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ORIGINAL ARTICLE

Workplace gossip and the evolution of friendship relations: the role of complex contagion

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Abstract

Gossip is a pervasive phenomenon in organizations causing many individuals to have second-hand information about their colleagues. However, whether it is used to inform friendship choices (i.e., friendship creation, friendship maintenance, friendship discontinuation) is not that evident. This paper articulates and empirically tests a complex contagion model to explain how gossip, through its reputational effects, can affect the evolution of friendship ties. We argue that hearing gossip from more than a single sender (and about several targets) impacts receivers' friendships with the gossip targets. Hypotheses are tested in a two-wave sociometric panel study among 148 employees in a Dutch childcare organization. Stochastic actor-oriented models reveal positive gossip favors receiver-target friendships, whereas negative gossip inhibits them. We also find evidence supporting that, for damaging relationships, negative gossip needs to originate in more than a single sender. Positive gossip about a high number of targets discourages friendships with colleagues in general, while negative gossip about many targets produces diverging trends. Overall, the study demonstrates that second-hand information influences the evolution of expressive relations. It also underscores the need to refine and extend current theorizing concerning the multiple (and potentially competing) psychological mechanisms causing some of the observed effects.

Keywords Workplace gossip · Friendship · Organizational networks · Complex contagion · Social network analysis · Network evolution

1 Introduction

Gossip—talking about others in their absence—is pervasive in casual conversation. Previous studies claim that humans devote around two-thirds of their speaking time to sharing evaluative information about others' deeds and traits (Dunbar et al. 1997; Emler 1994), and organization studies report that up to 90% of employees engage in it (Grosser et al. 2012). Meanwhile, the relevance of workplace gossip to the functioning of organizations and their members has been amply documented (Beersma and Kleef 2012; Beersma, Kleef, and Dijkstra 2019; Michelson et al. 2010; Mills 2010; Sun et al. 2022). Despite its negative connotation and much research addressing its dysfunctional aspects (Danzinger 1988; Duffy et al. 2002; Liu et al. 2020; Martinescu et al. 2021; Ribeiro and Blakeley 1995; Robinson and Bennett 1995), gossip also has multiple positive outcomes for individuals and groups (Brady et al. 2017; Giardini and Wittek 2019a; Kniffin and Wilson 2005, 2010; Noon and Delbridge 1993).

At the individual level, gossip can enhance the sender's status (Erdogan et al. 2015; Kurland and Pelled 2000; McAndrew et al. 2007) or facilitate negative emotion venting (Dores Cruz et al. 2019; Waddington 2005). If the information is valid, the receivers can also benefit because it enables them to learn from others' experiences (Bai et al. 2020;

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Kuo et al. 2018; Martinescu et al. 2014), which helps career advancement in turn (Cooper and Kurland 2002). Those who engage together in gossip often experience increased feelings of closeness and trust (Bosson et al. 2006; Ellwardt et al. 2012; Peters et al. 2017; Weaver and Bosson 2011), which facilitate cooperation and deter selfishness (Feinberg et al. 2012, 2014). At a macrolevel, gossip allows the spread of important information (Eder and Enke 1991; Granovetter 1973), offering alternative routes to the formal organization. Notwithstanding all this, theory and evidence on how information exchanged in gossip impact interpersonal relationships are scarcer and more fragmented (Baum et al. 2020; Costello and Srivastava 2021; Shinohara et al. 2021; Smith and Collins 2009). This holds in particular for its interplay with expressive relationship ties like *friendship* or trust (Gambetta 1994; Giardini and Wittek 2019b, 2019a).

Like in most settings, social networks in organizations are dynamic. New friendships form between previously unconnected individuals, while pre-existing links can demote, and some of them are lost (Chen et al. 2022; Doreian and Stokman 1997; Salancik 1995). The mechanisms facilitating *tie-creation* are well-established and include: friendship reciprocation, closeness, preferential attachment, shared social focus, and some form of assortative mixing (Block 2018; Feld 1981; Lazarsfeld and Merton 1954; McPherson et al. 2001; Merton 1973; Newcomb 1956; Rivera et al. 2010). Some individuals may intentionally treat their expressive connections instrumentally and form amities to help with specific problems (Desmond 2012). Rivalries and interpersonal conflict can account for some *tie-loss* (Kilduff et al. 2016). The absence of meeting opportunities, network embeddedness, or similarity in specific dimensions is also responsible for this phenomenon (Mollenhorst et al. 2014; Small, Deeds Pamphile, and McMahan 2015; Tulin et al. 2021). Maintaining connections demands time, but there is an upper bound on the amount of time a person can afford to devote to social interactions (Dunbar et al. 2009; Sutcliffe et al. 2012). It explains why some relationships decay over time (Roy et al. 2022).

In organizations, other colleagues can play a role in forming and maintaining friendship ties. Attitudes toward workmates can be subject to social influence and imitation processes (Friedkin and Johnsen 1990; Harrison and Carroll 1991; Hedström 1998; Marsden and Friedkin 1993; Moskowitz 2005). Besides, some individuals actively engage in changing others' relationships (Halevy et al. 2019). Still, most measures capturing third-party influence are structural and indirect (Barrera and Bunt 2009; Burt 2001; Burt and Knez 1995; Dahlander and McFarland 2013), like the presence of mutual connections. As a result, there is still little knowledge of how expressive ties form, persist or disappear because of second-hand information.

Following previous research on reputation effects (Milinski 2016; Molleman, van den Broek, and Egas 2013; Sommerfeld et al. 2007; Sommerfeld et al. 2008; Stiff and Van Vugt 2008), we propose that positive gossip favors friendship creation and maintenance, whereas negative gossip discourages friendship formation and fosters discontinuation.[1] Our key contribution, however, is in articulating and empirically testing a *complex contagion* model (Centola 2018; Centola and Macy 2007) to explain the effect of gossip on the evolution of friendship ties. Since gossip tends to carry false or distorted bits of information (Giardini et al. 2022), we argue that receiving similar information from *multiple senders* (compared to a single one) is crucial for activating reputation effects on friendship choices. Also, we propose that reputational information about a specific person cannot be understood in isolation from similar information concerning other individuals. Specifically, we argue that hearing gossip about *multiple targets* can impact one's friendship networks directly by fostering (in case of positive gossip) or inhibiting (in case of negative gossip) a general inclination to form new or maintain existing ties. And indirectly, by moderating the gossip-friendship link in specific receiver-target dyads. Namely, the more the receiver is exposed to similar gossip about other targets, the weaker the potential impact of gossip on each specific tie (what we refer to as a "decaying-information-value" effect). For gossip to be most impactful, it must be targeted. Otherwise, it becomes increasingly useless to detecting reputational differences.

Hypotheses are tested with data from two consecutive waves of a sociometric panel study among 148 employees of three units in a Dutch childcare organization. Stochastic actor-oriented models (SAOMs; Snijders 2017; Snijders, van de Bunt, and Steglich 2010) are employed to measure the association between the gossip exchanged in wave one and the evolution of the friendship networks between waves one and two. Results reveal positive gossip favors the creation and maintenance of receiver-target friendships, whereas negative gossip inhibits them. We also find evidence supporting that, for damaging relationships, negative gossip needs to originate in more than a single sender. Positive gossip about a high number of targets seems to discourage friendships with colleagues in general, while negative gossip about many targets produces diverging trends across the units investigated. No evidence is found for either a

[1] Note that "gossip" here can refer to the communication of positive or negative content about the object or target (Brady, Brown, and Liang 2017; Dores Cruz et al. 2021; Spoelma and Hetrick 2021; Sun, Schilpzand, and Liu 2022).

decaying-information-value effect or asymmetries in the impact of negative vs. positive forms of gossip.

Our study enriches current scholarship in at least three ways. First, it bridges the gap between the literature on gossip and reputation and network dynamics with mechanisms of the literature on behavior change. Specifically, it extends current gossip theorizing, which is rooted in a simple contagion model by complex contagion mechanisms (Centola 2018; Centola and Macy 2007). These allow for incorporating mechanisms that up until now have been largely neglected, including tipping points when similar information is endorsed by a second sender (Lamberson and Page 2012), negativity biases in case of incongruence (Rozin and Royzman 2001), and decaying information value in case of gossip overload. Second, by finding evidence of reputation affecting receiver-target friendships, our study demonstrates that gossip is not only the product of pre-existing relationships (Burt 2001; Estévez et al. 2022; Giardini and Wittek 2019b; Wittek and Wielers 1998). Instead, it suggests that social networks and communications may be affecting each other, so the need to address the two phenomena and their intricacies. Last but not least, our results encourage the need for refining and extending current theorizing. Specifically, the discrepancies detected across units raise questions concerning the degree to which the impact of gossip may be mediated by features of the organizational environment (McFarland et al. 2014).

2 Theory

2.1 Friendship dynamics and workplace gossip

Humans are inherently social beings, and they tend to form relationships of amity and trust with other humans. Organization scholars often refer to these as 'primary' or 'expressive' ties (Lincoln and Miller 1979; Umphress et al. 2003), and their study dates back to at least the Hawthorne experiments (Roethlisberger and Dickson 1934). Numerous studies have shown how the structure of intra-organizational friendships can substantially impact various organizational processes like conflict resolution, job involvement, or team cohesion (Balkundi and Harrison 2006; Blau 1963; Homans 1951; Kapferer 1972; Kilduff and Brass 2010; Thurman 1979). Friendships, however, are seldom static. After several decades of scholarship on the topic (Chen et al. 2022; Doreian and Stokman 1997; Salancik 1995), there is already a sizeable body of knowledge about the mechanisms behind the creation and transformation of friendship networks.

Among the major determinants of friendship network evolution, there are structural patterns. One is 'reciprocity' or the tendency to befriend those who see us as their friends (Newcomb 1956). Another is 'triadic closure' or the inclination to create (or maintain) ties with our friends' friends (Cartwright and Harary 1956; Simmel 1950). 'Preferential attachment' refers to the tendency of an individual with already many ties to accrue even more (Barabási and Albert 1999; Merton 1973). Assortative processes like 'homophily'—the tendency to create or maintain relations with those who are akin in one or several traits (Lazarsfeld and Merton 1954; McPherson et al. 2001; Tulin et al. 2021)—are ubiquitous along multiple dimensions (e.g., gender, ethnicity, educational level, political partisanship). Physical proximity and shared 'social focus' (Feld 1981; Kossinets and Watts 2006) enables acquaintanceship and mutual exposure. Also, they provide meeting opportunities to prevent ties from wearing out (Mollenhorst et al. 2014). Although some of these mechanisms underscore the importance of third parties, the emphasis still lies on direct experience within the dyad. For example, while transitive closure (the tendency to create friendship ties with friends of friends) can partly account for the effect of information exchanges (Burt and Knez 1995), this is considered less important compared to other reasons, like a higher chance of convening (Feld 1997).

