

The Knowledge Gap Hypothesis Across Modality: Differential Acquisition of Knowledge From Television News, Newspapers, and News Websites

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This study investigates how Tichenor’s hypothesized “knowledge gap” is affected differently by different modalities of news media. Measuring the acquisition of new surveillance facts in subsequent survey waves, we modeled how strongly people’s level of knowledge grew over time and how this growth was affected by news consumption. Results show that news media consumption (i.e., television news, newspapers, and news websites), across the board, has a positive effect on how much knowledge is acquired. Next, we examined how these learning effects are conditional on education level. Theorizing about how modality impacts learning effects, we confirm that television news especially benefits the acquisition of knowledge by the lower educated. Results also show that learning due to newspaper consumption does not depend on education level. Similarly, the positive effect of news website consumption was equally strong among low and highly educated citizens.

Keywords: knowledge gap, opportunities–motivation–ability framework, learning effects, panel survey, news media, modality

Research has repeatedly demonstrated that news media—print, television, or online—inform the citizenry about politics and current affairs (Andersen & Hopmann, 2018; Dimitrova, Shehata, Strömbäck, & Nord, 2014; Shehata, Hopmann, Nord, & Höijer, 2015). This kind of learning is pivotal in most normative models of democracy (Althaus, 2012): The knowledge that is acquired may guide citizens to the “right” vote choice (Galston, 2001), inform about issue positions of political parties (Lenz, 2009), and stimulate political participation (Andersen, Bjørnøe, Albæk, & de Vreese, 2016). For decades, however, concerns have been expressed that certain segments of society would become more knowledgeable while others would lag behind, causing a “knowledge gap” (Lind & Boomgaarden, 2019; Tichenor, Donohue, & Olien, 1970). The

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knowledge gap hypothesis is not uncontested, however. In particular, it is unclear whether certain modalities of news media (i.e., textual vs. audiovisual) have a different impact on the knowledge gap than others.

How much citizens learn from the news media depends on three factors grouped within the opportunities–motivation–ability framework (O-M-A; Luskin, 1990): (1) the *availability* of news in one’s personal environment (Shehata, 2016) and geographical context (Jerit, Barabas, & Bolsen, 2006), (2) individual citizens’ *motivation* to seek out news within the abundance of media choice (David, 2009; Lee, 2013), and (3) citizens’ *ability* to learn from the exposure to news coverage (Norris & Sanders, 2003; Price & Zaller, 1993). These three factors, moreover, interact with one another, such that the influence of the individual-level variables motivation and ability is conditional on the macro-level variable of the news exposure opportunities provided by the media landscape (Prior, 2007). In the current circumstances in which media choice is nearly unlimited, individual-level factors more strongly determine whether people are exposed to the news. In other words, the opportunity to be accidentally exposed to news decreases, and motivation becomes a stronger driver of encountering current affairs information (Hopmann, Wonneberger, Shehata, & Höijer, 2015). Research into this interplay between the macro-level opportunities and individual factors has mainly focused on motivation; the role of ability has received much less scholarly attention (Strömbäck, Djerf-Pierre, & Shehata, 2016, p. 92). The question, thus, remains whether the media inform people more effectively who already possess most skills and resources or instead especially enlighten the ones with a lower ability.

Using a combination of a panel survey with repeated measurements of new current affairs knowledge, we investigated which citizens acquire the most knowledge from the consumption of news media produced in different modalities (i.e., audiovisual or textual). The study was conducted in the Netherlands, which has a strong public broadcaster that functions alongside a dozen commercial channels. Dutch newspapers have a relatively high circulation, and Internet penetration is among the highest of the world (96% of population; Newman, Fletcher, Kalogeropoulos, Levy, & Kleis Nielsen, 2017). This diverse range of information opportunities provides an excellent context to study learning effects in the current high-choice media environment.

Our study zooms in on the importance of media modality for the knowledge gap: We tested whether citizens with a higher ability acquire more or less knowledge from news consumption than their lower ability counterparts, and whether this learning effect is different for television news (audiovisual mode), newspapers (textual mode), or websites (combination of modalities). A longitudinal design was employed to disentangle causality in the relationship between news consumption and knowledge levels or, more precisely, the acquisition of current affairs knowledge over time. Thereby, the study contributes to the literature with new insights from a considerably different context than the previous U.S.-dominated research, included news websites in its design, and employed an innovative methodological as well as analytical design (growth modeling).

The Knowledge Gap and Media Modality

When investigating the potential of news media to inform citizens, a rough distinction has been made between textual media (i.e., newspapers) and audiovisual media (i.e., television news). TV has from its beginning been assumed to cause less public knowledge than newspapers because it offers less space

and is less repetitive, watching requires less attention than reading, and the pace is not controlled by the consumer but by the medium (Postman, 1986; Robinson & Davis, 1990). Empirical evidence for this assertion is mixed, however (see Druckman, 2005).

Several studies have found a learning effect of watching television news alongside the positive impact of newspaper readership (Chaffee, Zhao, & Leshner, 1994; Liu, Shen, Eveland, & Dylko, 2013). Interestingly, stronger learning effects of reading the news have not been found in experiments (Norris & Sanders, 2003): When content is kept constant but medium type is manipulated (TV, newspaper, or online), people across the board learn to a similar degree from news exposure (Kruikemeier, Lecheler, & Boyer, 2017). In a real-life context, however, substantial differences have been found across different types of outlets in terms of the extent and amount of (political) information (Reich, 2016). Irrespective of these differences, most news media (in the Netherlands) have remained rather substantive (Brants & van Praag, 2017); consequently, we expected that exposure to any type of media outlet, generally, should enhance knowledge acquisition:

H1: The consumption of (a) television news, (b) newspapers, and (c) news websites positively affects the acquisition of current affairs knowledge.

