

# Hypotesen om självförvållade filterbubblor

## The self-imposed filter bubble hypothesis

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**Abs.** *It is commonly assumed that algorithmic curation of search results creates filter bubbles, where users' beliefs are continually reinforced and opposing views are suppressed. However, empirical evidence has failed to support this hypothesis. Instead, we suggest that filter bubbles may result from individuals acting selectively on information made available by search engines. When presented with search engine results pages, links and sources that validate users' beliefs should be attended more than other links. This prediction is testable using eye-tracking technology. Here, we presented biased participants (n = 48) with sets of simulated Google Search results, controlling for the ideological leaning of each link. Results indicate that, on average, politically Liberal participants spend more time viewing own-side links than other links, while political Conservatives do not. However, both Liberals and Conservatives tend to select same-side links. Further, there is a significant effect of trust, such that links associated with less trusted sources are attended less and selected less often. Implications, study limitations, and directions for further study are also discussed.*

## 1 Introduction

### *The problem of filter bubbles*

Every day, millions of people search for information online using search engines such as Google Search, Yahoo, and DuckDuckGo. The results we see on the web influence our interpretations of world events and our beliefs about the world. Google Search is particularly ubiquitous, with billions of search queries processed every day (Internetlivestats, 2021). However, it has also been subject to extensive criticism. Search engine result pages (SERPs) are typically based not only on the search terms used but also on users' previous searches. It has been alleged that this process, known as personalization, leads to ideological segregation and polarization. By reinforcing searchers' beliefs and hiding or suppressing user-opposing views, Google Search allegedly creates ideological filter bubbles, potentially emphasizing real-life political affective polarization and segregation (Pariser, 2011; Sunstein, 1999) and fragmenting political discourse (see Garrett & Resnick, 2011). Despite widespread intuitive appeal, however, empirical evidence has largely failed to support this hypothesis.

In one study of Google users, Hannak et al., (2017) found small (~12%) differences in search results, defined as links or the position of links. Counter to the prediction of the filter bubble hypothesis, however, the authors found no measurable history-driven effect of personalization. Being logged into the Google system, and searchers' geographic location were the only statistically significant factors. Similarly, Haim et al., (2017) found only minor differences in link position between accounts when 1200 individuals searched for information on suicide. Further, while Curtois et al., (2018) did find extensive variation in search results for

social and political search terms, most of that variation was explained by the time of the search. Finally, in studying the browsing histories of over 1.3 million U.S.-based users, Flaxman et al., (2016) found that while news access was segregated, online search tools such as search engines actually increased users' chances of being exposed to opposing or disconfirming views (see also Cardenal et al., 2019). Empirically, then, the Google Search engine itself appears not to be driving filter bubble-type ideological segregation (see also Zuiderveen Borgesius et al., 2016). Thus, the problem of the filter bubble phenomenon facing academics is not necessarily the facilitation of political segregation (though that may still be so), but that it is apparently difficult to study in the first place. Notably, however, one aspect of online information search that remains largely unexplored is the role of the searcher himself.

Typically, in studies on SERPs, top links receive the most attention from users, with less attention afforded to each subsequent link (Salmerón et al., 2013; Granka et al., 2014). Hotchkiss et al., (2005) introduced the term *golden triangle* to describe a heatmap illustration of this phenomenon, where gaze is concentrated in the rough form of a right triangle with the right angle facing upwards to the left, such that gaze on average drops off significantly beyond the hypotenuse (see Figure 1). Further, while search engines typically return hundreds of pages of results, users commonly choose results from only the first page (Joachims et al., 2007), and even in initial SERPs, more than two-thirds of all clicks tend to go to the first five link positions presented (Petrescu, 2014). Thus, available research suggests that link position tends to bias selection, which – all other things being equal – should facilitate depolarization of political beliefs (through homogeneity in selection), as opposed to increased polarization. While a significant amount of research has investigated the ways in which users typically interact with search engines, few have sought to investigate the way in which users' beliefs interact with such behaviors. These studies have also tended to ignore political content in the links presented.

Yom-Tov et al., (2014) have suggested an alternative proposition with important implications for the filter bubble hypothesis. Biased persons, acting on the large set of information made available via the internet, may be selectively curating their own newsfeeds and information sources – effectively engaging in self-segregating behavior. This assertion, henceforth referred to as the *self-imposed filter bubble hypothesis*, does indeed find significant support in relevant research literature from social psychology, cognitive science, and communication (see below). Further, while Yom-Tov and colleagues did not themselves attempt to test this hypothesis empirically, its core assertion presents researchers with clear premises, open to investigation via experimental means. In this thesis, I present the results of one such investigation.

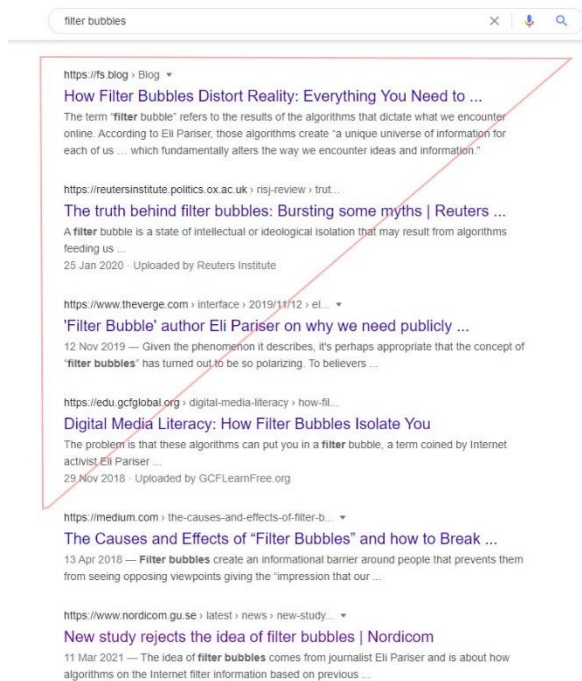


Figure 1. In empirical studies on SERPs, users' attention is typically concentrated in a triangle-like pattern, such that lower-position links are attended less and read less extensively on average, outside a "golden triangle".

### Ingroups, outgroups, and dealing with sources

It is a well-replicated set of findings in social psychology that group identity often becomes a cause of differential treatment between groups (Eibl-Eibesfeldt, 1979; Brewer, 1979; Tajfel & Turner, 1986; for a comprehensive review, see Hewstone et al., 2002) and is easily established, for example, based on real-world groupings such as ethnicity and political affiliation (Rand et al., 2008). These findings have been repeatedly validated and replicated, with a review by Mullen et al., (1992) finding that ingroup favoritism did not once fail to replicate in any one culture where it was investigated. Many factors are known to influence ingroup bias, including the ease of identification, salience, and status (see Hewstone et al., 2002). Further, ingroup and outgroup cognitive biases may extend even beyond conscious information processing.

According to Cohen (2003, p. 1): “[G]roups define the very meaning of objects in the social world.” Indeed, dynamics of ingroup and outgroup appear to affect even unconscious cognitive processing (for an overview, see Chong, 2013), extending to seemingly objective facts about the world (Bartels, 2008). As a consequence, people often see the same thing but

experience it differently. For example, in a classic work, Hastorf and Cantril (1954) found that participants were more likely to perceive errors in the playing of student football players from teams of students from competing schools, than they were to perceive them in players representing their own school. This was later revisited and further supported by Kahan et al., (2012), who showed that participants viewing identical footage disagreed about key aspects of the observed events (a protest), depending on their own political ideology.

There is considerable consensus in the field that partisanship biases information processing in the context of politics as well (e.g., Chong, 2013; but see also Gerber & Green, 1998). Such effects also tend to be more readily found in people with greater political knowledge and insight – i.e., political sophisticates. For instance, a survey study by Brader (2006) found that sophisticates self-reported stronger discrete emotions toward politicians. In the words of Lodge and Taber (2005, p. 473): “[Political] sophisticates, because of their interest in politics, have formed crystallized attitudes to a fuller set of political issues.” Interestingly, in this regard, a difference has been found between political liberals (i.e., left-wingers) and political conservatives (i.e., right-wingers), such that liberal persons are more likely to avoid exposure to political disagreement, at least in online interactions (e.g., Bode, 2016).<sup>1</sup> Finally, ingroup favoritism apparently also extends to levels of perception, including visual attention, such that own-side social stimuli are more thoroughly attended to and processed (Xiao et al., 2016; Kawakami et al., 2014). For example, Kawakami et al., (2014) found significant evidence of preferential attention to the eyes and faces of ingroup members, such that White participants tended to attend more to the eyes of White target faces, compared to Black target faces. This effect seemingly holds also for novel ingroup and outgroup faces. This state of research let us pose a set of main hypotheses.

**H1a:** Partisans select search results in line with their group and ideology, and do not select search results that fail to conform to their group and ideology.

**H1b:** The top-link heuristic – which posits that top-presented search results are selected more often due to their position as initial – holds when search results align with searcher’s ideology, but not when it does not.

Another particularly meaningful marker for whether to trust information is delineated by its source. The question of how to treat others as sources is of importance to several disciplines, such as developmental psychology (Mills, 2013), decision making (Birnbaum et al., 1976; Birnbaum & Stegner, 1979), and persuasion (Petty & Cacioppo, 1984; 1986).

<sup>1</sup> Relatedly, Sperber et al., (2010) have suggested that humans are equipped with mechanisms of “epistemic vigilance”, designed to minimize the risk of unreliable

information sampled from others. These mechanisms may also include a check on new information, testing whether it is consistent with one’s own beliefs (e.g., Mercier, 2020).

