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Popularity, Similarity, and the Network Extraversion Bias

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Abstract

Using the emergent friendship network of an incoming cohort of students in an M.B.A. program, we examined the role of extraversion in shaping social networks. Extraversion has two important implications for the emergence of network ties: a popularity effect, in which extraverts accumulate more friends than introverts do, and a homophily effect, in which the more similar are two people's levels of extraversion, the more likely they are to become friends. These effects result in a systematic *network extraversion bias*, in which people's social networks will tend to be overpopulated with extraverts and underpopulated with introverts. Moreover, the most extraverted people have the greatest network extraversion bias, and the most introverted people have the least network extraversion bias. Our finding that social networks were systematically misrepresentative of the broader social environment raises questions about whether there is a societal bias toward believing other people are more extraverted than they actually are and whether introverts are better socially calibrated than extraverts.

Keywords

personality, extraversion, social networks, social judgment

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A fundamental notion of social psychology is that one's beliefs about social behavior are largely determined by the individuals in one's immediate environment (Sherif, 1936). Because social perceptions are shaped by the people one is connected to (McArthur & Baron, 1983), a deeper understanding of how individuals' social networks are composed is valuable. It is particularly important to understand factors that may cause individuals' social networks to be misrepresentative of the broader social environment. As a step in this direction, we explored whether individuals' personalities could cause systematic biases in the composition of their social networks.

We examined whether the levels of extraversion of two individuals made them more or less likely to become friends and how these dyadic underpinnings influenced the composition of people's social networks in aggregate. The likelihood that any two individuals in a social environment become friends is known to increase (a) as they have more opportunities to interact and (b) if they like each other upon interacting (Byrne, 1961; McPherson, Smith-Lovin, & Cook, 2001). We argue that extraversion, a fundamental personality variable, plays a role in shaping opportunities for interaction and interpersonal liking and is therefore an important psychological determinant of social-network composition. However, the effects of extraversion on social connection ultimately lead to a bias in social networks. Our results provide an underlying logic for why people may not be as outgoing as you think (unless you are very introverted).

Extraversion-introversion[1]—the extent to which one is outgoing and sociable, as opposed to reserved and quiet (McCrae & Costa, 1990)—has long been established among psychologists as one of the Big Five dimensions along which personality varies (Costa & McCrae, 1992; Eyesenck, 1981). The key features of extraversion are sociability, outgoingness, and assertiveness; compared with introverts, extraverts tend to engage in more social interaction (McCrae & Costa, 1990) and to seek and attract more social attention (Ashton, Lee, & Paunonen,

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2002). Individuals who are more extraverted tend to be more talkative and to spend more time interacting with other people than individuals who are more introverted (John & Srivastava, 1999; Paunonen & Ashton, 2001). More extraverted individuals are more likely to initiate social interactions and enter more social situations, both of which are conducive to the formation of new relationships (Shipilov, Labianca, Kalnysh, & Kalnysh, 2014). Introverts, by contrast, are inclined to spend more time alone and, when they do socialize, tend to prefer more intimate settings. Support for the link between extraversion and popularity has been found in work on school children, online profiles, and self-perceptions (Jensen-Campbell et al., 2002; Ong et al., 2011; Paunonen, 2003). Therefore, we expected *extraversion popularity*: Extraversion should be associated with larger networks. More precisely, all else being equal, greater extraversion makes one more likely to become friends with any given other person.

Extraversion may also affect networks through social homophily—the tendency to associate with people similar to oneself (McPherson et al., 2001). For more than 50 years, psychologists have explored whether similarity leads to liking and attraction (e.g., Byrne, 1961; Montoya, Horton, & Kirchner, 2008) and whether greater similarity between people and their friends leads to greater happiness (Seder & Oishi, 2009); in particular, the research has been focused on attitudinal similarity (Byrne, Baskett, & Hodges, 1971; Condon & Crano, 1988). Sociologists have argued that homophily also occurs because similar people choose to enter into similar situations (Feld, 1981), which increases their opportunity to connect circumstantially, even in the absence of any underlying preference for such connection. Evidence for the link between extraversion similarity and relationship formation has been found in work on spouse selection, marriage distress, and "best friend" designation (Gattis, Berns, Simpson, & Christensen, 2004; Humbad, Donnellan, Iacono, McGue, & Burt, 2010; Selfhout, Branje, Raaijmakers, & Meeus, 2007; cf. Furler, Gomez, & Grob, 2013). Therefore, we expected that because of either greater liking due to similarity attraction or greater interaction due to choice of similar social situations (or both), people with similar levels of extraversion should be more likely to become friends than people with different levels of extraversion. We refer to this as *extraversion homophily.*

