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Twitter and divides in the Dutch parliament: social and political segregation in the following, @-mentions and retweets networks

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ABSTRACT

MPs communication on Twitter with other MPs may facilitate forming cross-party solidarity networks and provide public micro deliberation but may also be segregated leading to information bubbles and political polarization. That party-based division lines are running through the online communication networks of politicians is a well-established finding in social media studies; however important knowledge gaps have remained on the complexity of Twitter's *multilayered* network *developments* and their interrelatedness with *socio-demographic* segregation. Here, we integrate the online-network literature with that on the political consequences of the digital architecture of social media platforms to theorize and scrutinize the extent to which and why Twitter following, @-mentioning and retweeting networks among MPs are segregated along party lines and sex, age and ethnicity. Our unique dynamic take allows us to rigorously study network segregation, including feedback mechanisms between Twitter layers, based on descriptive network statistics and *SIENA* analyses for Dutch MPs at three time points. The findings show that *political* segregation patterns are strongest within the retweet layer and weakest for @-mentions. The interrelations between the Twitter network layers aggravate party-based segregation over time. MP Twitter networks are not consistently segregated along social dimensions.

1. Introduction

Twitter is popular among politicians (Spierings et al., 2019; van Vliet et al., 2020) and MPs engaging via Twitter may facilitate forming cross-party solidarity networks (McLoughlin et al., 2020) as well as provide public micro deliberation. However, in (offline) social networks people tend to have relatively more relations with those who have similar social and political identities; these networks tend be socio-politically

segregated (McPherson et al., 2001).[1] If this holds for MPs' online networks too, this might strengthen information bubbles and political polarization.

Partially, social media studies have confirmed such segregation. Hsu and Park (2012) showed that Korean MPs were more likely to have links to fellow party members. Del Valle and Bravo (2018) demonstrated that the Twitter networks among Catalan parliamentarians are ideologically segregated. And more recent sophisticated cross-country comparisons of parliamentary Twitter networks demonstrated that party-based segregation is common (Praet et al., 2021; van Vliet et al., 2021). However, important knowledge gaps remain.

With exception of Del Valle et al. (2022), studies provide little explanation for the observed party-based Twitter segregation, and Del Valle et al. (2022) relied on only one snapshot of the Twitter @-mention network. To make more substantiated claims on how network mechanisms explain party-based segregation and to build grounded longitudinal perspectives, we need to study network evolution (cf. Weaver et al., 2018). This allows us to assess or rule out certain explanations for party-based segregation, including structural network mechanisms and segregation along socio-demographic dimensions. Moreover, while some studies include Twitter's different network layers (e.g., follows, @mentions, retweets), the layers' *interrelatedness* has been neglected, while this might partly explain patterns of segregation.

Therefore, this study investigates *party-based and social* segregation *dynamics* in three *interrelated* Twitter networks. To provide a more thorough theoretical understanding of these dynamics, we bring together the conceptual notion of digital architectures from the political communication literature (Bossetta, 2018; Jacobs & Spierings, 2016) and the literature on segregation dynamics in online social networks (Boutyline & Willer, 2017; Hofstra et al., 2017; Lin & Lundquist, 2013; Wimmer & Lewis, 2010). Particularly, we theoretically and empirically engage four questions: (a) to what extent are the Twitter networks among MPs segregated?; (b) to what extent are party-based segregation patterns a by-product of social homophily?; (c) to what extent do the segregation patterns by following, @-mentioning and retweeting relations reinforce or mitigate each other?; and (d) how do segregation patterns and dynamics develop?

Our empirical focus is on the evolvement of the Twitter network among the 150 Dutch MPs after the 2017 national elections, in which 13 party MPs were elected. After the election, effective coalition or opposition parties need to collaborate to find and maintain majorities, which implies a least-likely case for strong party and ideological segregation (cf. Praet et al., 2021; but see, van Vliet et al., 2021). Methodologically, we take advantage of our unique *complete* network data on Twitter relations among Dutch MPs collected on *three points in time* (April, June and September 2017). First, we visually inspect these networks and provide the observed degree of segregation. Next, we employ an Stochastic actor-orientated modeling strategy (Ripley et al., 2021; Snijders et al., 2010) by which we disentangle the impact of structural network effects, characteristics of MPs and the Twitter architecture.

2. Theoretical background

2.1. Multi-domain: segregation along political and social dimensions

As of the 2010s, Twitter is widespread in Dutch politics and used rather professionally. Political actors are aware of the algorithms and show, social media specific, strategic

behavior (Jacobs & Spierings, 2016; Spierings & Jacobs, 2019). Together with the results of previous research on MPs Twitter use and Twitter segregation (Colleoni et al., 2014; Del Valle et al., 2022; Del Valle & Bravo, 2018; Hsu & Park, 2012; Praet et al., 2021), our general expectation is therefore to observe party-based segregation in Dutch MPs' Twitter networks (Hypothesis 1).

Bringing in a multi-domain perspective, however, raises the question whether segregation in Twitter networks along party membership (political domain) is partly a by-product of sex, age and ethnicity-based inbreeding homophily (social domain). Social interactions are more likely between people who are similar (McPherson et al., 2001) due to opportunity structures and initial levels of segregation being amplified by structural network processes such as reciprocity (i.e., 'If you scratch my back, I will scratch yours') and transitivity (i.e., 'Friends of friends become friends'). Additionally, people commonly have preferences to interact with similar others (i.e., inbreeding homophily preferences), which drives segregation in both offline and online networks (Hofstra et al., 2017).

Shifting towards politics, the representation literature reflects homophily preferences in the concept of homosocial capital: a network with similar people leads to shared norms, values and perceptions, leading to predictability and trustworthiness being ascribed to similar politicians (Bjarnegård & Kenny, 2015). While online Twitter networks of MPs are no typical trust-based strong-ties network, MPs will be exposed to each other in parliament regularly and reiteratively. It can therefore be expected that real-life social cleavages matter, and because parties often differ from each other in their socio-demographic composition (see Supplementary Material A), political segregation in Twitter networks could be a (by-)product of socio-demographic inbreeding homophily.