Attitudes toward others (both friends and non-friends) are often subject to social influence (Friedkin and Johnsen 1990; Harrison and Carroll 1991; Marsden and Friedkin 1993; Moskowitz 2005). Thus, information obtained from others is also likely to influence the dynamics of informal networks in organizations. Earlier findings in experimental studies indeed show that information gathered during casual conversations, even if uncertain, impacts our impression of others (Baum et al. 2020; Costello and Srivastava 2021; Shinohara et al. 2021; Smith and Collins 2009), with positive gossip attracting more prosocial behavior (Feinberg et al. 2014; Molleman et al. 2013; Sommerfeld et al. 2007, 2008; Stiff and Van Vugt 2008), enhancing likeability and esteem, and negative reputations triggering suspicion (Molleman et al. 2013), aversion (Stiff and Van Vugt 2008), or expulsion from the group (Feinberg et al. 2014). One can expect that receiving positive gossip about a third party with whom one did not have much personal contact may favor the emergence of an expressive relationship. Conversely, negative impressions about this colleague will likely temper the inclination to intensify the contact (Baum et al. 2020; Costello and Srivastava 2021; Jaworski and Coupland 2005), preventing the formation of a tie.

Similarly, gossip may influence how a receiver deals with an existing relationship. According to some experimental studies, this may go as far as individuals attaching more value to second-hand information than to their direct experiences from previous interactions with someone (Molleman et al. 2013; Sommerfeld et al. 2007). Due to selective disclosure of information (Behfar et al. 2019; Cowan 2014; Cowan and Baldassarri 2018), one cannot expect that most

people will usually hear negative gossip about their friends. Still, there are circumstances in which this norm of silence is broken, for instance, because of the solidarity norm governing friendship (Lindenberg et al. 2006): If one discovers that a friend is being hurt, one might decide to tell on at a certain point. Positive gossip can have an amplifying effect on existing relationships (Burt and Knez 1995), increasing the likelihood of friendship retention. In contrast, relationships not supported by positive exchanges with third parties seem more inclined to wear out and, eventually, be discontinued (Dahlander and McFarland 2013).

Based on the above, we argue that positive gossip is likely to favor the creation of new friendship ties and prevent the dissolution of existing ones. Negative gossip will discourage the creation of new friendships and contribute to the weakening and dissolution of existing ones:

> *Single Sender Effect* (H1): An employee who hears positive gossip about a colleague is more likely to create or maintain a friendship relationship with this colleague (H1a). An employee who hears negative gossip about a colleague is less likely to create or maintain a friendship relationship with this colleague (H1b).

2.2 The complex contagion of friendships through gossip

Whereas changing ties often involves costs and risks (e.g., time and emotional investment in the case of friendship creation, a loss of social support in the case of friendship dissolution), gossip is relatively cheap behavior for its sender (Giardini and Wittek 2019b). Unsurprisingly, false and distorted bits of information often circulate with honest signals (Giardini et al. 2022). Because of its inherent uncertainty, individuals have developed psychological adaptations to prevent their decisions from relying on false or dishonest information (Hess and Hagen 2006). Cone and colleagues (2019) argued that, in gossip, the believability of evidence matters, which is often closely intertwined with how reliable the receiver perceives the sender or gossip source. Sommerfeld et al. (2008) suggested that an abundance of gossip statements can palliate the uncertainty inherent in gossip. Hess and Hagen (2006) found that *reinforcement* from multiple sources (and the independence of these sources) increases the perceived veracity of second-hand information, hinting that the number of gossip senders instead of the number of statements is the critical dimension.

Though closely related to the argument posited by Hess and Hagen (2006), here we propose that gossip from multiple vs. one single sender can be substantially different in informing friendship choices. Our argument is inspired by *complex contagion* (Centola 2018; Centola and Macy 2007), a theory maintaining the existence of *thresholds* for behavior adoption or shift. This theory asserts that, for meaningful behaviors, change does not occur below a certain threshold (e.g., unless a specific number of contacts have adopted the new behavior), which causes discontinuities in adoption (e.g., who starts using a brand-new technology at a certain point in time). For gossip, one vs. more than one sender is not a fortuitous tipping point (Lamberson and Page 2012). If we adopt the receiver's point of view, a unique sender of gossip always throws themselves under the spotlight. They risk being seen as mean-spirited or having some concealed intention (Gambetta 1994), especially when the information does not match the receivers's expectations or previous opinion of the target. It will cause their image (not that of the target) to be reframed (Caivano et al. 2020; Farley 2011; Farley et al. 2010; Gawronski and Walther 2008), while the information concerning the target is left aside.

Conversely, when similar gossip emanates from two (or more) sources, it shifts the focus from the sender's motives to the information itself and, therefore, to the target. Subsequent senders might further confirm the information received. Still, additional sources are most likely characterized by decreasing marginal contributions for the effect of gossip on the receiver's decision to befriend or not the target. Figure 1 visually depicts our theoretical threshold model and compares it with a model where the effect of gossip is driven by mere reinforcement. As the reader observes, the second (not the third or fourth) sender causes the attention to shift to the target and has the triggering power. An analogous mechanism is hardwired in some legal systems where the testimony of more than one witness is required as proof of guilt (Given 1997) to prevent conviction based on false denunciation.

In summary, it might be the case that gossip does impact one's friendship choices but only when similar information originates in more than a single sender. Our second set of hypotheses thus captures this qualitative difference between hearing gossip from one vs. more than one sender:

> *Multiple Sender Congruence Effect* (H2): An employee who hears positive gossip about a colleague from multiple senders is more likely to create or maintain a friendship relationship with this colleague (H2a). An employee who hears negative gossip about a colleague from multiple senders is less likely to create or maintain a friendship relationship with this colleague (H2b).

There might be situations when receivers are exposed to multiple senders communicating contrasting instead of congruent views of the same target, with some sharing positive and others sharing negative evaluations. It can occur, for example, because the receiver occupies a bridging position between groups of friends (Burt 1992; Tasselli and Kilduff 2017). In situations of incongruence, receivers are likely

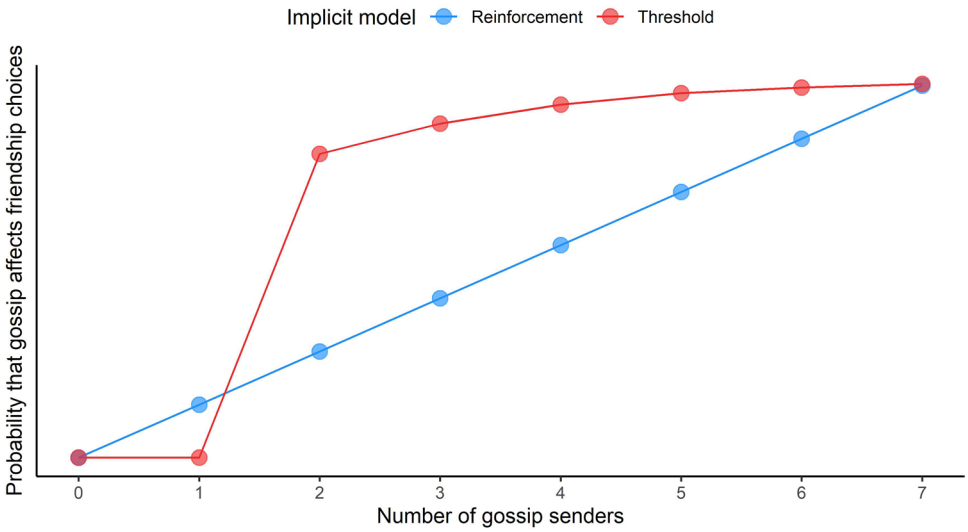


Fig. 1 Theoretical models capturing how gossip affects friendship choices

to search for extra clues about the credibility and motives of the gossip senders (Gambetta 1994) and the veracity of the information (Cone et al. 2019). But in the absence of such additional information, we argue that incongruence is likely to trigger the *negative-is-stronger-than-positive principle* (Rozin and Royzman 2001; Taylor 1991). Previous research has repeatedly demonstrated that people exhibit a systematic bias in the perception of negative stimuli so that negative emotions, events, and relationships tend to be more impactful, stable, and long-lasting than their positive counterparts (Davis and McLeod 2003; Offer 2021; Pratto and John 1991; Rozin and Royzman 2001; Taylor 1991). One possible consequence of this asymmetry is that incongruent forms of gossip harm the receiver-target relation, everything else held constant. If this was the case, the effect of incongruent gossip on friendship dynamics should resemble that of negative gossip (namely, discouraging friendship creation and favoring dissolution) rather than that of positive gossip (fostering both creation and maintenance):

> *Multiple Sender Incongruence Effect* (H3): An employee who hears both positive and negative gossip about a colleague from multiple senders is less likely to create or maintain a friendship relationship with this colleague.

Just like multiple senders can affect the effectiveness of gossip, hearing gossip about many colleagues can affect friendship dynamics, both directly and indirectly. First, it can have *direct* repercussions on a receiver's friendship choices because a high prevalence of positive (or negative) gossip may signal the salience of a specific social climate in the group (Beersma and Kleef 2011; Tan et al. 2021). Previous research has shown that features of the organizational environment tend to moderate the expression of tie-formation processes (McFarland et al. 2014). Different environments come with expectations concerning the risks and rewards associated with engaging in particular social relationships. A workplace where positive gossiping prevails, for example, reflects a climate of friendship and interpersonal trust. Such cultures of positive gossip, in which an employee hears good things about a large proportion of group members, signal that befriending others will be rewarded, thereby raising the general inclination to build friendly relations within the group. Conversely, workplaces characterized by constant backbiting about a large part of the group reflect a culture of negative gossip. Such cultures will likely signal the prevalence of strained personal relations, hostility, and conflict. They are likely to dissuade their members from investing in the creation and maintenance of relationships because building ties to some group members may trigger criticism or disdain, and come with the risk of negative consequences for relations with other group members.

