Network evidence of intermedia frame building among partisan news outlets

News media can shape public perceptions of political reality and subsequent attitudes towards important issues on topics such as public health, the environment and the economy (Fowler & Gollust, 2015; Kahan & Landrum, 2017). Under the media effects tradition, two theoretical models have been explored extensively, often in tandem (D. A. Scheufele & Tewksbury, 2007): The *agenda-setting theory* (McCOMBS & Shaw, 1972) posits that mass media shapes public perceptions by setting a public agenda, thus, influencing *what people think about*. Going a level further, *framing theory* (Entman, 1993) claims that by selecting certain aspects of an issue and making them more salient in presentation, mass media influences *how people think about* an issue.

However, only a few existing studies have inquired into the generative processes within the media ecosystem that shape news discourse (Lecheler & De Vreese, 2018). One such generative mechanism is proposed by the *Intermedia agenda-setting* (IAS) theory, which posits that news discourses are characterized by outlets that influence each other's coverage by co-orienting journalists towards a specific agenda, thus causing outlets to converge on *what issue gets talked about* (Vonbun et al., 2016). Moreover, studies on *frame building* show that media frames are influenced by factors external to individual outlets, such as political actors, interest groups and elites (D. Scheufele, 1999).

In this study, we extended the IAS hypothesis to frame building, introducing the *Intermedia frame-building* hypothesis which claims that *media outlets shape each other's frame choices, and thus influence how they talk about an issue*. First, we tested the hypothesis on a case study of the news media coverage surrounding Mpox. Setting Mpox as the agenda and sexuality as the issue-specific frame, we studied the network of intermedia influence on news outlets' emphasis of this frame. Second, we identified the primary frame-builders, i.e., the central actors in the intermedia influence network. Third, given how partisan leanings of news outlets drive their reporting ("What Drives Media Slant?," 2010), we studied how partisanship interacts with intermedia influence patterns, and the extent to which frame-building is shaped by co-partisan and counter-partisan influence.

Data and Methods

In 2022, the United States was struck with an epidemic of Mpox Clade II virus, which led to over 32,063 cases and 58 deaths. While it was not classified as a sexually transmitted infection (STI), the community (human-to-human) transmission of Mpox occurred overwhelmingly among sexual contact networks of Sexual and Gender Minorities (SGMs), particularly Men who have Sex with Men (MSMs) (95.2% of all cases) (*2022 U.S. Map & Case Count | Mpox | Poxvirus | CDC*, 2023; Philpott, 2022). Studies on the media coverage of the Mpox epidemic (Bragazzi et al., 2023; März et al., 2022) highlight the controversial and competitive framing environment that characterized the public discourse. When right-

leaning outlets emphasized sexuality as a frame, they tended to highlight sex as the exclusive transmission route, MSMs as the only high-risk group, blamed "gay male promiscuity", and prescribed abstinence as the solution. On the other hand, when left-leaning outlets emphasized sexuality as a frame, they tended to highlight contact transmission beyond sex, the potential for Mpox to spill over to non-MSM demographics, and the dangers of stigmatizing sexuality and SGMs when communicating about health. While both, the right-leaning and left-leaning frames emphasize on sexuality as an important consideration with respect to Mpox, they can be viewed as competitive frames since they offer conflicting perspectives.

First, we obtained a dataset of 844 articles published in 16 national US news outlets between May 1 to October 31, 2022 through Media Cloud (Roberts et al., 2021), an online open-source database that maps news coverage of current events. We chose these outlets since we have a reliable notion of partisan leaning for each of these outlets based on audience partisanship (Robertson et al., 2018). Second, we curated and preprocessed texts for these articles by web-scraping through the Python package newspaper4k (Paraschiv, n.d.). Third, we manually annotated these articles using the applied thematic analysis (Guest et al., 2012) framework to identify articles that emphasized sexuality frames when communicating about Mpox. The annotations were conducted by the first author and an undergrad research assistant using a codebook-approach, which yielded an inter-rater agreement of 81% and Cohen's Kappa of 0.62. Finally, we derived time series of frame usage for the 6 months on each of the 16 outlets, signifying the number of published articles every day that framed Mpox in terms of sexuality. The time series was further used to infer the intermedia influence network.

Prior work on networked intermedia agenda-setting patterns (Stern et al., 2020; Vargo & Guo, 2017) used granger causality to infer the underlying network. However, the usage of granger causality for network inference is contested for two reasons: firstly, relationships on networks often encompass higher-order dependencies, which violates the assumption of pairwise independence between edges required by granger causality. Secondly, granger causality assumes linear relationships between variables, which is a strong and often inaccurate assumption. To address the aforementioned limitations, we developed a methodological pipeline that combines two techniques: transfer entropy (Zimmermann et al., 2018) and Bayesian structure learning (Scutari & Silander, 2024).

