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Gender homophily and gender distribution in social networks: The case of older adults in long term care settings

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ABSTRACT

Distinctiveness theory suggests that numeric rarity is correlated with stronger homophily. In this paper, we examine this theory by studying gender homophily in social networks of older adults. We document subjective social networks in multiple long term care settings for older adults over several time points. Homophily for each gender is estimated using exponential random graph models. We find evidence for positive homophily across all networks, and show that it is correlated to the magnitude of the female majority or male minority. Our findings empirically verify distinctiveness theory and could improve interventions to promote tie formation in social networks.

1. Introduction

Similar people tend to form ingroup ties, a process termed *homophily* (McPherson et al., 2001), 416). Homophily by gender or sex, meaning ties that are formed within the group of men or women, has been repeatedly reported in all age groups (Recent examples include (Goodreau et al., 2009; Di Tommaso et al., 2020; Schafer, 2015). Competing explanations to patterns of social relationships such as homophily focus either on network processes including clustering and transitivity (Davis, 1967; Holland and Leinhardt, 1971) or on network members' personal and social attributes (Blau, 1977). The extent to which a given set of ties can be explained using only the distribution of attributes among people, with little regard to their cultural meaning, had been previously examined and discussed when researching social groups, and termed "structural sociology" (Blau, 1977).

This research contributes new empirical evidence to the structural sociology approach which suggests that the current attribute distributions, and especially the majority-minority dynamics, are key to understanding tie formation. We focus on the differential homophily of men and women, and how it relates to the gender distribution among older adults. We hypothesized that homophily is strongly correlated with the gender distribution, so that the *minority* of men exhibit higher levels of homophily as they become a smaller minority. The *majority* of women follow a similar pattern, where they exhibit lower levels of homophily as they grow to a larger majority. For this purpose, we utilize the almost unavoidable majority of women in this age group, due to females' higher life expectancy (WHO, 2020). The data includes 21 whole social networks as the basis for this research. By observing all network members, we can account for the properties of the group, and in particular for the gender distribution within it. We tease apart the dynamics of homophily by controlling for other, possibly confounding, effects.

The results could be helpful for interventions to promote social relations. They are particularly important for older people, as extended social networks were found to be a contributing factor to for their better physical, cognitive and psychological health and general well-being (e.g. Cornwell and Laumann, 2015; Tomini et al., 2016). The growing prevalence of Long-Term Care (LTC) settings intended to alleviate loneliness (among other goals) provide an opportunity to directly benefit from this research. The results could also aid in designing interventions in other social networks with minorities within them, such as school classes (Boda et al., 2020) or workplace settings (Di Tommaso et al., 2020).

The remainder of the paper is organized as follows. In Section 2 we start with the theoretical background: We highlight homophily, or ingroup associations, as a leading structural explanation to tie formation and offer distinctiveness theory as a specific focus in structural sociology. Section 2.3 presents the social context of the current study, LTC settings of older adults. In Section 3, we explain the details of the data collection and the use of exponential random graph models (ERGM) to

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analyze the data. Section 4 presents the results of the analysis. We follow with a discussion in Section 5 and end with conclusions in Section 6.

2. Theoretical background

2.1. Homophily

Homophily has long been identified in the social sciences as a leading factor to forging ties. First mentions of homophily are attributed to Aristotle and Plato, with modern empirical observations recorded as early as the 1920s (McPherson et al., 2001) with the term *homophily* first used in social theory by (Lazarsfeld and Merton, 1954). Research into ties formed between similar people has since expanded in theory and in empirical nuance.

Past research identified two possibly complementary forces (McPherson et al., 2001; Goodreau et al., 2009; Kossinets and Watts, 2009; Cepić and Tonković, 2020). On the one hand is the circumstantial aspect, often termed *baseline homophily* or *induced homophily*. Baseline homophily is the level of ingroup ties expected in random mixing given the group demographics, without ingroup bias. An example in our study would be many ties among women in a women-majority group. It is also the level expected for non-salient parameters. An attribute shared by many, such as a common eye-color, would appear to display homophily even if does not affect tie formation (Blau, 1977). On the other hand, *choice homophily* or *inbreeding* is the added effect due to the salience of a parameter in a specific context and the social effect of ingroup preference, a voluntary aspect often explained in subjective or psychological terms. This is the level of homophily beyond the baseline homophily (McPherson et al., 2001) and the phenomenon we seek to capture empirically. The LTC settings have a women majority because there are more women in the relevant age group, and this majority affects the baseline homophily. We will simultaneously control for this expected baseline homophily when modeling choice homophily in our statistical analysis.

Ingroup ties could result from other tie formation forces aside from choice homophily and the confounding effect needs to be distinguished with the appropriate statistical methods (Goodreau et al., 2009). For example, a personal attribute could be attractive and relatively important, because it is rare or prized. This includes health among older adults (Schafer, 2016) or rank in a work organization (Di Tommaso et al., 2020). Another force driving tie formation is transitivity, or the process often described as triadic closure (Goodreau et al., 2009; Kossinets and Watts, 2009). Put plainly, two sides of a friendship triangle are formed by a friend of a friend, often resulting in the third tie forming. Both forces could also lead to resulting homophily, by forging ties between people of the same category. As we focus on tie formation within gender categories, popularity could be a confounding effect if, for example, men are very popular and ties among men (as well as from women to men) are observed as a result. Triadic closure could also be a confounding effect in a case where women tend to congregate in groups, resulting in many ties among women that are part of a larger pattern of all-women cliques. The statistical methodology we use controls for these processes to properly estimate homophily.

There are two main reasons why we focused on gender, meaning ties from Women to Women (hence W-to-W) and ties from Men to Men (M-to-M). The first is that it is a fixed, predetermined attribute, especially in the older population. As such, gender simplifies the analysis with a reasonable assumption of no reversed causality, meaning the attribute is not induced or adopted because of the social ties (Steglich et al., 2010). This can be contrasted, in the extreme, to being influenced by friends to adopt certain traits, such as choosing to ethnically identify a certain way (Lien et al., 2003) or even adopting harmful habits such as smoking due to peer pressure (Engles et al., 1999).

The second reason is the uniqueness of our data in terms of status within an organization, what Weber conceptualized as “legitimate authority” (Max,1914), and gender distribution. Previous research analyzing gender homophily was often based on data originating from the workforce and focused on the manifestation of homophily within hierarchical networks where gender was correlated with rank and authority (Ibarra, 1992; Elliott and Smith, 2004). Some even demonstrated an obvious majority of men (Di Tommaso et al., 2020). LTC settings provide an opportune study case for examining the correlation between a majority of women and gender homophily, independent of status within an organization.

2.2. Distinctiveness theory

The interplay between homophily and different social contexts, each with its distribution of personal attributes, has been considered in the deductive theory of social structure developed by Blau (1977). Simmel was the first sociologist to quantify and abstract the structure independently of the cultural meaning attached to it (Simmel,1950). This was followed Blau’s macrosocial theory “structural sociology” (Blau, 1977; Blau et al., 1982). The premise of the theory is that the social relations within a structure can be explained by the distribution of attributes, or “social positions”. Blau first theoretically deduced that heterogeneous societies have more intergroup ties: Homophily was an assumed social force in tie formation, mitigated by heterogeneity (1977). This was later also empirically demonstrated by the comparison of 125 American standard Metropolitan Statistical Areas (SMSAs) (Blau et al., 1982). According to Blau’s theory, intergroup associations lower social boundaries and promote social mobility.

While we partly draw from Blau’s structural analysis, we do not share his focus. Blau was interested in achieving social interconnectedness and viewed intergroup relations as the basis for it. In contrast, the LTC settings analyzed here are intent on expanding the social associations of their members using tie formation of any kind, and ingroup ties achieve this goal more easily than intergroup ties. This goal can also be relevant to other micro-social settings focusing on ingroup networks.