Based on the above, we argue that receivers of positive gossip about many colleagues will be more inclined to create and maintain friendly relations with other colleagues in general. In contrast, those who receive negative gossip about many colleagues will be less likely to form new ties and maintain those they already have:

> *Direct Multiple Target Effect* (H4): The more colleagues an employee hears positive gossip about, the more likely it is that this employee creates or maintains friendship relations with others (H4a). The more colleagues an employee hears negative gossip about, the less likely it is that this employee creates or maintains friendship relations with others (H4b).[2]

[2] Note that, whereas H1, H2, and H3 capture the effect of gossip on relations to specific others (multiplex reciprocity), H4 captures the effect on generalized others (i.e., out-degree).

Finally, being aware that, in one's group, multiple colleagues are the targets of gossip can *indirectly* affect friendship dynamics by moderating the gossip-friendship link in specific receiver-target dyads. The reason is that if gossip is perceived as overused, it becomes increasingly less useful as a source to detect reputational differences between group members. For example, its information value for assessing the reputation of specific others declines. Imagine a workplace where everybody keeps praising everybody else. Although such a climate may favor the formation of friendships with others in general (see H4a), the discriminative value of each piece of positive gossip becomes smaller: 'target *x* might be a good choice, but so is target *y*, target *z*, and so on.' The point is that, for second-hand information to be most impactful on behavior, it must be scarce and directly beneficial (Samu et al. 2020). Otherwise, receivers will discount the value of gossip for informing their friendship choices toward specific others. Put differently: gossip effects will weaken to the degree that the receiver hears the same type of gossip about multiple other targets.

Based on this *decaying-information-value* effect, we hypothesize that the interaction between hearing positive gossip about a specific target and the number of targets one heard positive gossip about will have a negative impact on friendship dynamics. Likewise, the interaction between hearing negative gossip about a specific target and the number of targets one heard negative gossip about will have a positive on friendship dynamics:

> *Indirect Multiple Target Effect* (H5). Hearing positive gossip about many colleagues will temper the inclination of receivers to befriend a colleague about whom they received positive gossip (H5a). Hearing negative gossip about many colleagues will temper the inclination of receivers not to befriend a colleague about whom they received negative gossip (H5b).

Table 6 summarizes all hypotheses formulated above.

3 Data, method, and measures

3.1 Data

Data come from a sociometric panel dataset of the relationships between 148 employees in three units of a Dutch childcare organization. The dataset spans three years and contains six waves. Our analyses, however, are restricted to the first two waves (March 2008 and September–October 2008), when complete gossip data (sender, receiver, target, and valence) are collected.

The organization is a major independent, subsidized, regional child protection institution. The three units (hereafter units A, B, and C) are medium-sized daycare units focusing on children with special needs. Professions comprised behavioral scientists, medical doctors, (physio) therapists, pediatricians, social workers, and administrative and household staff. All units are formally subdivided into work teams, each team responsible for a group of children. Hierarchies are flat, with only one line manager directly supervising all employees. The units consist primarily of young women working on a part-time regimen (for a detailed description of the sample, see Table 7 in Appendix). Due to employee turnover and enrolment, the size of each unit varies between waves one and two (see Table 8). Of those who stay in both waves, response rates are 66.7% (20/30) in Unit A, 56.5% (26/46) in Unit B, and 78.8% (26/33) in Unit C. No association was found between turnover and neither friendship nor gossip. Figure S1 in the Supplementary Material shows that employees who left the organization had a similar number of incoming friendships to their colleagues. Similarly, they were not more (or less) often the targets of their colleagues' positive or negative talk.

The data were collected using self-administered computer-based questionnaires, interviews, and secondary data. We gathered information covering individual attributes, employment data, the formal team structure of each unit, relational data, and gossip between employees (a complete list with all the information available in the dataset can be found in Table S1 in the Supplementary Material). Rosters of names (Hlebec 1993) were used to collect sociometric information and gossip (cued recall; Marsden 1990) to reduce biases due to memory effects.

3.2 Measures

3.2.1 Friendship

Friendships were self-reported. Within each unit, we asked respondents to describe the quality of their social relationships with every other member of the unit on a five-point Likert scale: (1) "very difficult," (2) "difficult," (3) "neutral," (4) "friendly," and (5) "good friend." Values were dichotomized, with relationships described as "friendly" or "good friend" coded as the presence of a friendship relation "1," and the remaining categories coded as "0," representing their absence (Ellwardt, Labianca, and Wittek 2012; Ellwardt et al. 2012; Labun et al. 2016; Pauksztat et al. 2011). If a respondent reported not knowing someone else, the response was treated as the absence of a friendship tie and coded as "0." A directed, binary adjacency matrix (X_{ij}) for each wave and unit was retrieved. In these matrices, "1" stands for the presence of a friendship nomination from *i* to *j*, and "0" for the absence of it.

Due to issues with the estimation of results, we had to correct the nominations of a few respondents who

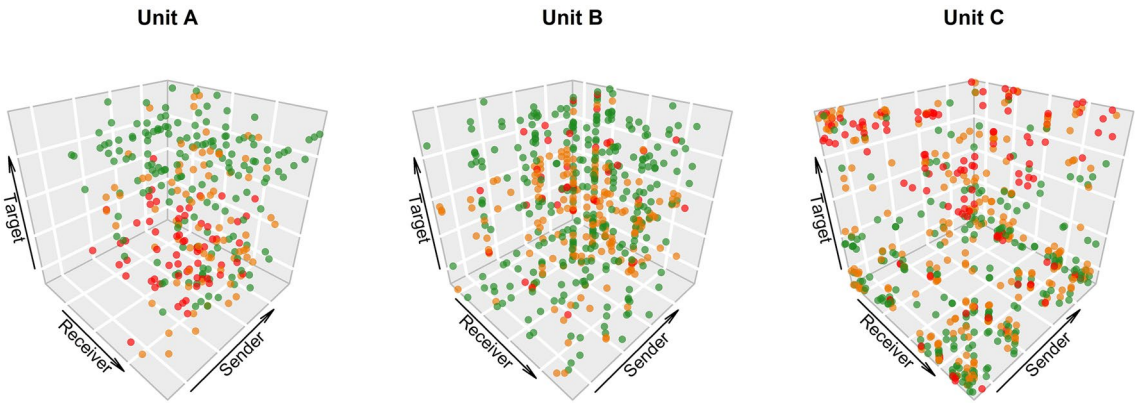


Fig. 2 Gossip triplets colored by the tone of information: Positive gossip in green, negative gossip in red, and mixed gossip in orange

reported (almost) everybody else in their unit as 'friends.' For respondents with over 20 nominations using the criterion above, we only considered as "friendships" those ties initially qualified as "good friends" (5). This operation accounts for the fact that some individuals interpret network items slightly differently than others. Instead of discarding their information entirely—for example, by coding their outdegree as missing (Light et al. 2013; Rijsewijk et al. 2020)—we assumed that, compared to the rest of their colleagues, they might have used the term "friendly" with more liberty.[3]

Data from wave 3 (t_3) were used for inputting friendships missing in wave 2 ($x_{ij,t_2} = NA$). The procedure was as follows. First, for an individual (i) who was already part of the organization in wave 1, we imputed the value reported in wave 3 only if this coincides with the answer given in wave 1. It means that if person i nominated person j as a friend in both wave 1 and wave 3 ($x_{ij,t_1} = x_{ij,t_3} = 1$), we considered the tie also existed in wave 2 ($x_{ij,t_2} = 1$). Likewise, if i did not nominate j as a friend in neither wave 1 nor wave 3 ($x_{ij,t_1} = x_{ij,t_3} = 0$), we assumed that a friendship did not exist in wave 2 either ($x_{ij,t_2} = 0$). For those who were not part still of the organization in wave 1, we simply inputted the values reported in wave 3 ($x_{ij,t_3} \rightarrow x_{ij,t_2}$). As a result of this procedure, we added 16 ties and 157 zeroes (absence of a tie) in Unit A; 11 ties and 208 zeroes in Unit B; and six ties and 72 zeroes in Unit C.

[3] Without correction, SAOMs in Unit A present divergence, producing no results. Models in Unit B and C can be converged but with a very high rate parameter (above 45). This entails that, in the simulated networks, every individual needs, on average, 45 turns for the friendship network to evolve from wave 1 to wave 2. Although such high values have been reported to capture the change in a network over the course of several years (Redhead and Rueden 2021), we judged them excessive for networks measured six months apart, which makes results unreliable. Results using alternative thresholds (viz., 15, 25, 30) are provided in the Supplementary Materials (see Tables S13-S15).

3.2.2 Gossip

Respondents reported the gossip they heard using a three-step procedure included in the online questionnaire. They were asked to indicate 1) who, in the last three months, came to them with informal evaluative information about an absent colleague (*senders*). 2) Who this absent colleague was (*targets*). 3) And then to characterize the gossip as (mostly) positive, negative, or a mix of both (*valence*). This procedure provides us with several "rated gossip triplets" (g_{srtv}) per unit, where s stands for the gossip sender, r for the receiver, t for the target, and v for the valence or sentiment of the contents (see Fig. 2). Although 'mixed gossip' is eventually merged with 'negative gossip' for the analyses, its usage in the questionnaire was to prevent underreporting of negative gossip because of social desirability biases (Ellwardt et al. 2012; Labianca and Brass 2006).

3.2.3 Age

Based on previous research on friendship network dynamics, we included age as a control variable on the grounds of homophily patterns—the tendency of individuals sharing traits to become friends (Lazarsfeld and Merton 1954; McPherson et al. 2001). Given that our sample is homogenous in terms of ethnicity (all Dutch) and a very low proportion of male employees (3–12%), neither ethnicity nor gender was included in the analyses.

3.2.4 Tenure

Employees working longer in an organization had more time to build a friendship network. They may therefore be less inclined to build new friendship ties. At the same time, colleagues with longer tenure are better informed about the organization and its processes, which may make them appealing connections, in particular for employees

who joined the organization only recently. These may have fewer contacts and, therefore, be more inclined to form new relationships. *Tenure* was measured in years worked at the organization.

3.2.5 Working hours

In this organization, some employees work only a few hours per week, whereas others do it on a full-time basis. Employees spending more time in the workplace have more opportunities to build friendships with their colleagues or be chosen as friends by others. *Working hours* were measured in hours per week spent at work as specified in the job contract.