In this contribution, we focus only on Twitter relations among MPs themselves (thus excluding other politicians or relations with non-politicians). Naturally, the Twitter networks of MPs may differ from the (online and offline) social networks of ordinary citizens. For MPs, party-based identities may be very salient and trump the importance of identities based on key social dimensions. Moreover, MPs may use Twitter strategically to reach political goals (e.g., increase visibility online and offline, access to information, forge cross-party alliances). These instrumental motives for using Twitter – likely to be related to characteristics typical for MPs (e.g., list position, incumbency) – may outweigh personal preferences who to socialize with on Twitter and lead MPs to search for MPs to form relations with outside their immediate preferred 'choice set'. Relatedly, the contact network on Twitter is partly (informally) regulated by political parties, and the specific party communication doctrine may give more or less room for personal decisions who to form relations with on Twitter. It is therefore not self-evident that among MPs on Twitter, common explanations for forming and maintaining ties – proximity, structural network effects and preferences to interact with socially similar others – also hold.

We recognize that Twitter networks among MPs are likely to differ from the networks of ordinary citizens and acknowledge that political and institutional-structural factors may condition the relevance of social similarity for forming relations on Twitter. However, because social inbreeding homophily has been so widely observed across other networks, we expect to observe social divisions within MPs Twitter networks as well (Hypothesis 2a) and, because political parties have clear different social compositions, this may partly explain party-based segregation (Hypothesis 2b).

2.2. Multiplexity: segregation in different Twitter layers

Twitter creates different layers due to its digital architecture including different types of interaction (Bossetta, 2018). Three of the most prominent Twitter layers include follow relations, direct retweets and @-mentions (including replies) (Anger & Kittl, 2011; Ausserhofer & Maireder, 2013; Jacobs et al., 2020; Lee et al., 2020; Metaxas et al., 2015).

On Twitter, one can *follow* others in a non-reciprocal way. Once a connection is made, the tweets of the followee will appear in the timeline of the follower. Following an account could thus indicate that a follower finds the followee's posts interesting, regardless of whether one agrees or disagrees with it. A need for information diversity may explain why MPs are also likely to form follow relations with MPs from other parties. MPs know the political messages of one's own part, but also want information from important other MPs. Accordingly, the number of followees is generally considered a proxy of how important an account is. Forming following relations can and has been used strategically to boost the prominence of an account and the spread of the accounts' tweets (Jacobs & Spierings, 2016, p. 197).

Twitter allows users to 'forward' posts of other users to their own timeline without alteration of the original tweet: a basic *retweet*. A basic retweet is created by only two simple clicks and posts the original tweet in the timeline of the retweeting MP and thus (a) shows up in the feeds of the followers of the retweeting MP and (b) gains a higher algorithm score (Anger & Kittl, 2011), leading it to be pushed more to other users. In their seminal work, Boyd et al. (2010) study the reasons for retweeting, covering both basic retweeting (our focus) and reposting someone's tweet accompanied by new content (modified/cited/quoted retweets). They show that retweeting is mainly rooted in wanting to share, amplify, agree, validate, endorse and support. Among the other found reasons to retweet, only 'to comment on a tweet' or 'to engage in conversation' are more ambiguous in term of affect, but these reasons seem to apply more to modified retweets, which are not our focus. While politicians sometimes claim in their profiles that a retweet is not necessarily an endorsement (Klinger & Svensson, 2015), retweeting a message of another MP without adding one's own thought while disagreeing with the content of the tweet is unlikely (Praet et al., 2021; on Dutch politics: Jacobs & Spierings, 2019; Spierings & Jacobs, 2019). Of the three relationships we study, retweets are most likely to signal positive affect.

Lastly, we discuss the *@-mention*, and there are two ways in which one can @-mention others. First, in a post one can include the handle identifying a user by which the @-mentioned account is automatically notified. This strongly increases the likelihood that the @-mentioned MP responds. Second, below each tweet, Twitter puts a small speech bubble icon via which users can directly, and publicly, reply to a message. The active @-mention and @-reply have been referred to as indirect and direct addressing, respectively (Ausserhofer & Maireder, 2013), indicating that both are about interaction or conversation. Of the different networks the @-mention function provides the primary way to pull another user into a discussion when a tweeting MP disagrees with the @-mentioned MP. Indeed, existing studies indicate that @-mentions, of our three different Twitter networks, are used most to hold discussions (e.g., Conover et al., 2021; Del Valle et al., 2022; Jacobs et al., 2020). For the @-reply this seems rather evident; however, also studies specifically focusing on active @-mentions show this. For instance, the majority of

gubernatorial candidates' @-mentioning tweets are attacks indeed (Hemsley et al., 2018) and negative empathy is not uncommon in cross-party @-mentions (Del Valle et al., 2020), albeit this higher negative sentiment is mostly relative to the other Twitter layers. Moreover, MPs are well aware that a back-and-forth in the open Twittersphere with an ideologically opposite MP is a digital version of standard campaign strategies to attract the attention of journalist and regular media, certainly in the Dutch multiparty system, which have a much larger audience (Jacobs & Spierings, 2016).

Nuancing our general expectation (i.e., to observe party-based segregation in all three layers of MPs Twitter networks), we consider that Twitter's architecture makes direct retweets being most about positive affect, and thus we expect that party segregation will be most pronounced in the retweet layer of the Twitter network (Hypothesis 3a). Contrarily, @-mentions, tap most into inter-party debate and negative affect, hence we expect the @-mention relation to be formed *relatively* most between MPs from different parties (Hypothesis 3b).

