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Article

A Matter of Perspective? The Impact of Analysis Configurations on Testing the Agenda-Setting Hypothesis

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Abstract
The media's capacity to stimulate public concern and create a common ground for issues can counteract the fragmentation of society. Assessing the intactness of the media's agenda-setting function can be an important diagnostic tool for scholars. However, the manifold design choices in agenda-setting research raise the question of how design choice impacts analysis results and potentially leads to methodological artefacts. I compare how the choice between 20 plausible analysis configurations impacts tests of the agenda-setting hypothesis, coefficients, and explanatory power. I also explore changes in agenda-setting effect size over time. I develop a typology of analysis configurations from five basic study design types by four ways of linking content analysis to survey data (5 × 4 = 20). The following design types are compared: three single-survey/between designs (aggregate-cross-sectional, aggregate-longitudinal, and individual-level) and two panel-survey/within designs (aggregate-change and individual-change). I draw on the German Longitudinal Election Study data (2009, 2013, and 2017). All 20 tests of the agenda-setting hypothesis support the hypothesis, independent of the analytical configuration used. The choice of analysis configuration substantially impacts the coefficients and explanatory power attributed to media salience. The individual-level analyses indicate that agenda-setting effects became significantly weaker at later elections, though not linearly. This study provides strong empirical support for the agenda-setting hypothesis independent of design choice.

Keywords
agenda-setting; aggregation; design choice; data analysis; data linkage; methodological artefacts

Issue
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1. Introduction

Agenda-setting research is more relevant today than ever. The media's capacity to stimulate public concern for issues is an important prerequisite for effective public problem management in democracies. Facing changes in information environments and information habits, the media's capacity to (a) focus the public's attention on the most pressing issues, (b) create a common meeting ground, and (c) contribute to collective memory can no longer be taken for granted. Fragmentation is a common apprehension, and the presence of strong and universal agenda-setting effects is a strong bulwark against such centrifugal social forces. In that sense, agenda-setting research could provide orientation in telling us whether, where, and at which pace there is an erosion of the agenda-setting function (Djerf-Pierre & Shehata, 2017)—and how societal integration can be safeguarded and strengthened.

Agenda-setting research is characterized by methodological diversity, which is an asset through which methodologies with specific strengths can compensate for each other's blind spots. I leave aside the experimental tradition (e.g., Iyengar et al., 1982) and focus on non-experimental studies. McCombs' (2007) Acapulco typology distinguishes four types of non-experimental

agenda-setting study designs: (a) automaton studies (McLeod et al., 1974), (b) cognitive portrait studies (Rössler, 1999), (c) competition studies (e.g., McCombs & Shaw, 1972), and (d) natural history studies (e.g., Brosius & Kepplinger, 1990; Geiß, 2019b). Each of these design types tests the original and seemingly simple (first level) agenda-setting hypothesis which will also be at the core of this article:

> H1: The more salient an issue is on the media agenda, the more salient it will become on the public agenda.

The potential theoretical insights that methodological diversity could generate for agenda-setting research are clouded by the confusion that has emerged. We lack an understanding of which differences in results can be attributed to methodological differences between study designs and which signal theoretical implications such as previously unknown mechanisms or contingencies.

My review of the findings from studies of the distinct design types (see Section 2) suggests that the degree of support for the agenda-setting hypothesis varies strongly between design types. For instance, the competition studies tradition consistently supports the agenda-setting hypothesis (Luo et al., 2019; Wanta & Ghanem, 2007); natural history, cognitive portrait, and automaton studies often find no (or weaker) general agenda-setting effects but suggest a set of contingent conditions for the effect to play out (Brosius & Kepplinger, 1990; Geiß, 2019b; Luo et al., 2019; Rössler, 1999). As Rössler (1999, p. 667) notes, "The question of whether the supposed media effect is analyzed on an aggregate level…or on an individual level…has become a crucial point in agenda-setting research….Obviously, the meaning of the results varies according to the research strategy applied." As a consequence, there is substantial disagreement regarding the contingency, strength, and pervasiveness of the effect.

On the one hand, differences in results may reflect theoretical nuances: Longitudinal versus cross-sectional studies test a different mechanism just as aggregate studies and individual-level studies test a different mechanism (see e.g., Shehata & Strömbäck, 2013). We could split up the agenda-setting hypothesis into four (or even more) sub-hypotheses that all deal with the transfer of salience from the media to the audience, one for each of the design types. Each of them can be treated and tested separately. We would expect consistency within, but not between the distinct design types.

But, on the other hand, differences in results can also trace back to methodological factors. Historically, the different designs were developed in the attempt to find the best way to test the agenda-setting hypothesis (and establish causality) rather than formulating additional hypotheses (Erbring et al., 1980; McLeod et al., 1974). This means that tests of these hypotheses that are based on the same data do not constitute statistically independent tests. Also theoretically, the designs test different facets of agenda-setting theory. Together, they form a comprehensive system of steering societal attention towards issues. The hypotheses remain closely related, conceptually and empirically, and inconsistencies between tests can still be puzzling when developing the theory further.

Hence, clarifying the impact of design choice on tests of agenda-setting is a pressing question. Answering it would allow telling apart substantial from methodologically rooted differences in study results. This would reduce confusion and expand enlightenment from methodological diversity and conflicting results in agenda-setting theory: Which results really challenge the hypothesis and/or reveal additional contingent conditions? Which can rather be attributed to methodological choices?

The present study uses the same data set to implement five different study design types and four different ways of estimating news exposure. As the same underlying data are treated in 5 × 4 = 20 different ways—which I call analysis configurations—it allows estimating the systematic impact of these choices on the results. In all these configurations, a positive relationship between media and public salience is hypothesized (see H1). I explore the impact of these choices on coefficient values (RQ1) and explanatory power (RQ2). I will also explore whether there are any signs of erosion of effect size with time (RQ3), as some scholars apprehend in the face of changes in the information environments that citizens draw on for forming their personal agenda (Djerf-Pierre & Shehata, 2017; Shehata & Strömbäck, 2013).

My argument is developed as follows: In Section 2, I will explore five different agenda-setting study designs. In Section 3, I will present several distinct ways of computing media salience at aggregate or individual levels, which yields four different data linking choices that demonstrate the range of possible solutions. In Section 4, I combine designs (five types) and data linking (four setups) into a five-by-four matrix of analysis configurations as any data linking setup can be freely combined with any design type. I then present methods, results, and a discussion of the study.

2. Agenda-Setting Study Designs

I build my typology of agenda-setting study designs (Table A1 in the Supplementary File) on the basic distinction in the survey data (public salience measurement) between *between-data* and *within-data*. Between-data relies on one or several cross-sectional surveys (or treats the data like cross-sectional survey data). Changes in individuals over time are not measured or not analyzed. Other studies analyze within-data using panel surveys where the same person is interviewed and is identifiable in at least two-time slices, and the analysis considers this information on within-person change. All designs conduct analysis across 23 different issues, so all make use of between-issue variation.