The extraversion-popularity and extraversion-homophily hypotheses are straightforward; in combination, however, they yield an interesting implication for the overall composition of individuals' social networks. We will refer to the true mean extraversion of the entire social environment as the *population extraversion*. The mean extraversion of an individual's social contacts—which we refer to as that individual's *network extraversion*—may deviate from the population extraversion. If friendships are randomly developed among the population, then one would expect no systematic deviation between network extraversion and population extraversion. However, because we expect greater extraversion to make one more likely to build friendships, extraverted individuals will be overrepresented, and introverted individuals will be underrepresented, in the networks of other people. Network extraversion will therefore be systematically higher than the population extraversion. In making this argument, we build on and extend the "friendship paradox," about which Feld (1991) provocatively argued that "your friends have more friends than you do" because of the mathematical truism that as one has more connections, one is present in a greater number of other people's networks. Therefore, people's social networks disproportionately contain individuals that have many connections. We extend this idea beyond a purely mathematical claim by joining the friendship paradox with extraversion popularity and hypothesize the existence of a *network extraversion bias*: On average, people have networks that are more extraverted than the overall social environment.

Finally, we argue that this bias should depend on one's own level of extraversion. Throughout this article, we use the notation of person i as the focal individual and person j as an individual who may or may not be i's friend. As illustrated in Figure 1a, for an introverted i, the popularity and homophily effects work in opposition: A more extraverted j is more sociable and popular (which increases the likelihood of friendship) but is also less similar to the introverted i (which decreases the likelihood of friendship). In contrast, for an extraverted i, the popularity and homophily effects work in concert (see Fig. 1b): A more extraverted j is both more sociable and popular (which increases the likelihood of friendship) and more similar to the extraverted i (which also increases the likelihood of friendship). Therefore, we expect that extraverts will have networks that are disproportionally populated with other extraverts. Introverts, by contrast, may have social networks that are less biased and more representative of the true population with regard to extraversion. In sum, we predict an overall network extraversion bias and expect the magnitude of bias to be the greatest for the most extraverted individuals.

Data and Measures

To test these hypotheses, we studied a complete cohort of M.B.A. students at a private university in the northeastern United States. An incoming cohort of M.B.A. students is a useful sample because the students are initially unfamiliar with each other, they simultaneously enter a social environment, and friendships emerge in the first several months. This simultaneity, control, and access make it an

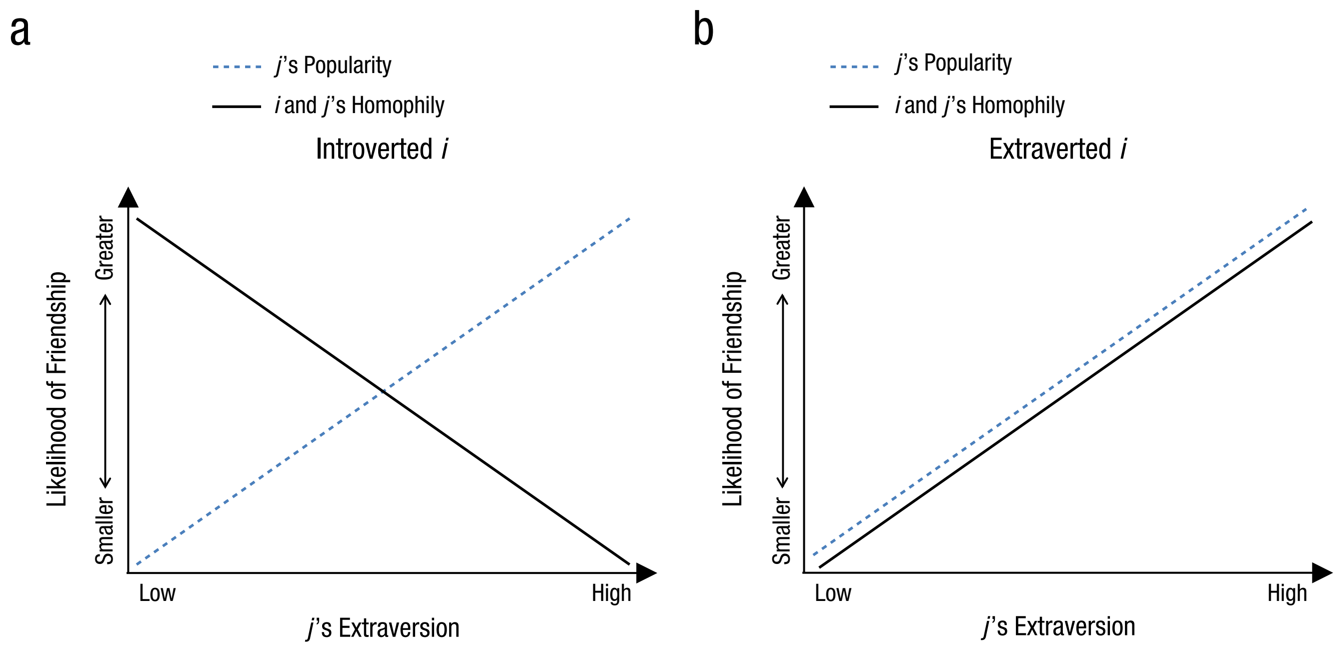

Fig. 1. Dual effects of extraversion. The diagrams illustrate the dual effects of individual *j*'s extraversion on the likelihood of a friendship between individual *i* and individual *j* when *i* is (a) introverted or (b) extraverted.