On average, people have trust in search engines' ability to rank and present users with the best results (Purcell et al., 2012; Pan et al., 2007), though this may have diminished in recent years (Schultheiß et al., 2018). Even when presenting participants with manipulated reverse-ordered search results, participants still placed significant trust in Google's own link positioning as being relevant for assigned task purposes (Kammerer & Gerjets, 2012). However, source position does not seem to serve as an apparent clue to trustworthiness in search results, such that links with higher position are not necessarily trusted more as sources than are lower-position ones (Kammerer & Gerjets, 2014). Thus, judgements of trust in a search engine may be more concerned with relevance to search enquiries, than with explicit trust in a given source, suggesting that conscious processing and evaluation of that source may override the initial attentional bias towards top-presented search results (e.g., Salmerón et al., 2013). For delineating the role of trust in the reliability of communicated information, it is useful to look to models of message reliability.

Olsson and Angere's Bayesian model of belief updating (see Olsson, 2011; Olsson & Vallinder, 2013) suggests that content and source reliability interact bidirectionally, such that the reliability of a source moderates evidential impact of message content – and message content, in turn, provides evidence about the reliability of the source (for another model emphasizing this relationship, see Bovens & Hartmann, 2003). Just as statements from an unreliable source are regarded as implausible, implausible statements themselves make a source appear less reliable: it leads to a reduction in subjective degree of belief of reliability. In Olsson and Angere's model, source reliability is represented by a distribution over possible reliability profiles, updated via Bayesian inference. In such a model, at the bottomed-out value of  $P = 0$ , a report would be taken as evidence of the opposite of what was asserted. More recently, these predictions have also been borne out empirically by empirically Collins et al., (2018). One particularly important aspect of (mis)trust in a source, with crucial ramifications for political cognition, is individuals' opinions and beliefs. In the context of political information processing, then, if a claim can be traced to an ideologically disconfirming (opposing) source, political partisans would – all other things being equal – be less inclined to trust it, and therefore, to engage with it:

**H2:** People pay more attention to links associated with trusted sources, compared to untrusted ones, and select them more often.

### *Selective exposure and cognitive bias*

Research from the 1940's and onward has found that people's ideological convictions skew their willed exposure to news that conform to those beliefs (e.g., Lazarsfeld et al., 1948), a finding that has more recently been reaffirmed by modern research (Garrett

and Resnick, 2011; Yom-Tov et al., 2014; see also Gentzkow & Shapiro, 2011). In the social sciences, selective exposure theory describes this general tendency of people to seek out information that conforms to already held convictions and avoid or disregard information that does not (see Klapper, 1960; Sears & Freedman, 1967; Frey, 1986; see also Mutz & Martin, 2011). To Festinger (1957), this tendency was central to his concept of cognitive dissonance as a means of reducing the mental discomfort that results from holding incongruent beliefs. The construct also aligns closely to Nickerson's (1998) definition of the confirmation bias, individuals' tendency to evaluate evidence and hypotheses in such a way as to support prior conclusions – which is found across populations and cultures. With impacts for political life, Dilliplane (2011) also found that selective exposure to partisan political information impacted voters' levels of participation over time.

The technological development of the late 20<sup>th</sup> and early 21<sup>st</sup> centuries has led to widespread internet access and internet use across the world, which coincides with a greatly increased access to information. Therefore, much recent literature on selective exposure – the willful engagement with some information or source over another – has focused specifically on the way users engage with information on novel social media platforms, such as Facebook (e.g., Bakshy et al., 2015; Sülfrow et al., 2019; Cinelli et al., 2020, Instagram (Parmelee et al., 2020) and Twitter (Himmelboim et al., 2013; Colleoni et al., 2014; see also Garrett, 2013).

However, unlike search engines, social media are already socially and selectively curated (e.g., Weeks et al., 2017; Spohr, 2017; Messing & Westwood, 2014), with Messing and Westwood (2014) arguing that social endorsements play the role of heuristic cues in individuals' deciding to select a story that appears in their newsfeed. There is thus an important distinction to be made between engaging with presented socially curated content, which is mediated by previous interactions weighted by social relationships – and information search using own-selected search terms, which is dynamic, continuous, and driven by task goals. It is of significant interest, then, to investigate attention and engagement with political claims and news items in an internet-based environment bereft of such social cues – where all that remains is the individual and his or her biases.

Jamieson and Cappella (2008) have argued that selective exposure may facilitate ideological echo chambers, which may have some bearing on the creating of filter bubbles also. Crucial to this argument, Stinchcombe (2010) found that when discussing topics solely with like-minded individuals, their opinions tend to polarize. Knobloch-Westerwick and Meng (2011) found that participants preferred attitude-consistent messaging, which also tended to strengthen political self-concepts. However, results for the internet echo chambers, as described by Jamieson and Cappella

(2008), have been mixed. Overall, it does not appear that individuals actively avoid information that fails to conform to their own worldview. In a large internet-administrated study, Garrett (2009a) found that while opinion-reinforcing information promoted exposure to news stories compared with opinion-challenging information, the difference was marginal. Importantly, however, Garrett (2009b) has further argued that while partisans tend to seek out opinion-reinforcing information, they do not exhibit systematic bias against challenges to those opinions (see also Valentino et al., 2009).

However, before information can be processed, it must be attended, and a small but growing body of research now suggests that selective own-side-biased filtering may take place at an even earlier stage of processing (e.g., Kawakami et al., 2014). Accordingly, I argue that participants' ideological biases play a role in attending to novel information also. For this purpose, one tool of significance is eye tracking, which lets us investigate the early stages of attention that operate before any conscious reasoning has taken place.

#### *Visual attention and depths of processing*

Attention is by its nature selective, selecting for and prioritizing some stimuli in the world – and not others. One way of examining attentional processes is eye tracking, which allows for in-depth capture of eye movements in real time. Gaze behavior can often reveal intricacies of information processing (see Duchowski, 2002). For example, the eye-mind hypothesis, as posited by Just and Carpenter (1980), proposes a direct relationship between cognition and eye movements, such that longer fixations (or pauses in eye movements) indicate a greater cognitive load implicit in the stimulus. In research on reading, Rayner (1998) has found support for just such a relationship.

Further, saccadic eye movements are obligatorily coupled with shifts in visual attention (see Deubel & Schneider, 1996). Typically, more meaningful parts of an image will draw more attention than less meaningful ones (Henderson & Hayes, 2017). Eye movements are also influenced by a variety of factors, including the rarity or frequency (Kliegl et al., 2006; Just & Carpenter, 1980), level of expectancy or consistency (Henderson et al., 1999; Luke & Christianson, 2016; Staub, 2015; Vö & Henderson, 2009) or meaningfulness (Luke & Henderson, 2016; Henderson & Hayes, 2017; Peacock et al., 2019) of stimuli (or parts of stimuli), all of which typically elicit longer viewing times by participant. Even in settings where stimuli are identical, differences in instructions may significantly influence eye movement patterns (Yarbus, 1967; Navalpakkam & Itti, 2005). Finally, previous research on visual decision tasks has shown how fixations may be used to derive preferences (Glaholt et al., 2009; Glaholt & Reingold, 2009).

Eye tracking provides a measurement of individuals' attention, enabling capture even of unconscious behavioral processes that mediate

conscious cognition and decision making (Holmqvist et al., 2011; Pärnamets et al., 2015). Accordingly, Higgins et al., (2014) considered eye movements as preference indicators at a very early stage of cognitive processing. Similarly, Pärnamets et al., (2015) have argued that attention plays a mediating role in decision making. Shimojo and colleagues have previously presented the gaze cascade model of preference decision making, wherein participants exhibit gaze bias toward preferred items prior to selection (Shimojo et al., 2003; Simion & Shimojo, 2006; 2007). While this model has never been tested in the context of SERP information search, it has proven a resilient finding in a variety of decision-making tasks (e.g., Gidlöf et al., 2013; Armel et al., 2008; Krajbich et al., 2010). Similarly, in preference decision-making tasks, before selecting one face as the more attractive, people tend to look more toward that face than other ones (Shimojo et al., 2003; see also Maughan et al., 2006).

In online contexts, an eye tracking study by Sülflow et al., (2019) found that Facebook users tend to select news posts where content reinforced their own attitudes. This assertion finds further support in results from eye tracking studies assessing selective exposure in political advertising (Marquart et al., 2016; Schmuck, et al., 2019), and Facebook news feeds (Vraga et al., 2016; Sülflow et al., 2019). However, relatively little is known about selective exposure at the early stages of processing, such as visual attention (but see Marquart et al., 2016; Zillich et al., 2019).

While eye tracking has been used extensively in web-related research (e.g., Nielsen & Pernice, 2010), to the author's knowledge, this work represents the first examination of its kind as it applies to everyday search engine link selection – and, in particular, the attention paid to links based on their perceived content. Relating specifically to search behavior in interactions with search engines, Granka et al., (2004) found that mean time spent fixating on the first and second links in a set of links were almost equal, after which there was a steep drop-off in attention to subsequent links; however, participants tended to select the first link in a set (see also Salmerón et al., 2013). Thus, while earlier eye tracking studies have investigated eye movements in search such as the significance of link order, finding strong preferences for top-presented links (Pan et al., 2007), no previous research has examined the impact of the perceived ideological content of available links on the visual attention paid to those links.

In light of the above related research, we should expect that users selectively attend and select link alternatives that are distinguished by user-politically dissident and source unreliability, such that disliked sources are attended less and selected less often (see Figure 2). Thus, attention is here operationalized as aspects of gaze behavior: total time spent fixating on and number on fixations on, any one link. Selection is operationalized as the choice of clicking on one of several links in presented SERPs.