2.1. Between/Cross-Section Data

2.1.1. Aggregate Between Design (Design I)

The aggregate between design (Design I) regresses the aggregate public salience of an issue (e.g., the percentage of the population that rates an issue as important) on the aggregate media salience of an issue (e.g., the number of news stories published about the issue). Time is not considered as a variable. The classical agenda-setting study by McCombs and Shaw (1972) is an example of an aggregate cross-sectional design. It corresponds to the competition type in the Acapulco typology. A vast number of studies uses this design (Luo et al., 2019). Wanta and Ghanem (2007) conducted a meta-analysis of this type of design, finding strong support for a positive correlation between the media and the public agenda. This also holds in newer studies (Geiß, 2019b; Luo et al., 2019; Shehata & Strömbäck, 2013). I conclude the likelihood to find support for H1 is high when using Design I.

2.1.2. Longitudinal Between Design (Design II)

The longitudinal between design, like the aggregate between design, regresses the aggregate public salience of an issue (e.g., the percentage of the population that rates an issue as important) on the aggregate media salience of an issue (e.g., the number of news stories published about the issue). However, it considers time by dividing the media and public salience data into different time slices, computes the media and public salience measure for each time slice, and analyzes them as a time series. The study by Funkhouser (1973) can be regarded as the prototype for aggregate longitudinal designs in agenda-setting research. It corresponds to the natural history type in the Acapulco typology. The evidence for the agenda-setting hypothesis in this type of study is more mixed (Boukes, 2019; Brosius & Kepplinger, 1990; Djerf-Pierre & Shehata, 2017; Geiß, 2019b). The bottom line is that in many issues' natural histories, agenda-setting effects are conditional on the characteristics of the issues and the coverage (Brosius & Kepplinger, 1990; Geiß, 2019b; McLaren et al., 2017). For example, the stronger the movement on the media agenda, the more likely are we to find patterns that fit the agenda-setting hypothesis (Geiß, 2019b). I conclude the likelihood to find support for H1 is moderate in Design II.

2.1.3. Individual Between Design (Design III)

Individual between designs regress individual issue salience on individual exposure to the issue. Time is not considered as a variable. The study by McLeod et al. (1974) can be regarded as the prototype of individual-level design studies. Erbring et al. (1980) refined that design and more fully exploited the types of analyses it permits. Often, the aggregate media salience of an issue is used as a regressor instead of individual issue exposure. This simplification of the analytical logic presumes a more or less monolithic media agenda across outlets (e.g., Djerf-Pierre & Shehata, 2017; Sheafer & Weimann, 2005). Individual between designs largely correspond to automaton studies. However, automaton studies are defined as analyses of entire agendas rather than single issues; individual between design studies are defined by the kind of variation that is analyzed: The analysis stems from differences between issues and individuals, not change within individuals over time. The results from individual design studies vary between showing either no, small, or conditional agenda-setting effects (Djerf-Pierre & Shehata, 2017; Erbring et al., 1980; McLeod et al., 1974). I conclude that with Design III, *the likelihood of finding support for H1 is moderate*.

2.2. Within/Panel Data

2.2.1. Aggregate Change Design (Design IV)

Aggregate change designs regress aggregated changes in individual salience on aggregate changes in individual exposure to media coverage about the issue *i*. Time is not considered explicitly but having at least two-time slices is essential for calculating the individual change scores. Aggregate change designs are technically possible but do not take full advantage of the panel design feature (studying change at the individual level) and are therefore usually not chosen—at least I am not aware of any study that uses an aggregate change design. Given the similarities with Design I, I expect that the likelihood of finding support for H1 is high when using Design IV.

2.2.2. Individual Change Design (Design V)

Individual change designs regress changes in individual issue salience to changes in the same individual's exposure to media coverage about the issue *i*. Time is not considered explicitly but having at least two-time slices is essential for calculating the individual change scores. The study by Rössler (1999) can be regarded as the prototype of individual change design studies. It corresponds to the cognitive portrait type in the Acapulco typology. There are some other examples of such studies (Geiß, 2022; Matthes, 2008; Shehata, 2010). Results from individual change designs are mixed (Shehata & Strömbäck, 2013), mostly in line with those that employ Design III: Some studies find agenda-setting effects and others do not, but all emphasize contingent conditions at the individual level. I conclude that the likelihood of finding support for H1 is moderate when using Design V.

3. Content-to-User Linking

Estimating how much audience members were exposed to media coverage about an issue is of paramount importance in the individual-level Designs III and V.

In the current study, it also affects the aggregate media salience measures in Designs I, II, and IV. However, I expect that the aggregation will smooth out some of the differences created by the detailed individual-level linking procedure. Hence the choice of linking procedure would be less consequential in Designs I, II, and IV vis-à-vis Designs III and V.

The first attempts to assign each study participant their individual exposure to news about an issue started early in agenda-setting research (Erbring et al., 1980; McClure & Patterson, 1976; McLeod et al., 1974), and have become more elaborate over time (Dalton et al., 1998; Matthes, 2008; Rössler, 1999; Schuck et al., 2015). I base my argument on my own systematic approach to linking users with the content they were exposed to, which considers time frames, effect envelopes, news story salience, and individuals' news use (Geiß, 2019a). The code for the analysis is available from my GitHub repository (Geiß, 2021).

3.1. Time Frame

The time of exposure relative to the time of interview affects the agenda-setting potential of content. Only content that has been received prior to the interview can affect issue salience which is measured in the interview. Also, exposure that has happened a long time ago may no longer be relevant (Price & Tewksbury, 1997). To account for that, content-user-linking needs to specify a time frame. In a panel survey, only content received between the two interviews can have contributed to a *change* in issue salience between the two interviews.

In the present study, the time frame is held constant at a maximum 14-day time window before the interview (for the non-panel analysis) or for the whole period between the two interviews of the same individual (in the panel analysis).

3.2. Effect Envelope

The effect of exposure to media coverage about an issue will fade over time. Hence, recently published content would get a greater weight than content received a longer time ago.

The present study uses a linear effect envelope throughout. If the time window is 14 days, the content received on the day before the interview is assumed to still have full effect (14 ÷ 14 = 100%) whereas content received at the start of the time window has almost no assumed effect (1 ÷ 14 = 7%).

3.3. Precision of News Story Salience Measurement

Lead stories on the front page have a high chance of being read and of making an impact on issue salience. In contrast, stories published at the bottom of the lower-right column on page eight will most likely be overlooked by most. More salient news stories have a higher potential to trigger agenda-setting effects. They attract more attention and function as agenda cues (Pingree & Stoycheff, 2013).

The present study varies between a *high precision* and a *low precision* measurement of news story salience. This is to check how neglecting news story salience impacts (and probably impairs) the prediction of agenda-setting effects: Setup 1 (high precision for salience, S+) uses all news story salience measures included in the content analysis to create a salience score between 0 and 1 for each news story. Setup 2 (low precision for salience, S−) simply weighs all news stories with the full weight of 1, independent of the salience.