Given two dynamic variables X and Y, transfer entropy quantifies the predictive power of Y on X, by calculating the information gained on the future state of X when information about the history of Y is added over the information on the history of X. This quantity can detect non-linear relationships and hence circumvents the assumptions of linearity between intermedia relations. However, transfer entropy still assumes pairwise independence between edges. Bayesian structure learning provides probabilistic directed graphs that quantify predictive power between variables while accounting for higher-order relationships by using tests of conditional independencies, thus circumventing the assumption of pairwise independence between edges. However, Bayesian structure learning algorithms don't account for

autocorrelations within variables. To leverage the strengths of each technique, we first calculate the statistical significance of each edge as calculated by transfer entropy between pairwise nodes. If an edge was statistically insignificant ($p < 0.05$), we blacklisted the edge. Causation implies association (Altman & Krzywinski, 2015), and hence a lack of association using transfer entropy entails a lack of causation between outlets. Then, we inferred the intermedia influence network using Bayesian structure learning, by including the blacklisted edges as the prior information – forcing the algorithm to neglect over 85% of all possible edges.

Results

The inferred network of intermedia influence (**Figure 1**) comprised 16 nodes and 48 weighted edges. Here, the nodes and edges represent outlets and the magnitude of frame-building influence between outlets respectively. First, we found that most nodes (15 out of 16) were part of the giant connected component (the biggest collection of nodes such that given two nodes, there always exists a path between them) of the inferred network, supporting our hypothesis that framing choices surrounding Mpox could be modelled in terms of intermedia influence. To address the possibility that the results were merely an artifact of the methodology or patterns in news cycles, we performed the same analysis on a non-competitive frame about Mpox, where both left, and right-leaning outlets critiqued the CDC's response to the epidemic in a similar vein (**Figure 3, left**). We found that given an agenda and a non-competitive frame, there was very weak support for intermedia frame building for non-competitive frames.

Second, in contrast to previous studies (Chen et al., 2024; Stern et al., 2020) that highlight left-leaning and credible outlets such as the New York Times as the central actors in intermedia influence networks, we underscored low credibility, right-leaning outlets such as PJ media, Breitbart and Daily Caller as central influencers (**Table 1**). In terms of total influence, Breitbart, Blaze and PJ media were the top 3 outlets. In other words, fringe outlets, not mainstream and establishment media outlets, were the intermedia frame-builders.

Third, we found that right-leaning outlets were influenced by both, left, and other right-leaning outlets (**Figure 2**). Surprisingly, left-leaning outlets were disproportionately influenced by right-leaning outlets, while barely being influenced by other left-leaning outlets. Both of these results provide strong evidence for counter-partisan frame building, defying expectations of co-partisan influence as suggested by theories of echo chambers and homophily. For example, when New York Times would frame Mpox in terms of sexuality, it would often be in response to counter-partisan outlets such as the Daily Caller, as opposed to co-partisan outlets such as NPR. Again, we found no such evidence for counter-partisan frame building for the non-competitive framing case (**Figure 3, right**).

Conclusion

In this study, we introduced the Intermedia frame-building hypothesis, which states that given an agenda, the framing choices adopted by different media outlets are influenced by each other. Leveraging social network inference methods, we provided networked evidence for the hypothesis. Moreover, we showed that frame building is driven by cross-partisan influence, which highlights patterns of outgroup rivalry that drives political processes (Rathje et al., 2021). Finally, we noted that these counter-partisan frame building processes are peculiar to competitive and controversial frames. Thus, our study provides important insights as to how social network analysis can be leveraged to understand the reactive intermedia influence patterns underlying health controversies.