3.2.6 Work team

The formal structure of an organization creates both opportunities and constraints for interaction. In the organization under investigation, employees have to interact more frequently with colleagues working for the same team than with colleagues in other teams. This shared "social focus" (Feld 1981; Kossinets and Watts 2006) can make friendship more likely to happen within teams rather than between teams. Also, work teams often provide the necessary meeting opportunities to make existing friendships durable or less inclined to be discontinued (Mollenhorst et al. 2014). Between seven and nine work teams were active within each of the three units, and the organization provided us with the information concerning which *work team* every respondent was part of.

3.2.7 Communication frequency

To account for the effect of regular mutual exposure (Mollenhorst et al. 2014), we added how often each pair of employees interacted during the last three months. Although communication frequency and friendship are likely closely interrelated, their causes and implications (e.g., the chance of interpersonal conflict) can differ. Communication frequency was self-reported and measured directionally, using a six-point Likert scale ranging from (1) "never" to (6) "eight or more times a week."

3.3 Method

Hypotheses are tested using stochastic actor-oriented models (SAOMs; Snijders 2017; Snijders et al. 2010). SAOMs comprise a family of stochastic network models developed for modeling the unobserved change processes between two or more observed time points in a network. A fundamental assumption of the SAOM is that the change between the observed network at time points m and $m + 1$ can be decomposed into multiple small steps (mini-steps), happening one after the other. As the actual chain of these changes is unobserved, SAOM estimation is based on simulation. During the estimation, thousands of potential network evolution processes are simulated, each consisting of a series of mini-steps.

These evolution processes are modeled by two functions: the rate function and the objective function. The *rate function* determines whether, and if so when, an actor is allowed to make a choice; the *objective function* models which decision is made by this actor (i) based on a multinomial logit discrete choice model. The rate function assigns waiting times to all actors. Then, the actor with the shortest waiting time is chosen and can either drop an existing outgoing tie ($x_{ij,t_1} = 1 \rightarrow x_{ij,t_2} = 0$), create a new tie to a yet unconnected alter ($x_{ij,t_1} = 0 \rightarrow x_{ij,t_2} = 1$), or do nothing ($x_{ij,t_1} \rightarrow x_{ij,t_2}$), resulting in $2(N - 1)$ possible choices [N stands for the number of individuals in the unit in question]. The probability for each of these possible choices is determined by the objective function, in which actor-specific network statistics $s_{ki}(x)$ and exogenous statistics $s_{ki}(z)$ are weighted with parameters of the network evolution $\widehat{\theta}_k$, given the state of the network x at the current mini-step,

$$f_i(\widehat{\theta}, x, z) = \sum_k \widehat{\theta}_k s_{ki}(x, z)$$

Once the model reaches a stopping rule for the parameter estimation, thousands of networks are simulated from the estimated model, which are used to estimate the standard errors and the convergence for each parameter.

A SAOM can be estimated for each of the three units separately. To test our hypotheses, however, we used the multi-group capability of RSiena (see Ripley et al. 2021, Sect. 11.2) to fit a single model for the three units altogether. The procedure assumes that all parameters are the same for the various units, except for the basic rate parameter (the amount of change needed between waves 1 and 2).

3.3.1 Rate function

By default, a SAOM assumes that all actors have the same chance to get the opportunity to swap a tie. Given that, in our data, some individuals made noticeably more friendship changes than others (see Table 1), we first checked whether this considerable amount of changes could be associated with either the independent variable or some control. Overall, no systematic association was found between the number of friendships changed, on the one hand, and gender, age, tenure, working hours, the number of friendships sent

or received in wave 1, the number of targets a respondent heard positive/negative gossip about, or the work team, on the other (see Figure S2 and Table S2 in the Supplementals). Therefore, we decided that the rate function needed no further specification to account for heterogeneity.

3.3.2 Objective function

We included six endogenous effects in our SAOMs to account for the evolution of the friendship network based on well-known dependencies between relations. First, *out-degree (density)* captures the baseline tendency to have friends in the network. *Reciprocity* captures the preference for reciprocating an incoming tie (Newcomb 1956). The *transitive GWESP* (*geometrically weighted edgewise shared partners*) estimates the tendency for triadic structures (i.e., friends of friends tend to be friends; Cartwright and Harary 1956; Simmel 1950). The interaction between *reciprocity* and *transitive GWESP* models the tendency to reciprocate friendships within transitive triplets. This interaction constitutes an alternative to the often used three-cycle effect, which can be regarded as the opposite of hierarchy (Block 2015). The square root version of *out-degree activity* captures the so-called expansiveness bias: the tendency of actors to send ties when they are already sending many other ties (Feld and Carter 2002). Finally, the square root version of *in-degree popularity* captures the so-called Matthew effect (Merton 1973) or preferential attachment (Barabási and Albert 1999): the tendency to send ties to an actor of many other incoming friendships.

Ego, *alter*, and *similarity* effects of age, tenure, and working hours were added to the endogenous effects. The *ego* term models the tendency of employees who are older (have a longer tenure, or have more working hours) to nominate more friends. The *alter* term captures the preference for sending ties to individuals scoring high in those variables above (e.g., those who work many hours in the organization are more often nominated by others). *Similarity* seizes the existence of homophily: a preference for having friendships with similar individuals (Lazarsfeld and Merton 1954; McPherson et al. 2001). The *same* work team was included to capture the tendency for intra-team versus inter-team friendships (Feld 1981; Kossinets and Watts 2006). Communication frequency was added as an *entrainment* effect to seize the preference for having friendships with those colleagues one frequently interacts with (Mollenhorst et al. 2014).

Finally, to test our theoretical expectations, three models were specified. Model 1 contains the main effects of gossip only, Model 2 adds multiple sender effects, and Model 3 adds multiple target effects.

In Model 1, *positive gossip* captures the preference for having friendships with colleagues about whom one heard positive gossip (H1a). *Negative gossip* captures the preference for having friendships with those colleagues about whom one heard negative (or mixed) gossip (H1b).[4] The two variables were obtained by turning the gossip triplets shown in Fig. 2 into two weighted matrices (one for positive gossip: W_{ij}^{+}; the other for negative gossip: W_{ij}^{-}) where i is the gossip receiver, j is the target, and w_{ij} contains as a value the number of senders ($w_{ij} \in [0, (N-2)]$). Both W_{ij}^{+} and W_{ij}^{-} were dichotomized. If $w_{ij}^{+} > 0$, i heard positive gossip about j. The same logic applies to W_{ij}^{-}.

To check if the presence of multiple senders activates the effect of gossip on friendship, in Model 2, we split *positive gossip* and *negative gossip* into two different binary predictors each: from *one sender* only (if $w_{ij} = 1$) vs. *several senders* (if $w_{ij} \geq 2$). In the case of positive gossip, for example, *positive gossip (one sender)* captures the preference for having friendships with colleagues about whom one heard positive gossip from a single sender only. *Positive gossip (several senders)* captures the preference for having friendships with colleagues about whom one heard positive gossip from at least two senders. The estimates for *positive gossip (several senders)* and *negative gossip (several senders)* were used to test H2a and H2b, respectively. *Incongruent gossip* captures the preference for having friendships with those colleagues about whom one heard both positive and negative gossip from different senders (i.e., $w_{ij}^{+} > 0$ and $w_{ij}^{-} > 0$), and it was used to test H3.[5]

In Model 3, we added multiple target effects. For each respondent, we retrieved the number of targets about whom they heard positive and negative gossip, respectively. Then, we added these values to the model as *ego* effects: *positive targets (ego)* and *negative targets (ego)*. These two ego effects model the tendency to send friendship ties when an actor hears positive (or negative) gossip about many colleagues (H4a-b). The interaction terms *positive gossip x positive targets (ego)* and *negative gossip x negative targets (ego)* were included to test whether the effects of gossip on friendship lose strength when the receiver hears gossip of the same tone about many targets (H5a–b).

[4] Remember respondents were offered the option of categorizing the gossip received from a specific sender as both positive and negative (see the section "Measures"). This "mixed gossip" category should not be confused with what we refer to as "incongruent gossip." The latter entails the existence of two senders at least who convey different content valences about the same target (e.g., one positive gossip, another negative or mixed gossip). "Mixed gossip" is presented for descriptive purposes in Table 2 and Fig. 4 but, for the analyses, mixed gossip and negative gossip are merged. For conciseness, however, we will also refer to the combined category as *negative gossip*.

[5] Note that H2a and H2b are tested against no-gossip as the reference category, not against hearing gossip from a single source. H3 is tested as the interaction term between positive gossip and negative gossip.