3.4. Precision of Media Use Measurement

Which media a person uses has implications for the content that person will be exposed to and that can affect issue salience. Besides some studies based on copy tests (Donsbach, 1991a, 1991b) and prototype studies with online tracking (Stark et al., 2017), media use is usually (and also in this study) measured not at the level of individual news stories or editions, but the (habitual) usage of news outlets. Respondents will usually only use a few news outlets regularly, and only content published in outlets they habitually use is considered when estimating exposure. The more frequent the use of the outlet, the greater the likelihood of exposure to its content, according to this logic. If, for instance, a person exclusively relies on a single outlet that chose to not cover an issue, that person might have little exposure to the issue even if it is generally covered broadly.

The present study varies media use measurement, contrasting two setups. In Setup 1 (high precision for usage, U+), we use these data in their full level of detail: If a person used the news outlet in that a news story was published on four out of seven days, the news story would be weighted by 4 ÷ 7 = 0.57. In Setup 2 (low precision for usage, U−), we construct a simple index of news use and use the highest media use measurement of any of the 10 news media considered as the total exposure index.

3.5. A Practical Example

The overall weight of a news story for an individual would be calculated like this—It is a multiplicative filter of all four components: time frame weight × effect envelope weight × content salience weight × usage likelihood weight. It is calculated for each combination of news items and individuals. For example, if we have 1,000 news stories and 1,000 interviews, this results in one million weights.

If a news story was published eight days before the interview, it passes the time frame filter (1: *passed*; 0: *not passed*) and receives an effect envelope weight of (14 − 8 + 1) ÷ 14 = 0.5 (meaning that we assume that half of the effect has already faded). If the news

story is not very well placed, this would be indicated by a low content salience weight, e.g., 0.3. If the individual uses the publishing outlet on six out of seven days, this results in a usage likelihood weight of 6 ÷ 7. The exposure weight for this news item/interview combination would be: 1 (time frame) × 0.5 (envelope) × 0.3 (news story salience) × 0.86 = 0.129. The maximum value of a news story would be 1.0 (right time frame, immediately before the interview, salient front-page coverage, in an outlet the individual always uses). If any of the weights becomes 0, the total weight becomes 0. Table A2 in the Supplementary File shows some examples of how different weights affect the total exposure weight.

4. Analytical Configurations

Combining the five design types (I–V) and the four user-to-content linking procedures (1–4) results in a four-by-five matrix of analysis configurations (Table 1). Each design has specific strengths and weaknesses. For instance, Design V is best suited to establish causality. In contrast, Design I is relatively easy to implement and can show the de-facto similarity between agendas that powerfully shape political debates and political decision-making. Designs III and V avoid the danger of an ecological correlation when it comes to detecting causality (Robinson, 1950) but they may fail to account for broader societal patterns of cumulative effects. A mismatch between individual-level and aggregate-level results would occur when many individuals respond to media coverage of an issue by heightened attention to the issue, but the exact strength of their reaction is conditional on individual factors and is not linearly responding to the extent of exposure. This would result in apparently strong effects at the aggregate level and apparently weak effects at the individual level. However, if results with all these different designs—I through V—point in a similar direction, it would be a strong argument for the occurrence of agenda-setting effects that (a) can be traced at the individual level but that (b) also do not cancel out in the aggregate and make a meaningful and observable difference in society.

A similar argument applies to the user-to-content linking: High precision (Linking 4: U+S+) is more useful for tracing individual-level effects of just the content that the individual was exposed to. However, a low precision linking (such as Linking 1: U−S−) can be advantageous if the media agenda is highly consonant across news media, leading to relatively similar exposure across individuals independent of which outlets one is using. One can expect that precision of content-to-user linking is consequential (and more precision is beneficial) in Designs III and V whereas it is less consequential (and potentially, more precision can even be detrimental) in Designs I, II, and IV. On the other hand, more precise content-to-user linking could also be advantageous in aggregate-level analysis because it induces a precise aggregate-level weighting of content according to the estimated frequency of exposure among the respondents. For instance, if the content analysis included some highly popular and some less popular news outlets, the popular outlet will figure more prominently in the aggregate media salience measure. Again, if the results establish that agenda-setting effects can be observed independent of content-to-linking choice, it offers strong support for the agenda-setting hypothesis.

5. Methods

5.1. Data Overview

I use two components of the German Longitudinal Election Study (GLES) 2009, 2013, and 2017: the newspaper and TV content analysis (GLES, 2019a) and the Rolling Cross Section survey with an additional post-election panel wave (GLES, 2019b). The raw data can be downloaded in the GESIS data archive (GLES, 2019b, 2019a) as presented in Sections 5.2 and 5.3. In Sections 5.4 and 5.5, I document how I modified the data for implementing the 20 analysis configurations (Section 5.4) and how I analyzed the data (Section 5.5).

5.2. Survey

The surveys are two panel waves of telephone interviews with a probability sample of the German population with the right to vote in the Bundestag election. The interviews were spread out such that each day a random cross-section of the total panel was interviewed on each day (with approximately 100 participants per day). A total of 21,537 interviews were conducted and are included in the analysis. I did not use any weights for the analysis since representing the population's distribution of demographics was not deemed necessary.

Table 1. Overview of all 20 analytical configurations.

	Between variance			Within variance	
Content-to-user linking	Aggregate I	Longitudinal II	Individual III	Aggregate IV	Individual V
1. Low precision (U−S−)	I.1	II.1	III.1	IV.1	V.1
2. Mixed precision (U−S+)	I.2	II.2	III.2	IV.2	V.2
3. Mixed precision (U+S−)	I.3	II.3	III.3	IV.3	V.3
4. High precision (U+S+)	I.4	II.4	III.4	IV.4	V.4

The respondents were asked for the most important problem (MIP) in Germany today. The GLES team recorded the open-ended responses and coded them using the same category system that was used in the media content analysis for classifying issues (328 different issues). The follow-up question on one's second most important problem was ignored to not give more weight to those respondents that mentioned two problems rather than only one problem.

Media use was captured with a question on how many of the past seven days respondents had used the respective news outlet. Respondents could mention up to three newspapers and up to four TV news programs they watch regularly.

5.3. Content Analysis

The content analysis covers the following time periods: 28 June 2009 to 26 September 2009, 23 June 2013 to 21 September 2013, and 27 June 2017 to 23 September 2017. It analyses one popular and five prestige national newspapers across the political spectrum (*Die Tageszeitung*, *Frankfurter Rundschau*, *Süddeutsche Zeitung*, *Frankfurter Allgemeine Zeitung*, *Die Welt*, and *BILD*) in which all articles on the front page and in addition page 2 (*BILD*; most political news are placed on the second page), and the opinion page (*Süddeutsche Zeitung*, *Frankfurter Rundschau*, and *Die Tageszeitung*) were analyzed. In addition, the national TV newscasts in ARD, ZDF, RTL, and Sat.1 were considered completely. The news stories were scanned and only included in the sample if they dealt with national-level politics and policy. A total of 24,463 news stories were analyzed and are included in the analysis.