Yet, people of different ability may still learn more effectively from one particular mode of presentation than from another modality (Kim, 2008). This strongly relates to the "knowledge gap hypothesis" coined by Tichenor et al. (1970):

As the infusion of mass media information into a social system increases higher socioeconomic status segments tend to acquire this information faster than lower socioeconomic status population segments so that gap in knowledge between the two tends to increase rather than decrease. (p. 159)

Two reasons that explicitly relate to news consumption explain why one group learns more from the media than others. First, citizens of higher social status, for a variety of motivations (e.g., surveillance, habit, social), are more likely to expose themselves to the news media than lower status citizens (see also Donohue, Tichenor, & Olien, 1975). This notion is in line with the motivation factor in the O-M-A framework (Luskin, 1990). Research has repeatedly confirmed the relationship between individuals' interest in politics and their political sophistication (David, 2009; Lee, 2013). The importance of motivation has, furthermore, increased because of the increasing choice in the traditional media landscape (Hopmann et al., 2015; Prior, 2007), for example, on social network sites (Boukes, 2019).

Second and squaring well with the O-M-A framework, even if the amount of exposure is the same, the outcome of it may vary among recipients. Citizens of higher social status would be better able to process news messages (Tichenor et al., 1970): They have more developed communication skills, which makes reading easier and following the fast pace of television news less difficult (Price & Zaller, 1993; Robinson & Davis, 1990). Regarding this second reason, however, Liu and Eveland (2005) write that "the research literature is full of findings inconsistent with the original expectation" (p. 910).

It seems, actually, that citizens with the lowest ability potentially benefit most from exposure to news in terms of knowledge acquisition (Norris & Sanders, 2003). Accordingly, the knowledge gap between citizens of high and low ability might become smaller (i.e., not larger as predicted by the original hypothesis) among heavy news consumers compared with people who consume less news (Eveland & Scheufele, 2000). Thereby, news media may fulfill a "bridging" role in society (Chaffee & Kanihan, 1997). Citizens with higher ability perhaps learn less from the same news consumption because they have alternative sources of information (Luskin, 1990; Robinson & Davis, 1990). Alternatively, low-ability citizens will benefit most from any comprehensible information that they are exposed to via the news media (e.g., Fraile & Iyengar, 2014). Ability may under some circumstances, thus, function differently than originally expected by the O-M-A framework and knowledge gap hypothesis.

Who Learns From Television News, Newspapers, and News Websites?

The information function of news consumption has been shown to especially pertain to citizens of lower ability (Shehata et al., 2015). When this differential learning effect is observed, it happens mostly with regard to audiovisual news and not textual news. Compared with print news that is written deliberately, television news appears as more spontaneous and similar to real-life communication (Cho et al., 2003), which enhances the ease of processing (Graber, 2001; Kwak, 1999). The technological features of television (e.g., close-up, sound, slow motion) evoke a sense of presence that automatically grabs the attention of viewers and makes news more comprehensible for people with fewer cognitive skills (Neuman, Just, & Crigler, 1992). Audiovisual presentation activates a larger number of senses in memory than written presentations (see dual-coding theory of Paivio, 1990). Television news, accordingly, requires fewer skills and less cognitive engagement to learn about current affairs than textual media (e.g., Grabe, Zhou, & Barnett, 2001; Shehata et al., 2015). Combining visual and verbal information may aid large population segments with limited skills to effectively process textual information (Prior, 2014). Television news, thus, could facilitate the acquisition of knowledge for citizens of lower ability and potentially close the knowledge gap. Hence, we expected the following:

H2: The consumption of television news has a positive effect on the acquisition of current affairs knowledge that is stronger for citizens with lower levels of ability.

Ability seems more likely to function in the moderating way as predicted by the knowledge gap hypothesis and O-M-A framework for newspapers than for television news. Textual news media, after all, have to overcome a barrier of minimum literacy and demand more effort and ability to process. This makes it unlikely that readers with little ability learn more from it than the ones with more cognitive skills (Kleinnijenhuis, 1991). On the contrary, highly educated readers may learn more from newspapers (Kim, 2008). It is not simply exposure to a textual news medium that causes learning, but rather the number and diversity of stories that one reads (Eveland & Schmitt, 2015). Citizens with higher ability may, therefore, benefit more from this mode of presentation because they can read more news stories in the same time. This argument does not apply to television news because all who are watching a news broadcast will be presented the same number of news items in the same time span, irrespective of their ability. As Tichenor et al. (1970) predicted, acquiring knowledge from textual news sources, plausibly, will be more likely for those with the highest ability (see also Jerit et al., 2006).

H3: The consumption of newspapers has a positive effect on the acquisition of current affairs knowledge that is stronger for citizens with higher levels of ability.

Following the theory above, we expected the consumption of television news to mitigate the knowledge gap, whereas this gap may be amplified for increasing levels of newspaper consumption. The current literature is unclear about how the knowledge gap is affected by the consumption of news websites (i.e., not social media or blogs, but journalistically produced online news). This is important, however, as online sources have already overtaken newspapers as many citizens' main source of news and approach the popularity of TV news (Newman et al., 2017).