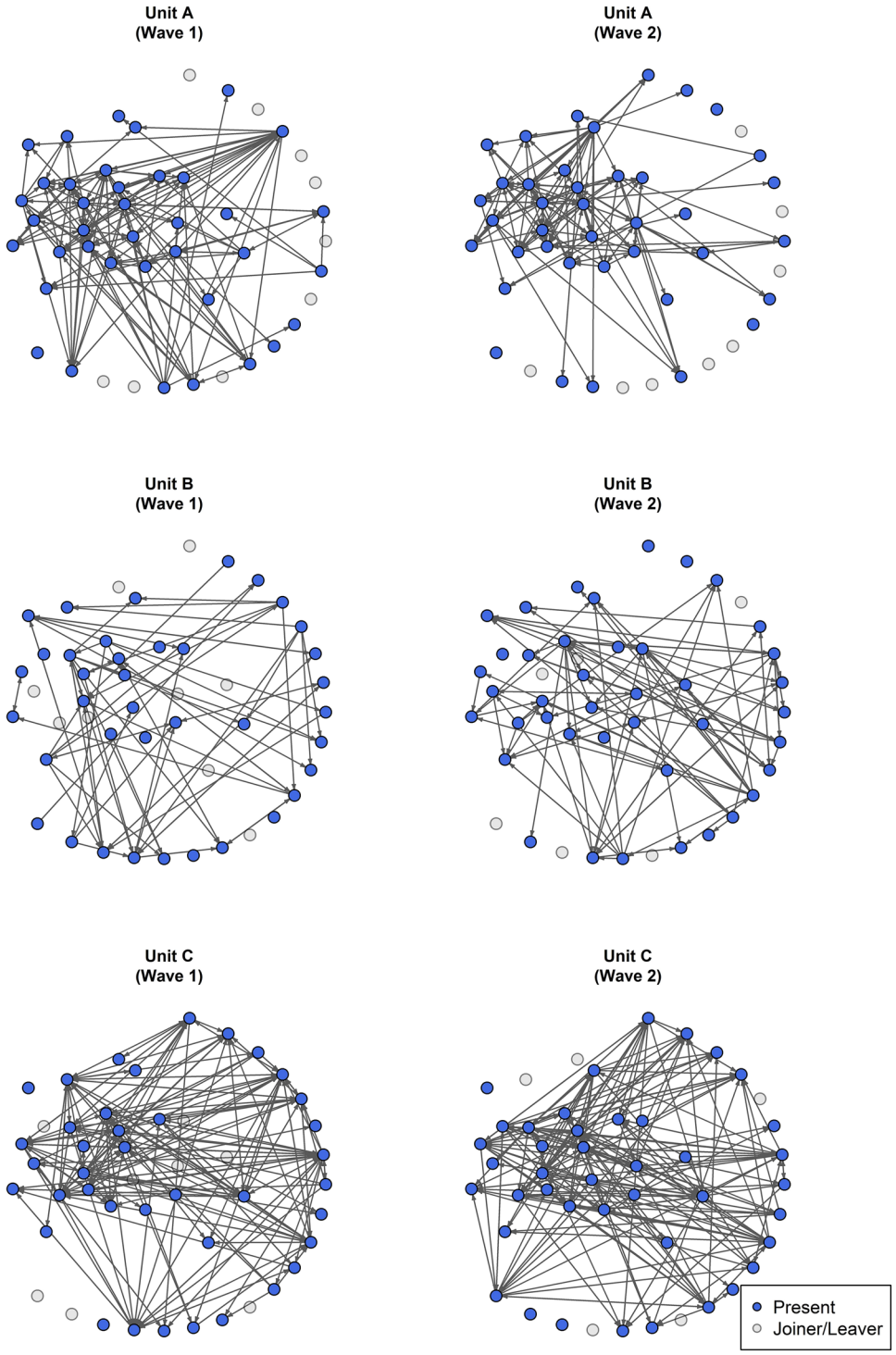


Fig. 3 Visual representation of the friendship networks

Table 9 in Appendix contains all the effects included in the present study, together with a graphical representation.

3.3.3 Change in personnel composition

Although we cannot consider participants who either left or entered the organization between waves for parameter estimation, they were included during the simulations as part of the set of actors that can swap ties or be chosen by others. The "method of joiners and leavers" was used to treat structural missingness separately from non-response (Huisman and Snijders 2003): employees who enrolled later are incorporated as isolates (no ties) at a random moment after the start of the simulation. Employees who left are excluded

Table 1 Friendship ties: descriptive statistics

	Unit A		Unit B		Unit C	
	Wave 1	Wave 2	Wave 1	Wave 2	Wave 1	Wave 2
Cross-sectional						
Nodes	38	39	54	55	38	41
Missing-tie fraction (%)	29.9	39.6	33.4	39.0	24.4	26.6
Density (%)	18.2	17.5	8.6	9.1	17.8	16.9
Reciprocity (%)	51.7	45.9	52.5	48.7	55.8	41.3
Transitivity (%)	47.0	47.8	26.1	23.2	46.1	41.9
Isolates	1	3	6	3	2	4
Avg. degree	4.7	4.0	3.0	3.0	5.0	5.0
Max. out-degree	20	19	16	16	20	19
Max. in-degree	11	11	10	10	14	12
Longitudinal						
Ties created		56		61		82
Ties broken		28		41		52
Stable ties		64		53		72
Jaccard index (%)		43.2		34.2		35.0
Avg. ties changed		1.8		1.6		2.9
Max. ties changed by an employee		15		12		17
Employees with at least one change		13		20		23

(with all their ties) randomly between the start and end of the simulation. These joiners and leavers can be visually observed in Fig. 3.

Analyses were performed in the statistical system R (R Core Team 2021), using the package RSiena 1.3.0.1 (Ripley et al. 2021). We estimated our models with the method of moments using 5,000 simulated networks. After convergence was reached, we assessed Goodness of Fit (GoF) statistics (in-degree distribution, out-degree distribution, triad census type, and geodesic distribution) to see whether the estimated model could have created the observed dynamics (Lospinoso and Snijders 2019). The p values were adjusted using the method proposed by Benjamini and Hochberg (1995) to prevent false discoveries.

4 Results

4.1 Descriptive results

Before moving to the SAOM results, we provide a description of the response and explanatory variables and their interplay, both cross-sectionally and longitudinally.

Table 1 includes descriptive statistics of our friendship networks and their change over time. As we see, Units A and C look more alike in terms of the number of employees (roughly 40), density (16.9–18.2%), and transitivity (41.9–47.8%). Unit B is slightly larger than the other two (around 55 employees), has a lower density (ca. 9.0%), and transitive closure (ca. 25.0%). The lower density, however, cannot be attributed to the larger size of Unit B. Employees in Unit B report on average 3.0 friendship nominations, whereas those in Unit A report 4.0–4.7, and those in Unit C report 5.0. Regarding reciprocity, all three units present similar indices (ca. 50.0–55.0% in wave 1). Tie reciprocation drops from wave 1 to wave 2. The decline is particularly remarkable in Unit C, where it falls from 55.8 to 41.3%. Concerning the change between waves 1 and 2, a total of 199 ties were created, 121 broken, and 189 remained stable. More changes happened in Unit C, followed by Unit B. The higher stability of Unit A is captured by its higher Jaccard index (the proportion of stable ties in a period among the ties that existed at least at one of the two observation moments). Despite differences in the amount of change, all units have more than one-third of their ties stable between waves 1 and 2, a good value for conducting a SAOM (Ripley et al. 2021).

Table 2 contains a description of the gossip data collected in wave 1. As expected from the self-reported nature of the data, negative gossip is comparatively scarcer than positive or "mixed" gossip. After merging negative and mixed forms of gossip, the ratio of negative-to-positive gossip triplets reported is 1.73 (Unit A), 0.57 (Unit B) and 0.56 (Unit C). Put differently, negative gossip represents slightly more than half of the positive gossip in units B and C, and it almost doubles its positive counterpart in Unit A. When gossip triplets (g_{srt}) are turned into receiver-to-target dyads ($g_{.rt}$), we observe there are 387 dyads with positive gossip and 303 with negative (or mixed) gossip overall. In roughly half of these dyads, the gossip did not come from a single sender but from two senders at least (199 dyads for positive gossip,

Table 2 Gossip: descriptive statistics

	Unit A	Unit B	Unit C
Gossip triples (g_{srt})			
Positive tone	111	322	380
Negative tone	67	44	49
Mixed tone	125	141	165
Gossip dyads: receiver-target ($g_{.rt}$)			
Positive gossip	64	154	169
From more than one sender	28	74	97
Negative (or mixed) gossip	89	103	111
From more than one sender	44	44	49
Incongruent gossip	6	25	36
Avg. number of positive gossip targets	1.4	2.4	3.7
Max. number of positive gossip targets	9	33	27
Avg. number of negative (or mixed) gossip targets	1.9	1.6	2.4
Max. number of negative (or mixed) gossip targets	13	23	17

137 for the negative). This almost even split provides additional support for the decision to model the effects of gossip (one sender) and gossip (several senders) separately. Cases in which the receiver heard both positive and negative (or mixed) gossip about the same target from different senders are comparatively infrequent, especially in Unit A (six only). As for the number of gossip targets per receiver, on average, respondents heard positive information about 1.4–3.7 colleagues and negative (or mixed) information about 1.6–2.4. These values, however, can be a misleading summary given the presence of a few respondents with a very high number of gossip targets.

When looking at the interplay between gossip and friendship, the receiver nominates the sender as a friend in 954 of the 1,404 gossip triples (67.9%). If we consider the valence of the information, these proportions are 65.9% (536/813) for positive gossip, 69.4% (111/160) for negative gossip, and 71.2% (307/431) for mixed gossip. This agrees with the expectation that most gossip happens between personal contacts, particularly negative gossip (Grosser et al. 2010). Still, in almost one-third of the cases, gossip occurred between colleagues who are less close. As for the receiver-target relationship, the former nominates the latter as a friend in 491 of the 1,404 gossip triplets (35.0%). These proportions are 45.8% (372/813) for positive gossip and 20.1% (119/591) for negative and mixed gossip together. When the gossip refers to a friend, the odds that it was emitted by a sender that is also a friend (vs. a non-friend) are not negligible: 3.59 (291/81) for positive gossip and 4.17 (96/23) for negative (or mixed) gossip. Figure 4 displays the interplay between gossip and friendship per unit.

Finally, Table 3 includes a description of the interplay between the changes observed in the friendship network and the type of gossip heard. Of the total amount of ties created (199), 25 (12.6%) were with colleagues about whom the receiver heard positive gossip, whereas 10 (5.0%) were with colleagues with negative gossip. When we look at the ties that endured between waves 1 and 2, 30.7% (58/189) were with colleagues with positive gossip, and 6.9% (13/189) were with colleagues with negative (or mixed) gossip. Of all the ties broken (121), 11 were with colleagues with negative (or mixed) gossip (9.1%), and 22 were with colleagues with positive gossip (18.2%).

4.2 Hypothesis testing

To correctly interpret Table 4, we recall that a SAOM retrieves a generalized linear function where a positive parameter indicates a contribution of that effect to the existence of a friendship nomination in wave 2. A negative parameter indicates that such an effect favors its non-existence. The first parameter, the *rate of change*, shows the number of chances, on average, that every actor had to swap ties. In our models, this estimate ranges between 13.50 and 20.76, which is an expected range given friendship networks measured six months apart (Ellwardt et al. 2012; Labun et al. 2016).