**H3a:** People pay more attention to search results that are in line with their ideology.

**H3b:** Liberal and left-wing partisans exhibit stronger attention bias compared to right-wing partisans.

Finally, whereas there are – at the time of writing – no studies known to this author investigating political partisans’ reading behavior, reading as general information processing has been extensively studied (for an overview, see Rayner, 2009). Reading patterns, such as thorough reading versus skimming, have been found to lead to differentiating levels of comprehension and retention (Strukelj & Niehorster, 2018). Significantly, Strukelj (2018) has investigated how readers’ expectations – including having feelings about the topic at hand, and knowing some text originated from more or less respected news sources – may impact even the process of reading itself. The state of research thus presents researchers of political information processing with the intriguing hypothesis that partisans may engage differently with confirming versus non-confirming political reading material, such that disconfirming information would be less closely scrutinized. Against this background, I define the final hypothesis of the thesis:

**H4:** People inspect opposing-side information less carefully, operationalized as differences in reading depth.

Thus, I suggest that searchers’ personal beliefs lead them to act selectively on the abundant set of available information afforded by search engines, such that personal ideological biases systematically skew their attending to and selecting of information. In selecting relevant information, searchers’ cognition may bias attention to ideologically charged content, such that ideologically confirming information is emphasized, and disconfirming content is disregarded.

## 2 Methods

### Instruments

Ideology may be operationalized both as a constellation of beliefs and as group identity, separate constructs which may or may not have independent effects on political information processing. Thus, participants’ ideology was assessed through responses to items from the SECS inventory (Everett, 2013) and group identity via self-identification as left-wing, centrist, or right-wing. Finally, participants were also asked to rate, on seven-point Likert scales, (1) how much they trusted each of a set of sources and (2) how often they consumed news from those sources.

### Apparatus

Eye movement data were recorded using Tobii Pro Spectrum remote eye trackers. The tracker sample rate was 600 Hz. The screen size of the monitors was 23.8”, with a resolution of 1920 x 1080. For stimulus presentation and data acquisition, the Tobii Pro Lab software was used. Viewing distance from the monitor was ~66cm. For all participants, both eyes were tracked, and chin rests were used. Mouse clicks were also recorded.

### Pre-study

Links were sampled from Google Search results from various online news sources, such as online magazines and newspapers, to represent a diversity of viewpoints across the political spectrum. For each topic, 10 links were sampled, for a total of 80 links. To judge the perceived ideology of each link, online participants ( $n = 3$ ) were recruited. Each link was presented once, along with a seven-point Likert scale, and participants were asked to rate how they perceived the ideological skew of each link from left (liberal) to right (conservative), where lower ratings signified more left-

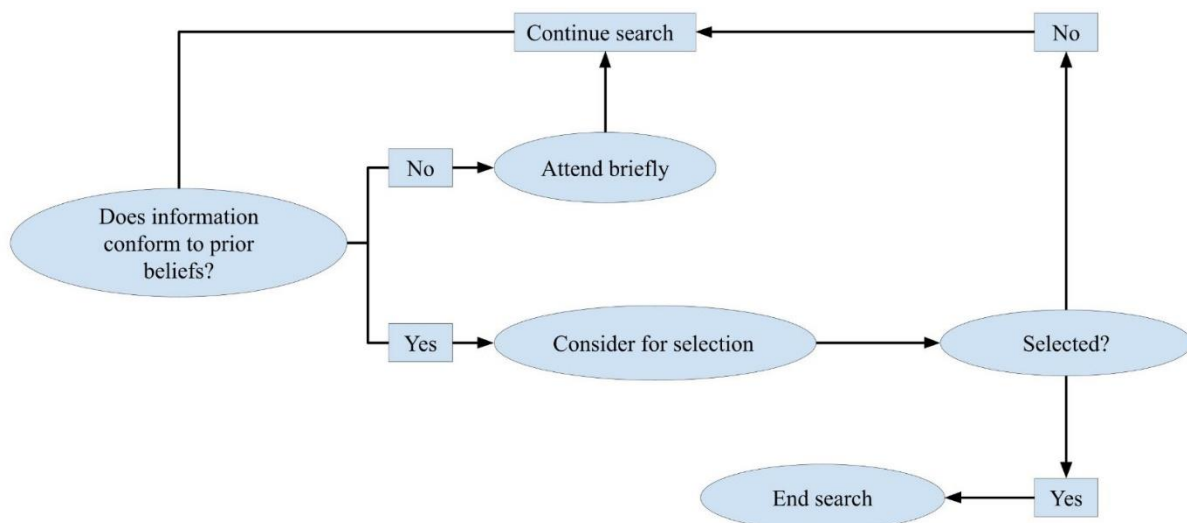


Figure 2. Selective attention in online information visual search (hypothesized).



wing content and higher ratings signified more right-wing content. The ordering of the links was fully randomized for each participant. The pre-study took ~5 minutes on average to complete. Participants were not compensated. Cronbach's alpha for the 80 items was deemed sufficient ( $\alpha = .79$ ). In subsequent categorization of the links, raters' scores for each link were averaged, and the average of the scores assigned to each link. The purpose of this procedure was to obtain a value of political leaning for each link, by which to correlate the eye movement analyses.

### Participants

Participants ( $N = 48$ , 22 women) took part in the experiment. They were aged 18 – 53 ( $M = 23.19$ ,  $SD = 5.79$ ) were recruited from local politically partisan groups (e.g., left- and right-leaning political youth groups) and from college courses that were deemed likely to attract politically active students (e.g., political science). Six participants were excluded because of significant data loss during recording. Out of all participants, 25 self-identified as left-wing, 5 as being in the center, and 18 as right-wing. All participants were Swedish natives and spoke native Swedish. In return for participation, participants received a voucher for 100 SEK for use in a national chain of bookstores.

### Stimuli

Stimuli were created using the EBImage R package (Pau et al., 2010). From the original 80 links, sets of six links per topic were selected for the study proper, for a total of 64. This number was selected because the standard setting on most desktop monitors allows for at least six links at any one time; it also aligns closely with previous research showing selection as driven by link position (e.g., Salméron et al., 2013). To control

for ordering effects, in each set of search results, the links were ordered according to a 6x6 Latin square, resulting in a total of six stimuli for each topic, from which one was sampled and presented to any given participant (see Figure 3). This also required the number of participants to be a factor of six. In all, 8 SERP stimuli were presented to each participant. For the sake of environmental validity, stimuli should be as visually similar as possible to real Google SERPs. All links and all linked-to sites were in Swedish.

### Safety precautions regarding Covid-19

As data collection took place during the Covid-19 global epidemic, a set of additional safety measures were implemented to ensure the safety of both experimenter and participants, and to limit the spread of the virus. All participants were asked to use hand-rub alcohol upon entering the lab and interactions with the experimenter were kept at a minimum. After each usage, keyboards, computer mice, and chin rests were wiped off using wet wipes. Eye trackers were not wiped. Initially, participants were limited to at most five at a time in the lab; as recommendations changed, this was further restricted to one participant at a time in later sessions. All data collection was carried out in line with the then-current guidelines issued by the Public Health Agency of Sweden.

### Procedure

Prior to the experiment, informed consent was obtained. Participants were informed that their data would be anonymized, that they would not be exposed to harm of any kind, and that they had the right to opt out of participation at any point during the experiment. Participants were invited to sit down in front of a Tobii Pro Spectrum eye tracker and asked to use the provided chin rest. Each participant was instructed to keep their head still for the duration of the experiment. The eye tracker was then calibrated. Participants then received on-screen instructions.

They were instructed that they were about to take part in an experiment about searching for information in Google Search. They were to examine the provided sets of search results and select (by clicking) the link they would be most likely to select in natural search settings. In each set of search results, six links were visible. For each trial, one mouse click was saved per trial. After a participant had clicked on a link, the experiment moved on to the next trial. Once all 8 stimuli screens had been presented, participants were asked to fill in a Google Forms survey. There, they provided on 7-point Likert scales their affects towards a set of political topics and phrases (derived from the SECS inventory). They were also asked to rate how important each topic was to them personally. Finally, they were asked to state their familiarity with a list of sources, as well as the degree to which they trusted each source. After the experiment, participants were debriefed as to the true motivation of the study and

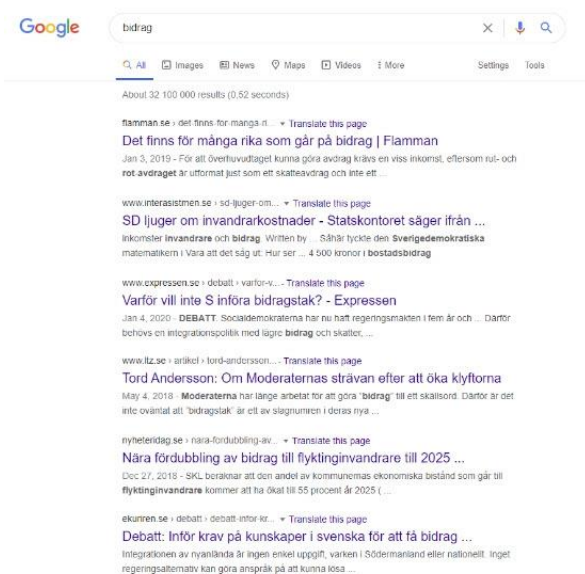


Figure 3. Example SERP stimulus.