5.3.1. Issues Emphasized

In each news story the most prominent polity issue (political institutions and structures), politics issue (political processes), and policy issue (policy content) were coded, leading to up to three issues per news story. Per election, the GLES method report provides estimates of intercoder agreement separately for two media types (print, TV) and for three issue categories (polity, policy, and politics issues), leading to a total of 18 estimates (Table A3 in the Supplementary File). Eleven out of 18 are above 0.80 and five more are above 0.667. Two outliers at $\alpha = 0.22$ and $\alpha = 0.57$ are reported. These two low agreement estimates are based on an extremely small number of cases that make the estimates more volatile. Overall, intercoder agreement is acceptable.

5.3.2. Salience

For the news stories in newspapers, their page, placement on the page, size (from 1 *very small* to 5 *very large*), and illustration (0.00 = *no*, 0.33 = *small*, 0.67 = *medium*, 1.00 = *large pictures*) were recorded. For news stories in TV news, their duration (in seconds), the duration of the newscast (in seconds), and the runtime in the newscast at which the news story started (in seconds) were recorded.

5.4. Data Preparation

5.4.1. Issue Recoding

I created a recoding scheme that assigned each of the GLES issue codes to one of 23 different issue categories. This was applied to the MIP response of each participant such that each participant could mention only one issue category (0 = *category not mentioned* and 1 = *category mentioned*).

I re-classified the content analysis data issue variables (up to one polity, one politics, and one policy issues per news story) into 23 issue categories analogous to the responses to the MIP question. For each of the 23 issue categories (and the associated issue codes), I checked whether they occurred in either the polity issue, the politics issue, or the policy issue score such that binary data (23 variables) represent for each issue whether it is emphasized in a news story or not.

5.4.2. News Story Salience

For the news stories in newspapers, their page (1 = *front page* = 1 and 0.5 = *not front page*), salience on the front page (1 = *top of page* and 0.50 = *less favorable position*), size (recoded from 0 = *very small* to 1 = *very large*), and illustration (0.00 = *no*, 0.33 = *small*, 0.67 = *medium*, and 1.00 = *large pictures*) were recorded and multiplied to obtain a total salience score for newspaper news stories (ranging from 0 to 1). For news stories in TV news, their duration (1.00 = *100 or more seconds*, 0.75 = *45 to under 100 seconds*, and 0.50 = *below 45 seconds*) and relative position in the newscast (1 = first news story in the newscast; 0.75 = *news story number two to five*; 0.50 = *news story six or later*) was computed from the recorded variables. These two are multiplied to obtain a total salience score for TV news stories (ranging from 0 to 1).

5.4.3. Independent Variable

The main predictor in all models is the exposure to news stories about the issue whose salience should be predicted. The basis of this computation is the individual-level exposure measure created with the content-user linking procedure.

The content-to-user linking is conducted using an R script (Geiß, 2021) that has been used in several studies (Geiß, 2019a, 2020, 2022). It allows specifying the time frame and the effect envelope, the degree of usage of the outlet, and the salience of the news story. For each respondent r and each of the 23 issues i, the four weights are multiplied for each news story u that deals with the issue. Their sum gives the exposure score of that respondent r for the issue i.

$$\exp_{i,r} = \sum_{u=1}^{U} \text{Time frame}_{i,r,u} \bullet \text{effect envelope}_{i,r,u} \bullet \text{media use}_{i,r,u} \bullet \text{story salience}_{i,r,u}$$

5.4.4. Control Variables

The control variables are, depending on the model, the category of the issue (23 issues) and the election (three elections), included as random intercepts if possible. In the longitudinal design (II), there are two additional control variables: the lagged dependent variable (from the previous day; theoretical range: 0–1) and time (the number of days since the study was started in the respective election, divided by the total duration of the study in days; theoretical and empirical range: 0–1, in which 0 = *first day of study* in the respective election and 1 = *last day of study*).

5.4.5. Implementing Analysis Configurations

The five study design types are implemented in the current analysis in the following way: The raw data for the between data (neglecting the second measurement occasion) implement Design III. The data of Design III (n = 21,436; h = 495,351) are aggregated in different ways to implement Designs I (n = 69) and II (n = 4,485). The raw data for the within design (dependent variable: change scores between first and second measurement occasion) implements Design V; through aggregation of Design V (n = 13,624; h = 313,352), Design IV (n = 69) is implemented. The implementation of the different user-to-content linking decisions results from calculating the independent variable (see Section 5.4.3) based on different input data (see Sections 3.3, 3.4, and 4).

The independent variable is aggregated by computing the arithmetic means for the aggregate. The dependent variable varies by design (I–V) but is constant across data linking choices.

I. Share of the respondents that mentioned the issue *i* as the most important issue;
II. Share of the respondents on the respective day *d* that mentioned the issue *i* as the most important issue;
III. A respondent mentioning the respective issue *i* as the most important issue;
IV. Share of the respondents that changed towards the issue *i* as the most important issue;
V. A respondent changes towards mentioning the respective issue *i* as the most important issue.

5.5. Statistical Analyses

The following statistical analyses are conducted for each design type:

I. Linear mixed-effects model (Bates et al., 2015). Fixed part: logarithmized issue exposure, intercept. Random effects: 23 issues as random intercepts.
II. Linear mixed-effects model (Bates et al., 2015). Fixed part: logarithmized issue exposure, closeness to the election, lagged dependent variable, intercept. Random effects: 23 issues as random intercepts nested in three elections.
III. Generalized linear mixed-effects model. Fixed part: logarithmized issue exposure, intercept. Random effects: 23 issues as random intercepts.
IV. Linear mixed-effects model (Bates et al., 2015). Fixed part: logarithmized issue exposure, intercept. Random effects: 23 issues as random intercepts.
V. Generalized linear mixed-effects model. Fixed part: logarithmized issue exposure, intercept. Random effects: 23 issues as random intercepts.

6. Results

6.1. Agenda-Setting Hypothesis (H1)

All 20 analysis configurations support the agenda-setting hypothesis. Higher/lower media salience of an issue is associated with higher/lower public salience of that issue independent of design choice and content-to-user data linking choice (see analysis of coefficients in Section 6.2). The association's statistical significance is at $p < 0.05$ in all analysis configurations (though narrowly in cell IV.1; Table 2).

6.2. Coefficients (RQ1)

The coefficients of exposure to news stories about an issue are all positive and statistically significant (Figure 1). While the data analysis procedures differ, the direction of the relationship is always indicated by the sign of the coefficient, which is consistently in the positive range.

The size of coefficients within a design type increase with greater precision of the data linking choices. In the individual-level analyses (III and V), this difference is clearly statistically significant while confidence intervals overlap for the aggregate-level analyses (I and IV). The longitudinal analysis (II) also has overlapping confidence intervals. The main reason is the greater statistical power in the individual-level analyses.