ideal field setting in which to examine emergent social networks. Our sample included all 284 students (34% female; 56% White, non-Hispanic; 65% U.S. citizens; average age = 28.4 years) who began their graduate program in the fall of 2012.

The emerging social network within their cohort was measured at two points in time. Time 1 was 5 weeks after students had arrived on campus for orientation. Time 2 was 11 weeks after their arrival (and 6 weeks after Time 1). Given our interest in social relations in general, rather than close friendships specifically, we asked students the following question (adapted from Burt, 1992, p. 123) on the study Web site at each time point:

> Consider the people with whom you like to spend your free time. Since you arrived at [university name], who are the classmates you have been with most often for informal social activities, such as going out to lunch, dinner, drinks, films, visiting one another's homes, and so on?

To avoid problems of incomplete recall (Brewer, 2000), we included in our survey a list of all other students in the first year of the M.B.A. program. The names were displayed in columns; each column represented one class section, and the names were listed alphabetically.[2] Each respondent indicated the other students with whom he or she socialized by checking a box next to those people's names. A minimum of two contacts were required, but no upper limit was imposed.

Following the Time 2 network survey, each individual's personality characteristics were measured using the Big Five Inventory (John & Srivastava, 1999), a well-established, 44-item instrument that measures extraversion, openness to experience, conscientiousness, agreeableness, and neuroticism. The extraversion measure required subjects to rate the extent to which they agreed or disagreed (on a 5-point scale) with each of eight statements about themselves. For example, the items included "is outgoing, sociable," "is talkative," and "is reserved" (reverse-scored). No analyses were initially run on any of the other personality characteristics in this project.[3]

Finally, demographic data were provided by the school's registrar about each student's gender, race, citizenship, age, class section, study group assignment, and residence status (i.e., whether he or she lived on or off campus). For each source of data, all personally identifying information was removed, which left the various sources of data linked only by anonymous student ID numbers.

Models

Dyad-level models

We used dyad-level models to answer the following question: How does the extraversion of two individuals affect whether one names the other as a friend? Person *i* designated which other individuals in the social environment he or she considered to be friends, and person *j* was someone who could possibly be named as a friend by *i*. Therefore, each individual appeared in the data not only as an *i* but also as a *j* for all others in the social environment. In our dyadic models, an observation is a given *ij* ordered pair and the dependent variable was an indicator of whether *i* cited *j* as a friend (0 = no, 1 = yes).

We estimated our dyadic effects with linear probability models using fixed effects for each individual (Angrist & Pischke, 2009; Mayer & Puller, 2008). Fixed effects were important because they allowed us to control for all characteristics of one individual (*i* or *j*) while testing whether the extraversion of the other individual (*j* or *i*, respectively) affected the likelihood of friendship. In the similarity models, we use fixed effects for both individuals to control for all individual characteristics of both individuals, allowing us to isolate effects related to the combination of individuals, such as extraversion similarity. In the following section, we clearly state which fixed effects were used in each model before presenting the results.

Although fixed effects enabled us to isolate effects of interest, there were still many interdependencies across observations because of the dyadic and repeated nature of the data. We were careful to account for these interdependencies using clustering, which adjusted the standard errors of the coefficient (via the covariance matrix) by relaxing the assumption of independence within each cluster.[4] To account for common-person effects (e.g., whether A names B as a friend is not independent of whether A names C),[5] we clustered standard errors around each *i* and each *j* (Kenny, Kashy, & Cook, 2006). To account for reciprocal autocorrelation (e.g., whether A names B as a friend is not independent of whether B names A) and repeated measures across time, we clustered standard errors around each unordered dyad *ij*. The multiway clustering of standard errors was accomplished using Kleinbaum, Stuart, and Tushman's (2013) implementation of Cameron, Gelbach, & Miller's (2011) algorithm.