While some scholars showed the different network layers' dynamics, it has remained unclear how the different Twitter network types co-evolve, even though they are structurally related. In the present contribution, we take this so-called multiplexity into account. It is known that exposure to others is an important determinant for tie maintenance (Rivera et al., 2010). Hence, we expect that the digital proximity that results from a follow relation (and thus popping up in one's feed) will increase opportunities for both MPs to retweet each other or to react via @-mentions, and consequently that the degrees of segregation in the retweet and @-mention layer are partly resulting from segregation in the follower layer (Hypothesis 4a and 4b, respectively). Inversely, when an MP retweets/@-mentions or is retweeted/@-mentioned by another MP, this may be an incentive for the first MP to start following the latter, i.e., following segregation is also partly the result of segregation in the retweet and @-mention networks (Hypothesis 4c and 4d, respectively).

2.3. Multiple time points: development of Twitter segregation

We expand on previous work by theorizing and investigating the over-time development of the Twitter networks (Weaver et al., 2018). We started to focus on MPs in the month after the elections, with the election period being one in which they work particularly closely together with other candidates from their party. In such a strongly shared social context, their will undoubtedly have been homogeneity in their offline and online relations. This degree of segregation is, however, unlikely to be stable.

We may expect that initial levels of segregation deepen, because of meeting opportunities in parliament (e.g., same-party MPs are seated together). Furthermore, common structural network dynamics like reciprocity and transitive closure may contribute to the over-representation of intra-party relations also with the newly elected MPs (cf. Del Valle et al., 2022).

On the other hand, given formal rules of parliament regarding committees and general meetings, networks are also likely to become more integrated over time due to offline inter-party contact opportunities, spilling over to Twitter. Also, MPs may increasingly form strategic follower relations with dissimilar MPs, in order to be informed or forge alliances – a crucial political dynamic in coalition-based democracies – with weakening party-based homophily preferences as a result.

In sum, meeting opportunities and structural network mechanisms might contribute to increasing network segregation, while weakening party-based homophily may reduce party-based segregation, but the empirical literature on this is scarce. As we cannot deduce an a priori expectation on which mechanism(s) dominate, we formulate a research question, not a hypothesis: To what extent do party-based network segregation in the different layers of Twitter networks among MPs change over time? (Research question 1).

3. Data and methods

3.1. Data

The Netherlands was and is a Twitter frontrunner: we found 147 of 150 politicians who entered Parliament in 2017 on Twitter. Via the REST API follower and retweet relations were mapped and via the SEARCH API @-mentions collected, both for three time points starting het month after the elections and ending the month before the new government was installed (April, June and September).

The follower relations are measured rather straightforwardly: one follows the other or not. The retweet relation is based on tweets starting with 'RT': the (direct) Retweet. This excludes the since 2015 available cited/quoted tweets. Focusing on direct retweets aligns with our theoretical focus on positive affect, as cited/modified/quotes tweets are much more likely to include negative appraisal or disagreement. The @-mention data include both replies to and active @-mentions of MPs, both of which are returned searching '@ [handle]' in the SEARCH API. Retweets also include the @[handle] but were removed based on the 'RT' opening. Despite the somewhat different functioning of @-replies and @-mentions, keeping them together aligns with our focus and how others studies have discussed them (Dambo et al., 2022; Guo et al., 2020; Keller et al., 2020).

Regarding the MPs' demographics, their *sex* is included as reported on the ballot, MPs' *age* was collected via the official website of the House of Parliament, and we considered 16 MPs to having a *visible ethnic-minority background*, using a common contextual definition and procedure in the literature on representation: name and photo recognition or being well-known as such (e.g., Bloemraad & Schönwälder, 2013).

As we aim to test whether party-based segregation is rooted in a preference to interact with same-party MPs or is a by-product of social homophily, we need to rigorously take into account other structural network dynamics and covariate effects that could also explain why relations between same-party MPs are relatively common. Unfortunately, it goes beyond the scope of this study to develop an encompassing theory of how political and institutional-structural factors influence MP's strategic motivations and Twitter behavior in parliament. However, our models will control for some important factors and hopefully our results provide a springboard for future (theoretical) work thereon. In our multivariate models, with respect to covariate effects, we logically control for demographic characteristics at the ego (i.e., the MP sending a tie) and alter (i.e., MP receiving a tie) level such as sex, age and minority status. Moreover, the literature on Twitter use by MPs shows that the list-puller position in the election, the list position generally, and incumbency status of MPs (i.e., having been MP in an earlier session of parliament) matters for both the MPs behavior as well as 'incoming' relationships like @-mentions (on the Netherlands, see Jacobs & Spierings, 2019).

At the dyad (i.e., connected pair of MPs) level, we control for similarity in incumbency status and include physical or geographical proximity within parliament, based on seating positions of MPs in April 2017, which are allocated based on party size and ideological position of the party and on status within the party. As this physical proximity partly overlaps with ideological proximity, additional models were run with ideological distance based on the parties general left-right position as reported in the Chapel Hill data.

With respect to endogenous network dynamics, we take into account that degree distributions are skewed (i.e., most have few, some have many). Moreover, we include reciprocity, transitivity and shared popularity effects. These structural effects are discussed in (slightly) more detail in the next section. More information on both the structural variables and the control variables, including theoretical rationales and results, can be found in Supplementary Material D and E.

Dataset, code and results are accessible via our replication website (https:// jochemtolsma.github.io/Twitter/).

3.2. Analytical strategy

We start with a visual inspection of the network and descriptive statistics assessing the extent of segregation. Staying close to our definition of segregation, we provide intragroup and intergroup densities (i.e., ratio of observed to possible ties). To account for relative groups sizes and differences in MPs activity and popularity, we also report Newsman's Assortativity Coefficient, which is 1 when all dyads are formed within-groups and 0 when the probability to observe a within-group dyad is solely the result of proportionate mixing. These statistics help to answer Research Question 1.