Generally, it has been shown that Internet access more broadly, and the use of journalistic online content in particular, positively affects learning about the news (e.g., Dalrymple & Scheufele, 2007; Groshek & Dimitrova, 2011): Consuming news from tabloid and broadsheet news websites increases knowledge significantly (Dimitrova et al., 2014). However, learning effects from news websites could also be conditional on citizens' ability level. After all, news websites provide a combination of textual and audiovisual news and have the opportunity for interactive features (Du & Thornburg, 2011). High-ability citizens may benefit from the rich availability of textual news stories published on news websites (Yoo & Gil de Zúñiga, 2014) and be able to process these more effectively (Eveland & Schmitt, 2015). Simultaneously, citizens with lower ability could benefit from the video clips and infographics provided on these online portals (Dick, 2014). Hence, it remains an open question which citizens acquire most knowledge by the consumption of news websites:

RQ1: How does the consumption of news websites affect the acquisition of current affairs knowledge differently for citizens with higher versus lower levels of ability?

Method

Data

A three-wave online panel survey was conducted from February to July 2015 by I&O Research. Exact dates of fielding were February 23 (Wave 1), April 20 (Wave 2), and June 15, 2015 (Wave 3), with a gap of eight weeks between each of the waves. Respondents had 24 days to complete the survey; however, a majority (i.e., > 50%) responded within two days after the survey opened. In total, 22,879 panel members were invited, and 9,112 people started the first questionnaire (response rate, RR2 = 39.8%), of which 6,386 completed the survey (RR1 = 27.9%; cooperation rate, COOP1 = 70.1%). Respondents who participated in the previous wave were invited in the subsequent one. For Wave 2, 4,301 respondents completed the questionnaire (RR1 = 67.4%). In Wave 3, 3,270 respondents completed the survey (RR1 = 76.0%).

Respondents who dropped out between Wave 1 and Wave 3 were slightly younger ($M = 57.38$ years, $SD = 13.36$) than those who completed all waves ($M = 61.44$ years, $SD = 11.08$), $t(6384) = 13.25$, $p < .001$; more likely female (54.4%) than male (45.5%), $\chi^2(1) = 47.92$, $p < .001$; but did not differ on education, $t(6319) = 0.95$, $p = .343$. Although attrition of respondents was considerable (on average 28% per wave), response and completion rates were similar to or higher than those reported in previous panel

studies using different pollsters and in different contexts; clearly, this is an inherent issue for this otherwise externally valid panel survey method.

Measurements

Independent Variables

Questions were asked in Wave 1 about how many times per week or per month respondents watched certain TV programs, read certain newspapers, or visited certain news websites. All variables indicated the number of times per week a specific outlet was consumed, ranging from 0 (*never*), 1 (*one day per week*), to 7 (*every day or multiple times per day*). Thereby, media consumption was measured in a way that has been found to result in the most reliable self-reports (Andersen, de Vreese, & Albæk, 2016; Dilliplane, Goldman, & Mutz, 2013; see meta-analysis of Scharrow, 2019): asking about specific outlets (i.e., not TV or TV news generally) with concrete response options that refer to days per week (i.e., not hours or less specific frequency options).

Composite latent constructs were then created by summing the self-reported consumption scores of outlets within the same modality. Because the observed indicators determine the latent constructs rather than are reflections of it (i.e., a principal component affecting the indicators), no internal consistency or positive interitem correlations are required to form a valid scale (Bollen & Lennox, 1991; Jarvis, MacKenzie, & Podsakoff, 2003). After all, the consumption of specific outlets does not per definition correlate with the use of other outlets of the same modality. On the contrary, when a citizen subscribes to a particular newspaper, s/he will be less likely to also consume other newspapers. The same goes for TV: If one already has seen the evening news on one's preferred channel, that person may be less inclined to also watch the news on the competing channel. Observed items, thus, are formative rather than reflective indicators, making interitem correlations or measurements of internal consistency reliability (e.g., Cronbach's α) an unnecessary and inappropriate standard for evaluating measurement adequacy (Bollen & Lennox, 1991; Jarvis et al., 2003).

Yet, for such a formative measurement model, "a census of indicators, not a sample" (Bollen & Lennox, 1991, p. 308) is needed to obtain a complete picture. Accordingly, we measured the exposure to a wide range of outlets. For each modality, we selected the outlets/programs that are most frequently used for news and current affairs consumption based on subscriptions and viewer ratings. Both quality and popular sources for the printed and online outlets were included as these substantively do not differ as much in the Netherlands as in countries with clear tabloid outlets (e.g., *The Sun* in the United Kingdom or *Bild* in Germany; see de Vreese, Esser, & Hopmann, 2017). No soft television news programs were included in the measurements because they differ substantially from hard news programs in their topic selection and rarely deal with political affairs. Hence, soft news programs can impossibly contribute to the type of knowledge that the current study has focused on. Importantly, the mean scores for television news (highest), newspaper (lowest), and news website consumption in our sample reflect the popularity of information sources in the Netherlands (Costera Meijer & Groot Kormelink, 2017).

Television news consumption. The Netherlands has three television programs that cover the daily news and fit Reinemann, Stanyer, Scherr, and Legnante's (2012) description of hard news. How many days

per week people watched *NOS Journaal*, *RTL Nieuws*, and *Nieuwsuur* were summed and combined in one measure indicating the consumption of television news ($M = 10.00$, $SD = 4.93$).