Distinctiveness theory originated as a psychological theory in the research of the context-specific salience of certain attributes (McGuire et al., 1978). This theory addresses the psychological mechanism and was developed at the micro-social level appropriate to our study. According to distinctiveness theory a-la McGuire, an attribute that is rare in the specific context is more salient in each individual’s self-perception (McGuire et al., 1978). Even with this additional subjective aspect, both theories consider the context-specific distribution of attributes to be important. When applied to the question of tie formation and homophily, distinctiveness theory suggests that the relative rarity of a category determines its precedence as a cause for choice homophily (Mehra et al., 1998). As found by Mehra et al. (1998) in a workplace environment, ethnic and racial minorities tended to make friends of the same group, and of the white majority, women tended to befriend women. Leonard et al. (2008) focused on a specific student organization that was comprised of two ethnic/racial groups that are minorities in the general student population. When comparing the homophily levels of the 83% African Americans and 17% Hispanics, they found more homophily on the basis of Hispanic identity than African American identity. Di Tommaso et al. (2020) looked at homophily on the basis of gender and rank (as a dichotomous category) in an international network of companies. They found stronger homophily for the minority: executive men tended to connect with other executives and not with other men, and non-executive women tended to connect with other women and not with other non-executives.

Although they did not test for distinctiveness theory specifically, Goodreau et al. (2009) present findings supporting it. They analyzed data from almost 60 social networks of cross-sectional data collected on adolescents to highlight the relative importance of different ethnic/race categories in different settings. They found partial choice homophily in all categories and especially for the minority at each setting. However, higher levels of choice homophily were measured for different categories, and the interaction between minority/majority in each category played out differently. For example, whites had very high levels of choice homophily when they were a small minority but only minimal choice homophily once they were at least ~20% and almost none when they were the majority. Blacks, on the other hand, had high levels of choice homophily if they were anywhere up to 50%, which declined to practically none when they were the majority. Their research exemplifies the power of comparing multiple settings with different social compositions.

With distinctiveness theory in mind, it is surprising that researchers ignore the possible difference between choice homophily among women and men in contexts where the distribution is not numerically equal. In some cases, homophily is not differentiated but measured with a single parameter, even when there is a clear minority, usually of women (e.g. Huang et al., 2009; Yap and Harrigan, 2015; Boda et al., 2020). For instance, if W-to-W choice homophily is strong but M-to-M choice homophily is zero or very weak, a single measurement would reduce these effects to a middle ground. Therefore, in our case, we will measure W-to-W choice homophily and M-to-M choice homophily separately to allow the comparison between them. With this type of analysis we can argue for higher levels of choice homophily by the minority of men and validate distinctiveness theory.

2.3. The current study and hypotheses

Drawing on Distinctiveness theory, we propose that choice homophily by gender category is more common and prominent for the minority group, determined at the level of the specific setting. We now present the settings where the data were collected to provide new evidence for this theory. Our study is characterized by multiple comparable social networks with varying level of minority populations, which allows us to rigorously analyze this effect.

In this research, we focus on age-segregated Long-Term Care (LTC) settings for older adults, intended to promote social relationships (among other things). LTC settings provide opportunities for older adults to be socially engaged and form ties with contemporaries through leisure activities and physical proximity (Biggs et al., 2000; Ayalon and Green, 2013; Schafer, 2015). We compiled networks of familiarity ties, or acquaintance, from face-to-face interviews conducted in two types of LTC settings: Adults Day Care Centers (ADCCs) and Continuing Care Retirement Communities (CCRCs).

The most important advantage in studying social networks at theses settings is that the individuals joining these settings hope to benefit from the social network there (Biggs et al., 2000; Ayalon and Green, 2013; Schafer, 2015). This makes LTCs an exemplary "social interaction foci": a social setting around which social activity is organized and which in turn facilitates interpersonal interactions (Feld, 1981; Feld and Carter 2009; Kossinets and Watts, 2009, 418). It also places a responsibility on the administration of the LTCs, to design the institutions and intervene as necessary to achieve this goal. Promoting the easier and more natural homophilous social ties will better help the individuals attending the LTCs expand their social network.

We focused on familiarity ties which are considered secondary groups, following a previous differentiation between primary and secondary groups (Mcintosh and Alston, 1982; Ayalon et al., 2018). The primary group refers to the few intimate contacts whom the individual is concerned about, and the secondary group refers to multiple, weaker, and perhaps superficial acquaintance. LTC settings can be a source of social relationships that form a secondary group, because people join the LTC settings with the intention of taking part in the social (and care) aspects they offer. Most of the previous research on older adults focused on the closest ties, the primary group, leading to the secondary group being under-researched (Carstensen, 2006). However, these social ties can develop to become more intimate and supportive ties. Therefore, understanding the formation of familiarity ties in LTC settings is itself helpful in expanding and improving the social networks of older adults in new ways.

The data we analyze originated in two types of LTC settings: Continuing Care Retirement Communities (CCRCs) and Adults Day Care Centers (ADCCs). The LTC settings are located in various geographic locations in Israel. They were revisited 3 times over 3 years, helping control for site- and time-specific effects. The older adults in each LTC setting and their respective familiarity ties are considered a social network.

These networks have several advantages in studying homophily: They have clear membership boundaries, both geographic and formal. These boundaries help determine the individuals included in the network and the distribution of attributes among them. The people in these networks have similar attributes such as age and level of physical functioning. Most importantly, as noted previously, the individuals joining LTC settings are often interested in expanding their social ties and therefore are making an effort to form ties within them (Ayalon and Green, 2013).

However, there are some notable differences between the types of LTC setting. CCRCs are privately funded and require that members be physically independent when joining. CCRCs are residential facilities and are utilized by a minority of older Israelis, with less than 2% of older Israelis living in institutions. On the other hand, ADCCs are sponsored through the public welfare system and are aimed at keeping older adults living in the community, allowing physically impaired individuals to join. Of the 17% older Israelis supported by the LTC Insurance Law, 7.4% participate in ADCCs (meaning almost 1.3% of the older Israeli population). They operate during weekdays for 6–7 h per day. For more details on the LTC settings, see Ayalon et al. (2018). These differences will be addresses in our analysis to demonstrate that the results are not dependent on the specific type of setting.

The data we collected are from different LTC centers and center types, and across multiple years; we can therefore compare the correlation of gender homophily with these aspects. By checking these competing explanations, we demonstrate that distinctiveness theory best explains the choice homophily differences among the networks. Understanding tie formation and the importance of the demographic composition in LTC setting to this process is necessary for the LTC settings to succeed in fostering the social networks of their members.

Our first argument is that choice homophily should be measured separately for women and men and not assumed to be the same, because of their differential distribution. We expect that choice homophily differs by gender, and operationally that measuring them separately would produce substantially different estimates. The hypothesis we test to support this is:

Hypothesis (1). Women and Men exhibit different levels of choice homophily in each network when estimated separately.

The presented networks are relatively unique in their gender distribution, with 54%−89% women (see details in Fig. 3.1). This women-skew is common in these ages but is less common in network data presented in previous research, which are more balanced or have a majority of men (Ibarra, 1992; Huang et al., 2009; Yap and Harrigan, 2015; Boda et al., 2020; Di Tommaso et al., 2020). Our main argument is that extreme minority status of a gender category leads to higher levels of choice homophily. We expect that in networks where men are a smaller minority, the choice homophily among them will be stronger. On the other hand, where women are a larger majority, the choice homophily of women would be weaker. Put formally:

Hypothesis (2). W-to-W choice homophily would *decrease* and M-to-M choice homophily would *increase* as the proportion of women *increases*.

To demonstrate the robustness of our main results, we also check competing hypotheses that could explain the differences between levels of homophily in the networks present in our data.