Next, to explain the found segregation and development therein, we turn to the stochastic actor-oriented model (SAOM) as implemented in simulation investigation for empirical network analysis (SIENA), estimated in RSiena (R Core Team, 2021; Ripley et al., 2021). The implemented SAOM allows only one actor per time to make one tie change (a so-called *ministep*) and it assumes that the decision on tie change is based on how the actor evaluates the current and possible future network structures in its direct vicinity. How these networks (i.e., x) are evaluated is determined by the so-called evaluation function: $f_i^{net}(x) = \Sigma_k \beta_k^{net} s_{ik}^{net}(x)$, and the evaluation depends on network statistics $s_{ik}^{net}(x)$ (e.g., number of reciprocal ties). Each actor evaluates the attractiveness of its own local network environment hence the subscript i. Actor i is most likely to take the ministep that will result in the network with the highest attractiveness value. β_k^{net} then refers to the estimated parameters of the model and these parameters of the evaluation function are what we are interested in, of which the interpretation is similar to that of a logistic regression: $\exp(\beta_k^{net})$ is the ratio of the probabilities to observe network x_a versus x_b, with the only difference between these networks being that $s_{ik}^{net}(x_a) - s_{ik}^{net}(x_b) = 1$.

We started with a preliminary model for the three dependent network-variables in which we included (uniplex) structural network effects (see Ch.12 RSiena manual (Ripley et al., 2021)): (a) the *out-degree effect*: the likelihood to observe a tie; (b) the *reciprocity effect*: the extent to which forming a reciprocated tie is more likely than a non-reciprocated tie; (c) *in-degree popularity* and (d) *out-degree activity* because degree distributions are skewed and MPs who receive/send many ties at time T may also receive/ send many ties at time $T + 1$; (e) the *out-degree popularity* effect: the covariance

between indegrees and out-degrees; (f) the *transitive triplets effect* to test network closure (i.e., 'friends of friends are my friends') and (g) the *shared popularity effect*, whereby MPs are more likely to form a relation to a specific MP when they observe that other MPs with similar relations as oneself also have a relation to this specific MP (cf., Harrigan et al., 2012).

Next (Model 1), we included controls and our main variable to test Hypothesis 1: the dyadic *similarity in MPs' party membership*. Positive values indicate that MPs are more likely to form intra-party ties than inter-party ties (i.e., network segregation along party lines). Model 1 also assesses the relative strength of party-based homophily along the three layers (Hypotheses 3a and 3b).

With Model 2, we assess the extent to which MPs are more likely to form relations with MPs with a similar sex, age, and ethnic-minority background and whether observed social inbreeding homophily explains the impact of similarity in party membership (Hypotheses 2a and 2b), by including *same sex*, absolute *age difference*, and *same visible ethnic minority status*. Any remaining positive effect for similarity in party membership in this model we will interpret as corroborative evidence for party-based homophily preferences, being in part responsible for party-based network segregation.

Model 3 assesses Twitter's digital architecture's impact by adding structural multiplex effects between the follow, the retweet and @-mention layers: *crprod* and *crprodRecip*. The first assesses the likelihood that an MP who 'sends' a relation to another MP in a specific layer at time T will create a connection to this MP in another layer at time $T + 1$ as well. The second captures the likelihood that an MP who 'receives' a connection from another MP in a specific layer at time T will create a connection to this MP in another layer at time $T + 1$. This will show whether segregation in one layer causes segregation in the other layers (Hypotheses 4a, 4b, 4c and 4d).

Finally, to assess the impact of party-based homophily preferences over time, we included an interaction between *period* (with the value '1' for period 2 (June to September) and '0' for period 1 (April to June)) and our dyadic variable *same party* in Model 4.
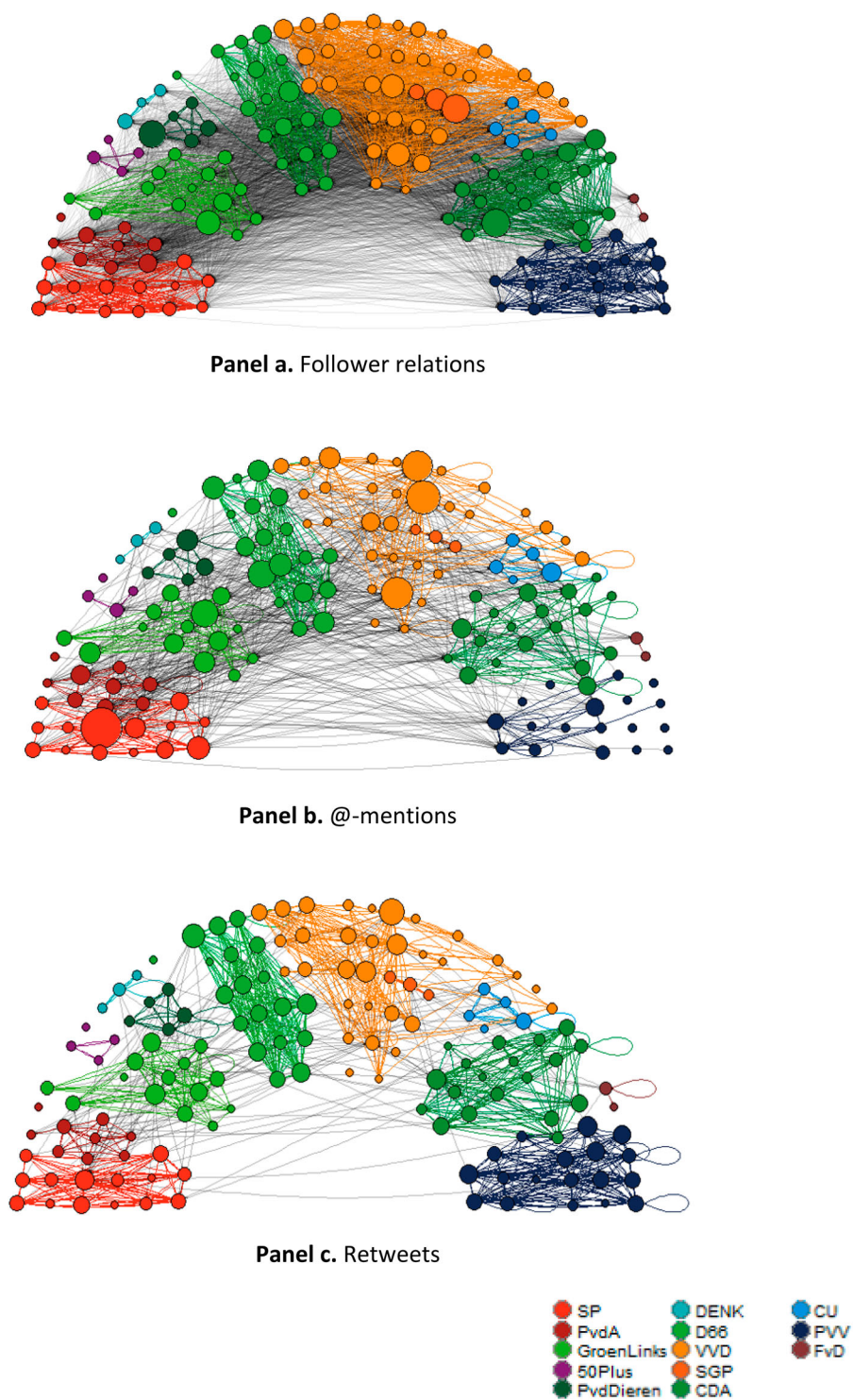
To model the (co-)evolution of the three layers of Twitter, two-waves is the minimal requirement but to assess time heterogeneity in effects (here in the same-party variable) we need at least three waves of data, which is an unique feature of our data. Admittedly, given the Twitter pace, with our three waves approximately 90 days apart, we are still limited in our assessment, and we need to be cautious in extrapolating our findings outside the studied time window.