Newspaper consumption. The summed days per week that people read *De Telegraaf*, *Algemeen Dagblad*, *Metro* (all popular outlets; see Boukes & Vliegthart, 2017), *De Volkskrant*, *NRC Handelsblad*, *NRC Next*, and *Trouw* (quality newspapers), or a regional newspaper with national focus were used as the indicator of quality newspaper consumption ($M = 4.63$, $SD = 4.61$). As the regional newspaper market occupies 39% of the Dutch newspaper landscape, it was important to include regional newspaper readership in the measurement of overall newspaper reading.²

News website consumption: The accumulated score of how many days in an average week people visited the following seven websites (i.e., combination of popular and quality sources) was used as the measurement of news website consumption ($M = 6.89$, $SD = 7.46$): *www.nu.nl*, *telegraaf.nl*, *ad.nl*, *nos.nl*, *rtlnieuws.nl*, *volkskrant.nl*, and *nrc.nl*. The first, *nu.nl*, is the biggest (independent) news website in the Netherlands tailoring to a mass audience. All others are online portals of traditional news outlets that were also included in the measurement of either television news or newspaper consumption. Together, they form the most frequently visited news websites of the Netherlands (Newman et al., 2017).

Moderator Variables

Following the conventional indicator that was applied in the original work on the knowledge gap hypothesis (Tichenor et al., 1970; Donohue et al., 1975, but also more recently by Eveland & Scheufele, 2000; Fraile & Iyengar, 2014; Kim, 2008), we measured the ability to process and learn from the news by means of citizen's level of education (Galston, 2001).³ In Wave 1, people were asked, "What is the highest degree or level of school you have followed?" Responses were tapped on a 7-point scale ranging from 0 (*primary education*) to 6 (*master's degree*) ($M = 4.03$, $SD = 1.55$).

Control Variables

Analyses controlled for several variables: age, gender, left-right political preference, internal efficacy, political trust, and political interest. The latter is indicative of the *motivation* to select news coverage (Lecheler & de Vreese, 2017). The analyses also controlled for an alternative source of information: frequency of talking with others about current affairs (i.e., politics and economy, $\alpha = .86$). All of these variables are argued to be related to levels of political knowledge (see, e.g., Delli Carpini & Keeter, 1996), with, for example, adolescents

² Newspaper and news website consumption variables are not normally distributed; both are rightly skewed with heavy-tailed distribution. To verify the robustness of our findings, we replicated our main models using bootstrapping estimation (50 replications): Results were highly similar, with only the three-way interaction Time \times Television News \times Education becoming borderline significant ($p = .10$).

³ Using an alternative indicator of ability (i.e., "existing knowledge" similar to Norris & Sanders, 2003; Price & Zaller, 1993), we found results that, in terms of interpretation, were highly comparable. We have used "education," though, because it is more in line with the original literature on the knowledge gap hypothesis.

and females having lower levels of knowledge and knowledge being related to other attributes of "good citizenship," such as trust and efficacy (Delli Carpini, 2000).

Dependent Variable

Following the same approach as Shehata et al. (2015) as well as Andersen and Hopmann (2018), we constructed a cumulative measure that reflects the growth of knowledge over time. For the first survey wave, five multiple-choice questions on different topics were asked to measure citizens' existing level of knowledge of current affairs. In both waves that followed, two additional questions were asked that focused on new information (i.e., information that very unlikely or impossibly could be known before the previous survey wave). Summing the number of correct answers to these questions in a cumulative scale resulted in an 8-point knowledge index (0–7) for Wave 2 and a 10-point index (0–9) for Wave 3.

The existing level of knowledge in Wave 1 was measured with questions that dealt with the following topics: current interest rates (i.e., higher than normal), the Dutch minister of finance (i.e., Dijsselbloem), the managing director of the International Monetary Fund (i.e., Lagarde), most important trading partners of the Netherlands (i.e., not Spain), and Fitch and Moody's credit rating of the Netherlands (i.e., AAA). All combined, this created a 6-point scale ranging from 0 (everything wrong) to 5 (all answers correct; $M = 3.62$, $SD = 1.17$) indicative of general current affairs knowledge (see Delli Carpini & Keeter, 1996, p. 151). Questions were multiple choice with four answer options plus a "don't know" option to minimize the number of false positives (i.e., randomly guessing the right answer).

The acquisition of current affairs knowledge, then, was captured in the dependent variable by adding the number of correct answers to the two questions about new information in Wave 2 ($M = 5.19$, $SD = 1.38$) and in Wave 3 ($M = 6.60$, $SD = 1.77$). In total, four multiple-choice questions were answered about new information that received media attention about 10 days preceding a survey wave. Knowing the answer to these questions, accordingly, could not be the consequence of learning about it beforehand (e.g., in school), but most likely was the outcome of recent news consumption. Focusing on recent surveillance-policy facts (Barabas, Jerit, Pollock, & Rainey, 2014), we can be certain that the knowledge was actually acquired in the period of study; so, we can confidently speak of media effects rather than the reverse. Our operationalization inherently resulted in higher scores over time: By answering additional questions in Wave 2 and 3 and adding the number of correct answers to the knowledge score of the previous wave(s), values increased by definition. The Analysis section explains how our modeling strategy fit this operationalization.

In Wave 2, questions asked which government-owned bank came into disrepute because of the bonuses of their directors (i.e., ABN Amro), and which law was approved by Parliament that directly influences Dutch employees (i.e., allowing flexible working times). Wave 3 asked which semipublic corporation Timo Huges worked for before he resigned after problems with public procurements (i.e., NS Dutch Railway), and about the percentage of economic growth as predicted by the Dutch National Bank (i.e., 2%). The questions focused on economic topics because of the wider research project this survey has been part of. However, the questions dealt with issues and events that were not limited to the economic sections of news outlets, but were instead widely discussed and received ample coverage.