In estimating the dyad-level models, we controlled for *i* and *j* having the same class section, study group, gender, race, nationality, campus-residence status, as well as for their age difference (which was added to 1 and log-transformed). All of these covariates were mean-centered. Although including covariates that are known to affect the likelihood of social connection enabled more accurate parameter estimates for our variables of interest, we showed that identical patterns of significance held when they were omitted from the analysis. We also included a binary indicator for the time the network was recorded: –1 for Time 1 and +1 for Time 2. This variable coding scheme allowed us to directly interpret the estimators as the main effects of explanatory variables (i.e., by pooling both time periods) and also to test whether the key effects increased in magnitude over time, using interactions of the explanatory variables with time.

Individual-level models

We then proceeded to individual-level models to test how these dyadic underpinnings affected the composition of an individual's network as a whole. The unit of analysis was the individual, and the dependent variables were measures of that individual's network.

Our first individual-level models tested whether extraversion led to popularity. For these models we operationalized popularity in two ways: the number of people that named the focal person as a friend, and the number of people that the focal person named as friends. The popularity measures were count variables, which were truncated at the lower end. Because ordinary least squares regression is inappropriate with truncated data, these models used a Poisson quasimaximum likelihood specification[6] (Wooldridge, 1997).

The final individual-level model tested the network-extraversion-bias hypothesis. This model tested whether the average extraversion of the people in one's network (i.e., network extraversion) was different from the average extraversion of the entire cohort (i.e., population extraversion). Extraversion was standardized, so the population extraversion was zero and the model was run using ordinary least squares regression.

To account for additional factors that might affect network composition, in our individual-level models we controlled for gender, U.S. citizenship, on-campus residency, and belonging to a racial minority group. All control variables were mean centered. Again, we controlled for the time when the network was recorded using a binary time indicator set to –1 (for Time 1) or +1 (for Time 2), a coding scheme that allowed us to interpret the estimated coefficients as main effects (i.e., by pooling both time periods and treating them equally) and to test whether the effect of extraversion changed in magnitude over time.

Results

The median respondent cited 16 friends at Time 1 and 26 at Time 2; both distributions had very long right tails (Time 1: range = 2–148, *SD* = 17.8; Time 2: range = 2–184, *SD* = 29.0).[7] The increase in network size across time indicates that social networks were actively being formed during the time period of study. Additional descriptive statistics appear in the Supplemental Material available online.

The reliability of the extraversion measure was very good (Cronbach's α = 0.86). The extraversion measure had a mean value of 3.45 and a standard deviation of 0.81 (on a scale from 1 to 5) before being standardized. The response rate from the cohort for both network surveys was 100%; however, 4 of the 284 students failed to complete the extraversion scale and were dropped from all analyses, yielding a final response rate of 98.6%.

The results for each key significance test for each model described in the following sections is in boldface type in Tables 1 and 2. We were also able to replicate all results with a three-item subscale of extraversion using only the items that pertain to being energetic rather than outgoing: "is full of energy," "generates enthusiasm," and "has an assertive personality" (see Supplemental Material).

Dyadic underpinnings

To begin establishing the dyadic underpinnings of how extraversion is associated with network composition, we examined whether the responder's extraversion was predictive of the likelihood that he or she would cite a given other person as a friend. We controlled for all observable and unobservable attributes of *j* using individual fixed effects for *j*. We then tested whether *i*'s extraversion increased the likelihood that *i* would cite *j* as a friend (Model 1). In using these fixed effects, we controlled for all heterogeneity across *j*s as possible targets for friendship. We then reestimated the model while controlling for dyadic covariates known to be associated with tie formation, which gave us a more accurate estimate of the effect size (Model 2). We found that being more extraverted significantly increased the likelihood that an individual would cite any given other person as a friend (see Table 1; $p < .01$ in both models).

Overall, the effect size was significant: After covariates and fixed effects were subtracted, a 1-*SD* increase in extraversion from the mean increased by 1.4 percentage points (from 9.6% to 11.0%) the probability that a person would cite any given other person as a friend. All other things being equal, the likelihood that an extravert in the 90th percentile of extraversion would cite any given other as a friend was 11.7%, whereas the same likelihood for an introvert in the 10th percentile of extraversion was 7.8%. Furthermore, disaggregating the Time 1 effects from Time 2 reveals that this effect grew substantially over time, from 0.6 percentage points (0.014 − 0.008) at Time 1 to 2.2 percentage points at Time 2 (0.014 + 0.008), $p < .01$.

Next, we tested whether being more extraverted makes one more likely to be cited by other people as a friend. In Model 3, we controlled for all observable and unobservable attributes of the responder *i* using fixed effects for *i*. We then tested whether *j*'s extraversion increased the likelihood that *i* would cite *j* as a friend. In Model 4, we added the dyad-level covariates that are known to affect social ties, which gave us a more accurate estimate of the effect size. We found that being more extraverted significantly increased the likelihood that an individual would be cited as a friend by any given other person ($p < .01$ in both models). After covariates and fixed effects were subtracted, a 1-*SD* increase in extraversion from the mean increased by 1.3 percentage points (from 9.6% to 10.9%) the probability that a person would be cited as a friend by any given other person. An extravert in the 90th percentile of extraversion had an 11.6% chance of being cited as friend by a given other person, whereas an introvert in the 10th percentile of extraversion had a 7.9% chance. Again, this effect grew larger across time, from 0.8 percentage points (0.013 – 0.005) at Time 1 to 1.8 points (0.013 + 0.005) at Time 2.