4. Results

4.1. Observed segregation

The networks that existed in April 2017 are summarized in Figure 1. The node positions reflect the seating positions within Parliament. It becomes apparent immediately that the density is much higher in the follower network than in the @-mention or retweet layer, which is logical given the architecture of the platform: following connections are permanent unless actively broken and we focus on temporal snapshot outside election campaigns (in which activity is much higher). Moreover, the figure shows that it is not necessarily the same MPs who have a relatively high out-degree, as indicated by node

Panel a. Follower relations

Panel b. @-mentions

Panel c. Retweets

● SP	● DENK	● CU
● PvdA	● D66	● PVV
● GroenLinks	● VVD	● FvD
● 50Plus	● SGP	
● PvdDieren	● CDA	

Figure 1. Directed Twitter relations between Dutch MPs (2017).
Notes: Node size based on degree. Edge color based on Party affiliation, black if MPs from different party.

size. Clearly, the three network layers differ from each other, warranting that they are studied separately but interrelatedly.

Turning to political segregation, Figure 1 suggests that, as expected, especially @-mention relations go across party boundaries, while retweet relations predominantly exist between MPs of the same party. This becomes even sharper when only reciprocate ties are included (Supplementary Material B) and when nodes are positioned based on their connections (Fruchterman and Reingold (1991) algorithm), see Figure 2 (and Supplementary Material C).

Party clusters are identifiable in both the follower and retweet layer, as expected for these two layers specifically (Hypothesis 1), but not so much for the @-mentions. Additionally, these figures also show that the position within the generated network aligns largely with the parties' ideologies or actual seating position within parliament. For instance, the left-wing Socialist Party and Party for the Animals are close, as are the Christian CU and CDA and the – rather detached - radical right PVV and far right FvD.
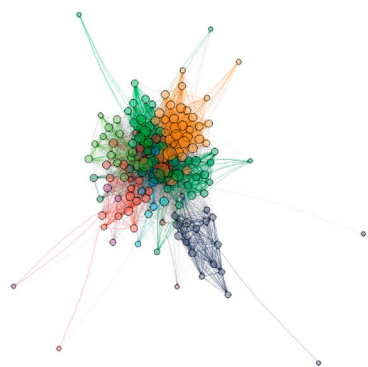
4.2. Segregation indices

Turning to the formal descriptive indices, we observe that MPs connect more within than across political parties: in all three layers and at all three time points, the intra-party densities are higher than the inter-party densities (see Table 1). Similarly, all Newman's Assortativity Coefficients (NACs) are positive (Table 2: row 'party'), but they differ and suggest weak, moderate and strong party-based segregation (Cohen, 1988), respectively within the following, @-mention and retweet layer. While in line with our expectations, this goes against the results of Praet et al. (2021) for the Netherlands. However, they analyzed the members of the Lower *and* Upper house as one network. Based on the NACs, party-based segregation seems thus most pronounced for retweets, which reflects our theoretical reasoning that retweets indicate positive affect most. In contrast to our expectation, party segregation is weakest within the follower layer, not the @-mention layer. Part of this might be that, despite the @-mention layer being geared most to negative affect and debate, still quite a lot of affirmative mentioning takes place.

The replication website (https://jochemtolsma.github.io/Twitter/) also reports results for Coleman's homophily index, also for each party separately. It deserves mention that party-based segregation is not similar across parties. Most notably in the following layer, we find it strongest for the radical right PVV, which may reflect the relatively strong party communication doctrine (Spierings & Jacobs, 2019) and marginalization in parliament (i.e., being categorically excluded from coalition formation).