The first counterargument is that the type of setting leads to different levels of choice homophily, and not minority status. For example, that

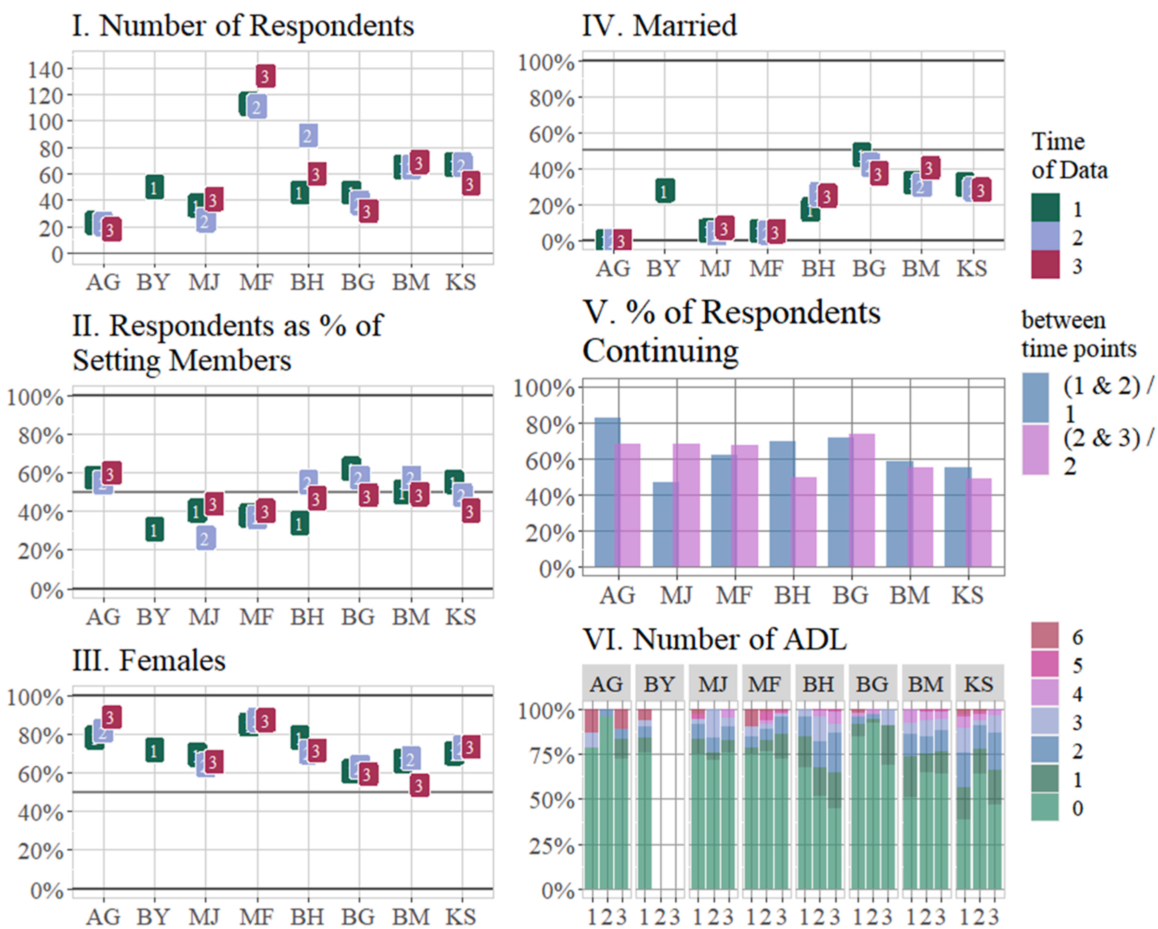

Fig. 3.1. Descriptive statistics of the network data. In Figures I-V, the X-axis groups the LTC settings and in Figure VI they are presented in the facets. The Y-axis is noted in the figure's title.

settings that include residential facilities will have stronger gender homophily relative to day centers, or vice versa. Because very little is known about the specific dynamics of choice homophily, and specifically in CCRCs and ADCCs, it is hard to estimate the directionality of the comparison. Given already known differences between CCRCs and ADCCs, including the amount of time spent daily at the setting and the functional limitations of the members of each setting, we examined possible differences between the settings. However, our hypothesis in not directed:

Hypothesis (3). Women and Men choice homophily in the ADCC is different from choice homophily in the CCRC.

In the second counterargument to distinctiveness theory, we consider another aspect available in our longitudinal data, the turnover of people. One could argue against distinctiveness theory that we outlined above, that the tendency for choice homophily is not context-dependent but a personal tendency. In this case, when observing the same people at different periods of time, we would expect very little change. If the individuals in the group change dramatically, there is a higher chance of change in the measurements of the social dynamics, regardless of the attribute distribution. In our analysis, we use the overlap of people over 2 consecutive time points as a parameterization of this continuous aspect. This ranges 47%–83% and is presented in the following Fig. 3.1.V. Put more formally,

Hypothesis (4). Gender choice homophily difference *within* settings can be explained by overlap as measured by the percentage of people consistently appearing in multiple time points.

3. Data and methodology

The data points in our study are the social networks in their entirety. Each network includes both the composition of people and the relations between these people. A *complete* social network is one with clear boundaries and full knowledge of the people and ties within it, and is an optimal analysis tool to address questions of tie formation. We view the social network at a certain time point as a discrete observation which should ideally be compared to the same setting at different time points and to networks in other settings.

Data were collected over a period of 3 years, 2017–2019, using face-to-face interviews in the two types of settings in Israel, 4 ADCCs and 4 (3) CCRCs. Eight settings from around Israel were recruited for the project but only 7 continued in all 3 time points. The data were collected using face-to-face interviews. At each session of interviews, all the members of the 4 ADCC or 4 (3) CCRC were invited to be interviewed, excluding people deemed unfit by the staff due to various health reasons or people with deteriorated cognitive abilities. For further details see Ayalon et al. (2018).

The network structure was gleaned from questions directed to each of the respondents. As part of the interview, they received a list of all the fellow participants in the respective setting. They were then presented with the question "Please indicate whether you know the following person [NAME OF ALL PARTICIPANTS]." Through these answers we constructed a directed network of familiarity ties.

Descriptive statistics are displayed in Fig. 3.1 and Tables 3.1 and 3.2 and summarized in Table 3.3. Due to turnover and deteriorating health, the networks examined do not include the exact same set of people in all 3 time points. For example, the highest level of continuity is in setting

Table 3.1
Personal attributes included in the analysis.

Setting	AG			BY	MJ			MF			BH			BG			BM			KS		
Time Point	1	2	3	1	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Respondents	23	22	18	50	36	25	41	113	111	134	46	89	60	46	38	32	65	65	69	67	67	53
% of setting members	58%	55%	60%	31%	40%	26%	44%	38%	37%	40%	34%	55%	47%	62%	58%	48%	50%	58%	49%	55%	49%	40%
Pesonal Attributes																						
Women (vs Men)	78%	82%	89%	72%	69%	64%	66%	85%	87%	87%	78%	71%	72%	61%	63%	59%	66%	68%	54%	70%	72%	74%
Married (vs not)	0%	0%	0%	28%	6%	4%	10%	5%	5%	5%	17%	26%	25%	48%	42%	38%	34%	31%	41%	30%	30%	28%
ADL																						
0	78%	95%	72%	78%	75%	72%	76%	75%	77%	72%	67%	52%	45%	85%	92%	69%	49%	65%	64%	40%	67%	47%
1	–	–	11%	6%	8%	4%	7%	4%	6%	13%	17%	16%	20%	7%	3%	22%	23%	11%	13%	18%	12%	19%
2	–	5%	6%	6%	8%	8%	7%	6%	6%	10%	11%	15%	22%	4%	3%	–	12%	9%	12%	19%	12%	21%
3	9%	–	–	4%	3%	16%	5%	5%	3%	1%	4%	13%	5%	–	–	9%	6%	9%	6%	13%	3%	9%
4	–	–	–	–	–	–	5%	–	2%	1%	–	3%	7%	2%	3%	–	9%	5%	4%	4%	3%	4%
5	–	–	–	–	3%	–	–	–	5%	1%	–	1%	2%	–	–	–	–	2%	1%	1%	1%	–
6	13%	–	11%	6%	3%	–	–	10%	2%	1%	–	–	–	2%	–	–	–	–	–	3%	1%	–

Table 3.2
Overlap of respondents in each network across different time points.