Contrary to the formative measurement model of news consumption scales, current affairs knowledge is a reflective measurement model in which the observed indicators (i.e., number of correct answers) are determined by the latent construct. Accordingly, internal consistency is assumed (Bollen & Lennox, 1991). Principal factor analysis demonstrated that the nine observed knowledge items formed one factor that exceeded the Kaiser criterion (eigenvalue > 1). Reliability analysis found Cronbach's $\alpha = .58$, which was only moderate but can be explained by the deliberately chosen variation in the scope of the questions and their level of difficulty. Accordingly, the separate items all contributed unique variance. The mean interitem correlation of $r^* = .27$ (i.e., tetrachoric correlation for binary variables) indicated an optimal level of homogeneity (i.e., not too high and not too low; see Briggs & Cheek, 1986, p. 114, who specify a range from .20 to .40).

To validate that the new knowledge was acquired in the period during the panel survey rather than before, we counted the media coverage of these facts in the seven newspapers mentioned above, the television news programs *NOS Journaal* and *Nieuwsuur*, plus the Dutch newswire ANP that provides a majority of the content for news websites (Boumans, Trilling, Vliegthart, & Boomgaarden, 2018; Welbers, van Atteveldt, Kleinnijenhuis, & Ruigrok, 2018). Coverage was indeed much more salient in the eight weeks preceding the respective survey wave in which a knowledge item was measured than in the eight weeks before the first survey wave commenced: ABN bonuses (before panel survey: $n = 0$; during panel survey: $n = 85$); law on flexible working times (before: $n = 1$; during: $n = 8$), Timo Huges (before: $n = 6$; during: $n = 117$), economic growth (before: $n = 0$; during: $n = 13$). This confirms the strongly increased availability of the factual information measured in the dependent variable.

Analysis

We tested a two-level hierarchal growth model (see Andersen & Hopmann, 2018; Shehata et al., 2015, for recent applications of this analysis strategy) to analyze whether the knowledge gap amplified or narrowed with more news media consumption. The model followed the structure of a multilevel random-intercept model in which waves (i.e., time) are nested within individual respondents. Clustering observations within individuals using a random-intercept model, we effectively controlled for the differences between respondents and explained the variance in knowledge that occurred within individuals over the course of time.

This growth model had several advantages. First, it did not require all respondents to complete all survey waves; by analyzing the knowledge (growth) per wave in one model, we could include people who only took part in Waves 1 and 2. This reduced the consequences of panel attrition (Hox, 2010): Answers from respondents who dropped out after Wave 1 could still be used to estimate the intercepts, whereas people who dropped out between Wave 2 and Wave 3 were still accounted for in the effect estimates of knowledge acquisition over time. Second and most central to the idea of the knowledge gap hypothesis, it allowed tracing how differences in knowledge between education levels developed over time. Third, the analysis controlled for general knowledge increases with every survey wave by controlling for the time of an observation (i.e., t_0 , t_1 , or

t_2). Interaction effects between time and news media consumption, then, showed how the general increase of knowledge over time was conditional on the frequency of news consumption.⁴

This altogether provided a stringent test of causality. By measuring media consumption at Wave 1 and knowledge acquisition at Waves 2 and 3, the cause (news consumption) preceded the outcome (acquisition of new knowledge) in time. Because knowledge questions asked about facts that effectively could only be known after the measurement of media consumption, it is very likely that knowledge was the outcome of news consumption: Reverse causality was implausible. Moreover, by including people's existing knowledge level in the model (i.e., starting point of the growth model), omitted variable bias was unlikely. Using panel data, including the existing knowledge level, and capturing knowledge growth with items based on new facts, any relationship between media consumption and current affairs knowledge should be indicative of learning effects. All independent variables were mean standardized ($M = 0$, $SD = 1$) to allow a comparison of effects, except for the time indicator (0, 1 or 2); so, the intercept still reflected the existing level of knowledge in the first survey wave.

Results

Descriptive Findings

Pairwise correlations provide several useful insights concerning the actual consumption of news (see Table 1). As already predicted by Tichenor et al. (1970), education may not only moderate the effects on knowledge acquisition of exposure to news coverage, but it also determines the frequency with which people consume news. As expected, education correlated positively with how frequently people read newspapers ($r = .14$) or visited news websites ($r = .07$). Yet, education and television news correlated negatively. The assumption that following the news, generally, would be something for "the more highly educated segments of society" (Tichenor et al., 1970, p. 159), thus, should be disregarded: It depends on the modality of news media. In all instances, correlations were weak ($r < .30$; see Cohen, 1988), indicating that differences in news consumption across people with different education levels were fairly limited; hence, strong self-selection processes into specific modalities based on educational background seem largely absent.

Second, the consumption of different modalities of news correlated only weakly among each other. The strongest correlation was found between the frequency of reading newspapers and news websites ($r = .22$) and the weakest between television news and news websites ($r = .09$). This indicates that a simple distinction in general high and low news users is oversimplified: Some people will consume more news from a particular modality, but that does not imply that they will also use the other types of news outlets more frequently.

⁴ Interaction effects were added simultaneously within the same model rather than one-by-one to hold the other interactions constant (e.g., the effect of television news consumption over time controlled for the effect of news website consumption over time). Multicollinearity did not pose a threat to our models, with the highest correlations between independent variables below .50 and variance inflation factor (VIF) values below 3.0.

Table 1. Bivariate Correlations Between Independent and Dependent Variables.