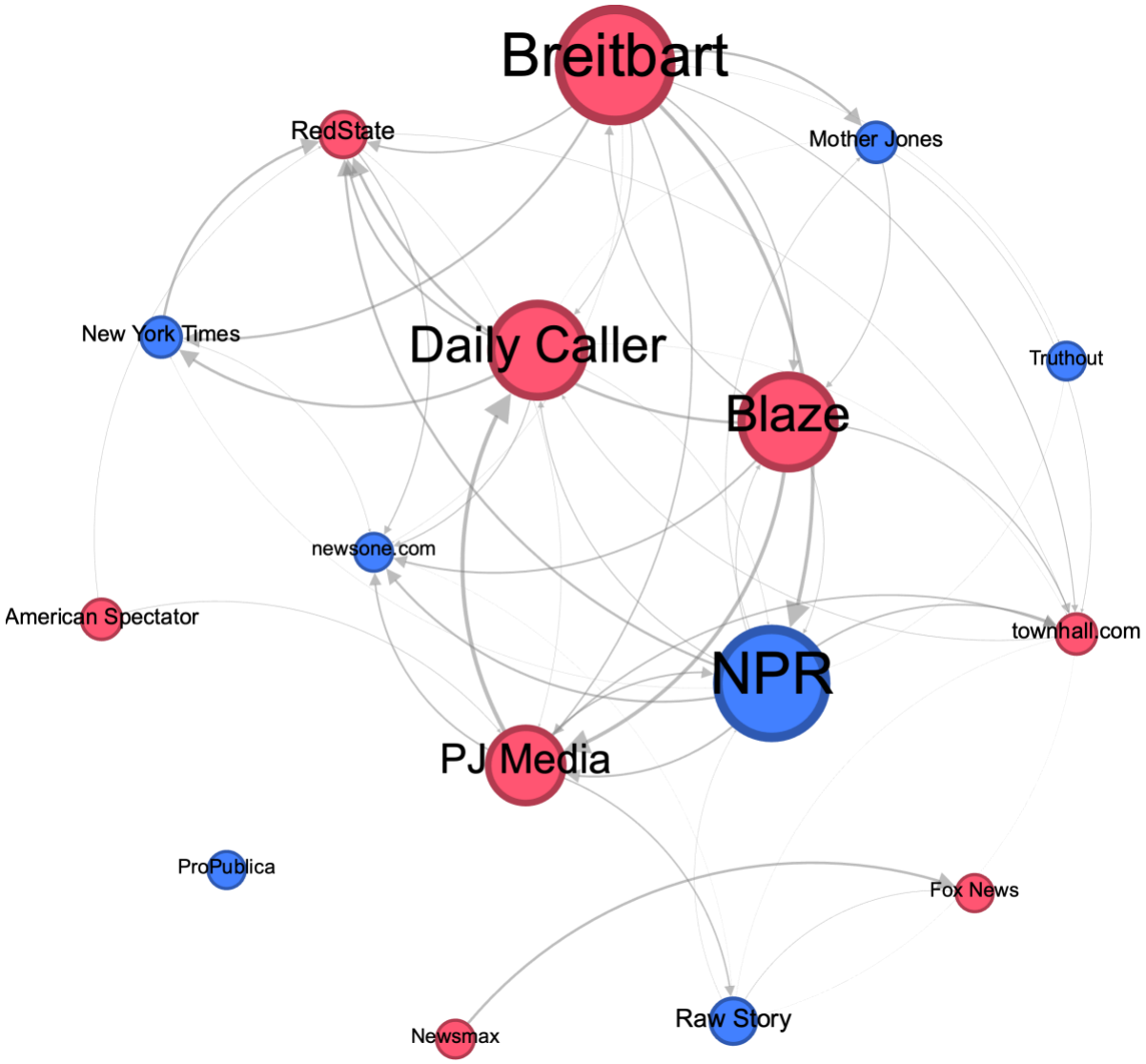

Figure 1: Sexuality frame (competitive)

Intermedia frame-building network (for sexuality frame) with 16 national news outlets - 9 left leaning (blue) and 7 right leaning (red), and 48 weighted influence relations. The network was plotted in Gephi using the Fruchterman Reingold layout. The node size was scaled by out-degree. The edge size was scaled by edge-weight.

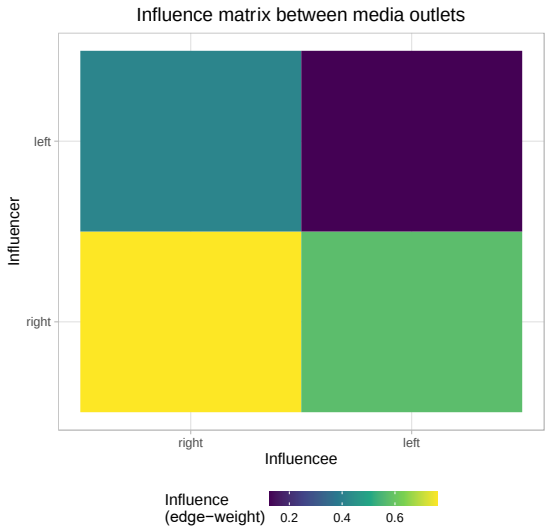

Figure 2: Sexuality frame (competitive)
Total influence of an influencer outlet (Y-axis) on an average influencee (X-axis), stratified by partisan leaning of the outlets.