Overlap of people between time points	AG	MJ	MF	BH	BG	BM	KS
1 –> 2	83%	47%	62%	70%	72%	58%	55%
2 –> 3	68%	68%	68%	49%	74%	55%	49%
1 –> {2,3}	57%	33%	47%	37%	52%	32%	34%
{1,2} –> 3	68%	71%	76%	53%	73%	55%	62%

Table 3.3
Explanation of personal attributes included in the analysis.

Attribute Name	Description
gender	Man or Woman, categorical
age	In years
tenure	years of tenure as a member of the institution
married	Indicator of being married vs not
ADL	Activities of Daily Living, range 0–6

AG (furthest left) with 80% of members at $t = 1$ appearing at $t = 2$, or 58% of members at $t = 1$ appearing at $t = 2$ and $t = 3$.

The questionnaire included personal questions about each respondent as well as questions about the ties to other people at the setting. The personal attributes included in the analysis are presented in Fig. 3.1:III-IV, VI and Table 3.1 and explained in Table 3.3. Activities of Daily Living (ADL) is a functional measure, counting the number of ADL limitations the respondent admits (such as functional mobility, self-feeding and bathing), with high values implying more limitations, and up to 6.

Some of the personal attributes were missing, with counts and percentages presented in Fig. 8.1 in the appendix. Missing values were imputed using predictive mean matching.[1]

3.1. Methodology

Previous research using complete social networks could only make limited claims due to scarcity of data. Research analyzing social networks has often focused on a single or few networks, often at a single time point. An obvious limitation is access to data, which happens usually in one of two ways. First, network data can be actively collected, a costly endeavor. This can be done either by interviewing the people that comprise the network or by collecting data on other social entities. Examples from recent years include two types of relationships of the same 282 university students (Yap and Harrigan, 2015), ties within a retirement community of 123 people (Schafer, 2016) and administrative data on gang activity in two US cities (Papachristos et al., 2013). Second, researchers could access a single communication platform, such as digital social network, and the network formed from its meta-data. In many of these cases, the entire network is analyzed as a single unit, perhaps due to the concern of network boundaries (Laumann et al., 1989). Examples from recent years include messaging between 2085 users in an organizational setting (Di Tommaso et al., 2020) and game communication and partnership between 3140 players in an online game (Huang et al., 2009).

In this section we explain how we test our hypotheses using multiple social networks. First, we estimate the micro-level tie-formation generative process to differentiate the various social processes contributing to tie formation. This method also controls for induced homophily in the immediate vicinity of the network member, allowing us to separate its effect from choice homophily. The model also separately measures other social processes in which the member takes part, such as age homophily or triadic closure. Second, we will estimate the effect of female majority and calculate its significance using permutation tests, which we will

[1] using the R-package mice version 3.12.0.

explain.

3.1.1. Exponential random graph models

We use Exponential Random Graph Models (ERGM) to estimate the different effects involved in tie formation *simultaneously* (Holland and Leinhardt, 1981, 76:34). These include personal and dyadic attributes such as gender and being of the same gender category, as well as endogenous network processes such as reciprocity and triadic closure. We estimate the model parameters with the MCMC-MLE algorithm (Snijders et al., 2006; Hunter, 2007).

In technical terms, we define the social network by the people (nodes or vertices) and ties (edges or arcs) between them. We define $Y \in R^{n \times n}$ as the adjacency matrix which describes the network ties. In our data, the ties are binary and directed. Therefore the existence of the tie $i \rightarrow j$ does not imply the existence of the tie $j \rightarrow i$, such that $Y_{ij} \neq Y_{ji}$ and the adjacency matrix Y is asymmetric. In our case, Y_{ij} indicates that person i knows person j but does not imply that person j knows person i. We define $X \in \mathbb{R}^{n \times p}$ as the matrix including the attributes (gender, age, etc) of the people in the network, with n rows for each person and p columns for the attributes. The general modeling of the ERGM ties these together:

$$\mathbb{P}(\mathrm{Y}|\mathrm{X}) = \frac{\exp[\theta^{\mathrm{T}} \mathrm{g}(\mathrm{y};\mathrm{x})]}{\psi(\theta, \mathrm{y};\mathrm{x})}$$

with the normalizing constant in the denominator

$$\psi(\theta, y; x) = \sum_{y \in \mathscr{Y}} exp[\theta^T g(y; x)]$$

The vector $g(y;x)$ includes the sufficient statistics describing the network. In the basic model we will present bellow, the network statistics includes (1) the count of mutual ties (2) count of ties in each of the 4 gender combinations. θ is a vector of model parameters that determine the influence each of the network statistics and are to be estimated.

In subsequent models, we test the effect of possible confounding variables. The personal attribute variables are tested both as personal effects and as dyadic effects. For example, when evaluating the effect of tenure, we considered both the tie-sender's and tie-receiver's tenure and the absolute difference between them. Regarding marriage, we considered both the tie-sender's and tie-receiver's marital status and whether they are of the same status.

Other confounding variables are the endogenous network-structural effects. The parameters for these network effects are Geometrically Weighted (GW) and place a decreasing importance on additional ties. The first is the GW Edgewise Shared partners (GWESP), a network summary statistic to capture the tendency to triadic closure (TC). The parameter places a decreasing importance on each additional shared partner, in our case a shared acquaintance. This means that while the first or second shared partner contribute greatly to the chance for tie formation, the additional seventh or eighth shared partner contributes much less. This is referred to as the TC model. The second is the GW Outdegree (GWOdegree), controlling for different levels of sociability and popularity. This is referred to as the degree model. It was previously demonstrated that the GW statistics, rather than triad and star counts, lead to more realistic models (Snijders et al., 2006; Hunter, 2007).

The general formulation of the model presented above can be more easily understood when in the form of a conditional log-odds:

$$\mathbb{P}(\mathrm{Y_{ij}} = 1\,|\mathrm{Y^c_{ij}}, \mathrm{X}) = \theta^{\mathrm{T}} \delta[\mathrm{g}(\mathrm{y};\mathrm{x})]$$

When focusing on an individual tie, the $\delta[g(y;x)]$ represents the change in the statistics that occur when Y_{ij} is toggled from 0 to 1. For example, in the basic model we explore, the difference between $Y_{ij} = 0$ and $Y_{ij} = 1$ could affect multiple statistics. It would influence the count of one of the gender combinations and could influence the count of mutual ties if $Y_{ji} = 1$.

3.1.2. Fitting ERGM

Our basic model measures the gender choice homophily and sociability (out-going ties) by gender which are the focus of the research, and they control for reciprocity, i.e. ties being mutual. Choice homophily was estimated in a separate parameter for males and females. In addition, we fitted multiple models with additional control variables to check the robustness of the gender choice homophily results. In most of the cases, the choice homophily estimates under consideration were unchanged, and we point out the differences when appropriate. The models are explained in Table 3.4. A personal attribute, when referred to, is included both on the individual level and the dyadic level. For example, age is included both as the age of the tie-sender, age of the tie-receiver and absolute difference between them. Some of the models are missing or altered due to small groups or missing variables.[2] For example, not all the models converged with a GW-Indegree term, and degree was only controlled for with the GW-Outdegree term. In addition, some of the personal attributes are not included in all the models with the higher-order network-structural processes.