Table 1. *Multiple linear regression analysis of relative total fixation durations on links.*

	Estimate	Std. error	<i>t</i> -value	<i>P</i> ( <i>z</i> )
(Intercept)	3.32	.11	30.35	< .001
Link position	-.04	.004	-9.65	< .001
Nr. of characters in link	.002	< .001	4.99	< .001
Participant ideology: Conservative	-.02	.07	-.27	.82
Participant ideology: Liberal	-.09	.06	-1.50	.13
Participant self-identification: Right-wing	-.000	.03	-.007	.995
Participant self-identification: Left-wing	.11	.03	3.96	< .001
Link ideology: Left-wing	-.17	.06	-3.002	<.01
Link Ideology: Right-wing	-.1	.06	-1.79	.07
Trust in Link source: Low	-.11	.02	-5.88	< .001
Trust in Link source: Mid	-.01	.03	-.41	.68
Participant ideology: Conservative * Link ideology: Left-wing	.02	.08	.25	.81
Participant ideology: Liberal * Link ideology: Left-wing	.16	.07	2.43	< .05
Participant ideology: Conservative * Link ideology: Right-wing	.05	.08	.7	.48
Participant ideology: Liberal * Link ideology: Right-wing	.11	.06	1.64	.10

Adjusted R<sup>2</sup>: 0.11

offered compensation. Each experiment lasted roughly ~20 minutes.

### 3 Results

In initial qualitative observations, it was observed that participants tended to investigate the presented search result page from top to bottom, which was consistent with Salmerón et al., (2013). In the present data set, no participant apparently deviated from this pattern. In addition, some participants did not attend to the last few links at all, aligning with prior research (e.g., Granka et al., 2004). Further, link position apparently affected how much attention was afforded to each link, generally resulting in the “golden triangle”-style gaze patterns as described by Hotchkiss et al., (2005; see Figure 1).

For subsequent quantitative analyses, due to a coding error, two links, one from each of two trial screens had no corresponding ratings for trust in link source. Therefore, these links were excluded from eye movement analyses; however, other links in the stimuli screen were still included. For analyses of link selection, trials containing these links were excluded, and only selected links were analyzed. In trials where

the wrongly coded link was not selected, data were included in the analysis.

#### *Fixation durations*

Because fixation duration was highly variable between participants (see Holmqvist et al., 2011), data distribution was significantly skewed. Therefore, data were log10 transformed prior to analysis. A multiple linear regression, excluding zeroes, was then calculated to predict total fixation duration based on Link position, Participant ideology, coded as Conservative, Liberal, or Center; Participant self-identification, coded as Right-wing, Left-wing, or Center; Perceived link ideology, coded as Left-wing, Right-wing, or Center; Trust in the link source, coded as High, Medium, or Low; and interactions between Participant self-identification and Link ideology. The model met homogeneity, homoscedasticity and multicollinearity assumptions; however, residuals were found not to be normally distributed. One data point was identified via Cook’s distance as highly influential and removed prior to subsequent analysis. A significant regression equation was found ( $F(14, 2144) = 19.02, p < .001$ ), with  $R^2 = .11$ . Link position was a



significant predictor of fixation duration ( $p < .001$ ). Mean fixation duration was found to be longer for left wing-identifying compared to center-identifying participants ( $p < .001$ ), but no difference was found between center- and right wing-identifying participants. Participants' trust in the sources associated with links was a significant predictor when trust was low ( $p < .001$ ) but not when it was medium-high or high, such that links associated with less trusted sources were attended significantly less, compared to more trusted ones. Finally, a significant interaction effect was found between participant ideology and link ideology, such that the combination of ideological liberals and left-wing links predicted greater fixation durations ( $p < .05$ ). There was no independent effect of participant ideology (see Table 1). The number of characters in each link was also included in the model as a covariate and found to be highly significant ( $p < .001$ ).

#### *Number of fixations*

In order to take account of zeroes (unattended areas of interest) in the data, a second regression analysis was performed including zeroes. When modelling the number of fixations per text AOI – a count variable –

the number of zeroes in the data were found to be overdispersed. Thus, a quasi-Poisson regression was calculated to predict the number of fixations per link based on the same predictors of Link position, Participant ideology, Participant self-identification, Link ideology, Trust in the link source, and interactions between Participant self-identification and Link ideology. A statistically significant model (Efron's  $R^2 = .08$ ) (Efron, 1978). Link position ( $p < .001$ ) and the number of characters in a link ( $p < .001$ ) were both significant predictors of fixation number per link. Participant self-identification was a significant predictor ( $p < .001$ ), such that participants who identified as left-wing made more fixations than those that identified as Center or right-wing. There was no observed significant sex difference. The perceived ideology of the link was a significant predictor, such that apparently left-wing links were fixated more than centrist or right-wing ones ( $p < .05$ ). Trust in the sources associated with the links was also a significant predictor of the number of fixations ( $p < .001$ ), such that links associated with sources for which trust was low were attended significantly less than were links associated with sources for which trust was medium-high or high. There were no significant interaction

Table 2. *Quasi-Poisson regression analysis of fixations per link.*

	Estimate	Std. error	t-value	P(z)
(Intercept)	2.23	.27	8.34	< .001
Link position	-.09	.01	-8.43	< .001
Nr. of characters in link	.01	.001	4.19	< .001
Participant ideology: Conservative	.14	.14	1.01	.31
Participant ideology: Liberal	-.12	.12	-1.02	.31
Participant self-identification: Right-wing	.1	.07	1.48	.14
Participant self-identification: Left-wing	.33	.07	5	<.001
Link ideology: Left-wing	-.27	.13	-2.14	<.05
Link Ideology: Right-wing	-.14	.12	-.15	.25
Trust in Link source: Low	-.18	.04	-4.11	<.001
Trust in Link source: Mid	.03	.06	.42	.67
Participant ideology: Conservative * Link ideology: Left	-.15	.17	-0.89	.37
Participant ideology: Liberal * Link ideology: Left	.26	.15	1.8	.07
Participant ideology: Conservative * Link ideology: Right-wing	-.12	.16	-.71	.48
Participant ideology: Liberal * Link ideology: Right-wing	.15	.14	1.06	.29

Efron's  $R^2 = .08$

Table 3. Multiple regression analysis of reading depth.

	Estimate	Std. error	t-value	P(z)
(Intercept)	-.93	.11	-8.69	< .001
Link position	-.04	.004	-9.74	< .001
Nr. of characters in link	-.0001	.0004	-.26	.8
Participant ideology: Conservative	-.0007	.07	-.01	.1
Participant ideology: Liberal	-.07	.06	-1.2	.23
Participant self-identification: Right-wing	.02	.03	.81	.42
Participant self-identification: Left-wing	.13	.03	5.05	<.05
Link ideology: Left-wing	-.17	.06	-3	<.01
Link Ideology: Right-wing	-.09	.05	-1.58	.11
Trust in Link source: Low	-.11	.02	-5.66	<.001
Trust in Link source: Mid	-.01	.26	-.26	.79
Participant ideology: Conservative * Link ideology: Left	.03	.08	.34	.73
Participant ideology: Liberal * Link ideology: Left	.15	.06	2.6	<.05
Participant ideology: Conservative * Link ideology: Right-wing	.05	.07	.7	.49
Participant ideology: Liberal * Link ideology: Right-wing	.09	.06	1.43	.15

Adjusted R<sup>2</sup>: .099

effects between Participant ideology and Link ideology (see Table 2).

#### Scrutiny in reading

To investigate the hypothesis that partisans read disconfirming links less closely, a measure of reading depth was computed using the number of fixations on each text AOI, divided by the number of characters (not including spaces) in that same AOI. One data point was excluded based on Cook's distance. A multiple linear regression was then calculated to predict reading depth based on the same variables as listed above (see Table 3). A significant regression equation was found ( $F(14, 2144) = 17.84, p < .001$ ), with  $R^2 = .10$ . Link position was shown to be a significant predictor of reading depth ( $p < .001$ ). Participant self-identification was shown to be significant, such that left-wing participants read the links more carefully than did those that identified as right-wing ( $p < .05$ ), which was consistent with overall fixation time. Link ideology was shown to be a significant predictor such that left-wing links were read more closely by all participants compared to right-wing ones ( $p < .01$ ). The interaction between Participant ideology and Link ideology was found to be a significant predictor of reading depth, such that

political liberals read politically left-wing links more carefully ( $p < .05$ ). Participant ideology was not found to be a significant predictor of reading depth. The number of characters in each link, again included covariate, was not found to be a significant predictor.