We first briefly discuss the effects that served as controls, followed by the hypothesized effects. In line with previous studies on the evolution of friendship networks, we find evidence for the structural effects of *reciprocity*, closure (*transitive GWESP*), and degree-related variability (*out-degree activity*, *in-degree popularity*). The interaction parameter of *reciprocity* with the *transitive GWESP* is negative, suggesting hierarchy in the friendship network. We also find evidence of homophily in age (individuals of similar ages are more likely to be friends) and some ego effects for age and tenure. Specifically, the positive parameter for *age (ego)* indicates that older employees, compared to younger ones, are more likely to have friendship ties. The negative

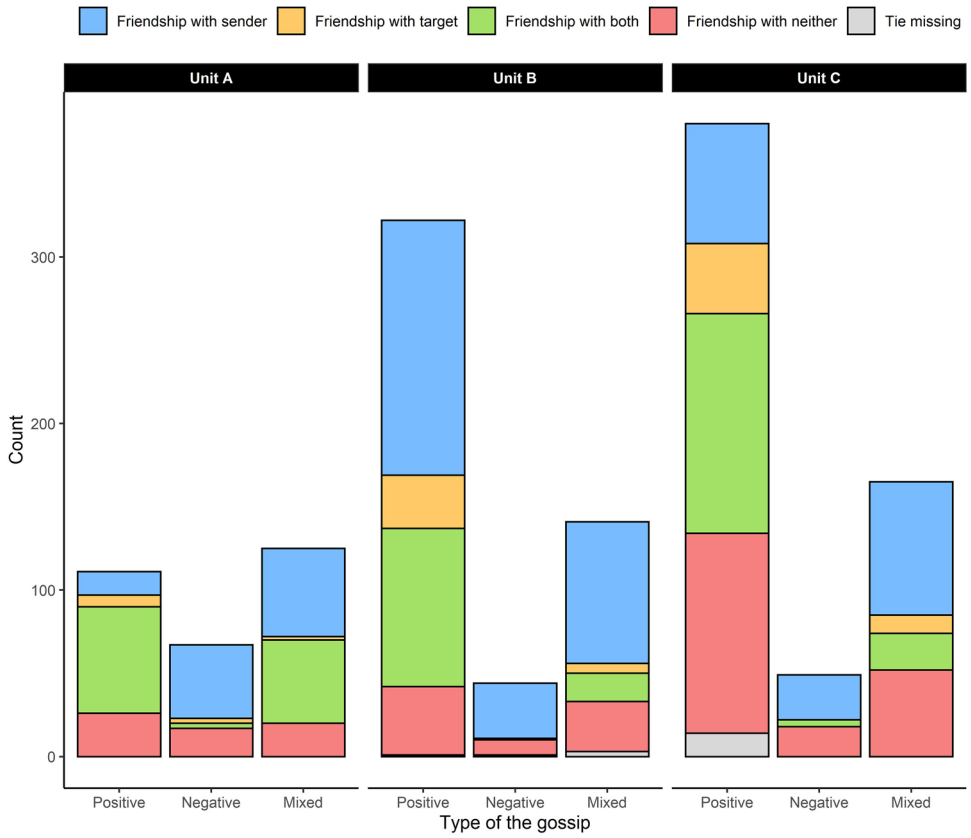


Fig. 4 Gossip received by the relationship tie with the sender and target (wave 1)

Table 3 Friendships changed by type of gossip heard

		Gossip				Total
		Positive (from several senders)	Negative or mixed (from several senders)	Both	None	
Unit A	Ties created	8 (4)	3 (0)	0	45	56
	Ties broken	3 (2)	4 (2)	0	21	28
	Stable ties	15 (8)	9 (7)	1	39	64
	Inexistent ties	11 (1)	22 (7)	2	295	330
Unit B	Ties created	8 (7)	3 (3)	0	50	61
	Ties broken	10 (8)	3 (0)	0	28	41
	Stable ties	17 (12)	2 (1)	4	30	53
	Inexistent ties	54 (22)	37 (19)	11	785	887
Unit C	Ties created	9 (5)	4 (0)	2	67	82
	Ties broken	9 (4)	4 (2)	2	37	52
	Stable ties	26 (15)	2 (0)	5	39	72
	Inexistent ties	49 (31)	43 (23)	15	451	558

parameter for *tenure (ego)* suggests that novice employees are less likely to choose others as friends relative to more senior colleagues. *Working hours (alter)* has a positive effect, whereas that of *working hours (ego)* is negative. The first indicates that employees who spend more hours at work tend to receive more friendship nominations. The second shows that employees who spend less time in the workplace send fewer nominations. Being or not in the same *work team* has no effect at all. Still, regular communication facilitates friendship in all three units, suggesting a tendency to befriend those colleagues with whom one frequently interacts. All these parameters are consistent irrespective of the model (see Table 4).

Turning to the test of our hypotheses, Model 1 finds evidence of a negative effect of *negative gossip* ($\widehat{\theta} = -0.46$, $p = 0.015$), meaning that receiving negative gossip about

Table 4 SAOM estimates of the association between gossip heard and friendship changes

	Model 1				Model 2				Model 3			
	Est	SE	*p*		Est	SE	*p*		Est	SE	*p*	
Rate of change (Unit A)	14.17	2.31	< 0.001	***	13.95	2.26	< 0.001	***	13.50	2.14	< 0.001	***
Rate of change (Unit B)	15.19	2.48	< 0.001	***	15.34	2.76	< 0.001	***	15.46	2.57	< 0.001	***
Rate of change (Unit C)	19.15	2.63	< 0.001	***	19.59	3.28	< 0.001	***	20.76	3.52	< 0.001	***
Out-degree (density)	− 1.89	0.47	< 0.001	***	-1.92	0.45	< 0.001	***	− 1.94	0.49	< 0.001	***
Reciprocity	2.33	0.48	< 0.001	***	2.38	0.50	< 0.001	***	2.37	0.54	< 0.001	***
Transitive GWESP	1.43	0.26	< 0.001	***	1.45	0.25	< 0.001	***	1.44	0.25	< 0.001	***
Reciprocity x Transitive GWESP	− 1.40	0.41	0.001	**	− 1.45	0.43	.002	**	− 1.43	0.47	0.005	**
Out-degree activity (sqrt)	0.20	0.07	0.004	**	0.21	0.07	.005	**	0.22	0.07	0.004	**
In-degree popularity (sqrt)	− 0.57	0.19	0.004	**	− 0.58	0.18	.003	**	− 0.57	0.18	0.004	**
Age (alter)	− 0.01	0.01	.399		0.00	0.01	.510		0.00	0.01	0.494	
Age (ego)	0.01	0.01	.035	*	0.01	0.01	.046	*	0.01	0.01	0.049	*
Age (similarity)	0.73	0.21	.001	**	0.73	0.22	.002	**	0.75	0.21	< 0.001	***
Tenure (alter)	0.01	0.01	.194		0.01	0.01	.248		0.01	0.01	0.230	
Tenure (ego)	− 0.05	0.01	< .001	***	-0.04	0.01	< .001	***	− 0.05	0.01	< 0.001	***
Tenure (similarity)	0.54	0.31	.103		0.58	0.30	.073		0.55	0.30	0.104	
Working hours (alter)	0.01	0.01	.041	*	0.01	0.01	.033	*	0.01	0.01	0.047	*
Working hours (ego)	− 0.02	0.01	.001	**	− 0.02	0.01	.002	**	− 0.02	0.01	0.032	*
Working hours (similarity)	0.23	0.20	.261		0.21	0.20	.360		0.20	0.20	0.392	
Work team (same)	0.07	0.10	.497		0.07	0.10	.561		0.05	0.10	0.694	
Communication frequency	0.30	0.04	< .001	***	0.31	0.05	< .001	***	0.30	0.05	< 0.001	***
Positive gossip	0.23	0.14	.117						0.72	0.20	< 0.001	***
Negative gossip	− 0.46	0.19	.023	*					− 0.35	0.29	0.283	
Positive gossip (one sender)					0.43	0.21	.061					
Negative gossip (one sender)					− 0.34	0.27	.262					
Positive gossip (several senders)					0.05	0.19	.795					
Negative gossip (several senders)					− 0.76	0.31	.024	*				
Incongruent gossip					0.16	0.42	.738					
Positive targets (ego)									− 0.02	0.01	.114	
Negative targets (ego)									− 0.01	0.01	.694	
Positive gossip x Positive targets (ego)									− 0.01	0.02	.445	
Negative gossip x Negative targets (ego)									− 0.02	0.04	.694	

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$; p values were obtained using the Gaussian distribution $\left(\frac{|Est.|}{SE} \geq z_{\frac{\alpha}{2}}\right)$ and adjusted with Benjamini's and Hochberg's method. Convergence ratios were lower than 0.10 per individual parameter. The overall maximum convergence ratios were 0.121 (Model 1), 0.124 (Model 2), and 0.135 (Model 3). Models fitted for each unit independently can be found in the Supplementary Material (Tables S3-S5). For GoF statistics, see Figures S6-S8 in the Supplementary Material. No evidence of heterogeneity in the estimated effects across units was found (see Table S6, also in the Supplementary Material)

alter decreases the likelihood of a friendship tie with them (as proposed in H1b). No evidence of the effect of *positive gossip* is found, however. Indeed, the sign of the estimate goes in the expected direction, and yet this is not significant under statistical standards ($\widehat{\theta} = 0.23$, $p = 0.117$).

Model 2 adds multiple sender effects, which allows differentiating between the effects of gossip from one vs. more than one sender. This second model finds no evidence supporting any impact of positive gossip on friendships neither from one sender ($\widehat{\theta} = 0.43$, $p = 0.061$) nor from multiple senders ($\widehat{\theta} = 0.16$, $p = 0.795$). Regarding negative gossip, this model demonstrates that the effect detected in Model 1 is driven by the negative gossip supported by more than one sender. Once we split the two effects, that of *negative gossip (several senders)* remains significant ($\widehat{\theta} = -0.76$, $p = 0.024$), whereas *negative gossip (one senders)* does not have any effect ($\widehat{\theta} = -0.34$, $p = 0.262$). This finding supports our argument that multiple senders can be the key to activating the effect of gossip. At least, this might be the case for the effect of negative gossip on friendship, as proposed in H2b. The effect of incongruent gossip is not significant ($\widehat{\theta} =$

0.16, $p = 0.738$), providing no support for the existence of negativity (or positivity) biases as proposed in H3.

Finally, Model 3 adds multiple target effects. Unlike in models 1 and 2, the effect of *positive gossip* is positive and finds statistical significance in this model ($\widehat{\theta} = 0.72$, $p < 0.001$). This provides some support for H1a. Specifically, it hints that positive gossip can favor friendship but only after controlling for individual differences in the number of targets one hears gossip about. At the same time, however, the effect of *negative gossip* loses significance in this third model ($\widehat{\theta} = -0.35$, $p = 0.283$). Moreover, no support is found for multiple target effects as proposed in H4a-b and H5a-b.