3.1.3. Permutation tests

Since we have a limited number of network observations, and because they are not all independent observations, we use permutation tests to calculate the exact p-value of our observed slope. We implement multiple permutation tests to account for different assumptions on our data structure.

First, we pool all the observations, ignoring the dependence between some of them. We then calculate a simple OLS with our observed choice homophily as the dependent variable and the proportion of women as the independent variable, with the slope measuring the effect we are interested in. We permute the choice homophily-female proportion pairs and calculate the complete event space of possible slopes, to achieve the significance level of our observed slope.

Second, we will run multiple tests under different dependence assumptions, keeping the homophily estimates originating in a setting clustered and the proportion of women from a setting clustered. This is also explained in Fig. 3.2. Some of the settings have 3 observations, so we calculate the observed slope using only these settings and permute the proportions of women of each setting together. For example, a proportion of women ranging 55%–60% in one setting at 3 time points will be randomized together to a different setting (with its choice homophily). Similarly, we will use only 2 data points to allow inclusion

Table 3.4
Description of the models analyzed. Each model controls for different variables, either personal attributes or network statistics. All models show similar results regarding our variables of interest and are therefore compared to demonstrate robustness.

Model Name:	Basic	Age	Tenure	ADL	Married	TC	Degree
Coefficient Term:							
gender	X	X	X	X	X	X	X
age		X	X	X	X	X	X
tenure			X	X	X	X	X
ADL				X			
married					X		
Network Statistics							
Reciprocity	X	X	X	X	X	X	X
GWESP						X	X
GWODegree							X

[2] * AG: at all times, no married. At t = 2, absolute majority with no ADL. At t = 3, only 2/18 male network members. therefore no male-choice homophily coefficient. * BY: only participated at t = 1. * BG: at t = 2, absolute majority with no ADL.

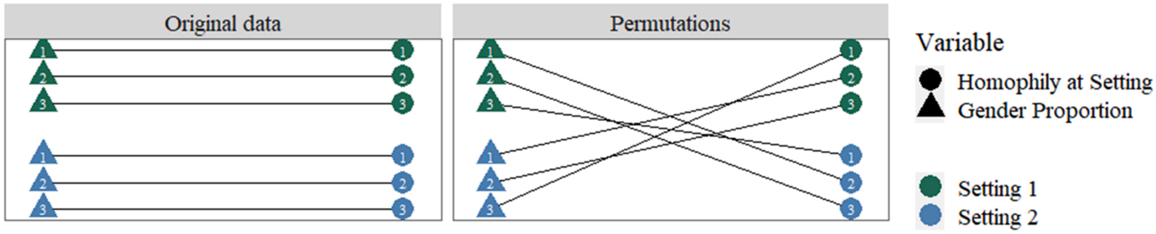

Fig. 3.2. Diagram describing permutations by setting. The numbers refer to the time point of data collection, with the permutations mixing the time points within settings.

of more settings that have only 2 observations, permuting in a similar clustered manner. One method used $t = 1, 2$ for all settings with these data points available. The other method used the 2 data points available for settings with only 2 data points and 2 randomly chosen data points for settings with 3 data points.

4. Results

We will present the main results of the fitted ERGM in the following plots. The plots include point estimates of the parameters with 95% Confidence Intervals $[\pm z_{0.975} \times \sqrt{Diag(\Sigma)}]$. An estimate is significant at the 5% confidence level in cases where the CI doesn't include zero. Positive values indicate choice homophily and negative values indicate Outbreeding, or disassortative mixing. We ran separate models, adding each control until reaching the full model. We will focus on the choice homophily while the fitted models are presented separately in the *Appendix*.

Fig. 4.1 presents the estimates for Female and Male choice homophily, for models basic, ADL, married, TC and degree at each setting. As can be seen, choice homophily is different within settings between waves, and within waves. As we alluded previously, the choice homophily estimates are similar in all the models, and especially in models with no higher-order network statistics. This is also evident from the overlap of the CI. We conclude that choice homophily is stable, robust and varies between settings and waves.

Regarding Hypothesis (1), we can see that in the vast majority of the settings, choice homophily is non-negative and even positive. The coefficients' CI is completely in the negative range only in one case. In many of the settings, the choice homophily estimates for women and men are different and even negatively correlated with each other. Therefore, we can say that Hypothesis (1) is partly supported.

According to distinctiveness theory, Hypothesis (2) predicts that the minority group of men would have a stronger tendency for choice homophily than the majority group of women. In line with this hypothesis, Fig. 4.2 present the estimates of choice homophily of men and women as a function of the percentage of women in the setting (along with Figs. 8.2 and 8.3 in the appendix). Each Figure presents the estimate from a different model with additional controlling variables. The Figures include a trend-line highlighting our finding. As can be seen, the observed trend is mirrored between women and men: While women exhibit less choice homophily when they are the majority, men exhibit more choice homophily when they are the minority.

These trends can be measured as the slope in a linear regression, modeling the choice homophily as a function of the proportion of females. Due to our limited number of observations, and the dependence between observations, we use permutation tests to calculate the

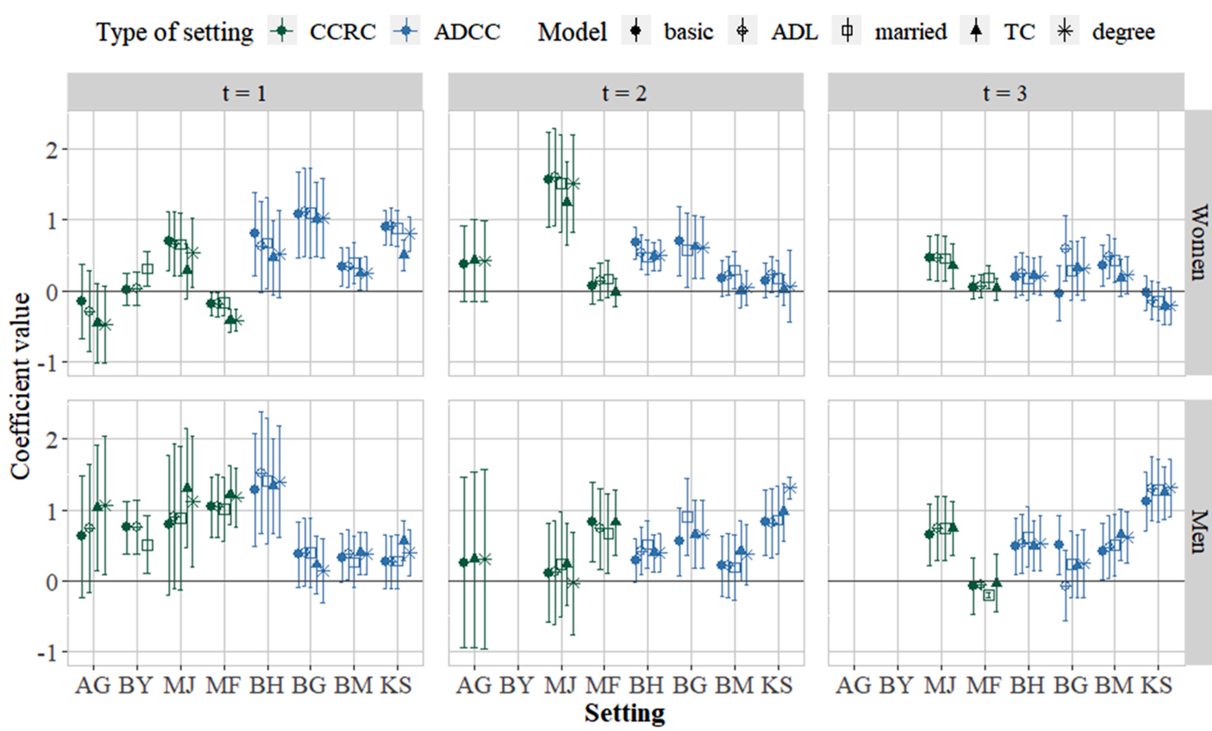

Fig. 4.1. Choice homophily by setting. The X-axis is grouped by setting and the Y-axis presents the value of the coefficient. Each facet displays a different gender and a different time point, 3 altogether, with one setting only participating in the first time point. Positive values indicate choice homophily and negative values indicate heterophily. The models are marked with different symbols, along with C.I. at 95%. The two colors indicate the two types of settings.