#### Selection

To investigate hypotheses H1a and H1b, a binomial regression for binary outcomes (clicks agreed versus did not agree with beliefs) was calculated based on Link position, Perceived link ideology, Participant self-identification, Participant ideology, and Trust in link sources, resulting in a significant model ( $p < .001$ ). Link ideology was a statistically significant predictor of selection-ideology agreement when the link was left-wing ( $p < .05$ ) and right-wing ( $p < .001$ ), compared to links representing the political center. Similarly, participant political self-identification was a significant predictor when participants identified as left-wing ( $p < .001$ ) or right-wing ( $p < .001$ ), compared to participants who identified as being in the political center. Trust in the source of the link was a significant

Table 4. Results from logistic regression analysis of link selection

	Estimate	Std. error	Wald stat.	sig.	Exp(B)	95 % CI	
						Lower bound	Upper bound
(Intercept)	-4.47	.86	27.24	<.001	.01	-6.15	-2.79
Link position	.001	.08	.0003	.99	1	-.16	.17
Link ideology: Left-wing	2.09	.92	5.18	<.05	8.11	.29	3.89
Link ideology: Right-wing	3.13	.78	16.06	<.001	22.94	1.6	4.67
Participant self-identification: Left-wing	1.93	.5	14.74	<.001	6.87	.94	2.91
Participant self-identification: Right-wing	2.06	.49	17.41	<.001	7.82	1.09	3.02
Participant ideology: Conservative	.2	.89	.05	.82	1.22	-1.54	1.94
Participant ideology: Liberal	-.58	.96	.35	.55	.56	-2.46	1.32
Trust in Link source: Mid	.94	.42	4.83	<.05	2.5	.1	1.78
Trust in Link source: High	.45	.31	2.05	.15	1.56	-.17	1.06
Participant ideology: Conservative * Link ideology: Left	-.16	1.29	.02	.9	.85	-2.7	2.37
Participant ideology: Conservative * Link ideology: Right	.43	1.08	.16	.69	1.5	-1.69	2.55
Participant ideology: Liberal * Link ideology: Left-wing	2.46	1.2	4.22	<.05	11.64	.11	4.8
Participant ideology: Liberal * Link ideology: Right-wing	-.17	1.1	.02	.88	.84	-2.32	1.98

McFadden  $R^2 = .34$

predictor when Trust was medium-high ( $p < .05$ ), but not when it was low or high. Participant ideology was not a significant predictor; however, a significant interaction was observed between participant ideology and link ideology, such that selection-agreement was significantly greater for liberal participants selecting left-wing links ( $p < .05$ ). There were no other statistically significant interaction effects. Link position was not a significant predictor of selection-ideology agreement, supporting hypothesis H1b (see Table 4).

## 4 Discussion

### *Moving the conversation on filter bubbles*

The filter bubble hypothesis posits that algorithmic curation of search results facilitates ideological segregation, with significant implications for society (Pariser, 2011; Liljeblad, 2012) and the personal beliefs of individuals (e.g., Miller & Record, 2013). However, empirical research on this topic has largely

failed to support the hypothesis (e.g., Hannak et al., 2017; Haim et al., 2017). An alternative explanation, here referred to as the self-imposed filter bubble hypothesis (see Yom-Tov et al., 2014), posits that filter bubble-like effects may be imposed by users themselves, acting preferentially on sets of search results, attending to, and selecting from, confirming (and trusted) sources of information, rather than disconfirming (and distrusted) ones. In this thesis, I have attempted an empirical test of this hypothesis.

Quantitative analysis of selection data provided support for hypothesis H1a (*Partisans select search results in line with their group and ideology, and select against search results that are not in line with their group and ideology*), such that both left-wing identifying and right-wing identifying participants tended to select own-side links; and strong support for hypothesis H1b (*The top-link heuristic holds when search results align with searcher's ideology, but not when it does not*), such that link position appeared irrelevant to partisans' selection. Notably, some of the

strongest evidence found by this thesis supported confirmation of hypothesis H2 (*People pay more attention to links associated with trusted sources, compared to untrusted ones, and select them more often*), such that trust in the source associated with a link predicted both the attention paid to, and subsequent selection of, that link. Analysis of eye movement data provided partial support for H3a (*People pay more attention to search results that are in line with their ideology*) and confirmation of hypothesis H3b (*Liberal and left-wing partisans exhibit stronger attention bias compared to right-wing partisans*), such that Liberal partisans did exhibit a stronger attention bias to own-side (left-wing) links, while Conservatives did not. Consistent with the results of the other analyses described above, there was partial support for hypothesis H4 (*People inspect opposing-side information less carefully, operationalized as differences in reading depth.*), such that Liberal participants read own-side links more closely than other-side links.

The present study contributes to the current literature in several ways. Firstly, it adds to an understanding of how politically partisan users of search engines engage with political content in SERPs. It also provides some empirical evidence of partisans' politically self-segregating online behavior, both in the early stages of information processing and attention – a novel contribution – and in subsequent selection of content, which is consistent with prior literature on selective exposure (Klapper, 1960; Sears & Freedman, 1967). Notably, however, a visual attention bias for own-side content was only observed for liberal participants. This bias in left-leaning participants is consistent with some previous research. For instance, there is evidence that left-wing and liberal partisans would be more punishing of opposite-side material, such as exhibiting a stronger tendency to “unfriend” opposite-side endorsing friends on social networks (e.g., Cox & Jones, 2016; but for a nuanced account, see Mitchell et al., 2014). As of the time of writing, it is unclear whether liberals and conservatives exhibit some measurable differences in terms of information processing that might otherwise explain these findings (but see Jost & Amodio, 2011). Significantly, while visual attention was biased in only a subset of the sample, analysis of selection data was more broadly consistent with earlier findings on selective exposure in online environments and information search (e.g., Garrett, 2009a; Bakshy et al., 2015). Both right-wing and left-wing partisans strongly curated their chosen links, effectively engaging in a process of selective exposure. Altogether, these results suggest that partisans' selection bias is stronger than that of their visual attention.

This thesis also provides evidence that trust in a source of information serves as an important predictor of both visual attention and selection of a link. In research on message reliability, people's evaluations of communicated information tend to be contingent on

both relevance and plausibility (see Sperber et al., 2010; Mercier et al., 2017; Mercier, 2020). In this study, I assumed that political alignment and agreement signified relevance more broadly; we further argue that participants' ratings of trust in sources of the presented links tapped into values of apparent plausibility, such that a more trusted source should on average be expected to provide more plausible and reliable news coverage and opinion-making. To the author's knowledge, this represents the first time such results have been demonstrated in an online information search environment. Notably, however, they align with previous research on what facilitates engagement with opposite-side information or sources. For example, Yom-Tov et al., (2014) found that people were more likely to click on documents representing the opposing view when the language model (computed based on popular Democrat- and Republican-leaning news outlets) of that document was consistent with their own views. Moving forward, others have emphasized the potential role of novel technology in facilitating interactions across political boundaries, such as software encouraging engagement with opposite-side sources and views (e.g., Bozdag & van den Hoven, 2015). Thus, taking account of the cognitive mechanisms that underlie selective exposure, allows researchers to gain better understanding into the supposed problem of filter bubbles.

Given the results presented in this thesis, it appears necessary that the focus of the filter bubble debate (e.g., Pariser, 2011) be shifted to properly incorporate the role of the individual user and how he or she engages with the information made available by internet search engines. If validated further, the findings presented in this work may have significant implications for government policy (and the choice of whether or not to regulate internet search engines), and for internet tech companies more broadly. After all, attempts at counteracting possible filter bubble-type effects through changes to the algorithms that generate search results – e.g., by presenting users with ideologically diverse information – has little consequence, if those users do not attend to other-side information, and thus never choose to interact with it. It is therefore necessary that researchers seek to move the discussion on filter bubbles, from algorithmic curation of search results (for which empirical results are few) to the mind of users who see, attend, and select from them.

### *Limitations*

The study suffered from several limitations that need addressing. First, in our data, some ideological concepts appeared almost universally appreciated. For example, only 4 out of 48 participants claimed to have negative feelings towards abortion. Thus, it appears that the SECS inventory (Everett, 2013) (which was invented for studying ideology in the US) may be less useful in a Swedish context. Swedes are, on average, high on secular values, and highly liberal by international standards (World Values Survey, 2021).

They are also among the people in the world scoring the highest on values of self-expression, signifying general acceptance of societal outgroups such as immigrants and sexual minorities (e.g., homosexuals), and trust in government. Thus, the lack of hypothesized interaction effect may stem from a failure to sample a sufficiently high number of Swedish conservatives (as defined by Everett, 2013). Relatedly, the present study also did not attempt to control for participants' actual knowledge of political affairs and events (i.e., political sophistication, see Lodge & Taber, 2005). It is likely that possessing demonstrable knowledge on some political topic may impact attention to presented information on that same topic.

Further, it is possible that a simple three-level coding of political material (left-Center-right; Liberal-Center-Conservative) is not sophisticated enough to capture the mechanisms of political information processing in a Swedish sample. Specifically, the lack of statistically significant effect of visual attention to own-side material in Conservative and right-wing participants may be an artefact of link sampling. Currently, Swedish right-wing politics is divided between a socially liberal but fiscally conservative faction, and another more socially conservative, anti-establishment faction (for an overview, see Esaiasson & Wängnerud, 2016). Meanwhile, no equivalent discrepancy currently exists for left-wing politics. It is possible, then, that supposedly right-wing content in presented links played to one of these right-wing factions and not the other, attracting some right-wing identifying participants but repelling others. Were this to be addressed in future research, it is possible that a visual attention bias for own-side content would be found for Conservative and right-wing participants. However, as no research of this kind is known to the author at the point of writing, this possibility remains solely hypothetical.

A second point of contention concerns the generalizability of the findings. Importantly, much eye-tracking research has shown discrepancies in eye movements for laboratory settings, as compared with their real-life counterparts (e.g., Gidlöf et al., 2013; Mulckhuysen et al., 2008; Born et al., 2011; Foulsham et al., 2011). In light of these findings, we cannot rule out the possibility that our information search task is not close enough to the real experience of online information search. In real life, search terms are not given but thought up dynamically by the user. Typically, users tailor search terms to current needs, using combinations of phrases they deem likely to produce wanted results. For political partisans, this may also involve searching for political information in biased *terms*, more likely to return lists of results appropriate to those same views. Thus, as links used in the present study were controlled for political content, this is unlikely to reflect the real-life situation of biased attention in online information search.