Variable	Education	Television news	Newspapers	News websites	Knowledge (total)
Education	1.00				
Television news	-0.13	1.00			
Newspapers	0.14	0.16	1.00		
News websites	0.07	0.09	0.22	1.00	
Knowledge (total)	0.26	0.12	0.17	0.20	1.00

Note. All Pearson correlations are significant at $p < .001$.

Finally, the correlations provide initial (although cross-sectional) evidence for a relationship between news consumption and knowledge levels. Just as for education, all three news media types (TV, newspapers, and websites) positively correlated with knowledge. Yet, these correlations did not allow an assessment of the directionality in the causal relationship. We now turn to the two-level hierarchical growth model to examine how news consumption affected the knowledge acquisition over time.

Predicting Knowledge Acquisition: Effects of News Consumption and Education

Table 2 presents the results of the growth models. The results of Model 1 demonstrate that on average the cumulated knowledge score increased with 1.45 correct answers per wave ($SE = 0.01, p < .001$). Figure 1 visually illustrates this general increase of knowledge over time.

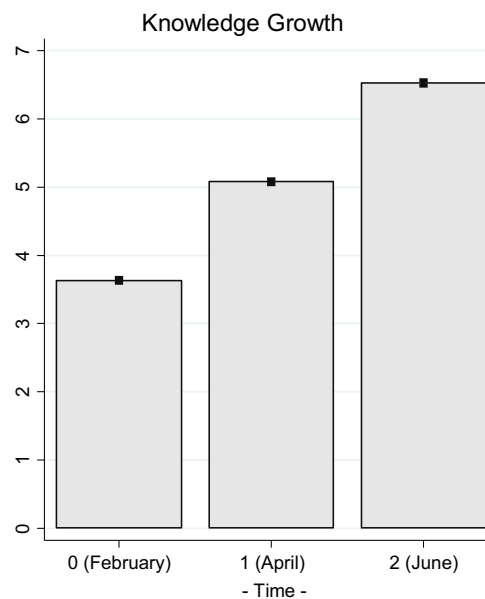


Figure 1. Predicted number of correct answers (y-axis) per survey wave.

Table 2. Two-Level Hierarchal Growth Model Predicting Knowledge Acquisition.

Variable	Model 1		Model 2		Model 3		Model 4	
	<i>B</i>	<i>p</i>	<i>B</i>	<i>p</i>	<i>B</i>	<i>p</i>	<i>B</i>	<i>p</i>
Independent variable								
Intercept	3.63	.000	3.64	.000	3.64	.000	3.63	.000
Time (0, 1, or 2)	1.45	.000	1.45	.000	1.44	.000	1.44	.000
Education			0.24	.000	0.19	.000	0.19	.000
Television news			0.04	.028	0.00	.811	-0.01	.733
Newspaper			0.03	.093	0.01	.726	0.01	.756
News website			0.15	.000	0.11	.000	0.11	.000
Time × Education					0.08	.000	0.08	.000
Time × Television News					0.06	.000	0.06	.000
Time × Newspaper					0.03	.000	0.03	.000
Time × News Website					0.06	.000	0.06	.000
Education × Television News							-0.04	.003
Education × Newspaper							0.01	.635
Education × News Website							-0.04	.009
Time × TV News × Education							-0.01	.024
Time × Newspaper × Education							-0.00	.697
Time × Website × Education							0.00	.457
Control variables								
Age			0.16	.000	0.16	.000	0.16	.000
Gender (male vs. female)			-0.20	.000	-0.20	.000	-0.20	.000
Internal efficacy			0.18	.000	0.18	.000	0.19	.000
Political trust			0.00	.746	0.00	.753	0.00	.743
Ideology (left-right)			0.02	.207	0.02	.226	0.02	.165
Current affairs talk			0.08	.000	0.09	.000	0.08	.000
Political interest			0.19	.000	0.19	.000	0.19	.000
<i>n</i> (individuals/observations)	6,321/13,825		6,321/13,825		6,321/13,825		6,321/13,825	
Log-likelihood	-18902.16		-18023.00		-17800.75		-17786.99	
Akaike information criterion (AIC)	37812.32		36076.00		35639.50		35623.97	
Bayesian information criterion (BIC)	37842.45		36189.01		35782.65		35812.33	

Note. All independent variables (except time) have been standardized to $M = 0$, $SD = 1$.

Model 2 added education and the news consumption variables to the model with the control variables. Because this model did not yet include interactions with time, its findings cannot exclude the possibility of reverse causality. The results show that education positively predicted knowledge. Similarly, a positive relationship was yielded with television news consumption and the frequency of visiting news websites. The effect of newspaper readership was only marginally significant. In line with previous studies, Model 2 verified that higher educated, older, male, politically interested, internally efficacious, and those who frequently talk about current affairs had a higher knowledge level.

To model the over-time dynamics, Model 3 adds interactions between media consumption and time to. Controlling for the interaction between time and education (i.e., positive effect: Higher educated citizens learn more over time), the results show that all three of the news media types had a positive interaction effect with time on the acquisition of knowledge.⁵ This means that the general increase of knowledge observed in Models 1 and 2 occurred more strongly for citizens who more frequently consumed television news ($B = 0.06$, $SE = 0.01$, $p < .001$), newspapers ($B = 0.03$, $SE = 0.01$, $p < .001$) and news websites ($B = 0.06$, $SE = 0.01$, $p < .001$). These findings are in line with Hypotheses 1a, b, and c.