To better envision the strength of a relationship expressed by the coefficients, I calculated a scenario prediction: In that scenario, an issue already is ranked MIP by 10% of the population (I, II, and IV) or has an a priori 10% probability of being mentioned as MIP by a person (III and V). Then, media attention towards that issue goes up such that the average exposure to that issue increases by 10 news stories. How does the percentage of people who mention the issue as MIP (I, II, and IV) or the probability that an individual mentions the issue as MIP (III and V) change?

According to this scenario, the greatest effect on the public agenda is predicted in Design I (10 to 17

Table 2. Statistical significance level of including issue exposure in the prediction of issue salience: Likelihood ratio tests.

Content-user linking	Usage precision	Content salience precision	Data gathering and data analysis: Between — I Cross-section aggregate	Between — II Longitudinal aggregate	Between — III Individual	Within — IV Aggregate	Within — V Individual
			(n = 69)	(h = 4,554) (t = 198)	(h = 495,351) (n = 21,436)	(n = 69)	(h = 313,352) (n = 13,624)
			$\chi^2_{df=1}(p)$	$\chi^2_{df=1}(p)$	$\chi^2_{df=1}(p)$	$\chi^2_{df=1}(p)$	$\chi^2_{df=1}(p)$
1. Low precision	Low (U–)	Low (S–)	15.5*** (<0.001)	55.9*** (<0.001)	2,497.5*** (<0.001)	6.5* (0.011)	137.0*** (<0.001)
2. Mixed precision	Low (U–)	High (S+)	17.2*** (<0.001)	74.7*** (<0.001)	3,038.1*** (<0.001)	7.4** (0.006)	202.2*** (<0.001)
3. Mixed precision	High (U+)	Low (S–)	17.8*** (<0.001)	76.7*** (<0.001)	3,164.6*** (<0.001)	8.6** (0.003)	258.3*** (<0.001)
4. High precision	High (U+)	High (S+)	18.1*** (<0.001)	87.7*** (<0.001)	3,315.1*** (<0.001)	8.8** (0.003)	301.2*** (<0.001)
Data analysis procedure			Linear regression	Linear regression (with lagged dependent variable)	Hierarchical binary logistic regression	Linear regression	Hierarchical binary logistic regression

Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

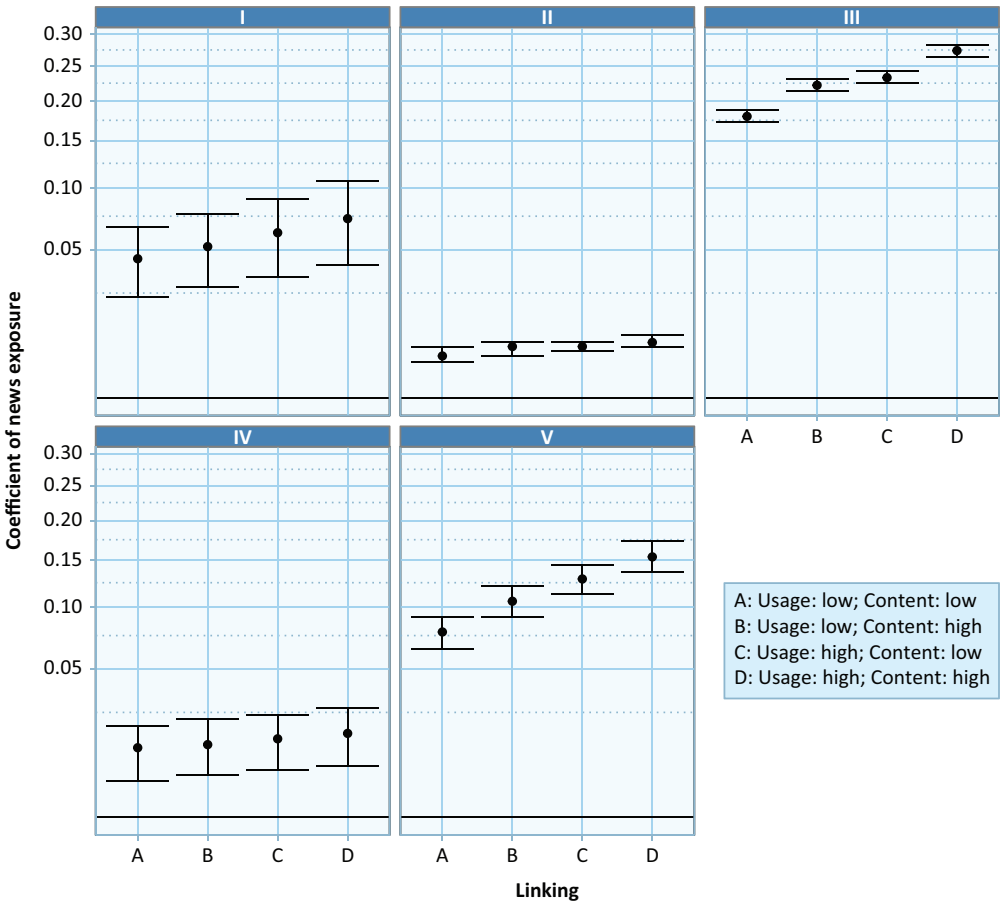

Figure 1. Coefficients of (logarithmized) issue exposure's effect on issue salience.

percentage points), followed by Design III (five to nine percentage points), Design V (two to five percentage points), Design IV (three to four percentage points), and Design II (one to two percentage points; Figure 2). While the strongest effects are observed in an aggregate-level analysis, the two individual-level designs exhibit moderate effects. More precise user-to-content linking seems to pay off in the sense that the coefficients appear to grow stronger if we measure exposure more precisely. This is observed within each design type.

However, the impact of user-to-content linking is not as clear-cut as it appears in Figure 2. The reason is that the more precise linking also leads to lower estimates of exposure. So, the exposure to 10 additional news stories is more likely to occur if user-to-content linking has low precision; if precision is high, exposure scores tend to be lower (Section 5.6.1, Figure A2 in the Supplementary File). Figure 3 displays, for a given issue, the predicted probability of mentioning the issue as MIP (Design III, left) or of changing their response to that issue (Design V, right), respectively. The four differently coloured lines represent the four user-to-content linkage conditions. The steepest increase is clearly found for the most precise linkage type (high/high), suggesting that the effect is strongest in this condition. However, the linkage procedure leads to a systematically lower estimate of exposure (see Figures A2, A3, and A4 in the Supplementary File). The steepness of the curves exaggerates the differences between the conditions because the density of cases in the upper sections of the curve is lower the more precise the linkage is. To account for that, black connecting lines in Figure 3 show the predicted value at comparable extents of exposure, comparing the top 10% with the highest exposure in each condition, the top 20%, top 30%, and so forth. If the black line is horizontal, it means that at comparable extents of exposure, the probability of mentioning the issue is the same. To find the condition with the strongest effect at equivalent levels of exposure, one would identify which of the connected points (=equivalent exposure) are the highest (on the y axis). This suggests that only among individuals with a high extent of exposure does user-to-content linkage lead to estimating stronger effects; among those with a low extent of exposure, the less precise linkage conditions may indicate stronger effects.

