this session. Only our research team will have access to the recording, and it will only be used for transcription and analytical purposes. Do you give your consent to be recorded?

Introduction:

Intent: To understand the degree to which the participant consumes news online

- In your survey, you said you follow the news [Survey Result] and get news from organizations like [Survey Result]. Let's walk through an example of what it looks like for you to get news: What is the most recent news article you read? How did you find the news article? What parts of the article did you read? Is that a typical interaction?

Defining Transparency:

Intent: How does the participant define transparency in online news sources?

- What does transparency mean to you when it comes to news?
- In your opinion, is there a relationship between accuracy and transparency when it comes to news? Please explain.
- Can you tell me about a time when you came across a news article that you thought was very transparent? What made it seem transparent to you?
 - Can you tell me about a time when you came across a news article that you thought was not transparent. What made it seem not transparent?
 - Do you think it's more typical for news publishers to be transparent or not be transparent? Please explain.

- In general, what do you think news producers are most transparent about? In general, what do you think they are least transparent about?

Assigning Trust:

Intent: What factors impact trust in online news source?

- How do you decide whether to trust the content of a news article or not?
 - What is more important to you: Who shares the article or the publisher the article comes from? Why?
- Thinking now about news organizations you do trust, what are some of the reasons you trust these organizations?
 - Is there a relationship between the transparency of the news publisher and trust? Why?
- Thinking now about news organizations you don't trust, what are some of the reasons you distrust these organizations?
 - Is there a news organization that has lost your trust over time? What would it take to regain your trust, if that is possible?

Preferred Alerts:

Intent: How would users like to have their online news authenticated? How would the participant prefer to be alerted of "bad" news when browsing content online?

- When reading a news article, how typical is it for you to check the URL of the article? Do you pay attention to the publisher or author? Do you pay attention to the date of the article? Why or why not?
- If you were to come across "bad" news online what would be the best way to alert you of this?
 - How detailed should the alert be?
 - Have you seen anything like this? What did you think of that alert?
 - Would you rather have your online news verified outright or be provided with helpful tips/symbols (nudges) to consider the validity of your news?
- In your survey, you said it was [Survey Result] for you to know if your news is actually coming from the stated source when reading news online. Why is that?
- In your survey, you said it was [Survey Result] for you to know if you are seeing the same version of a news story that other people are seeing when reading news online. Why is that?
- In your survey, you said it was [Survey Result] for you to know if changes have been made to the story since it was first published when reading news online. Why is that?
- In your survey, you said it was [Survey Result] for you to know if embedded material in a story was authentic (e.g. a social media post or image) when reading news online. Why is that?

Our goal is to design a news authentication tool that does four things: 1) It will cryptographically verify that a news article is coming from the stated publisher; 2) It will make it possible to detect if a publisher is showing two different versions of the same article to different users; 3) It will allow you to see every change to an article since it was published, and 4) It will confirm that embedded material in a news article truly originates from the stated publisher.

- Would you use a tool like this? Why or why not?
- What would your ideal tool look like? What would you add or change?
- Would you be willing to switch to a different app or interface to get that information?
- Would it make you more confident if you knew that news organizations could not alter the information published from this tool?

Conclusion:

With that last question, we have reached the end of our interview! I appreciate you taking the time out to speak with us today.

- Do you have any questions for me at this time?
- What questions did I not ask that I should have asked you?