The above limitation also dovetails with a more general concern for the ecological validity of the

presented work. Specifically, when participants are probed for responses to affectively charged stimuli – such as political content – they may be prone to self-censorship, shying away from particularly radical or unusual responses (i.e., exhibit demand characteristics). For this reason, future work on the topic may thus strive for more naturalistic settings. For instance, recent developments in eye tracking present the possibility of conducting eye movement research using participants' own webcams in their home (e.g., Papoutsaki et al., 2017; see also Semmelmann & Weigelt, 2018). However, it remains yet to be seen how this development could be used in the scientific study of visual attention in online information search outside of formal lab environments.

Finally, we cannot rule out any effect of framing. The sampled links included as stimuli were not controlled for any attention-grabbing quality inherent in their headlines. For instance, some authors have suggested that “clickbait” – a style of headline designed to generate engagement from its online audience by inducing them to click to access its content – may drive affective polarization between left-wing and right-wing online audiences (e.g., Settle, 2018). This possibility cannot as of yet be ruled out, although recent work on clickbait headlines by Munger et al., (2020) found no effect of clickbait headlines on affective polarization. There are also no studies known to this author, showing differences in prevalence or effectiveness of clickbait-style articles for left-wing or right-wing content. Additionally, while clickbait-type headlines were effective early to mid-2010's, they have recently seen a drastic reduction in use – and in profitability in recent years (see Rayson, 2018). Therefore, effects of framing of news items inherent in the links may be negligible – though it not possible to say for certain.

#### *Summary and directions for future research*

This work investigated potential filter bubble-type effects resulting from partisans' visual attention and subsequent selection. It appears that link position significantly affects which links are initially attended – but evaluation and (especially) selection are mediated by partisans' perception of its apparent content and by the trust placed in the sources associated with those contents. The expected interaction effect for visual attention between partisanship and link content was only found a subset of participants, Liberal participants attending left-wing content. As for now, however, this picture remains incomplete. Whereas the literature on selective attention in web search has integrated eye movement research, there is much still in the fields of cognitive science that might provide insights into any potential polarizing behavior.

Firstly, prior research on eye movements during reading have found that readers' expectations (Strukelj, 2018), and working memory capacity (Daneman & Carpenter, 1980; Dixon et al., 1988; Strukelj et al., 2017) may affect their visual processing of reading

material. This thesis contributes to this body of literature, suggesting that (some) partisans read own-side affirming information more carefully than other-side affirming, and that readers, in general, read trusted information more carefully than they do mistrusted information. For political information processing, this raises the possibility of social group differences in processing of reading material – something largely unexplored in the relevant literature.

It is also possible that opposite-side information constitutes a different working memory load compared to own-side information, where the first prompts avoidance and the second prompts engagement. The results presented in this thesis thus presents intriguing possible implications for future studies on the subject of political information processing in real time. How do partisans engage (or fail to engage) when reading news items or opinion pieces written by writers they distrust or presenting a disliked conclusion? Further research on the topic may help further elucidate the intricacies of biased information processing.

A second area for future investigation is that of so-called knowledge resistance (see Wikforss, 2017; Klinton, 2019; see also O'Connor & Weatherall, 2019; Mercier, 2020). In recent years, there has been widespread concern that (some or all) individuals are somehow resistant to information that might otherwise change their minds. The work presented in this thesis, attempting to integrate eye movements within a framework of partisans' information processing, helps point the way toward a formal integration of cognitive science with this novel and significant development (but see Mercier, 2020).

Finally, the findings presented in this thesis help provide clues into the cognitive mechanisms that underlie political partisanship – a development that should be seen against the backdrop of neuropsychological studies of partisan information processing (see Jost & Amodio, 2011; Jost et al., 2014). For example, a functional magnetic resonance imaging study by Westen et al., (2006) observed selective activity in the brains of American political Liberals and Conservatives while reasoning about information that was threatening either to their own candidate in the 2004 American presidential election or to the opposing candidate. Results suggested that motivated reasoning implicated emotional processing and was not linked to activity in brain regions associated with “cold” (or objective) reasoning. The authors argued that motivated reasoning was qualitatively distinct from reasoning, when participants do not have a strong emotional stake in the conclusions. Such and similar work may provide clues as to how partisans' treat information, once attended. As communication research has progressively sought to integrate tools of cognitive science, an extension to neuroscientific tools has become feasible. Moreover, the strong effect of trust found in this thesis suggests a role in information processing more broadly. Significantly, it also supersedes any definition of ideology and extends to

settings outside of online political information processing. Moving forward, neuropsychological research should seek to investigate the relationship between motivated reasoning, objective reasoning, and trust, incorporating what is known about selective exposure, so as to provide deeper knowledge of the partisan brain and mind.

## 5 Conclusions

This thesis presented the self-imposed filter bubble hypothesis, the proposition that political partisans engage in self-segregating behavior in online information search. It found partial empirical support for its main hypothesis and strong support that such behavior may be driven less by political persuasion per se, and more by the trust individuals place in the sources of link material, such that less trusted sources are typically both attended less and selected against.

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## References

- Armel, K. C., Beaumel, A., & Rangel, A. (2008). Biasing simple choices by manipulating relative visual attention. *Judgment and Decision making*, 3(5), 396-403.
- Bakshy, E., Messing, S., & Adamic, L. A. (2015). Exposure to ideologically diverse news and opinion on Facebook. *Science*, 348(6239), 1130–1132.
- Bartels, L. M. (2018). *Unequal democracy: The political economy of the new gilded age*. Princeton University Press.
- Birnbaum, M. H., Wong, R., & Wong, L. K. (1976). Combining information from sources that vary in credibility. *Memory & Cognition*, 4(3), 330-336.



- Birnbaum, M. H., & Stegner, S. E. (1979). Source credibility in social judgment: Bias, expertise, and the judge's point of view. *Journal of Personality and Social Psychology*, 37(1), 48.
- Bode, L. (2016). Pruning the news feed: Unfriending and unfollowing political content on social media. *Research & Politics*, 3(3), 2053168016661873.
- Born, S., Kerzel, D., & Theeuwes, J. (2011). Evidence for a dissociation between the control of oculomotor capture and disengagement. *Experimental Brain Research*, 208(4), 621-631.
- Bozdag, E., & Van Den Hoven, J. (2015). Breaking the filter bubble: democracy and design. *Ethics and information technology*, 17(4), 249-265.
- Bovens, L., & Hartmann, S. (2003). *Bayesian epistemology*. Oxford University Press on Demand.
- Brader, T. (2006). *Campaigning for hearts and minds: How emotional appeals in political ads work*. University of Chicago Press.
- Brewer, M. B. (1979). In-group bias in the minimal intergroup situation: A cognitive-motivational analysis. *Psychological bulletin*, 86(2), 307.
- Cardenal, A. S., Aguilar-Paredes, C., Galais, C., & Pérez-Montoro, M. (2019). Digital technologies and selective exposure: How choice and filter bubbles shape news media exposure. *The international journal of press/politics*, 24(4), 465-486.
- Chong, D. (2013). Degrees of rationality in politics. In (L. Huddy, D. O. Sears, & L. S. Levery (Eds.), *The Oxford handbook of political psychology* (pp. 96-129).
- Cinelli, M., Brugnoli, E., Schmidt, A. L., Zollo, F., Quattrociocchi, W., & Scala, A. (2020). Selective exposure shapes the Facebook news diet. *PLoS one*, 15(3), e0229129.
- Cohen, G. L. (2003). Party over policy: The dominating impact of group influence on political beliefs. *Journal of personality and social psychology*, 85(5), 808.
- Colleoni, E., Rozza, A., & Arvidsson, A. (2014). Echo chamber or public sphere? Predicting political orientation and measuring political homophily in Twitter using big data. *Journal of communication*, 64(2), 317-332.
- Collins, P. J., Hahn, U., von Gerber, Y., & Olsson, E. J. (2018). The bi-directional relationship between source characteristics and message content. *Frontiers in psychology*, 9, 18.
- Courtois, C., Slechten, L., & Coenen, L. (2018). Challenging Google Search filter bubbles in social and political information: Disconfirming evidence from a digital methods case study. *Telematics and Informatics*, 35(7), 2006-2015.
- Cox, D., & Jones, R. (2016). Merry Christmas' vs. Happy Holidays': Republicans and Democrats are polar opposites. *Public Religion Research Institute report*.
- Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of verbal learning and verbal behavior*, 19(4), 450-466.
- Deubel, H., & Schneider, W. X. (1996). Saccade target selection and object recognition: Evidence for a common attentional mechanism. *Vision research*, 36(12), 1827-1838.
- Dilliplane, S. (2011). All the news you want to hear: The impact of partisan news exposure on political participation. *Public Opinion Quarterly*, 75, 287-316.
- Dixon, P., Lefevre, J. A., & Twilley, L. C. (1988). Word knowledge and working memory as predictors of reading skill. *Journal of educational psychology*, 80(4), 465.
- Duchowski, A. T. (2002). A breadth-first survey of eye-tracking applications. *Behavior Research Methods, Instruments, & Computers*, 34(4), 455-470.
- Eibl-Eibesfeldt, I. (1979). Human ethology: Concepts and implications for the sciences of man. *Behavioral and Brain Sciences*, 2(1), 1-26.
- Efron, B. (1978). Regression and ANOVA with zero-one data: Measures of residual variation. *Journal of the American Statistical Association*, 73(361), 113-121.
- Esaiasson, P., & Wängnerud, L. (2016). Political parties and political representation. In J. Pierre (Ed.), *The Oxford Handbook of Swedish Politics* (pp. 188-205). Oxford University Press.
- Everett, J. A. (2013). The 12 item social and economic conservatism scale (SECS). *PLoS one*, 8(12), e82131.
- Festinger, L. (1957). *A theory of cognitive dissonance* (Vol. 2). Stanford university press.
- Flaxman, S., Goel, S., & Rao, J. M. (2016). Filter bubbles, echo chambers, and online news consumption. *Public opinion quarterly*, 80(S1), 298-320.
- Foulsham, T., Walker, E., & Kingstone, A. (2011). The where, what and when of gaze allocation in the lab and the natural environment. *Vision research*, 51(17), 1920-1931.
- Frey, D. (1986). Recent research on selective exposure. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 19, pp. 41- 80). New York: Academic Press.
- Garrett, R. K. (2009a). Echo chambers online?: Politically motivated selective exposure among Internet news users. *Journal of Computer-Mediated Communication*, 14(2), 265-285.
- Garrett, R. K. (2009b). Politically motivated reinforcement seeking: Reframing the selective exposure debate. *Journal of communication*, 59(4), 676-699.
- Garrett, R. K., & Resnick, P. (2011). Resisting political fragmentation on the Internet. *Daedalus*, 140(4), 108-120.