4.3 Additional analyses

Because the believability of the source can matter for the effects of gossip (Cone et al. 2019), we repeated the same analyses but with the subset of gossip in which the receiver nominates the sender as a friend only. The rationale behind this decision is that some people may toss aside information from potentially unreliable sources (e.g., non-friends) while still informing friendship choices with gossip emanating from those they trust.

As we see in Table 5, results are very similar to those obtained when considering all gossip, irrespective of whom emitted it. The effects observed in Models 4 and 5 mirror those in Models 1 and 2. *Negative gossip* harms friendships ($\widehat{\theta} = -0.71$, $p = 0.002$), and this effect comes primarily from the gossip emitted by *several senders* ($\widehat{\theta} = -0.96$, $p = 0.007$). The effect of *negative gossip (one sender)* is restrengthened ($\widehat{\theta} = -0.61$, $p = 0.056$) compared to Model 2, but it does reach statistical significance independently. This finding provides additional support for H2b, which sustains that coming from more than a single sender is essential for negative gossip to impact the receiver's friendship choices. This pattern seems to hold even when negative gossip comes exclusively from reliable sources (viz., friends). As in Model 3, *positive gossip* also has a positive effect on friendships in Model 6 ($\widehat{\theta} = -0.96$, $p = 0.007$) supporting H1a. Unlike in Model 3, *negative gossip* keeps its negative impact on friendships after adding the effects for multiple targets ($\widehat{\theta} = -0.86$, $p = 0.025$).

Model 6 reveals two additional findings. One is the negative effect of *positive targets (ego)* ($\widehat{\theta} = -0.03$, $p = 0.029$). This finding runs against H4a, according to which individuals who hear positive gossip about many colleagues are likelier to befriend others. The last finding is the presence of heterogeneity across units for the effect of *negative targets (ego)* ($\chi^2(\text{df} = 2) = 15.22$, $p < 0.001$).[6] Seemingly, hearing negative gossip about many targets fosters friendships in some units, whereas it discourages them in others. These opposing forces insinuate that a high prevalence of negative gossip may produce equivocal effects on friendship. Overall, the effects based on multiple targets have small effect sizes.

Extra analyses were conducted to evaluate whether controlling for *communication frequency* (which, as shown in Table S11, is closely related to friendship creation, friendship discontinuation, and friendship maintenance in all three units) could affect results. Also, we reran analyses using alternative cut-off points to correct the friendship network (see section "Measures"). Models S1-S3 (see Table S12 in the Supplementary Material) show that the exclusion of *communication frequency* increases the importance of working in the *same team*. However, it does not affect the patterns concerning gossip. *Negative gossip (several senders)* loses its statistical significance on an $\alpha < .05$ level, remaining only borderline significant ($\widehat{\theta} = -0.67$, $p = 0.062$). Tables S13-S15, also in the Supplementary Material, demonstrate that the findings found in our main models are sensitive to our data-correction procedure. Even so, the patterns observed regarding *positive gossip*, *negative gossip (several senders)*, and *positive targets (ego)* still hold, though sometimes at a marginally significant level ($\alpha < .10$). In addition, Models S9 and S12 reveal a positive effect of the interaction *positive gossip x positive targets (ego)*, providing some evidence against H5a.

In sum (see Table 6), findings are at least partially in line with the predictions for three of the nine hypothesized effects, and conflicting evidence is found for two others. (1) In line with H1a, hearing positive gossip about a colleague increases the likelihood of initiating or maintaining a friendship relation with this colleague. It seems to be the case at least once we control for variability in the number of targets people hear about. (2) In line with H1b, hearing negative gossip about a colleague decreases the likelihood of initiating or maintaining a friendship relationship. However, as H2b states, this happens when negative gossip comes from more than a single sender (3). (4) Contrary to what H4a predicts, hearing positive gossip about many targets does not foster friendship creation and maintenance. It rather discourages these. Although no direct evidence for (or against) H4b is observed, heterogeneity analyses revealed contradicting trends across departments for this effect. This means that hearing negative gossip about many colleagues may both favor and dissuade friendships with other colleagues (5). In addition, also running against our hypothesized effect (H5a), hearing positive gossip about many targets does not temper the impact of positive gossip on friendship evolution. If anything, it seems that it may even restrengthen it.

No significant results were obtained supporting the activating effect of multiple senders in positive gossip (H2b) or the negative-is-stronger-than-positive principle, which is assumed to result from hearing incongruent gossip from multiple senders (H3). Similarly, no evidence was detected supporting that hearing negative gossip about many

[6] See Table S10 in the Supplementary Material.

Table 5 SAOM estimates of the association between gossip heard and friendship changes (only gossip coming from receiver-reported friends)

	Model 4				Model 5				Model 6			
	Est	SE	*p*		Est	SE	*p*		Est	SE	*p*	
Rate of change (Unit A)	13.97	2.06	< .001	***	13.82	2.13	< .001	***	13.07	2.04	< .001	***
Rate of change (Unit B)	15.05	2.38	< .001	***	15.01	2.58	< .001	***	14.73	2.03	< .001	***
Rate of change (Unit C)	19.01	2.95	< .001	***	19.38	3.06	< .001	***	19.36	3.02	< .001	***
Out-degree (density)	− 1.92	0.48	< .001	***	− 1.90	0.47	< .001	***	− 2.03	0.46	< .001	***
Reciprocity	2.36	0.47	< .001	***	2.37	0.48	< .001	***	2.46	0.51	< .001	***
Transitive GWESP	1.42	0.23	< .001	***	1.44	0.25	< .001	***	1.47	0.27	< .001	***
Reciprocity x Transitive GWESP	− 1.42	0.39	< .001	***	− 1.43	0.42	.002	**	− 1.50	0.43	.002	**
Out − degree activity (sqrt)	0.22	0.07	.004	**	0.21	0.07	.004	**	0.25	0.07	.001	**
In − degree popularity (sqrt)	− 0.57	0.18	.003	**	− 0.59	0.18	.002	**	− 0.60	0.19	.004	**
Age (alter)	0.00	0.01	.470		0.00	0.01	.474		0.00	0.01	.470	
Age (ego)	0.01	0.01	.042	*	0.01	0.01	.056		0.01	0.01	.185	
Age (similarity)	0.74	0.21	.001	**	0.74	0.21	.001	**	0.73	0.22	.002	**
Tenure (alter)	0.01	0.01	.231		0.02	0.01	.219		0.01	0.01	.250	
Tenure (ego)	− 0.05	0.01	< .001	***	− 0.05	0.01	< .001	***	− 0.05	0.01	.002	**
Tenure (similarity)	0.54	0.30	.092		0.57	0.30	.085		0.55	0.30	.103	
Working hours (alter)	0.01	0.01	.030	*	0.01	0.01	.027	*	0.01	0.01	.039	*
Working hours (ego)	− 0.02	0.01	.002	**	− 0.02	0.01	.002	**	− 0.02	0.01	.054	
Working hours (similarity)	0.22	0.21	.354		0.21	0.21	.375		0.14	0.21	.547	
Work team (same)	0.08	0.10	.474		0.08	0.10	.474		0.07	0.11	.558	
Communication frequency	0.32	0.05	< .001	***	0.32	0.05	< .001	***	0.31	0.05	< .001	***
Positive gossip	0.12	0.16	.470						0.58	0.25	.030	*
Negative gossip	− 0.71	0.22	.002	**					− 0.86	0.35	.025	*
Positive gossip (one sender)					0.23	0.22	.374					
Negative gossip (one sender)					− 0.61	0.29	.056					
Positive gossip (several senders)					− 0.02	0.23	.938					
Negative gossip (several senders)					− 0.96	0.33	.007	**				
Incongruent gossip					0.21	0.58	.750					
Positive targets (ego)									− 0.03	0.01	.029	*
Negative targets (ego)									− 0.03	0.02	.139	
Positive gossip x Positive targets (ego)									0.01	0.02	.646	
Negative gossip x Negative targets (ego)									0.05	0.04	.312	

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; p values were obtained using the Gaussian distribution $\left(\frac{|Est.|}{SE} \geq z_{\frac{\alpha}{2}}\right)$ and adjusted with Benjamini's and Hochberg's method. Convergence ratios were lower than 0.10 per individual parameter. The overall maximum convergence ratios were 0.124 (Model 1), 0.157 (Model 2), and 0.140 (Model 3). Models fitted for each unit independently can be found in the Supplementary Material (Tables S7-S9). For GoF statistics, see Figures S9-S11 in the Supplementary Material. Evidence of heterogeneity across units in *negative targets (ego)* is identified (see Table S10 in the Supplementary Material)

colleagues will temper the impact of negative gossip on friendship dynamics (H5b).

5 Discussion and conclusion

The present study introduced simple and complex contagion processes into the study of workplace gossip and its impact on friendship relations. It argued that hearing gossip from multiple senders or about multiple targets impacts receivers' friendship relations with gossip targets. The related hypotheses were tested with longitudinal sociometric field data on gossip and friendships between colleagues in three units of a Dutch childcare organization. Stochastic Actor-oriented Models yielded at least partial support for three of the nine hypothesized effects and contradicting evidence for two others.