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Participant Demographics								
Characteristics	Survey				Interview			
	n		%		n		%	
Gender								
Male	191		48		4		33	
Female	203		51		8		67	
Prefer to Self-Describe	6		2		0		0	
Race/Ethnicity*								
White	282		71		10		83	
Black	36		9		0		0	
Hispanic	51		13		2		17	
Asian	28		7		2		17	
American Indian or Alaska Native	2		.5		0		0	
Native Hawaiian/Pacific Islander	1		.3		0		0	
Other	18		5		2		17	
Prefer not to Answer	33		8		0		00	
Age								
18 – 24	239		60		4		33	
25 – 34	97		24		2		17	
35 – 44	40		10		1		8	
45 – 54	11		3		2		17	
55 – 64	10		3		2		17	
65+	3		.8		1		8	
Political Ideology**	S	P	S	P	S	P	S	P
Conservative	164	150	41	38	5	5	42	42
Moderate	84	145	21	36	2	3	16	25
Liberal	149	105	37	26	5	4	42	33
Level of Education								
Less than HS	3		.8		0		0	
HS diploma/GED	84		21		1		8	
Some college	151		38		8		67	
Bachelor’s degree	101		25		2		17	
Some postgraduate or professional schooling	15		4		0		0	
Postgraduate or professional degree	48		12		1		8	
Technology Knowledge								
None	1		.3		0		0	
Basic	25		6		2		17	
Intermediate	180		45		7		58	
Advanced	165		41		3		25	
Professional	29		7		0		0	
<i>Note:</i> *Participants could select more than one race/ethnicity, so the percentages total more than 100%; **About half of the participants who originally reported being “Moderate” on their 3-item Prolific pre-screener P , changed their answer to “somewhat conservative” or “somewhat liberal” on the 5-item ideology measure in the survey S , resulting in fewer moderate participants than allotted for in the screener quotas. Adding a pre-screener to collect more “Moderate” participants would have required we move the political ideology question to the beginning of the survey, potentially priming participants’ responses, so we did not adjust for this.								

Table 1. The demographics of the 400 survey participants and 12 original interviewees broken down into six categories of interest.

News Source	Survey Participants
Television	68%
Radio	28%
Print Publications	12%
Smartphone	93%
Computer or Laptop	75%
Tablet	22%
Smartwatch	8%
Internet Streaming Service	35%
Smart Speaker	9%

Table 2. The various sources from which our survey participants indicated they receive news

Participant Demographics								
Characteristics	Survey				Interview			
	n		%		n		%	
Gender								
Male	7		64		5		71	
Female	4		36		2		29	
Prefer to Self-Describe	0		0		0		0	
Race/Ethnicity*								
White	9		82		7		100	
Black	0		0		0		0	
Hispanic	2		18		1		14	
Asian	3		27		0		0	
American Indian or Alaska Native	0		0		0		0	
Native Hawaiian/Pacific Islander	0		0		0		0	
Other	1		9		0		0	
Prefer not to Answer	0		0		0		0	
Age								
18 – 24	3		27		2		29	
25 – 34	3		27		1		14	
35 – 44	3		27		2		29	
45 – 54	0		0		1		14	
55 – 64	2		18		1		14	
65+	0		0		0		0	
Political Ideology**	S	P	S	P	S	P	S	P
Conservative	3	3	27	27	2	2	29	29
Moderate	2	4	18	36	3	1	42	14
Liberal	6	4	55	36	2	4	29	57
Level of Education								
Less than HS	0		0		0		0	
HS diploma/GED	2		18		2		29	
Some college	3		27		2		29	
Bachelor's degree	1		9		0		0	
Some postgraduate or professional schooling	1		9		0		0	
Postgraduate or professional degree	4		36		3		42	
Technology Knowledge								
None	0		0		0		0	
Basic	1		9		0		0	
Intermediate	7		64		7		100	
Advanced	2		18		0		0	
Professional	1		9		0		0	

Note: *Participants could select more than one race/ethnicity, so the percentages total more than 100%;

About half of the participants who originally reported being “Moderate” on their 3-item Prolific pre-screener **P, changed their answer to “somewhat liberal” on the 5-item ideology measure in the survey **S**, resulting in less moderate participants than allotted for in the screener quotas. Adding a pre-screener to collect more “Moderate” participants would have required we move the political ideology question to the beginning of the survey, potentially priming participants’ responses, so we did not adjust for this.