- Garrett, R. K. (2013). Selective exposure: New methods and new directions. *Communication Methods and Measures*, 7(3-4), 247-256.
- Gerber, A., & Green, D. P. (1998). Rational learning and partisan attitudes. *American journal of political science*, 794–818.
- Gentzkow, M., & Shapiro, J. M. (2011). Ideological segregation online and offline. *The Quarterly Journal of Economics*, 126(4), 1799–1839.
- Gidlöf, K., Wallin, A., Dewhurst, R., & Holmqvist, K. (2013). Using eye tracking to trace a cognitive process: Gaze behaviour during decision making in a natural environment.
- Glaholt, M. G., & Reingold, E. M. (2009). Stimulus exposure and gaze bias: A further test of the gaze cascade model. *Attention, Perception, & Psychophysics*, 71(3), 445-450.
- Glaholt, M. G., Wu, M. C., & Reingold, E. M. (2009). Predicting preference from fixations. *Psychology Journal*, 7(2), 141-158.
- Granka, L. A., Joachims, T., & Gay, G. (2004, July). Eye-tracking analysis of user behavior in WWW search. In *Proceedings of the 27th annual international ACM SIGIR conference on Research and development in information retrieval* (pp. 478-479).
- Haim, M., Arendt, F., & Scherr, S. (2017). Abyss or shelter? On the relevance of web search engines' search results when people google for suicide. *Health communication*, 32(2), 253–258.
- Hannak, A., Sapiezynski, P., Molavi Kakhki, A., Krishnamurty, B., Lazer, D., Mislove, A., & Wilson, C. (2013, May). Measuring personalization of web search. In *Proceedings of the 22<sup>nd</sup> international conference on World Wide Web* (pp. 527-538).
- Hastorf, A. H., & Cantril, H. (1954). They saw a game; a case study. *The Journal of Abnormal and Social Psychology*, 49(1), 129.
- Henderson, J. M., Weeks Jr, P. A., & Hollingworth, A. (1999). The effects of semantic consistency on eye movements during complex scene viewing. *Journal of experimental psychology: Human perception and performance*, 25(1), 210.
- Henderson, J. M., & Hayes, T. R. (2017). Meaning-based guidance of attention in scenes as revealed by meaning maps. *Nature Human Behaviour*, 1(10), 743–747.
- Hewstone, M., Rubin, M., & Willis, H. (2002). Intergroup bias. *Annual review of psychology*, 53(1), 575-604.
- Higgins, E., Leinenger, M., & Rayner, K. (2014). Eye movements when viewing advertisements. *Frontiers in psychology*, 5, 210.
- Himmelboim, I., Smith, M., & Shneiderman, B. (2013). Tweeting apart: Applying network analysis to detect selective exposure clusters in Twitter. *Communication methods and measures*, 7(3-4), 195-223.
- Holmqvist, K., Nyström, M., Andersson, R., Dewhurst, R., Jarodzka, H., & Van de Weijer, J. (2011). *Eye tracking: A comprehensive guide to methods and measures*. OUP Oxford.
- Hotchkiss G., Alston S., & Edwards G. (2005). Google Eye Tracking Report: How Searchers See and Click on Google Search Results (Enquiro Search Solutions). Accessed January 24, 2021, <https://searchengineland.com/figz/wp-content/uploads/2007/09/hotchkiss-eye-tracking-2005.pdf>.
- Google Search Statistics. (2021, May 12). Internet Live Stats. <https://www.internetlivestats.com/google-search-statistics/>
- Jamieson, K. H., & Cappella, J. N. (2008). *Echo chamber: Rush Limbaugh and the conservative media establishment*. Oxford University Press.
- Joachims, T., Granka, L., Pan, B., Hembrooke, H., Radlinski, F., & Gay, G. (2007). Evaluating the accuracy of implicit feedback from clicks and query reformulations in web search. *ACM Transactions on Information Systems (TOIS)*, 25(2), 7-es.
- Jost, J. T., & Amodio, D. M. (2012). Political ideology as motivated social cognition: Behavioral and neuroscientific evidence. *Motivation and Emotion*, 36(1), 55-64.
- Jost, J. T., Nam, H. H., Amodio, D. M., & Van Bavel, J. J. (2014). Political neuroscience: The beginning of a beautiful friendship. *Political Psychology*, 35, 3-42.
- Just, M. A., & Carpenter, P. A. (1980). A theory of reading: From eye fixations to comprehension. *Psychological review*, 87(4), 329.
- Kahan, D. M., Hoffman, D. A., Braman, D., Evans, D., & Rachlinski, J. J. (2012). They saw a protest: Cognitive illiberalism and the speech-conduct distinction. *Stan. L. Rev.*, 64, 851.
- Kammerer, Y., & Gerjets, P. (2012). How search engine users evaluate and select Web search results: The impact of the search engine interface on credibility assessments. In *Web search engine research*. Emerald Group Publishing Limited.
- Kammerer, Y., & Gerjets, P. (2014). The role of search result position and source trustworthiness in the selection of web search results when using a list or a grid interface. *International Journal of Human-Computer Interaction*, 30(3), 177-191.
- Kawakami, K., Williams, A., Sidhu, D., Choma, B. L., Rodriguez-Bailón, R., Cañadas, E., ... & Hugenberg, K. (2014). An eye for the I: Preferential attention to the eyes of ingroup members. *Journal of Personality and Social Psychology*, 107(1), 1.
- Klapper, J. T. (1960). *The effects of mass communications*. Glencoe, IL: Free Press.
- Kliegl, R., Nuthmann, A., & Engbert, R. (2006). Tracking the mind during reading: The influence of past, present, and future words on fixation

- durations. *Journal of experimental psychology: General*, 135(1), 12.
- Klinton, M. (2019). *Knowledge resistance: How we avoid insight from others*. Manchester University Press.
- Knobloch-Westerwick, S., & Meng, J. (2011). Reinforcement of the political self through selective exposure to political messages. *Journal of Communication*, 61(2), 349-368.
- Krajbich, I., Armel, C., & Rangel, A. (2010). Visual fixations and the computation and comparison of value in simple choice. *Nature neuroscience*, 13(10), 1292-1298.
- Lazarsfeld, P. F., Berelson, B., & Gaudet, H. (1948). *The people's choice: How the voter makes up his mind in a presidential campaign*. New York: Columbia University Press.
- Liljeblad, J. (2012). The Implications of Personal Internet Search for Theories of Global Civil Society. *International Journal of Technology, Knowledge & Society*, 8(1).
- Lodge, M., & Taber, C. S. (2005). The automaticity of affect for political leaders, groups, and issues: An experimental test of the hot cognition hypothesis. *Political Psychology*, 26(3), 455-482.
- Luke, S. G., & Henderson, J. M. (2016). The influence of content meaningfulness on eye movements across tasks: evidence from scene viewing and reading. *Frontiers in psychology*, 7, 257.
- Maughan, L., Gutnikov, S., & Stevens, R. (2007). Like more, look more. Look more, like more: The evidence from eye-tracking. *Journal of Brand management*, 14(4), 335-342.
- Marquart, F., Matthes, J., & Rapp, E. (2016). Selective exposure in the context of political advertising: A behavioral approach using eye-tracking methodology. *International Journal of Communication*, 10, 20.
- Mercier, H., Dezechache, G., & Scott-Phillips, T. (2017). Strategically Communicating Minds. *Current Directions in Psychological Science*, 26(5), 411-416.
- Mercier, H. (2020). *Not born yesterday: The science of who we trust and what we believe*. Princeton University Press.
- Messing, S., & Westwood, S. J. (2014). Selective exposure in the age of social media: Endorsements trump partisan source affiliation when selecting news online. *Communication research*, 41(8), 1042-1063.
- Miller, B., & Record, I. (2013). Justified belief in a digital age: On the epistemic implications of secret Internet technologies.
- Mills, C. M. (2013). Knowing when to doubt: Developing a critical stance when learning from others. *Developmental psychology*, 49(3), 404.
- Mitchell, A., Gottfried, J., Kiley, J., & Matsa, K. E. (2014). Political Polarization & Media Habits: From Fox News to Facebook. *How Liberals and Conservatives Keep Up with Politics*, Washington, DC: Pew Research Center.
- Mulckhuysen, M., van Zoest, W., & Theeuwes, J. (2008). Capture of the eyes by relevant and irrelevant onsets. *Experimental Brain Research*, 186(2), 225-235.
- Mullen, B., Brown, R., & Smith, C. (1992). Ingroup bias as a function of salience, relevance, and status: An integration. *European journal of social psychology*, 22(2), 103-122.
- Munger, K., Luca, M., Nagler, J., & Tucker, J. (2020). The (null) effects of clickbait headlines on polarization, trust, and learning. *Public opinion quarterly*.
- Mutz, D. C., & Martin, P. S. (2001). Facilitating communication across lines of political difference: The role of mass media. *American political science review*, 97-114.
- Navalpakkam, V., & Itti, L. (2005). Modeling the influence of task on attention. *Vision research*, 45(2), 205-231.
- Nickerson, R. S. (1998). Confirmation bias: A ubiquitous phenomenon in many guises. *Review of general psychology*, 2(2), 175-220.
- Nielsen, J., & Pernice, K. (2010). *Eyetracking web usability*. New Riders.
- O'Connor, C., & Weatherall, J. O. (2019). *The misinformation age: How false beliefs spread*. Yale University Press.
- Olsson, E. J. (2011). A simulation approach to veritistic social epistemology. *Episteme-Edinburgh*, 8(2), 127.
- Olsson, E. J., & Vallinder, A. (2013). Norms of assertion and communication in social networks. *Synthese*, 190(13), 2557-2571.
- Pan, B., Hembrooke, H., Joachims, T., Lorigo, L., Gay, G., & Granka, L. (2007). In Google we trust: Users' decisions on rank, position, and relevance. *Journal of computer-mediated communication*, 12(3), 801-823.
- Papoutsaki, A., Laskey, J., & Huang, J. (2017, March). Searchgazer: Webcam eye tracking for remote studies of web search. In *Proceedings of the 2017 Conference on Conference Human Information Interaction and Retrieval* (pp. 17-26).
- Pariser, E. (2011). *The Filter Bubble: What the Internet Is Hiding from You*. Penguin Press.
- Parmelee, J. H., & Roman, N. (2020). Insta-echoes: Selective exposure and selective avoidance on Instagram. *Telematics and Informatics*, 52, 101432.
- Pärnamets, P., Johansson, P., Hall, L., Balkenius, C., Spivey, M. J., & Richardson, D. C. (2015). Biasing moral decisions by exploiting the dynamics of eye gaze. *Proceedings of the National Academy of Sciences*, 112(13), 4170-4175.
- Pau, G., Fuchs, F., Sklyar, O., Boutros, M., & Huber, W. (2010). EBImage—an R package for image processing with applications to cellular phenotypes. *Bioinformatics*, 26(7), 979-981.