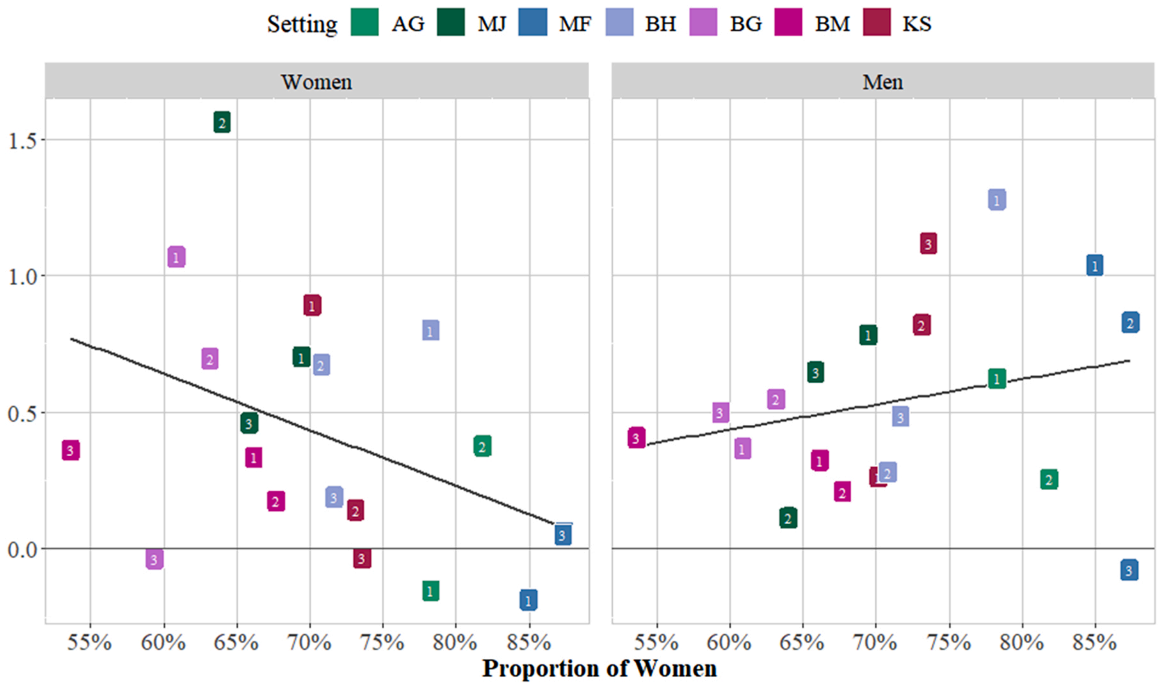

Fig. 4.2. Choice homophily by hender as a function of proportion of women, Basic model. The X-axis is the proportion of women at the setting and the Y-axis represents the value of the coefficient. Each facet displays a different sex. The colors indicate the different settings, and the markings indicate the time point by number.

significance. We test separately using the choice homophily estimated in each of the three models presented (Basic, TC and Degree). We used different permutations assumptions, and for each set of assumptions calculated the slope. The trend for females is between (−2) and (−4) and for males between (+1) and (+3.5), depending on the assumptions and the original models used to estimate the ERGM parameters. This means that the strength of the homophily decreases at a higher rate for females than it increases for males as the females become the majority. Fig. 8.4 in the appendix presents the results of the permutations: The X-axis presents the estimate of the slope and the Y-axis, the p-value calculated using the permutation. This effect is significant at the 5% level in most of the permutations for the women, but less of the permutations for the men are significant.

After examining the evidence in favor of the distinctiveness theory, we turn to examine alternative explanations to the differences between levels of choice homophily in different settings.

The first is Hypothesis (3), suggesting the difference between the type of LTC setting could explain the strength of choice homophily. Fig. 8.5 in the Appendix presents the results of a two-sided t-test for each model and each gender separately. The X-axis presents the value of the difference in means, ranging from −0.166 – 0.082, with CI at 95% significance level overlapping with zero, meaning the difference is not significant or meaningful. The Y-axis presents the p-value of the two-sided t-test, showing all differences to be not significant, with minimum probability to reject the null hypothesis in favor of the Alternative Hypothesis (3) of 0.444. Therefore, we do not reject the null hypothesis in favor of the difference in means by type of LTC.

Hypothesis (4) suggests that change in choice homophily can be explained by the percentage of people overlapping in the network between consecutive time points. We examined the estimates as a function of this overlap. For each of the 2 time lags (between t = 1 and t = 2, and between t = 2 and t = 3) we calculated the absolute difference between the choice homophily coefficients. Then, we matched the absolute difference with the corresponding overlap rate: $\frac{(t_1 \cap t_2)}{t_1}$ or $\frac{(t_2 \cap t_3)}{t_2}$, both presented previously in the descriptives in Fig. 3.1. V with the same colors. The pairs of overlap rate and absolute difference in coefficients are presented in a scatter plot in Fig. 8.6 in the Appendix, for both genders and different models. The Figures include a trend-line highlighting little to no correlation between the proportion of people overlapping at the setting and the similarity between the choice homophily coefficient in the consecutive time points. According to our hypothesis, the trend should be decreasing with a higher percentage of the same people, the change in choice homophily should be smaller, and this is not the case.

5. Discussion

We examined individual tie formation by considering the social network in which the network members are embedded. In our case, this refers to where they spend a considerable amount of time daily. We focused on gender homophily against the backdrop of the majority of women present in all networks, using a network model that accounts for additional factors that may promote tie formation.

Our main result is that gender is not uniformly important to tie formation but rather contextual. For men, it becomes more salient as they become a smaller minority, and for women it becomes less salient as they become the majority. This result was consistent even when controlling for other personal and dyadic attributes, and for simultaneous social processes at the dyadic and triad level.

Using multiple LTC settings is particularly helpful as part of our structural analysis. It allowed us to examine the unique case of men constituting different degrees of minority. In much of the past research, the gender distribution was either close to uniform (Ibarra, 1992) or men were the majority (Huang et al., 2009; Yap and Harrigan, 2015; Boda et al., 2020; Di Tommaso et al., 2020). Also, these past studies analyzed a single network or very few networks and could not compare different attribute distributions across the networks. The result is apparent in both types of LTC setting, the ADCC where members go home every day and CCRC where members reside in the setting. Accordingly, the trend was not substantially affected by the frequency of contact of the network members and should be relevant in a wide range of settings such as school, universities, the workforce, and live-in institutions.

Regarding the specific context of older adults, the argument can be raised that our research focused on mere acquaintances, and therefore limited comparisons can be made to previous research which focused on close ties (Antonucci et al., 2013; Schwartz and Litwin, 2018). However, the general conclusion regarding the differential importance of gender, and the importance of the surrounding social context, are still valid. Previous research about gender differences in these social networks highlighted women's larger social circle (Antonucci et al., 2013; Schwartz and Litwin, 2018), but it was not able to account for the surrounding social group available to the interviewee. We argue that gender homophily among older adults cannot be understood without acknowledging the majority of women.