With respect to the social dimensions, we find that in the following layer at all three time points, intra-group densities are higher than inter-group densities, but differences are small. Moreover, based on the NACs we should conclude that MPs do not preferentially connect with other MPs with same social characteristics; for all three social dimensions, three network layers and three time point, values are close to 0.

With the election campaigns being over and with the new parliament being installed, we see that Twitter activity decreased: total network density in the @-mention and retweet layers decline (Table 1, top row). Crucial to our core questions (and particular research question 1), we also observe that over time relatively more different-party ties

Panel a. Follower relations

Panel b. @-mentions

Panel c. Retweets

SP | DENK | CU
PvdA | D66 | PVV
GroenLinks | VVD | FvD
50Plus | SGP
PvdDieren | CDA
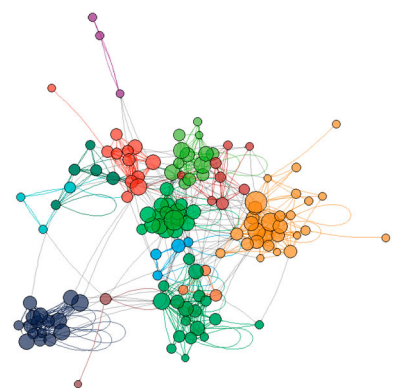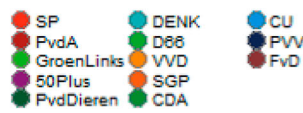
Figure 2. Directed Twitter relations between Dutch MPs (2017).

Notes: Position based on Fruchterman-Reingold algorithm. Node size based on degree. Edge color based on Party affiliation, black if MPs from different party. Isolates removed.

Table 1. Inter- and intra-group densities within the three Twitter layers among Dutch MPs (2017).

	following T1	following T2	following T3	@-mentions T1	@-mentions T2	@-mentions T3	retweets T1	retweets T2	retweets T3
Total	0.25	0.28	0.28	0.05	0.04	0.01	0.05	0.03	0.03
Same party	0.71	0.73	0.74	0.20	0.14	0.06	0.34	0.25	0.25
Different party	0.19	0.22	0.22	0.03	0.02	0.01	0.01	0.01	0.01
Same sex	0.26	0.29	0.29	0.05	0.04	0.01	0.05	0.03	0.03
Different sex	0.24	0.27	0.27	0.04	0.03	0.01	0.05	0.03	0.03
Same age (<6)	0.29	0.31	0.31	0.06	0.04	0.01	0.05	0.04	0.04
Different age (>5)	0.24	0.26	0.26	0.04	0.03	0.01	0.04	0.03	0.03
Same ethnicity	0.27	0.29	0.29	0.05	0.04	0.01	0.05	0.03	0.03
Different ethnicity	0.21	0.24	0.24	0.05	0.03	0.01	0.04	0.03	0.03

Table 2. Newman's assortativity coefficient within the three Twitter layers among Dutch MPs (2017).

	following T1	following T2	following T3	@-mentions T1	@-mentions T2	@-mentions T3	retweets T1	retweets T2	retweets T3
party	0.22	0.20	0.20	0.39	0.39	0.47	0.82	0.83	0.83
sex	0.04	0.03	0.04	0.10	0.04	0.06	0.01	−0.01	0.02
age	0.05	0.04	0.04	0.09	0.02	0.12	0.02	0.01	0.06
ethnicity	0.06	0.05	0.05	0.08	0.02	−0.07	0.09	0.02	0.04

were forged in the following and retweet layer, with same-party over different-party pro-portions (Table 1) decreasing from 3.7 to 3.4 and 34 to 25 between T1 and T3, and for the follower layer we observe a decreasing NAC (Table 2). Conversely, in the @-mention layer both the ratios and the NAC point to more intraparty activity over time; it might be that MPs seek discussion more in campaign mode than during times of coalitions negotiations.

4.3. Network dynamics

Lastly, we consider how different forms of segregation co-evolve in different layers, also after considering structural network effects and covariate effects. Regarding our covariates, before turning to the main outcomes, some results are noteworthy as springboard for future research on understanding institutional conditioning of MPs' behavior in Twitter networks (see Supplementary Material D & E). For instance, MPs with a better ballot position and party leaders follow fewer other MPs, but are @-mentioned and retweeted more, with party leaders also engage significantly less in discussion on Twitter. At the dyad level, we find that the closer MPs sit to one another, the more likely they are to follow and retweet each other, also after control for ideological distance. In short, offline physical and power structures matter in shap-ing online networks and should both be part of an larger framework explaining MP twitter behavior.[2]

4.3.1. Party-based and social homophily

The RSiena models show positive and significant same-party estimates in all three Twit-ter layers (Model 1, Table 3). Thus: accounting for structural network effects, factors impacting MPs' activity and popularity, and the physical distance between MPs in par-liament, we still observe that MPs are most likely to form Twitter relations with their own party's MPs. The odds to follow an MP of the same party versus a different party is approximately 3:1 ($e^{1.088}$), for @-mentions 2.5:1, and for retweets 4:1. These findings underscore our descriptive observations and Hypothesis 1 is corroborated.

As expected, based on the functionalities in the Twitter layers, party-based segregation is clearest in the retweet layer and significantly lower in the @-mention layer in the RSiena models (the difference is .468 with $se = .096$ and t-ratio $t = 4.887$, $p < 0.001$). The follow layers are in between. We consider Hypotheses 3a and 3b corroborated.

Next, Model 2 (Table 3) assesses social inbreeding homophily. Of the nine inbreeding covariates, we only find that MPs are more likely to retweet tweets of MPs of the same sex. Evidently, the sex, age and ethnic background of MPs themselves impact Twitter relations (see Supplementary Material E) but, it is not women MPs retweeting each other disproportionally, or younger MPs following each other disproportionally etcetera. Considering that network homogeneity with respect to age, sex and ethnic-minority background is commonly observed in social networks of ordinary citizens, this is a strik-ing null-finding. We falsify Hypothesis 2a and consequently 2b too.