We then examined extraversion homophily. To isolate the effect of similarity, we included fixed effects for both *i* and *j* in Models 5 and 6 (Reagans & McEvily, 2003). These fixed effects accounted for all observable and unobservable individual attributes of both *i* and *j* that affected their propensity to form friendship ties, including their individual levels of extraversion. Again, established dyad-level covariates were added in Model 6 to improve the accuracy of the key parameter estimate. These models then tested whether the remaining variance could be explained by attributes of the *ij* dyad. The key independent variable of interest in Models 5 and 6 was extraversion similarity. This was operationalized as the absolute value of the difference between the extraversion scores of *i* and *j*, multiplied by −1 to convert a difference into a similarity score. We found that greater similarity in extraversion between two individuals significantly increased the likelihood that one would cite the other as a friend ($p < .01$). This effect did not change significantly across time periods. Specifically, compared with two people who differed in extraversion by 1 *SD*, two people with identical extraversion scores were 0.5 percentage points (9.8% vs. 10.3%) more likely to cite one another than were people without such similar scores. Examining a more extreme comparison, we found that highly similar dyads (similarity score in the 90th percentile) had a 10.2% chance of citing one another, whereas highly dissimilar dyads (with similarity score in the 10th percentile) had an 8.8% chance. The fixed effects for *i* and *j* ensured that this similarity effect was not a by-product of any extraversion-popularity effects. On the whole, although we found significant effects of extraversion homophily, it seemed to play a smaller role in shaping social interactions than extraversion popularity.

Consequences for individuals' networks

Next, we examined how these dyadic underpinnings affected an individual's network composition as a whole, in terms of popularity and network extraversion bias (see Table 2).

Table 1. Dyad-Level Models Predicting the Number of Network Ties (N = 156,240)

Predictor	Model 1 (including *j* fixed effects)	Model 2 (including *j* fixed effects)	Model 3 (including *i* fixed effects)	Model 4 (including *i* fixed effects)	Model 5 (including *i* and *j* fixed effects)	Model 6 (including *i* and *j* fixed effects)
i's extraversion	**0.018 (0.004)****	**0.014 (0.004)****	—	—	—	—
j's extraversion	—	—	**0.017 (0.003)****	**0.013 (0.002)****	—	—
Extraversion similarity	—	—	—	—	**0.010 (0.003)****	**0.006 (0.003)***
Time indicator	0.023 (0.003)**	0.023 (0.003)**	0.023 (0.003)**	0.023 (0.003)**	0.023 (0.003)**	0.023 (0.003)**
i's Extraversion × Time Indicator	0.008 (0.003)**	0.008 (0.003)**	—	—	—	—
j's Extraversion × Time Indicator	—	—	0.005 (0.001)**	0.005 (0.001)**	—	—
Extraversion Similarity × Time Indicator	—	—	—	—	0.001 (0.002)	0.001 (0.002)
Same class section	—	0.038 (0.004)**	—	0.038 (0.003)**	—	0.038 (0.004)**
Same study group	—	0.452 (0.020)**	—	0.452 (0.020)**	—	0.454 (0.020)**
Both living on campus	—	0.055 (0.010)**	—	0.052 (0.007)**	—	0.061 (0.008)**
Same gender	—	0.042 (0.004)**	—	0.040 (0.003)**	—	0.042 (0.004)**
Same race	—	0.070 (0.007)**	—	0.065 (0.007)**	—	0.072 (0.008)**
Same nationality	—	0.035 (0.009)**	—	0.047 (0.007)**	—	0.088 (0.011)**
Age difference (log-transformed)	—	–0.019 (0.004)**	—	–0.016 (0.004)**	—	–0.014 (0.004)**
Constant	0.096 (0.004)**	0.017 (0.007)*	0.096 (0.002)**	0.012 (0.006)	0.057 (0.005)**	–0.078 (0.010)**
R^2	.03	.10	.07	.14	.09	.16

Note: The table presents unstandardized correlation coefficients with cluster robust standard errors in parentheses. Boldface type indicates the results for the key significance test for each model.
*p < .05. **p < .01.