Understanding the social dynamics in social contexts such as LTC settings could be helpful to designing better programs to promote tie formation and possible subsequent friendship development. As the populations ages, LTC settings become available to older adults interested in widening their social network, maintaining their independence, and receiving assistance in activities of daily living. The difference between men and women choice homophily patterns should be considered when developing the communities in LTC settings or among older adults in other settings. Practitioners could focus on forging new ties and maintaining connections among men as a primary peer-group. In addition, this group is a minority and could be very limited by the number of men present in the setting with whom ties can be formed. Therefore, other social forces contributing to tie formation should be advanced. For example, attributes other than gender could be highlighted as the basis for homophily and tie formation, such as personal interests and hobbies.

We found that other factors we hypothesized about were less important in determining homophily. This further strengthen the distinctiveness hypothesis. As we demonstrated, the type of the setting proved to be less important, as was the continuous aspect of the network. Examined together, we conclude that at least the superficial acquaintances are more affected by the current social structure, and less determined by the specific people. Future research could explore whether stronger friendships are similarly affected by the social structure.

The methodology we used applies Blau's social structure theory in new ways, by quantifying the correlation between the social composition and social ties across networks. Calculating the coefficient can be useful for estimating the expected homophily in a similar case or for comparing to other studies. A similar approach is found in Goodreau et al. (2009) study, but they did not calculate the correlation between the distribution of attributes and homophily and cannot compare the trends. As more data are available to research social networks, comparing different network compositions becomes more relevant and can be used more often.

6. Conclusions

Our study further confirms and extends structural sociology a-la Blau and distinctiveness theory. Much of the earlier work on social networks through this theoretical framework focused either on a single network, comparing the majority and the minority within it (Mehra et al., 1998; Leonard et al., 2008; Di Tommaso et al., 2020) or used multiple networks but was based on crude statistical analysis such as simple correlations (Blau et al., 1982). In this research we analyzed novel data using models that estimate the effect of social attributes on tie formation while controlling for other network processes. We used multiple settings and time points to establish the importance of the majority/minority axis to tie formation. We were able to utilize the range of women majority in our data to confirm what had been hypothesized previously, that homophily is affected by the composition of the network.

Despite its novelty, this research has several limitations. First, while this research uses multiple observations of the same LTC settings, our statistical analysis could not account for this in a rigorous manner. We recognized that there was not enough overlap in the network members to group the measurements of the same setting using longitudinal methods (such as Stochastic Actor Oriented Models, see (Snijders, 2017). For example, Snijders (2017) reported 81% (129/160) of overlap, meaning network members present at all 3 measurement points. The different rates of population overlap in the present study are lower as can be seen in Fig. 3.1.V.

In addition, the study focused on the acquaintance aspect of the social networks at the LTC settings. It did not address more socially meaningful aspects such as satisfaction with the relationship, sharing thoughts and secrets or frequency of meeting. These types of ties would be closer in importance to the marriage ties analyzed by Blau, Blum and Schwartz while demonstrating the theory of structural sociology (1982). Nonetheless, in LTC settings, superficial secondary relationships may constitute the norm (Ayalon and Green, 2013) and can potentially become close relationships.

Using multiple small to medium sized networks allowed us to scrutinize the relevance of the immediate social network in which a person is situated. We would argue that the microsocial context should be considered alongside the macrosocial structure favored by structural sociology (Blau, 1977; Blau et al., 1982). While the social networks we analyzed had clear boundaries, making this analysis easier, this conclusion should be examined in larger, dispersed networks, especially if smaller components can be defined.

Future researchers analyzing infinitely large networks should consider examining different components or subgroups separately. The attribute distribution might be different in various parts of the network, leading to different homophily levels. Analyzing a large network "piece by piece" could uncover different social dynamics that might be present locally but are overlooked or obscured in the global network level.

Our research also takes a different approach to gender dynamics. One aspect is the case of women majority, which is different from the broader societal demographics. Another aspect is the LTC setting which is different than the workplace hierarchical structure. For example, Di Tommaso et al.'s study (2020) supported distinctiveness theory when analyzing the men's majority and women's minority in a large multinational corporation. Other examples include a more balanced gender distribution within a hierarchical organization (Ibarra, 1992; Elliott and Smith, 2004). Both aspects touch on the complexity of gender and the unique opportunity presented by our data, to separate the attribute distribution from its cultural connotations.

In this manner, our study is more comparable to the research on ethnic minorities, such as Leonard et al.'s study (2008) on ethnic minorities which become the majority in a specific student association, or the results presented by Goodreau et al. (2009) on the proportion of different ethnic groups in each elementary school and their selective mixing patterns. In this light, our research further demonstrates the explanatory power of the social demographics and distribution of attributes, regardless of the cultural meaning attached to it. Measuring the correlation between minority status and homophily is an essential methodological step to comparing network structure and to systematically establishing structural sociology.

When considering the results, practitioners can find them useful also for interventions and for leading change in social networks that are similar. First and foremost, the social setting should either be intended for fostering interpersonal ties or would benefit from them. The former can include schools or extra-curricular activities where children can be encouraged or helped in finding ways to connect that do not reinforce existing social structures. The latter includes workforce organizations that wish to foster interaction and cooperation among different groups and avoid segregation. An example of an intervention in a population different from the LTC settings examined here can be found in Boda et al.'s (2020) research on an intervention among STEM university students, and particularly regarding mixed-gender friendships.

Future research can extend this type of analysis to other types of attributes. These include examining nominal parameters such as ethnicity/race but also examining graduated parameters such as physical ability or education. Group identification and ingroup boundaries might themselves be affected by the attribute distribution, requiring context-specific categorization. Comparing the patterns of homophily by different attributes could demonstrate the relative salience of each attribute and further enrich our understanding of social networks.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.socnet.2022.06.005.

References

Holland, Paul W., Leinhardt, Samuel, 1981H. An exponential family of probability distributions for directed graphs. J. of the Am. Stat. Association 76 (373), 33–50. https://doi.org/10.1080/01621459.1981.10477598.

Antonucci, Toni C., Kristine J.Ajrouch, and Kira S. Birditt. 2013. The Convoy Model: Explaining Social Relations From a Multidisciplinary Perspective 54 (1): 82–92. ⟨https://doi.org/10.1093/geront/gnt118⟩.

Ayalon, Liat, Green, Varda, 2013. Social ties in the context of the continuing care retirement community. Qual. Health Res. 23 (3), 396–406. https://doi.org/10.1177/1049732312468506.

Ayalon, Liat, Yahav, Inbal, Lesser, Ofrit, 2018. From a bird's eye view: whole social networks in adult day care centers and continuing care retirement communities. Innovation in Aging 2 (3), 1–12. https://doi.org/10.1093/geroni/igy024.

Biggs, Simon, Miriam Bernard, Paul Kingston, and Hilary Nettleton, 2000. Lifestyles of belief: narrative and culture in a retirement community. Ageing and Society 20, 649–672. ⟨https://www.cambridge.org/core/terms⟩.

Blau, P.M., 1977. A macrosociological theory of social structure. Am. J. of Sociol. 83 (1), 26–54.

Blau, Peter M., Blum, Terry C., Schwartz, Joseph E., 1982B. Heterogeneity and intermarriage. Am. Sociol. Rev. 47 (1), 45–62. https://doi.org/10.2307/2095041.

Boda, Z., Elmer, T., Vörös, A., et al., 2020. Short-term and long-term effects of a social network intervention on friendships among university students. Sci. Rep. 10, 2889. https://doi.org/10.1038/s41598-020-59594-z.

Carstensen, Laura L. 2006. The influence of a sense of time on human development. NIH Public Access. ⟨https://doi.org/10.1126/science.1127488⟩.

Cepić, Dražen, Tonković, Željka, 2020. How social ties transcend class boundaries? Network variability as tool for exploring occupational homophily. Soc. Netw. 62 (February), 33–42. https://doi.org/10.1016/j.socnet.2020.02.003.