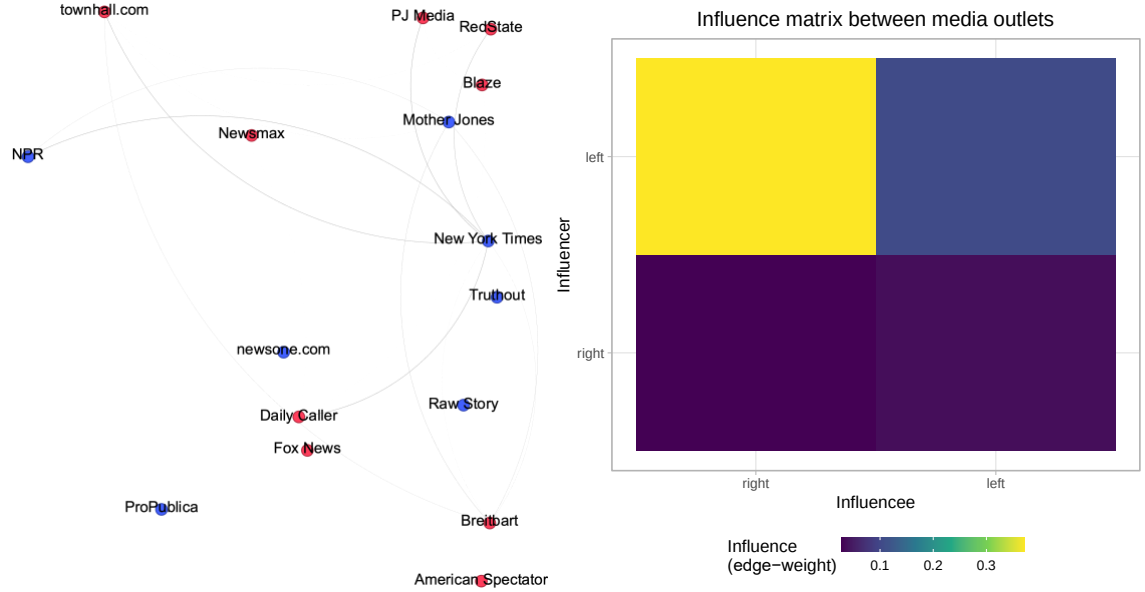

Figure 3: CDC critique frame (non-competitive)
(Left) Intermedia frame-building network with 16 national news outlets - 9 left leaning (blue) and 7 right leaning (red), and 16 weighted influence relations. The network was plotted in Gephi using the Fruchterman Reingold layout. The node size was scaled by out-degree. The edge size was scaled by edge-weight. Note the difference in sparsity and edge weight compared to figure 1.
(Right) Total influence of an influencer outlet (Y-axis) on an average influencee (X-axis), stratified by partisan leaning of the outlets. Note that the color scale has much lower values compared to figure 2.

ID	Outlet	Leaning	Weighted In-degree	Weighted Out-degree	Closeness centrality	Betweenness centrality	Eigenvector centrality
1	Breitbart	right	0.315	3.775	0.800	0.060	0.085
2	Blaze	right	0.760	2.755	0.632	0.122	0.294
3	PJ Media	right	1.908	2.553	0.545	0.107	0.437
4	NPR	left	1.583	2.533	0.667	0.233	0.589
5	Daily Caller	right	1.530	1.535	0.545	0.056	0.597
6	New York Times	left	1.240	0.690	0.333	0.000	0.359
7	Newsmax	right	0.000	0.605	1.000	0.000	0.000
8	RedState	right	2.885	0.440	0.400	0.036	0.547
9	Mother Jones	left	0.750	0.335	0.480	0.012	0.359
10	American Spectator	right	0.000	0.215	0.394	0.000	0.000
11	Raw Story	left	0.375	0.185	0.500	0.124	0.636
12	townhall.com	right	1.650	0.140	0.414	0.052	1.000
13	Truthout	left	0.055	0.030	0.444	0.000	0.027
14	newsone.com	left	2.045	0.015	0.353	0.041	0.828
15	Fox News	right	0.710	0.000	0.000	0.000	0.175
16	ProPublica	left	0.000	0.000	0.000	0.000	0.000

Table 1: Sexuality frame (competitive)

Descriptive node statistics of the intermedia frame-building network

The nodes are arranged in descending order of weighted out-degree (the size of nodes in figure 1)

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