Table 2. Individual-Level Models Predicting Number of Times Cited by Other People, Number of Friends Cited, and Network Extraversion ($N = 560$)

	Models predicting times cited by other people		Models predicting number of friends cited		Models predicting network extraversion			
Predictor	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13	Model 14
Extraversion	**0.175 (0.024)****	**0.142 (0.022)****	**0.173 (0.040)****	**0.145 (0.039)****	—	—	**0.065 (0.016)****	**0.050 (0.015)****
Time indicator	0.241 (0.008)**	0.241 (0.008)**	0.235 (0.024)**	0.235 (0.024)**	0.014 (0.009)	0.014 (0.009)	0.014 (0.009)	0.014 (0.009)
Extraversion × Time Indicator	0.010 (0.008)	0.010 (0.008)	0.043 (0.024)	0.042 (0.024)	—	—	–0.001 (0.009)	–0.001 (0.009)
Female	—	–0.041 (0.044)	—	–0.121 (0.083)	—	0.019 (0.034)	—	0.021 (0.033)
U.S. citizen	—	0.178 (0.066)**	—	–0.023 (0.116)	—	0.157 (0.049)**	—	0.142 (0.047)**
On-campus resident	—	0.208 (0.045)**	—	0.270 (0.086)**	—	0.002 (0.033)	—	–0.007 (0.033)
Racial minority	—	–0.121 (0.061)*	—	–0.249 (0.105)*	—	–0.062 (0.041)	—	–0.057 (0.039)
Constant	3.258 (0.025)**	3.243 (0.023)**	3.243 (0.043)**	3.227 (0.041)**	**0.122 (0.017)****	**0.120 (0.016)****	0.122 (0.017)**	0.120 (0.016)**
R^{2a}	.20	.25	.11	.15	.00	.09	.04	.11

Note: The table presents unstandardized correlation coefficients with cluster robust standard errors in parentheses. Models 7 through 10 used the Poisson distribution; Models 11 through 14 used the ordinary least squares distribution. Boldface type indicates the results for the key significance test for each model.
[a]The values presented for Models 7 through 10 are pseudo-R^2 values.
*$p < .05$. **$p < .01$.

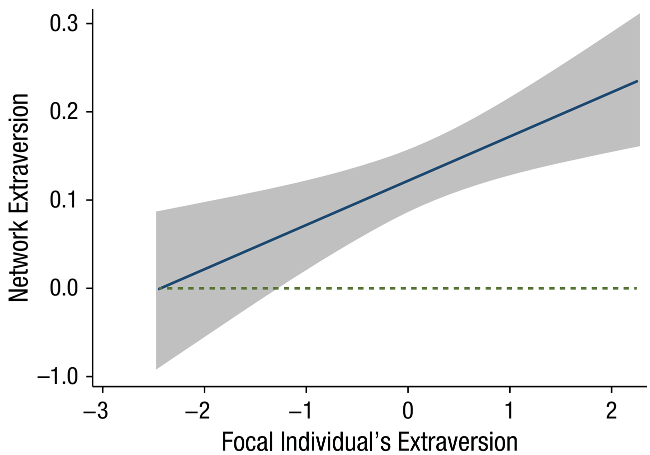

Fig. 2. Fitted estimates of network extraversion as a function of the focal individual's extraversion, according to Model 7. The shaded gray area represents the 95% confidence interval around the fitted solid line. The dashed line indicates the average extraversion of the population, which was zero by construction. The distance between the solid and dashed lines represents the estimated network extraversion bias at each level of extraversion.

We found that more extraverted individuals were cited as friends by significantly more people (Models 7 and 8, without and with control variables, respectively; *p*s < .01) and cited significantly more people as their friends (Models 9 and 10, without and with control variables, respectively; *p*s < .01).[8] All else being equal, a 1-*SD* increase in extraversion from the mean corresponded with being cited as a friend by 15% more people and citing 16% more people as friends. Moreover, the model estimated that extreme introverts (in the 10th percentile of extraversion) would be cited as friends by 22 people, whereas extreme extraverts (in the 90th percentile of extraversion) would be cited as friends by 34 people. Although the aggregate number of friends increased significantly over time (as evidenced by the positive coefficient on the time indicator, with $p < .01$), there was no evidence that it did so as a function of extraversion.

We then tested the network-extraversion-bias hypothesis (i.e., that the average extraversion of the individuals in one's network is systematically greater than the average extraversion in the population of potential friends). Because (a) all covariates were mean-centered, (b) the two time periods were coded as −1 and +1, and (c) the extraversion measure was standardized so population extraversion was zero, the ideal test statistic was the coefficient of the model intercept (Models 11 and 12, without and with control variables, respectively). That is, the test statistic for the estimated constant in the regression model examined whether, at the mean of all included explanatory variables and treating both time periods equally, network extraversion was greater than the true average extraversion in the social environment. We found that, on average, network extraversion was significantly higher than population extraversion ($p < .01$).[9] On average, people's network extraversion is .12 *SD*s higher than the population extraversion, a finding consistent with the prediction of the network-extraversion-bias hypothesis. The coefficient of the time indicator is statistically insignificant, which suggests that the network extraversion bias was not increasing over time.