Model 4 included three-way interactions between (1) time, (2) news consumption, and (3) education.⁶ The model controlled for two-way interaction effects between education and news consumption; these interactions did not assess changes over time and merely presented cross-sectional results. Accordingly, these two-way interactions were irrelevant to test our hypotheses and are not discussed in further detail. The three-way interaction terms tested whether the effect of a particular news modality over time was stronger or weaker for different levels of education. A significant three-way interaction effect was found for the consumption of television news ($B = -0.01$, $SE = 0.01$, $p = .024$). This means that the positive effect of television news consumption as observed in Model 3 occurred less strongly for highly educated citizens.

To ease interpretation, the interaction effect is visualized in Figure 2. The two lines show the marginal effect of time: the increase in knowledge for every subsequent wave. The figure shows that the marginal effect of time increased with more frequent television news consumption (i.e., the positive interaction effect between time and television news in Model 3). Yet, the figure also shows that this increasing knowledge acquisition due to television news consumption occurred stronger for lower educated citizens (steeper dashed line) than higher educated citizens (less steep solid line). Without television news consumption, the higher educated learned more than the lower educated (left side of graph). This gap significantly narrowed as citizens consumed more television news, almost to an insignificant difference between the low and highly educated (95% confidence intervals do not overlap yet). Altogether, this finding provides evidence for Hypothesis 2: The consumption of television news positively affected the acquisition of current affairs knowledge more strongly for citizens with lower levels of education.

⁵ Findings were highly similar when interactions between time and news consumption variables were not included simultaneously, but one at a time. In that case, significant and slightly stronger effect sizes for all three modalities resulted.

⁶ Results were similar when including three-way interactions separately, instead of simultaneously in one model.

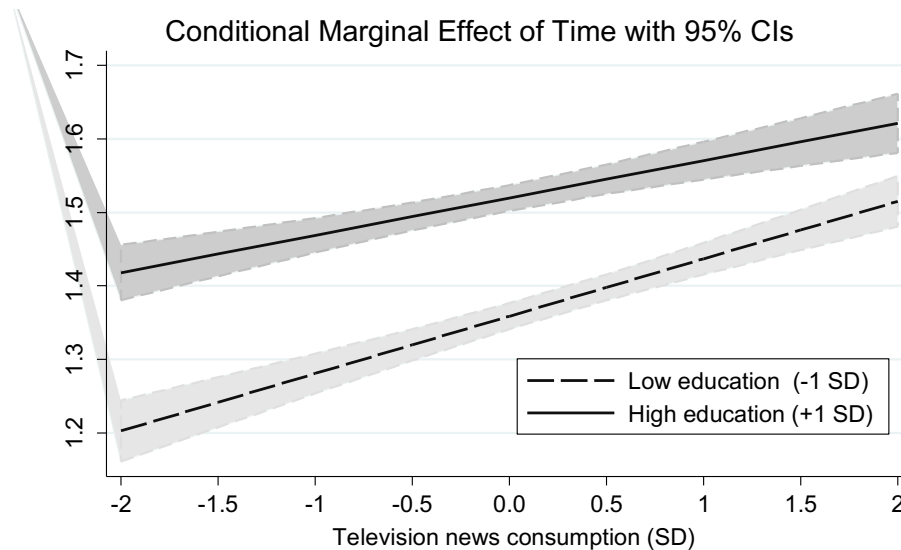


Figure 2. The marginal effect of time on knowledge acquisition (y-axis) for different levels of education when citizens consume more (right side) or less television news (left side).

The three-way interaction effects with newspaper consumption ($B = -0.00$, $SE = 0.01$, $p = .697$) and news website consumption ($B = 0.00$, $SE = 0.01$, $p = .457$) were not significant. Hypothesis 3, accordingly, has to be rejected: Citizens of higher and lower levels of education learned at equal rates from the consumption of newspapers. We reflect further on this finding in the Discussion section. The answer to our research question is that the positive learning effect of news website consumption does not differ among levels of education. Figure 3 shows that the positive effect of both newspaper and news website consumption was equally strong for lower and higher educated people.

Discussion

Using dynamic data to model knowledge acquisition over time, this study demonstrates how modality (audiovisual vs. text) matters for the effect that news consumption has on the knowledge gap. Findings show that citizens with the lowest ability learn comparatively the most from the consumption of audiovisual news: When consuming more television news, knowledge acquisition increases the most for citizens with a lower level of education; television news consumption does not have a similarly strong effect for the higher educated. Lower educated citizens, thus, benefit most from this mode of presentation, which slows down the growth of a knowledge gap. Television, accordingly, lives up its potential to "bridge" the knowledge gap (Chaffee & Kanihan, 1997).

In this study, the positive effect of newspaper consumption was not conditional on this ability factor. Although reading newspapers positively affected knowledge acquisition, citizens with a higher (or lower) level of education did not especially benefit from it. Hence, newspaper consumption neither further increases nor decreases the knowledge gap. Perhaps this is because the (in)ability of citizens to learn from

textual news has become “less of a pertinent issue” due to rising education levels (Lecheler & de Vreese, 2017, p. 548). In a country such as the Netherlands, almost every citizen can read, afford, and benefit from the information contained in textual news sources. With individual readers controlling their own pace of processing, moreover, citizens can adjust how much time they need to carefully read an article (Robinson & Davis, 1990).