6.3. Explanatory Power (RQ2)

Change in explanatory power of the proposed models when introducing exposure to an issue is greater for

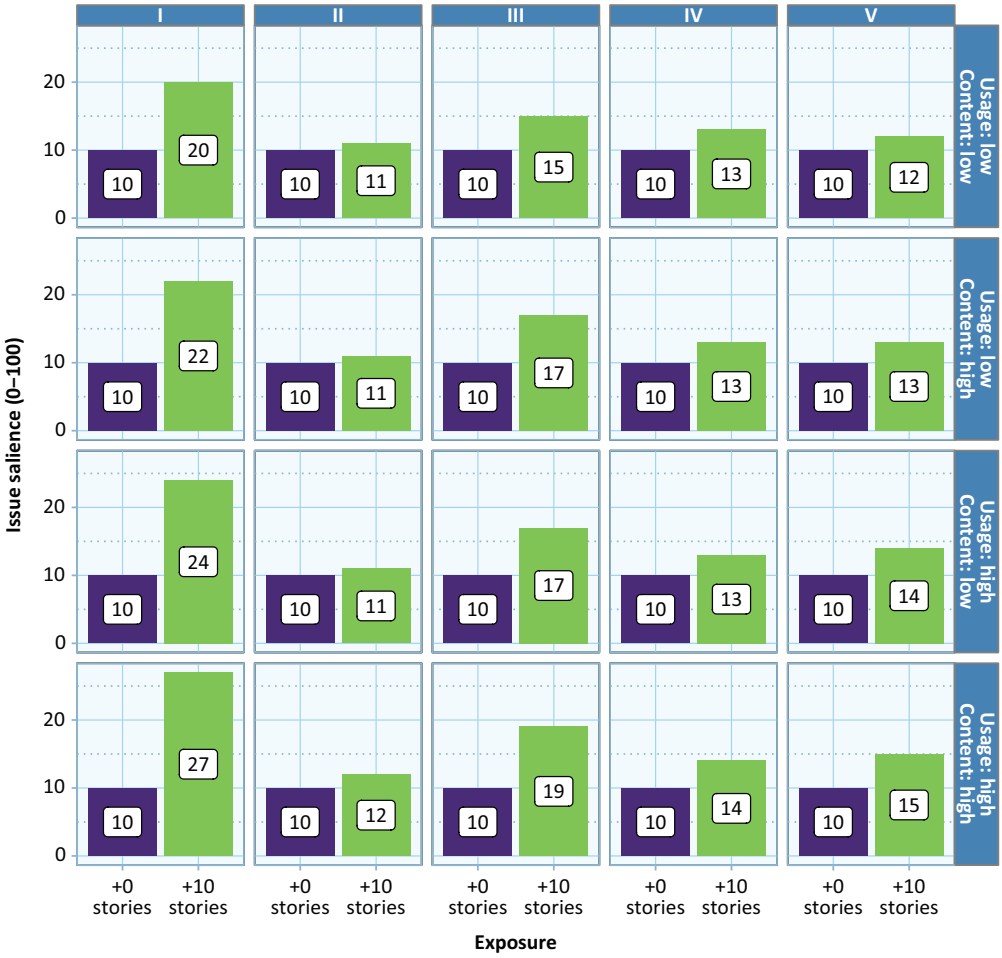

Figure 2. Predicted salience of issue if exposure to issue increases by 10 news stories.

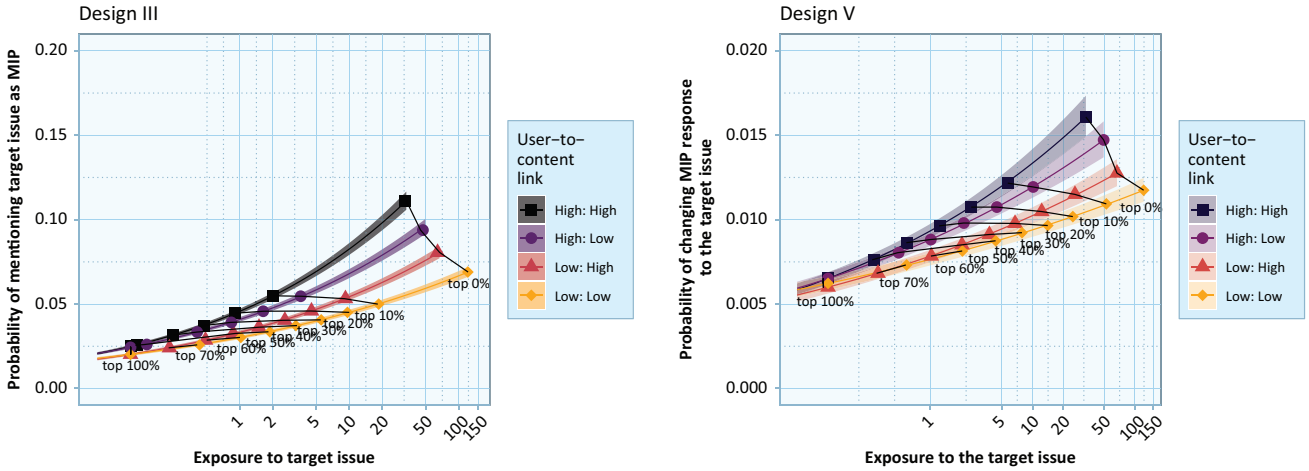

Figure 3. Issue exposure effects on individual probability of mentioning the issue as MIP.

aggregate-level (I, II, and IV) than for individual-level (III and V) studies and is greater for static/cross-sectional (I and III) than for their dynamic/longitudinal (II, IV, and V) counterparts (Figure 4, absolute values). While the aggregate/between design explains up to 27.6% of the variation in public salience of issues, the individual/within design explains only up to 0.9% of the variation in individual salience change of issues. In the longitudinal design (II) the explanatory power is even lower. However, it is a special case, as the inclusion of a lagged dependent variable eats up a lot of the variation, leaving little unexplained variation that news exposure could help explain (Figure A5 in the Supplementary File, Conditional R^2).