Table 3. The demographics of the 11 second phase recruitment participants and the 7 new interviewees broken down into six categories of interest.

	<i>M</i>	<i>SE</i>	<i>F – statistic</i>	<i>p</i>	ω
National News			$F(1, 398) = 17.59$	$<.001^{***}$	0.34
Conservative	2.09	.09			
Moderate	2.54	.09			
Liberal	2.82	.09			
Local News			$F(1, 398) = 6.917$	0.009^{**}	0.17
Conservative	2.43	.08			
Moderate	2.59	.07			
Liberal	2.74	.08			
Friends & Family			$F(1, 397) = 9.70$	$<.001^{***}$	0.26
Conservative	2.11	.08			
Moderate	1.61	.08			
Liberal	1.76	.08			
Social Media			$F(1, 398) = 1.49$	0.12	0.11
Conservative	1.41	.09			
Moderate	1.37	.07			
Liberal	1.54	.08			

Table 4. Participants were asked how often they trusted the information they get from various sources. The mean, standard error, F-statistic and its p value, and the effect size for each bad habit in the Political Ideology comparison are displayed.

	<i>M</i>	<i>SE</i>	<i>F – statistic</i>	<i>p</i>	ω
Two version of the same article circulating online			$F(1, 398) = 2.9863$	0.052	0.16
Conservative	2.98	.08			
Moderate	3.19	.08			
Liberal	3.20	.09			
Changes made to news article without documentation			$F(1, 395) = 1.3158$	0.283	0.105
Conservative	2.54	.08			
Moderate	2.60	.07			
Liberal	2.45	.08			
Sources are made up for news stories			$F(1, 397) = 14.6191$	<.001***	0.298
Conservative	2.47	.08			
Moderate	1.94	.08			
Liberal	1.94	.09			
Sources incorrectly cited in news story			$F(1, 396) = 1.4227$	0.248	0.112
Conservative	2.44	.08			
Moderate	2.34	.07			
Liberal	2.26	.08			
Articles pretend to be from one publisher but are from a different publisher			$F(1, 392) = 2.365$	0.1125	0.142
Conservative	2.20	.08			
Moderate	2.02	.09			
Liberal	1.90	.09			
Fake news articles circulating online			$F(1, 394) = 0.6198$	0.5445	0.074
Conservative	2.95	.08			
Moderate	2.88	.09			
Liberal	2.82	.10			
News story becomes inaccessible online			$F(1, 394) = 8.008$	<.001***	0.214
Conservative	2.27	.08			
Moderate	1.85	.08			
Liberal	1.96	.10			

Table 5. Participants were asked how often they believed these specified bad habits occurred online. The mean, standard error, F-statistic and its p value, and the effect size for each bad habit in the Political Ideology comparison are displayed.

	<i>M</i>	<i>SE</i>	<i>F</i> – <i>statistic</i>	<i>p</i>	ω
Importance of knowing news is actually coming from the stated source			$F(1, 398) = 0.7317$	0.4965	0.077
Conservative	2.95	.09			
Moderate	2.78	.09			
Liberal	2.98	.09			
Importance of knowing everyone is seeing the same version of a news story			$F(1, 398) = 0.6099$	0.575	0.082
Conservative	3.14	.08			
Moderate	3.14	.07			
Liberal	3.28	.07			
Importance of knowing changes were made to a story since initial publishing			$F(1, 398) = 0.4024$	0.667	0.073
Conservative	3.05	.08			
Moderate	3.07	.09			
Liberal	2.96	.11			
Importance of knowing embedded material in a story is authentic			$F(1, 397) = 0.1711$	0.836	0.054
Conservative	3.30	.08			
Moderate	3.28	.08			
Liberal	3.37	.08			

Table 6. Participants rated the importance of each of the above news practices. The mean, standard error, F-statistic and its p value, and the effect size for each bad habit in the Political Ideology comparison are displayed.