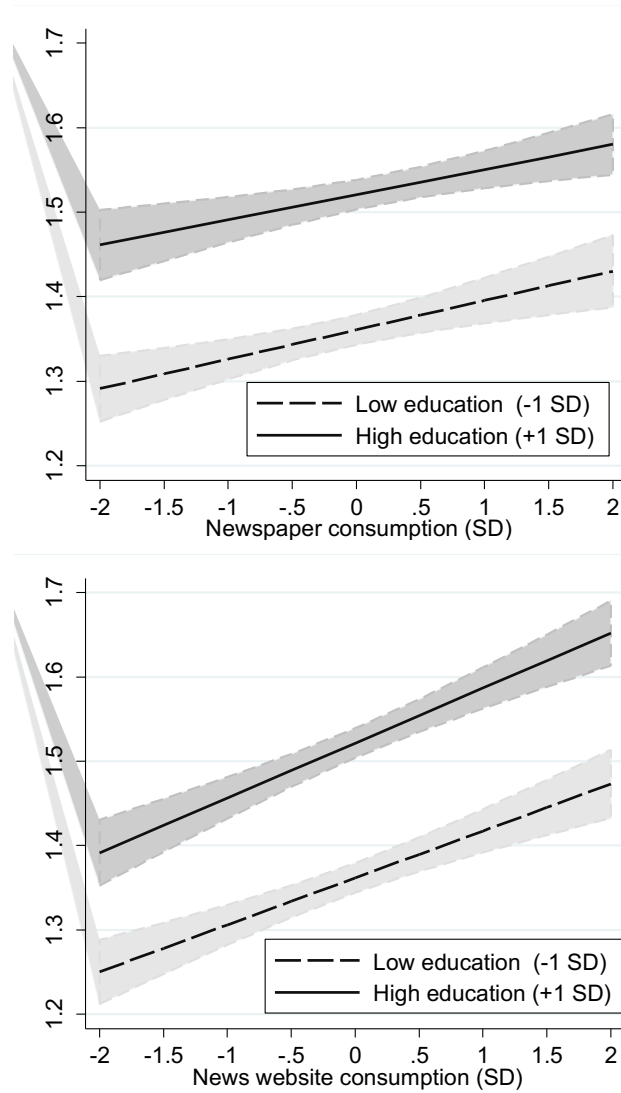


Figure 3. The marginal effect of time on knowledge acquisition (y-axis) for different levels of education when citizens consume newspapers (upper graph) or news websites (lower graph) more or less frequently (x-axis).

A differential learning effect was neither found for the consumption of news websites. One logical explanation could be that the news presented online largely reflects the news that appears in printed outlets (Boumans et al., 2018; Welbers et al., 2018). Most of the news websites—at least in the Netherlands—still present their news primarily in a textual format. The (costly) use of audiovisuals by news websites, such as video clips or infographics, remains more exceptional than the rule. Altogether, we conclude that the consumption of both newspapers and news websites has a learning effect that is not moderated by education level.

One important side note to this research is found in the correlations between news consumption and level of education. Whereas some may assume that education positively predicts news consumption in general (Lee, 2013; Tichenor et al., 1970), our data showed a more nuanced picture. Newspapers and news websites, indeed, are more frequently consumed by higher educated citizens; however, television news is consumed more often by those with less education. The strong position of the public broadcaster, arguably, plays an important role in this relationship (Wonneberger, Schoenbach, & van Meurs, 2012). Public broadcasters (but in the Netherlands, the commercial broadcaster too) provide a diverse mix of news, infotainment, and entertainment, which enables “incidental” exposure to television news for the audience that is not per se interested in politics and current affairs. Accordingly, the modality of TV is not only a particularly effective source of information for lower educated citizens: They actually tune in to this type of news, which makes the positive effect very likely to occur under regular circumstances. Our results can be considered an indirect confirmation of the importance of public broadcasters for an informed citizenry (see Soroka et al., 2013). However, we urge future research to replicate the current findings in contexts with less strong public broadcasters or a less literate citizenry.

Following recent research, we measured current affairs knowledge with factual multiple-choice questions (e.g., Andersen et al., 2016; Jebriil, de Vreese, van Dalen, & Albæk, 2013) about new current affairs information that could only be acquired between survey waves (Barabas & Jerit, 2009; Shehata et al., 2015). Key to “enlightened preferences” (Barabas & Jerit, 2009, p. 73), the surveillance-oriented information measured in this study had a focus on political-economic issues, which for a variety of reasons are important. After all, what people learn about the economy influences their approval of politicians (Nadeau, Niemi, Fan, & Amato, 1999) and eventually their electoral decisions (Sanders, 2000). Moreover, Delli Carpini and Keeter (1996) demonstrate that knowledge about the political economy is a dimension of and strongly relates to political knowledge, generally.

In addition to obtaining basic current affairs facts as measured in our dependent variable, future research may consider measuring the acquisition of more in-depth or structural forms of knowledge (see, e.g., Eveland & Schmitt, 2015; Hansen & Pedersen, 2014). Now, we can only speculate that especially the textual news media (newspapers and potentially websites) may provide readers with such kinds of knowledge that go beyond simple facts. The current study, nevertheless, provides insights into, what is believed, one of the most important functions that the media have in a democratic society (Althaus, 2012): informing the public about current affairs. Irrespective of modality, we demonstrate that consuming the news—whether via television, newspaper, or online—positively affects knowledge acquisition. Moreover and contrary to well-known theoretical frameworks as O-M-A or the knowledge gap hypothesis, we show that when exposure is equal, television news especially benefits citizens with a lower ability. Whereas newspapers

and websites did not further amplify the knowledge gap, this societal cleavage in knowledge may thus be reduced as the outcome of television news consumption.

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