Cornwell, Benjamin, Laumann, Edward O., 2015. The health benefits of network growth: New evidence from a national survey of older adults. Soc. Sci. and Med. 125, 94–106. https://doi.org/10.1016/j.socscimed.2013.09.011.

Davis, J.A., 1967. Clustering and structural balance in graphs. Hum. Relat. 20 (2), 181–187.

Di Tommaso, Giorgia, Gatti, Mauro, Iannotta, Michela, Mehra, Ajay, Stilo, Giovanni, Velardi, Paola, 2020. Gender, rank, and social networks on an enterprise social media platform. Soc. Netw. 62 (February), 58–67. https://doi.org/10.1016/j.socnet.2020.02.007.

Elliott, J.R., Smith, R.A., 2004. Race, gender, and workplace power. Am. Sociol. Rev. 69, 365–386.

Engels, R.C., Knibbe, R.A., Vries, H.D., Drop, M.J., van Breukelen, G.J., 1999. Influences of parental and best friends' smoking and drinking on adolescent use: a longitudinal study 1. J. of Appl. Soc. Psychol. 29 (2), 337–361.

Feld, Scott, William, C.Carter, 2009. Foci of activity as changing contexts for friendship. Placing Friendship in Context. Cambridge University Press, pp. 136–152. https://doi.org/10.1017/cbo9780511520747.008.

Feld, Scott L., 1981. The focused organization of social ties. Am. J. of Sociol. 86 (5), 1015–1035. ⟨http://www.journals.uchicago.edu/t-and-c⟩.

Goodreau, S.M., Kitts, J.A., Morris, M., 2009. Birds of a feather, or friend of a friend? Using exponential random graph models to investigate adolescent social networks. Demography 46 (1), 103–125. https://doi.org/10.1353/dem.0.0045.

Huang, Yun, Cuihua Shen, Dmitri Williams, and Noshir Contractor. 2009. "Virtually There: Exploring Proximity and Homophily in a Virtual Worldploring Proximity and Homophily in a Virtual World." In *International Conference on Computational Science and Engineering, 4* . ⟨https://doi.org/10.1109/CSE.2009.471⟩.

Holland, Paul, Leinhardt, W., Samual, 1971H. Transitivity in structural models of small groups. Comp. Group Stud. 2 (2), 107–124. https://doi.org/10.1177/104649647100200201.

Hunter, David R., 2007. Curved exponential family models for social networks. Soc. Netw. 29 (2), 216–230. https://doi.org/10.1016/j.socnet.2006.08.005.

Ibarra, Herminia, 1992. Homophily and differential returns: sex differences in network structure and access in an advertising firm. Adm. Sci. Q. 37 (3), 422–447. ⟨https://www.jstor.org/stable/2393451⟩.

Kossinets, Gueorgi, Watts, Duncan J., 2009. Origins of homophily in an evolving social network. Am. J. of Sociol. 115 (2), 450. ⟨http://www.journals.uchicago.edu/t-and-c⟩.

Laumann, Edward O., Marsden, Peter V., Prensky, David, 1989. The boundary specification problem in network analysis. Res. Methods in Soc. Netw. Anal. 61, 87.

Lazarsfeld, Paul F., Merton, Robert K., 1954. Friendship as a Social Process: a Substantive and Methodological Analysis. In Berger, Morroe, Abel, Theodore. and Page, Charles, H., Eds., *Freedom and Control in Modern Society*. Van Nostrand, New York, pp. 18–66.

Leonard, Ana Sierra, Mehra, Ajay, Katerberg, Ralph, 2008. The social identity and social networks of ethnic minority groups in organizations: a crucial test of distinctiveness theory. J. of Organ. Behav. 29 (5), 573–589. https://doi.org/10.1002/job.488.

Lien, Pei-te, Conway, Margaret, Wong, Janelle, 2003. The contours and sources of ethnic identity choices among Asian Americans. Soc. Sci. Q. 84 (2), 461–481. https://doi.org/10.1111/1540-6237.8402015.

McGuire, William J., McGuire, Claire V., Child, Pamela, Fujioka, Terry, 1978. Salience of ethnicity in the spontaneous self-concept as a function of one's ethnic distinctiveness in the social environment. J. of Personal. and Soc. Psychol. 36 (5), 511–520. ⟨https://psycnet.apa.org/fulltext/1979-13208-001.pdf⟩.

Mcintosh, Wm. Alex, Alston, Jon P., 1982. Lenski revisited: the linkage role of religion in primary and secondary groups'. Am. J. of Sociol. 87 (4), 852–882. https://doi.org/10.1086/227524.

McPherson, Miller, Smith-Lovin, Lynn, Cook, James M., 2001. Birds of a feather: homophily in social networks. Annu. Rev. of Sociol. 27, 415–444.

Mehra, Ajay, Kilduff, Martin, Brass, Daniel J., 1998. At the margins: a distinctiveness approach to the social identity and social networks of underrepresented groups. Acad. of Manag. J. 41 (4), 441–452. https://doi.org/10.5465/257083.

Papachristos, Andrew V., Hureau, David M., Braga, Anthony A., 2013. The corner and the crew: the influence of geography and social networks on gang violence. Am. Sociol. Rev. 78 (3), 417–447. https://doi.org/10.1177/0003122413486800.

Schafer, Markus H., 2015. On the locality of asymmetric close relations: Spatial proximity and health differences in a senior community. J. of Gerontol. - Ser. B Psychol. Sci. and Soc. Sci. 70 (1), 100–110. https://doi.org/10.1093/geronb/gbu043.

Schafer, Markus H., 2016. Health as status? Network relations and social structure in an American retirement community. Ageing and Society 36 (1), 79–105. https://doi.org/10.1017/s0144686×14000993.

Schwartz, Ella, Litwin, Howard, 2018. Social network changes among older Europeans: the role of gender. Eur. J. of Ageing 15 (4), 359–367. https://doi.org/10.1007/s10433-017-0454-z.

Simmel, Georg, 1950. The Sociology of Georg Simmel. Simon and Schuster.

Snijders, Tom A.B., 2017. Stochastic actor-oriented models for network dynamics. Annu. Rev. of Stat. and Its Appl. 4 (1), 343–363. https://doi.org/10.1146/annurev-statistics-060116-054035.

Snijders, Tom A.B., Pattison, Philippa E., Robins, Garry L., Handcock, Mark S., 2006. New specifications for exponential random graph models. Sociol. Methodol. 36 (1), 99–153. https://doi.org/10.1111/j.1467-9531.2006.00176.x.

Steglich, C., Snijders, T.A.B., Pearson, M., 2010. Dynamic networks and behavior: separating selection from influence. Sociol. Methodol. 40 (1), 329–393. https://doi.org/10.1111/j.1467-9531.2010.01225.x.

Tomini, Florian, Tomini, Sonila M., Groot, Wim, 2016. Understanding the value of social networks in life satisfaction of elderly people: a comparative study of 16 European countries using SHARE data. BMC Geriatr. 16 (203) https://doi.org/10.1186/s12877-016-0362-7.

Weber, Max. 1914/1968. *Economy and Society: An Outline of Interpretative Sociology*. Translated and edited by Guenther Roth and Claus Wittich, 3 volumes. New York: Bedminster.

WHO, World Health Organization. 2020. "Life expectancy at age 60 (years)." ⟨https://www.who.int/data/gho/data/indicators/indicator-details/GHO/life-expectancy-at-age-60-(years)⟩.

Yap, Janice, Harrigan, Nicholas, 2015. Why does everybody hate me? Balance, status, and homophily: The triumvirate of signed tie formation. Soc. Netw. 40, 103–122. https://doi.org/10.1016/j.socnet.2014.08.002.