- Peacock, C. E., Hayes, T. R., & Henderson, J. M. (2019). Meaning guides attention during scene viewing, even when it is irrelevant. *Attention, Perception, & Psychophysics*, *81*(1), 20–34.
- Petrescu, P. (2014, October 1). *Google Organic Click-Through Rates in 2014*. MOZ Blog. <https://moz.com/blog/google-organic-click-through-rates-in-2014>.
- Petty, R. E., & Cacioppo, J. T. (1984). Source factors and the elaboration likelihood model of persuasion. *ACR North American Advances*.
- Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. In *Communication and persuasion* (pp. 1-24). Springer, New York, NY.
- Purcell, K., Rainie, L., & Brenner, J. (2012, March 9). Search engine use, 2012. *Pew Internet and American Life Project*, *9*. Retrieved from <http://pewinternet.org/Reports/2012/Search-Engine-Use-2012.aspx>
- Rand, D. G., Pfeiffer, T., Dreber, A., Sheketoff, R. W., Wernerfelt, N. C. & Benkler, Y. Dynamic remodeling of in-group bias during the 2008 presidential election. *Proc. Natl. Acad. Sci. USA* *106*, 6187–6191 (2009).
- Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological bulletin*, *124*(3), 372.
- Rayson, S. (2018). Content, shares, and links: Insights from analyzing 1 million articles. *moz.com*, *8*.
- Salmerón, L., Kammerer, Y., & García-Carrión, P. (2013). Searching the Web for conflicting topics: Page and user factors. *Computers in Human Behavior*, *29*(6), 2161-2171.
- Schmuck, D., Tribastone, M., Matthes, J., Marquart, F., & Bergel, E. M. (2019). Avoiding the other side? An eye-tracking study of selective exposure and selective avoidance effects in response to political advertising. *Journal of Media Psychology: Theories, Methods, and Applications*.
- Schultheiß, S., Sünkler, S., & Lewandowski, D. (2018). We still trust in Google, but less than 10 years ago: an eye-tracking study. *Information Research: An International Electronic Journal*, *23*(3), n3.
- Sears, D. O., & Freedman, J. L. (1967). Selective exposure to information: A critical review. *Public Opinion Quarterly*, *31*(2), 194-213.
- Semmelmann, K., & Weigelt, S. (2018). Online webcam-based eye tracking in cognitive science: A first look. *Behavior Research Methods*, *50*(2), 451-465.
- Settle, J. E. (2018). *Frenemies: How social media polarizes America*. Cambridge University Press.
- Shimojo, S., Simion, C., Shimojo, E., & Scheier, C. (2003). Gaze bias both reflects and influences preference. *Nature neuroscience*, *6*(12), 1317-1322
- Simion, C., & Shimojo, S. (2006). Early interactions between orienting, visual sampling and decision making in facial preference. *Vision research*, *46*(20), 3331-3335.
- Simion, C., & Shimojo, S. (2007). Interrupting the cascade: Orienting contributes to decision making even in the absence of visual stimulation. *Perception & psychophysics*, *69*(4), 591-595.
- Spohr, D. (2017). Fake news and ideological polarization: Filter bubbles and selective exposure on social media. *Business Information Review*, *34*(3), 150–160.
- Staub, A. (2015). The effect of lexical predictability on eye movements in reading: Critical review and theoretical interpretation. *Language and Linguistics Compass*, *9*(8), 311–327.
- Stinchcombe, A. L. (2010). Going to extremes: How like minds unite and divide. *Contemporary Sociology: A Journal of Reviews*, *39*, 205–206.
- Strukelj, A. (2018). *Reading expectations: How expectations influence our reading, eye movements, opinions, and judgments*. Lund University.
- Strukelj, A., & Niehorster, D. C. (2018). One page of text: Eye movements during regular and thorough reading, skimming, and spell checking. *Journal of Eye Movement Research*, *11*(1).
- Strukelj, A., Nyström, M., & Holmqvist, K. (2017). The effects of conceptual and perceptual difficulty on processing and engagement in text during reading and learning. In *19th European Conference on Eye Movements*.
- Sülflow, M., Schäfer, S., & Winter, S. (2019). Selective attention in the news feed: An eye-tracking study on the perception and selection of political news posts on Facebook. *new media & society*, *21*(1), 168-190.
- Sunstein, C. R. (1999). The law of group polarization. *University of Chicago Law School, John M. Olin Law & Economics Working Paper*, (91).
- Tajfel, H., & Turner, J. C. (1986). The social identity theory of intergroup behavior. In S. Worchel & W. G. Austin (Eds.), *Psychology of intergroup relations* (2nd ed., pp. 7–24). Nelson-Hall.
- Valentino, N. A., Banks, A. J., Hutchings, V. L., & Davis, A. K. (2009). Selective exposure in the Internet age: The interaction between anxiety and information utility. *Political Psychology*, *30*(4), 591–613.
- Võ, M. L. H., & Henderson, J. M. (2009). Does gravity matter? Effects of semantic and syntactic inconsistencies on the allocation of attention during scene perception. *Journal of Vision*, *9*(3), 24–24.
- Vraga, E., Bode, L., & Troller-Renfree, S. (2016). Beyond self-reports: Using eye tracking to measure topic and style differences in attention to social media content. *Communication Methods and Measures*, *10*(2-3), 149-164.
- Weeks, B. E., Lane, D. S., Kim, D. H., Lee, S. S., & Kwak, N. (2017). Incidental exposure, selective exposure, and political information sharing:

- Integrating online exposure patterns and expression on social media. *Journal of Computer-Mediated Communication*, 22(6), 363–379.
- Westen, D., Blagov, P. S., Harenski, K., Kilts, C., & Hamann, S. (2006). Neural bases of motivated reasoning: An fMRI study of emotional constraints on partisan political judgment in the 2004 US presidential election. *Journal of cognitive neuroscience*, 18(11), 1947–1958.
- Xiao, Y. J., Coppin, G., & Van Bavel, J. J. (2016). Perceiving the world through group-colored glasses: A perceptual model of intergroup relations. *Psychological Inquiry*, 27(4), 255–274.
- Wikforss, Å. (2017). *Alternativa fakta: Om kunskapen och dess fiender*. Falun: Fri Tanke Förlag.
- World Values Survey. (2021, April 24). *Findings and Insights*.  
<https://www.worldvaluessurvey.org/WVSCContents.jsp?CMSID=findings&CMSID=findings>
- Yom-Tov, E., Dumais, S., & Guo, Q. (2014). Promoting civil discourse through search engine diversity. *Social Science Computer Review*, 32(2), 145–154.
- Zillich, A. F., Kessler, S. H., Peter, C., Naab, T., & Kühne, R. (2019). Measuring selective exposure to online information: combining eye-tracking and content analysis of users' actual search behavior. *Methoden und Forschungslogik der Kommunikationswissenschaft*, (14), 196–220
- Zuiderveen Borgesius, F., Trilling, D., Möller, J., Bodó, B., De Vreese, C. H., & Helberger, N. (2016). Should we worry about filter bubbles?. *Internet Policy Review. Journal on Internet Regulation*, 5.