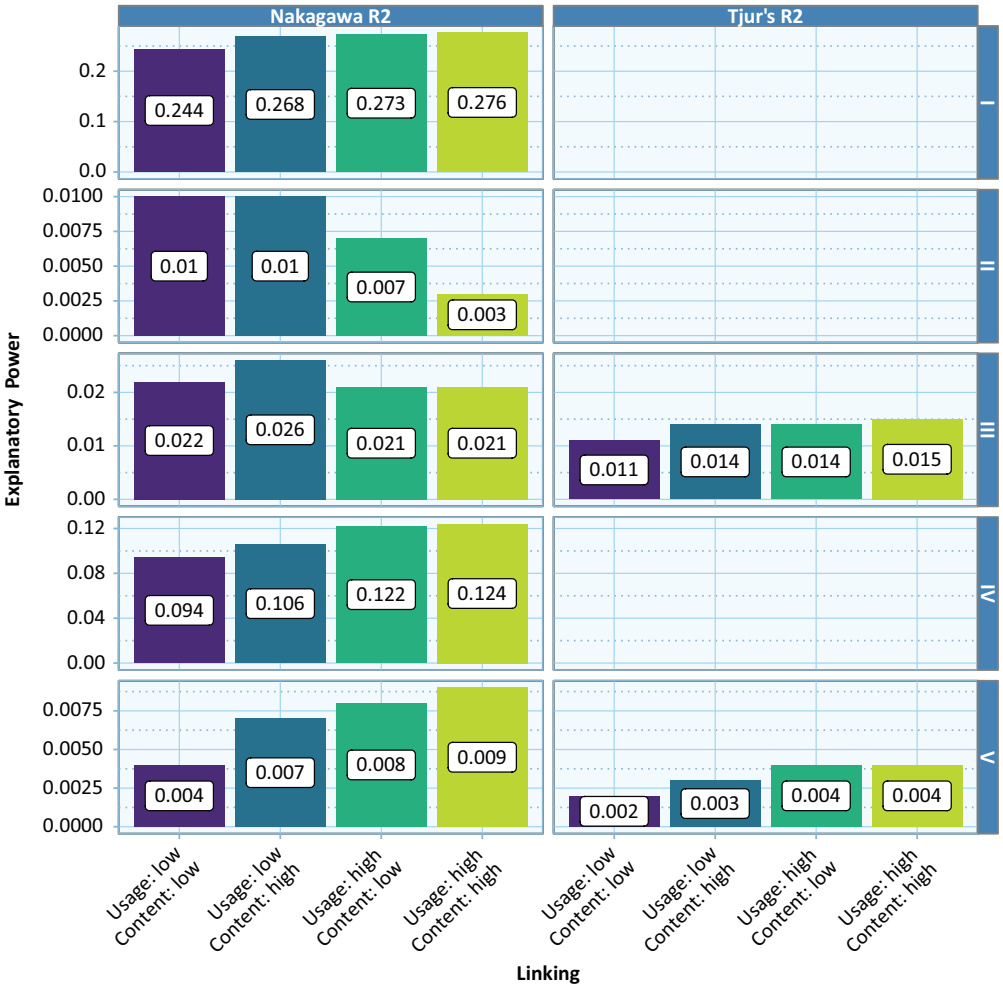

Figure 4. Change in explanatory power when adding media salience to explain issue salience.

The precision of the data linking leads to improvements in explanatory power in most (I, IV, and V) but not all designs. In Design II, the pattern is reversed, and design III shows no consistent pattern. However, design III shows the predicted pattern if we look at Tjur's R^2 (Figure 4, right panel) or at conditional R^2, i.e., the overall predictive capacity of random and fixed effects together (Figure A5 in the Supplementary File). I interpret this as showing that the *overall* prediction improves if the more precise measures are used, but less of the explained variation is attributed to the news use measure and more is attributed to random intercepts of issues. Thus, greater precision in data linking is beneficial in all designs except for the longitudinal-between design (II).

6.4. Change in Agenda-Setting Effects 2009–2017 (RQ2)

The data cover three elections during a phase of fundamental change in the media system toward a high-choice media environment (2009–2017). This allows no conclusive test but some insights into whether an erosion of agenda-setting effects of mass media during this period has occurred. We will investigate this primarily based on individual-level data (Designs III and V) because the other three designs (I, II, and IV) do not have the statistical power to make an informative test. We always rely on the high precision linking (4), but other linking configurations (1–3) lead to equivalent results and the same conclusions.

I started with design III.4. First, I tested whether adding interactions between news exposure and election year (categorical variable with three levels: 2009, 2013, and 2017) leads to an improvement of explanatory power. This is the case ($\chi^2(4) = 356.2$; $p < 0.001$). Agenda-setting effects differed in strength between the three elections. But has this been a consistent downward trend? To test this, I explored the interaction terms between elections and news exposure. 2009 has in fact been the year where agenda-setting effects had been the strongest: The probability of mentioning an issue increased with increasing issue exposure at the highest rate in 2009. However, agenda-setting effects were markedly stronger in 2017 compared to 2013. This does not rule out a downward trend. However, a linear trend does not offer the best explanation (Figure 5).

I repeated the analysis logic with design V.4. The findings are essentially the same: Adding the interactions leads to better models ($\chi^2(2) = 356.2$; $p < 0.001$), with 2009 as the year with the strongest agenda-setting effects, and agenda-setting effects in 2013 were weaker than in 2017 (Figure 5).

Only observing more elections can provide some more closure regarding a possible downward trend. What we can conclude is that if there is a downward trend, then it is not strong enough to overshadow all more situational influences on specific elections, as showcased by the weak agenda-setting effects in 2013.

7. Discussion and Conclusion

7.1. Results and Their Implications

The results offer some straightforward conclusions:

Robust agenda-setting effects: First, the data supported the predictions of the agenda-setting hypothesis in all 20 analysis configurations. This attests to a very robust phenomenon and provides strong support for the agenda-setting hypothesis across a wide range of issues. This does not mean that the effect is unconditional, but that it is observable in a broad set of cases across different conditions.

Precise user-to-content linking pays off: Second, user-to-content linking that was more precise benefitted the model specification and mostly led to greater explanatory power. This coincided with higher coefficients, which, however, must be interpreted with care (Section 6.2). All these differences were relatively small but suggest that more precise user-to-content linkage produces richer models of agenda-setting effects. The only is the longitudinal Design II, where more precise

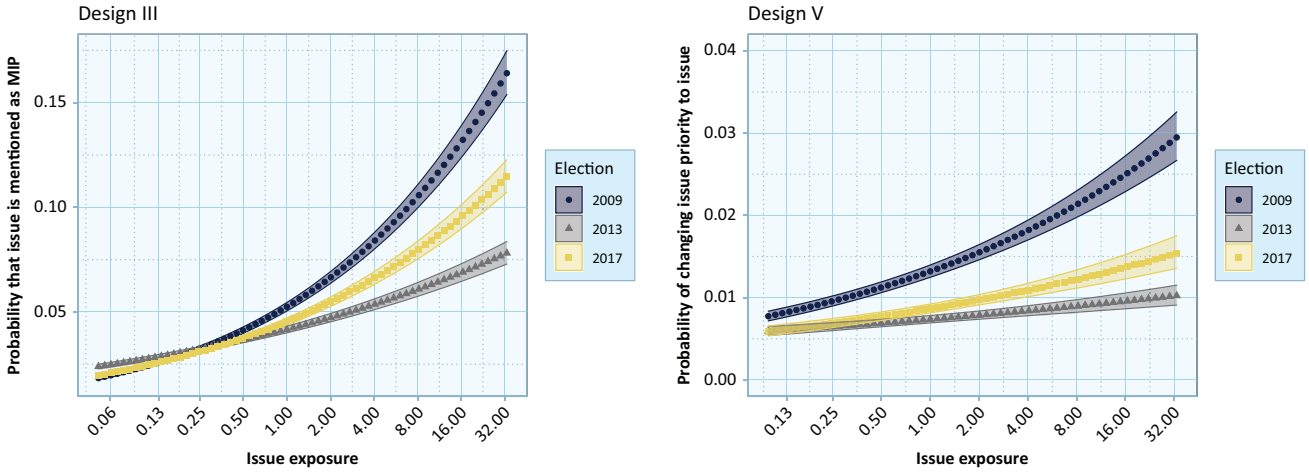

Figure 5. How agenda-setting effects differ between elections (Designs III and V).

linking was ineffective or even detrimental. User-to-content linkage may become even more important the less plausible it is to assume a monolithic media agenda.