In sum, results of our multivariate RSiena models clearly demonstrate the presence of party-based segregation in the Twitter layers, and that party-based segregation is not a by-product of social inbreeding homophily but instead party-based homophily prefer-ences are at play.

4.3.2. Interrelated layers

Does party-based segregation in the different Twitter layers co-evolve and mutually influence each other? They do, and in ways that reflect the digital architecture of Twitter, as shown in Model 3 (Table 3).

In line with hypothesis 4a and 4c, MPs are more likely to start @-mentioning and retweeting MPs who they follow or by whom they are followed, and MPs are more likely to start following MPs who they retweeted or were retweeted by, suggesting that interaction feeds into positive affect. We also hypothesized that @-mentions would lead to follow relations, unfortunately this effect could not be estimated due to convergence problems. While we did not formulate expectations on the interrelatedness between @-mentions and retweets, we find that @-mentioning and being @-mentioned by a colleague MP increases the chance to retweet this MP in the future, and that MPs are more likely to @-mention an MP who they retweeted in the past.

Considering these cross-network effects, the 'net party-based segregation effect' is considerably lower, the probability ratio's for following, @-mentions and retweets decreased from Model 2 to Model 3 by approximately 28%, 40% and 25% respectively. Party-based segregation in one Twitter layer is thus partly the result of party-based segregation in the other layers, corroborating Hypothesis 4b and 4c.

4.3.3. Segregation over time

The above suggest that party-based segregation increases over time. Our descriptive findings at the network-level discussed above, only demonstrated increasing segregation

Table 3. Multiplex RSiena model to predict Twitter relations among (147) Dutch MPs in 2017: summary of main results from Models 1, 2, 3 and 4.

	b	se	b	se	b	se
	following		@-mentions		retweets	
			Model 1			
same party	1.083	0.146	0.918	0.054	1.386	0.078
			Model 2			
same party	1.090	0.154	0.921	0.057	1.388	0.083
same sex	0.129	0.080	0.054	0.044	0.127	0.050
(absolute) age difference	0.035	0.006	0.000	0.003	0.001	0.003
same visible ethnic minority status	−0.389	0.138	0.074	0.052	0.115	0.081
			Model 3			
same party	0.755	0.189	0.406	0.106	1.106	0.093
same sex	0.130	0.087			0.115	0.056
(absolute) age difference	0.034	0.007				
same visible ethnic minority status	−0.410	0.145			0.134	0.094
retweets	1.718	0.536	0.454	0.212		
reciprocity with retweets	0.677	0.483	0.245	0.181		
following			0.400	0.072	0.647	0.092
reciprocity with following			0.158	0.066	0.251	0.076
@-mentions					0.801	0.228
reciprocity with @-mentions					0.988	0.231
			Model 4			
same party	1.215	0.157	0.804	0.060	1.386	0.079
period*same party	0.957	0.278	−0.448	0.099	0.265	0.056

Notes: The full results of Model 2 are summarized in Supplementary Material E, including a discussion of the effects of control variables. The full results of all models can be accessed via our replication website (https://jochemtolsma.github.io/Twitter/).

within the @-mention layer and, conversely, decreasing segregation within the follow and retweet layer.

In Model 4 (Table 3), we formally tested the extent to which party-based homophily decreased (or increases) over time. Surprisingly, this was only the case within the @-mention layer. It might be that just after the elections (i.e., period 1) MPs relaxed a bit from campaign mode and retweet MPs of other parties more and that they started forging between-party follow ties amongst others as a result of offline contact. However, towards government formation and politics as normal (i.e., period 2) the focus moved towards within-party preferences. This also aligns with the shift for @-mentions, as cross-party debates seem to become more important in period 2. However, more research is needed in the longitudinal trends of segregation in Twitter networks, thus also considering the context of the political election cycles. For now, we conclude that changes in party-based homophily preferences do not explain the trends in segregation patterns at the network-level.

5. Conclusion

We brought together the online-network literature (e.g., Boutyline & Willer, 2017; Hofstra et al., 2017; Lin & Lundquist, 2013) with that on the political consequences of social media's digital architecture (Bossetta, 2018; Jacobs & Spierings, 2016), in studying online party-based segregation among MPs, particularly the network of Dutch MPs in three Twitter layers – following, retweeting, @-mentioning. Using RSiena to estimate models for network evolution, novel to this literature, we are the first to study the different layers of Twitter *interrelatedly* and *dynamically*. Doing so, we help understanding party-based segregation among MPs on Twitter as the result of the political rules of the game and the architecture of the platform, while we show that social inbreeding homophily – an important driver of social segregation in the offline world – hardly plays a role.

Complementing previous studies (e.g., Del Valle & Bravo, 2018; Del Valle et al., 2022; Hsu & Park, 2012), we show that among MPs intra-party ties are substantially more common than inter-party ties, and this holds true for followers, retweets and @-mentions, even in the Dutch context of a multiparty system with a large number of small parties in Parliament, which in light of the larger comparative and country-studies literature (e.g., Del Valle & Bravo, 2018; Hsu & Park, 2012; Praet et al., 2021; Vliet et al., 2021) presents a most-likely case to find inter-party ties.

More in-depth, results reflect Twitter's architecture and the nature of politics. The party-based segregation is strongest for retweets, then for follower ties and finally for @-mentions, aligning with the theorization that (direct) retweets mainly function as political endorsements, follows signal importance (regardless of ideological alignment), and @-mentions are the main way to stress difference via micro discussions. Moreover, segregation decreases in the period between campaign and government formation for the positive affect layers (follows, retweets) and increases for @-mentions. In other words, political dynamics are crucial and more so than socio-demographic (age, gender, ethnicity) in-group preferences. Several decades ago, (informal) female and ethnic-minority networks were a tool for MPs from marginalized groups to empower themselves, but such cross-party solidarity seems to have waned, or at least Twitter is not the equalizing medium some expected it to be. However, our finding concerning party-based

segregation should not be interpreted as Twitter not offering a deliberative space for a rational-critical debate and coalition building, as there is still substantial inter-party interaction. At the same time, the absence of social homophily indicates that it are not particularly marginalized groups who utilize Twitter for such inter-party coalition building (cf. Jacobs & Spierings, 2016; Del Valle et al., 2020).