Finally, Models 13 and 14 tested the proposition that the magnitude of one's network extraversion bias depends on one's own level of extraversion. We found that being more extraverted corresponded with a significantly greater network extraversion bias ($p < .01$), which is consistent with that hypothesis. The magnitude of this effect did not change significantly across time periods ($p > .05$). All else being equal, a 1-*SD* increase in one's own extraversion from the mean increases one's network extraversion bias by 42% (from 0.120 at the population mean to 0.170). For a graphical depiction of the network extraversion bias, see Figure 2. The 95% confidence interval on the regression line represents an estimate of a statistically significant network extraversion bias for individuals at or above the 9th percentile of extraversion (1.31 *SD* below the mean), which is the point at which the 95% confidence interval intersects zero. The regression line itself intersects zero at −2.40 *SD* on extraversion, which implies that the model predicts that, all other things being equal, an individual at the first percentile of extraversion will have no network extraversion bias. The most extreme introverts have the best calibrated network extraversion, on average.

The estimated coefficients on the covariates also shed light on the relative importance of location, demographics, and personality for the emergence of friendships in this setting. The effect of U.S. citizenship on popularity (measured here as the number of times someone was cited as a friend by other people) was roughly equivalent to that of a 1.04-*SD* increase in extraversion. Living on campus was associated with an increase in popularity equivalent to a 1.07-*SD* increase in extraversion. Finally, belonging to the racial majority was associated with an increase in popularity equivalent to a 1.3-*SD* in extraversion. The only demographic variable that was significantly associated with network extraversion was U.S. citizenship: Compared with foreign nationals, U.S. citizens have higher network extraversion, equivalent to a 1.1-*SD* increase in their own extraversion.

An important consideration is whether our conclusions here are influenced by our M.B.A. student sample, which may be more extraverted than the general population. Our claim is that within any given social environment, if extraversion popularity and extraversion homophily occur, they will give rise to a network extraversion bias in which the extraversion of the people to whom one is connected will be greater than the average extraversion of the population of that social environment. This claim is empirically manifest in our statistical test comparing each individual's network extraversion with the mean individual extraversion within his or her social environment. Therefore, the theory is sufficiently general to apply in settings with varying levels of sociability.

Discussion

This article fills an empirical gap at the intersection of psychology and network science by documenting how the fundamental personality trait of extraversion is predictive of network composition. One is more likely to become friends with individuals who are (a) more extraverted and (b) similar in extraversion to oneself. The latter point is consistent with the notion of personality homophily. These dyadic underpinnings lead to two interesting network consequences. First, extraverts become overly represented, and introverts underrepresented, in the social networks of other people—put differently, the average extraversion of the people in one's network is greater than the average extraversion in the whole social environment. Second, the most extraverted people have the greatest network extraversion bias, and the most introverted people have the least network extraversion bias. Despite limitations (e.g., correlational data, unobservability of network ties outside our sample, a binary measure of friendship, extraversion measured after the dependent variable) and boundary conditions on generalizability (e.g., tie formation rather than tie maintenance, a sample of highly educated adults, a high-interaction social environment), these findings shed new light on issues fundamental to psychology.

Psychologists have long held that an individual's social beliefs are shaped by the people with whom they interact (e.g., McArthur & Baron, 1983; Sherif, 1936). Given the influence of availability in making judgments (Kahneman, 2011), people are likely to draw inferences about the general social environment on the basis of the people to whom they are socially connected. For example, Flynn and Wiltermuth (2010) showed that the structure of people's network affected their perceptions of consensus on matters of ethics. However, our results suggest that in some important respects, social networks are likely to be misrepresentative of the population. Future research should explore whether the network extraversion bias contributes to a societal misperception toward believing that other people are more extraverted on average than they actually are. Our results provide an underlying logic for why people may overestimate the number of extraverts in the general population. Such social miscalibration might affect people's self-perceptions or lead to poor policy and management decisions. A prevalent self-belief that one's social behavior is more reclusive than the perceived norm may reduce feelings of belongingness, self-esteem, and self-worth. Moreover, societal miscalibration regarding norms of outgoingness may also affect the manner in which young people are educated and encouraged to behave.