Statistical power advantages in individual-level analyses: Third, individual-level analyses have the greatest statistical power. Individual-level analyses will become even more important as the media agenda may become more fractured and there may emerge several distinct media agendas.

First signs of a downward trend in strength of agenda-setting effects? Fourth, agenda-setting effects may have lost strength since 2009, at least the data from 2013 and 2017 show a lower strength of agenda-setting effects compared to 2009. However, one must consider that effect strength can vary substantially from election to election due to their idiosyncrasies (candidate constellation, parties' strategies, issue dynamics). If there is a downward trend, it is not linear: The effect strength in 2017 was greater than in 2013. This possible erosion of agenda-setting effects at the individual level (Designs III and V) may reflect changing patterns of media use in hybrid information environments. The GLES measurements presuppose users habitually use a handful of outlets. But nowadays, more scattered exposure to single news stories from a wide range of outlets is possible (e.g., in social media) has become widespread and may become even more widespread in the future.

For the choice of research designs in agenda-setting, I can conclude that:

(1) We need methodological diversity in agenda-setting. Changes in information environments can challenge presumptions in both individual-level (e.g., the concentration on a few habitually used outlets per person) and aggregate-level studies (e.g., the existence of a monolithic media agenda) making it even more important to triangulate agenda-setting phenomena from several angles.

(2) Aggregating data (from Design III to Design I or from Design V to Design IV) was the design decision that had the greatest impact on analysis results regarding explanatory power, coefficients, and statistical power. The impact of analyzing within variance (designs IV and V) rather than between variance (designs I, II, and III) was moderate. Finally, user-to-content linking choices (1–4) had a small, gradual impact within each design type (I–V).

(3) While panel studies are often preferable epistemologically (Design V), the analysis suggests that studies without repeated individual-level measurements (Design III) allow substantial analyses of agenda-setting processes as well.

(4) We need to find ways to secure that even in hybrid information environments, exposure to issues in the news can be estimated with decent precision. The more diverse and unpredictable media use becomes the more challenging and the more work-intensive it will be to measure media use and media content appropriately. If such data are obtained, picking an appropriate content-to-user linking procedure is of great importance.

(5) R-squares from different design types are not comparable. Here, the exact same data led to an estimated marginal R^2 of 0.24–0.28 at the aggregate level (Design I; linear model) and only 0.02–0.03 at the individual level (Design III; binary-logistic model). This also signals that relatively modest percentages of explained variance at the individual level can entail impressive aggregate-level consequences.

At the same time, there are some more complicated discussions that are raised by the findings.

Precise content-to-user linkage leads to lower estimates of exposure: The greater coefficients as data linking gets more precise should be interpreted with care. The distribution of the independent variable changes in a way that greater exposure values tend to occur in the less precise data linking condition relative to the high precision condition. This means that the lower regression coefficients in the low-precision conditions will be combined with higher input values while the higher regression coefficients in the high-precision conditions tend to be combined with lower input values. Figure 3 shows this for Designs III and V.

More precise user-to-content linking leads to lower explanatory power in Design II: Why does precision harm predictions in Design II rather than improving them? One possibility is that the media sample in the analysis is far from complete, e.g., omitting regional newspapers. This raises the question of why the other aggregate-level analyses are not affected in the same way, however. What should be noted is that in Design II, marginal R^2 but not conditional R^2 is reduced as content-user-linking precision increases.

Explanatory power is systematically lower for individual-level data: The lower explanatory power when using individual-level data (or the higher ΔR^2s in models I and IV) could reflect an ecological correlation (Robinson, 1950) that occurs only in the aggregate-level models, but that is at best part of the story. Another crucial factor is that the noise in individual-level salience is much greater (measurement errors, situational effects). By aggregation to the issue-level, we smooth out a lot of this hard-to-explain (and probably less meaningful) variation through averaging.

We should expect a generally lower level of explanatory power in agenda-setting studies with individual-level data (compared to a situation where we aggregate the data) if individual-level effects across individuals point in the same direction and cumulate systematically (rather than cancelling out each other). That overall news emphasis on issues (still) has substantial predictive power, which in turn indicates that there is still a *big message* that most citizens in a country will be exposed to through most of the variety of channels despite all the differences between the channels—They would still recognize which issues are "on." However, changes in the information environment may increase strain on the assumption that most individuals will change their issue priorities in the direction of the

media tenor, up to the point where that assumption becomes untenable.

The conservative nature of longitudinal designs: The depressing effect of longitudinal designs (IV compared to I, V compared to III, II compared to I) on explanatory power corresponds to the expectation that change is more difficult to explain than the current level, probably because it controls for the initial level and thereby eliminates all kinds of stable third variables that affect both media salience and public salience of an issue. We should generally expect lower explanatory power in longitudinal designs.

7.2. Limitations and Next Steps

This study relies on a high-quality data set that only enables the comparison of the different analytical configurations based on the exact same data set. However, the data stem from only a single country and the patterns observed there may be far from generalizable. In particular, the focus on elections in a politically highly stable phase of German federal politics (with Angela Merkel's government continuing after each of the analyzed elections) may limit generalizability. However, this would probably rather work towards underestimating rather than overestimating the importance of agenda-setting effects. Anyway, adding other countries and overcoming the focus on election periods would be desirable. On a generally high level of data quality, the GLES is not a dedicated study on agenda-setting effects, such that operationalizations of some concepts could be improved upon, as could be the sample of media. Particularly, capturing "alternative media" will be necessary for the future. An even more precise measurement of media use could be used in a study dedicated to studying agenda-setting effects. Finally, for studying the change in the strength of agenda-setting effects over time, three-time points are still too few. The GLES results for the 2021 election (while the survey data are already published, the content analysis data are not yet publicly available) can be used in the future to extend this analysis. The impact of design and data linking choices is conditional on whether individual-level effects tend to accumulate or cancel out when aggregating them. This, again, is dependent on the structure of the information environment ("how consonant is media coverage across outlets?") and individuals' selection behaviour (e.g., "how much do individuals seek out attitude-consistent content?").

Methodological diversity will shape agenda-setting research also in the next decades, and seemingly conflicting results should reveal new insights rather than create confusion. Therefore, the current study can help uncover the systematic impact of design choice on hypothesis test outcomes of the agenda-setting hypothesis, while being aware of the conceptual differences the different designs entail and the theoretical insights they might reveal.

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Photograph taken by Thor Nielsen for NTNU.

Conflict of Interests

The author declares no conflict of interests.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

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