As social segregation is not very pronounced among MPs and hence party-based segregation is not simply the by-product of social inbreeding preferences, this underlines that MPs may have different motivations and incentives to use Twitter strategically. This may depend, for example, on the party to which they belong, their role within the party and on their position on the election list. However, it would be too quick to conclude that the parliamentary context drives the evolution of MPs' Twitter networks and that we therefore did not observe social homophily preferences. If this would be the case, we should not have observed clear structural network effects, nor socio-demographic and proximity effects. In brief, offline parliamentary factors, like regulations, physical proximity and power positions deserve a position in theoretical models on MPs Twitter behavior, next to Twitter architecture, political segregation and campaigning logics, which where our focus.

Our novel focus and theorization on the interrelatedness of the Twitter layers and how they form segregation patterns paid off (cf. Praet et al., 2021): follow relations stimulate the other interactions and retweets lead to follow relations. Crucially, the observed party-based segregation in each of the Twitter layer is partly the result of the segregation in the other layers and their interrelatedness: party-based segregation is reproduced by the Twitter architecture, although in the end it is of course the MPs who to decide who to engage with.

As such this study contributes to understanding the multitude of processes that expedite as well as counteract polarization simultaneously. To further that understanding, future work could also apply our approach and modeling strategy to the ideological position of individual MPs even on the different axis of the political space (i.e., economic left-right, cosmopolitan-nativist and moral progressive-conservative), also within their party, which was beyond the scope of our data and study. Doing so, might also shed lighter on the fascinating results we found for the seating position covariate. While not the focus of our contribution, we took into account the physical proximity within parliament (see Supplementary Material E). We demonstrated that the larger the geographical distance between the seats assigned to MPs are, the less likely MPs are to connect on Twitter, even after controlling for many factors including party membership (and party ideology in additional models). A more detailed investigation for instance including ideological distance between MPs based on roll-call voting or MP surveys or with information on shared committee membership, might lead to a more definitive conclusion of this very direct translation of offline contact in parliament to online interaction. Moreover, the party-based interaction within and between the networks of different representative bodies might shed lighter on this offline-online interaction. For instance, Praet et al. (2021) did include both members of the lower and upper house for the Dutch case – which might account for them finding more inter-party interactions. More generally, including politicians from other government bodies (municipal or regional councils) or former politicians might help answer new questions, such as whether intra-ethnic ties are forged more easily if no direct competition exists.

Lastly, we added longitudinal analyses, observing that network segregation decreased in the following layer and increased in the @-mention layer. Paradoxically, focusing on network dynamics, the preferences to form intra-party ties became more important in the following and retweet layer, but less important in the @-mention layer in our observation window. In line with Praet et al. (2021), we stress the importance of the context in understanding political dynamics on social media, as clearly, we observed time heterogeneity in the impact of party-based homophily.

The above also brings us to one of the main limitations of this study. While introducing unique longitudinal analyses to the MPs' Twitter network literature, our time frame was restricted and the theorizing on longitudinal developments is still limited. For understanding longitudinal dynamics, the moment in the political cycle focused on seems to matter for the development of the Twitter network (layers). Observing networks at more time points over a longer time period (the complete election cycle or multiple cycles) would be a valuable next step, whereby our results can also contribute to more in-depth grounded theory and a true longitudinal perspective.

In terms of scope, we have expanded the existing literature, but still, one could further unpack the Twitter network layers by including quoted retweets or by distinguishing between replies and active @-mentions. The patterns we found were in line with the logic behind the Twitter architecture, but further disentanglement might feed into more detailed new theorization, for instance on the (expectedly ambiguous) meaning of quoted retweets.

For now, by-and-large we illustrate clear party-based segregation across networks in a least-likely setting. While structural network effects and offline meeting opportunities (i.e., seating position in parliament) are clear determinants for relations on Twitter they do not explain away the segregation along party membership lines among MPs. Similarly, political segregation on Twitter among Dutch MPs is not a by-product of social inbreeding homophily. Instead, it aligns very much with the Twitter architecture and political communication logic, whereby segregation in different Twitter layers reinforces each other.

Notes

1. We define segregation as a network-level phenomenon whereby in-group relations are relatively frequent and out-group relations are relatively scarce (cf. Bojanowski & Corten, 2014). In such networks, relations between similar dyads are more likely than between dissimilar dyads. Closely related is 'network homogeneity': that connected individuals are more similar to one another than un-connected individuals. In the literature, the labels segregation, homogeneity and homophily are oftentimes used interchangeably.
2. The impact of control variables is discussed in more detail in Supplementary Material E. An anonymous reviewer suggested to additionally control for whether an MP was the last candidate on the election list of the party to be elected as MP which might influence their behavior, also in terms of forming cross-party ties. In additional analysis, we did not find that party-based homophily preferences were different for MPs who were 'last on the election list' (see replication website https://jochemtolsma.github.io/Twitter/).

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

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Jochem Tolsma is a professor by special appointment of Social Divisions between Groups in the Department of Sociology at the University of Groningen and associate professor in the Sociology Department of Radboud University Nijmegen. In his research, he focuses on social divisions between groups, the interplay of segregation, inequality and polarization. The data he employs range from big and thin to small and thick and combinations thereof. He promotes access to scientific knowledge and makes sure his work can be reproduced and replicated.

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