Simple contagion processes are reflected in two of the three significant findings. This is in line with the core prediction of reputation scholars, according to which positive gossip favors positive interactions between receiver and target, whereas negative gossip discourages them (Costello and

Table 6 Summary of results

No	Hypothesis	Result
Simple contagion: single sender		
H1a	There will be a positive association between receiving positive gossip about a specific target and the receiver creating or maintaining a friendship relationship with this target	Supported when multiple-target effects are controlled
H1b	There will be a negative association between receiving negative gossip about a specific target and the receiver creating or maintaining a friendship relationship with this target	Supported
Complex contagion: multiple senders		
H2a	There will be a positive association between receiving positive gossip about a specific target from multiple senders and the receiver creating or maintaining a friendship relationship with this target	Not supported
H2b	There will be a negative association between receiving negative gossip about a specific target from multiple senders and the receiver creating or maintaining a friendship relationship with this target	Supported
H3	There will be a negative association between receiving positive and negative gossip about a specific target from multiple senders and the receiver creating or maintaining a friendship relationship with this target	Not supported
Complex contagion: multiple targets		
H4a	There will be a positive association between the number of targets the receiver heard positive gossip about and her number of outgoing friendship nominations	Conflicting evidence when considering gossip emitted by friends only
H4b	There will be a negative association between the number of targets the receiver heard negative gossip about and her number of outgoing friendship nominations	Heterogeneous results across units when considering gossip emitted by friends only
H5a	The interaction between receiving positive gossip about the target and the number of different targets about whom the receiver heard positive gossip would be negative	Not supported, although some conflicting evidence detected in sensitivity analyses
H5b	The interaction between receiving negative gossip about the target and the number of different targets about whom the receiver heard negative gossip would be positive	Not supported

Srivastava 2021; Feinberg et al. 2014; Molleman et al. 2013; Shinohara et al. 2021; Smith and Collins 2009; Sommerfeld et al. 2007, 2008; Stiff and Van Vugt 2008). Nonetheless, we found evidence supporting our argument that more than a single sender can be essential to activate the damaging effect of negative gossip on friendship relations. This is in line with the core idea of complex contagion theory, which posits the existence of thresholds (e.g., exposure to a minimum number of previous adopters) for causing meaningful behavior change (Centola 2018; Centola and Macy 2007). It also agrees in part with previous studies maintaining that some reinforcement in the form of either multiple congruent gossip statements (Sommerfeld et al. 2008) or sources (Hess and Hagen 2006) may be essential in dispelling the inherent uncertainty of second-hand information. Relative to Sommerfeld et al. (2007), our study suggests that it is probably the number of sources (senders in our case) rather than statements that count for negative gossip. If it was a matter of simple reiteration, negative gossip from a single sender should suffice to produce an effect. From the way our data were collected, there is no way we can tell whether gossip from a specific sender included or not reiteration. However, it seems very unlikely that the gossip reported captures one-off events. Whereas Hess and Hagen (2006) found that multiple gossip sources increase its veracity,

our study hints at the presence of some sort of "tipping point" (Lamberson and Page 2012). Put differently: it is only after two senders have furnished the receiver with negative information about a target that the receiver can reframe their relationship with the target and act accordingly. No similar pattern was detected for positive gossip, however.

Perhaps most surprising are the findings for multiple target effects, which represent an extension of the complex contagion theory. A culture of positive gossip (in the sense of a high number of positive gossip targets), rather than favoring the tendency to build new friendship relations, seems to inhibit their emergence. A culture of negative gossip on its side produces diverging effects, encouraging friendships in some contexts but discouraging them in others. One plausible explanation for these contradicting findings is that signaling effects (as captured by the number of gossip targets) are possibly convoluted with endogenous dynamics of the friendship network. Regarding positive gossip, for instance, it may be the case that individuals who receive lots of gossip about many others do it precisely because they have many friends already. Provided they have many ties with colleagues, they have fewer incentives to create new ones. On top of it, if they have many ties, the chances are high that they can lose some simply because they cannot keep them all updated (Sutcliffe et al. 2012). Another possibility for the diverging effects of negative gossip is that organizational context conditions play a moderating role. Models fitted for each unit independently reveal a negative effect in Units A and C and a positive (although non-statistically significant) effect in Unit B (see Table S9 in the Supplementary Material). With 55 members, Unit B is considerably larger than the other two, in which membership fluctuates between 38 and 41 employees, and its members have a far lower average number of friendship relations (3 compared to 4.7–5). One could speculate that in cultures of negative gossip, building new friendships is particularly beneficial in larger groups in which the average number of friendships is still relatively low. Such settings may offer more potential for finding new friends, who may also be important allies in coalitions against joint enemies (Giardini and Wittek 2019a; Wittek and Wielers 1998). In contrast, in smaller and more connected groups, this option would be more limited. More generally, the strong variation of findings across groups underscores the importance of replicating studies across multiple departments and organizations and paying closer attention to group-level context differences.

Finally, at least in the organization under investigation, (in) congruence of reputational information did not systematically influence receivers' patterns of friendship nominations toward gossip targets. This implies that neither negativity nor positivity biases in reputational information seem to play an important role in guiding friendship nominations. Similarly, we did not find any evidence supporting the existence of decaying-information-value effects. Though, in theory, an overuse of gossip may lead to receivers discounting the value of reputational information as a source to differentiate between potential new friends, our empirical analyses did not support this conjecture.

Three limitations of our study need to be acknowledged. First, despite the longitudinal nature of our data, we cannot totally rule out the possibility of some reverse causation. The descriptive analyses showed some biases in gossip transmission, with positive gossip pertaining to friends more often than negative (or mixed) forms of gossip (45.8 vs. 20.1%). These findings insinuate some 'echo' in what individuals get from informal conversations (Burt 2001). Nonetheless, the fact that 54.2% of positive gossip is about non-friends, and roughly 25% of negative gossip is about a friend of the receiver, challenges the belief that gossip is simply a by-product of one's social networks. Second, since our expectations were always aligned for friendship-creation and friendship-maintenance, we did not disentangle these two effects in this study (Dahlander and McFarland 2013). However, this implies that we cannot know for certain whether the positive impact of positive gossip comes from favoring the creation of new friendships, the endurance of existing ones, or a mixture of both. Likewise, the negative effect of negative gossip could be produced by discouraging new ties, losing existing ones, or both. Future studies may benefit from disentangling these effects of creation and maintenance both theoretically and empirically. Third, though this study is among the first to inquire into some implications of complex contagion (Centola 2018) for gossip and intra-organizational network dynamics, it leaves much of the potential of this approach unused. Future studies may explore the possibility of a higher threshold for positive gossip (which is arguably cheaper behavior than negative gossip) or tipping points even in cases of incongruent gossip.

On a practical note, if negative gossip requires more than a single sender to harm friendship relations, it poses both a relief and a challenge from a managerial perspective. On the positive side, it suggests that a single person probably lacks the leverage to easily modify other relationships (Halevy et al. 2019). At the same time, however, this also implies that gossip may not be so effective as a tool for punishing defection or malfeasance (and enabling self-organization), as previous research emphasizes (Feinberg et al. 2012, 2014; Kniffin and Wilson 2005). Not at least if defection occurs on a one-person basis. In order to ostracise defective individuals in such cases, one may need to

build cooptive relations with others as a necessary first step (Gargiulo 1993).

Overall, our results suggest that reputational information obtained in informal conversations matters for friendship network dynamics. While previous studies underscore how the relationships within the gossip triad shape gossip (Burt 2001; Estévez et al. 2022; Giardini and Wittek 2019b; Wittek and Wielers 1998), our paper highlights that these two phenomena are most likely co-evolving. That said, our findings also underscore the need for refining and extending the previous theorizing regarding how reputational information influences expressive relations. Further inquiry into processes of complex contagion may benefit from a more careful delineation of its multiple (and potentially competing) underlying psychological mechanisms. For example, rather than invoking the negative-is-stronger-than-positive principle (Rozin and Royzman 2001; Taylor 1991), incongruent gossip may predominantly trigger the receiver's skepticism concerning the credibility of all involved senders (Hess and Hagen 2006). Similarly, rather than having an activating effect, hearing the same favorable assessment about the same target from several others may be perceived as redundant, with the result that the value of reputational information decreases with additional senders. More generally, contextual effects may play a far more important role both for simple and complex contagion processes than captured by current reputation models.

Appendix

See Tables 7, 8, 9

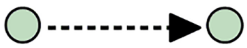
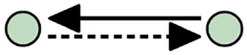
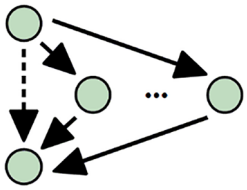
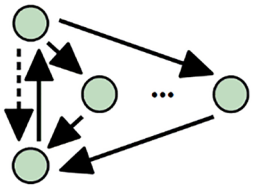
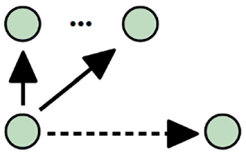
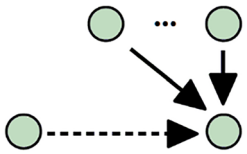
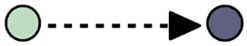
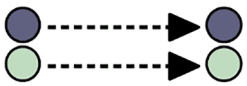
Table 7 Descriptive statistics of the sample

		Wave 1			Wave 2		
		Mean	Min	Max	Mean	Min	Max
Unit A	Gender (female = 1)	.95			.97		
	Age	37.4	22	59	36.7	22	59
	Tenure (in years)	7.9	1	22	6.6	0	22
	Working hours per week	25.0	3	38	22.3	3	36
	Number of work teams	7			8		
Unit B	Gender (female = 1)	.93			.95		
	Age	36.3	24	57	36.1	22	57
	Tenure (in years)	7.6	1	21	7.1	0	21
	Working hours per week	24.2	3	38	23.0	3	38
	Number of work teams	9			10		
Unit C	Gender (female = 1)	.89			.88		
	Age	39.6	23	60	36.8	23	60
	Tenure (in years)	7.9	1	30	6.0	0	21
	Working hours per week	22.1	3	36	19.8	3	36
	Number of work teams	8			8		

Table 8 Response rate and composition change

	Whole sample	Wave 1		Wave 2		Composition change	
		N	Response	*N*	Response	Joiners	Leavers
Unit A	47	38	30	39	28	9	8
Unit B	63	54	38	55	39	9	8
Unit C	46	38	30	41	32	8	5

Table 9 Effects included in the present study

Name	Rsiena specification	Visualization
Endogenous effects		
Out-degree (density)	density	
Reciprocity	recip	
Transitive GWESP	gwespFF	
Reciprocity x transitive GWESP	recip × gwespFF	
Out-degree activity (sqrt)	outActSqrt	
In-degree popularity (sqrt)	inPopSqrt	
Exogenous effects		
Alter effect	altX	
Ego effect	egoX	
Same/Similarity effect	sameX, simX	
Entrainment effect	X	

Non-binary effects were centered to achieve better convergence in the models

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Data availability Data are not publicly available for confidentiality reasons. The R code used in this study is freely available on GitHub: https://github.com/joseluisesna/Gossip_in_a_Dutch_organisation.

Declarations

Conflict of interest The authors declare no competing interests.

Ethical Approval Informed consent was obtained from all individual participants included in the study. Data collection was approved by the Ethics Committee of the Faculty of Behavioral and Social Sciences at the University of Groningen. All procedures performed involving

human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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