This work also builds on a growing literature in which it is argued that greater extraversion is not always better (Bendersky & Shah, 2013; Grant, 2013; Grant, Gino, & Hofmann, 2011). Our findings suggest that introverts have the smallest network extraversion bias, which might aid them, for example, as leaders. If introverts do in fact benefit from a hidden social-calibration advantage, they may be more tolerant of both introversion and extraversion among their colleagues, team members, or employees (Grant et al., 2011). This may be an important direction for future research, because past work has found that although extraverts are more likely than introverts to attain leadership positions (Judge, Bono, Ilies, & Gerhardt, 2002), introverts and extroverts are equally effective leaders (Grant et al., 2011).

Although we have examined how personality affects whether one's social network accurately reflects the general social environment, how individuals draw social inferences from their networks remains a critical empirical question. An important direction for future research will be to examine how misrepresentative social networks translate into skewed perceptions and inaccurate beliefs. We encourage further interdisciplinary collaborations to address and delve into these important questions.

Author Contributions

D. C. Feiler and A. M. Kleinbaum jointly developed the theoretical concept. Data collection was conducted by A. M. Kleinbaum. D. C. Feiler and A. M. Kleinbaum jointly performed the data analysis and drafted the manuscript. Both authors approved the final version of the manuscript for publication.

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Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Supplemental Material

Additional supporting information can be found at http://pss.sagepub.com/content/by/supplemental-data

Notes

1. Henceforth, we refer to this simply as extraversion. Occasionally, we refer to extraverts and introverts for convenience. In all cases, we are referring to a continuum upon which low extraversion is equivalent to introversion. We never use median splits on extraversion, as recommended by Grant (2013).
2. We found no evidence of order effects (i.e., people listed earlier on the roster were not cited more often).
3. We are grateful to an anonymous reviewer, who wondered whether our theory is specific to extraversion or whether it would apply to any positive personality trait. In response, we tested for popularity and homophily effects of agreeableness and found no evidence that either exists. These results appear in the Supplemental Material.
4. We obtained substantively identical results when alternatively accounting for this structural autocorrelation using multiple regression quadratic assignment procedure models (Dekker, Krackhardt, & Snijders, 2007), which appear in the Supplemental Material. Finally, to ensure that false positives were not induced by the structure of the data, a randomization test (Kennedy, 1995) simulated individual-level data and reestimated the t distribution; against this baseline as well, our models were all statistically significant, indicating strong robustness.
5. Likewise, whether A names B as a friend is not independent of whether C names B.
6. Our results remained statistically significant when we used other count model specifications, such as negative binomial.
7. To be sure that our results were not driven by extreme outliers, we reestimated all models of popularity and network extraversion while omitting the individuals who had cited, or been cited by, the most extreme number of friends—the top 1% or top 5% of the sample, respectively. In all instances, removing outliers slightly diminished the effect sizes but never affected their statistical significance (see Supplemental Material).
8. The same results hold if the measure of popularity incorporated not only the number of one's friends but also their popularity (i.e., eigenvector centrality). We note also that the correlation between extraversion and network size is moderate (0.20 if network size is measured as the number of friends one cites; 0.34 if measured as the number of times one is cited by others). These results suggest that extraversion and popularity are indeed independent constructs.
9. Because the coefficient on the intercept is an unusual test statistic, we also tested this hypothesis using a simple t test, which is more straightforward but lacks statistical controls. Here too, we found that the difference between network extraversion and the population extraversion was statistically significant (one-tailed mean-comparison test with paired data; $p < .002$).

References

Angrist, J. D., & Pischke, J.-S. (2009). *Mostly harmless econometrics: An empiricist's companion*. Princeton, NJ: Princeton University Press.

Ashton, M. C., Lee, K., & Paunonen, S. V. (2002). What is the central feature of extraversion? Social attention versus reward sensitivity. *Journal of Personality and Social Psychology*, *83*, 245–251. doi:10.1037/0022-3514.83.1.245

Bendersky, C., & Shah, N. P. (2013). The downfall of extraverts and rise of neurotics: The dynamic process of status allocation in task groups. *Academy of Management Journal*, *56*, 387–406. doi:10.5465/amj.2011.0316

Brewer, D. D. (2000). Forgetting in the recall-based elicitation of personal and social networks. *Social Networks*, *22*, 29–43.

Burt, R. S. (1992). *Structural holes: The social structure of competition*. Cambridge, MA: Harvard University Press.

Byrne, D. (1961). Interpersonal attraction and attitude similarity. *The Journal of Abnormal and Social Psychology*, *62*, 713–715.

Byrne, D., Baskett, G., & Hodges, L. (1971). Behavioral indicators of interpersonal attraction. *Journal of Applied Social Psychology*, *1*, 137–149.

Cameron, A. C., Gelbach, J. B., & Miller, D. L. (2011). Robust inference with multi-way clustering. *Journal of Business & Economic Statistics*, *29*, 238–249.

Condon, J. W., & Crano, W. D. (1988). Inferred evaluation and the relation between attitude similarity and interpersonal attraction. *Journal of Personality and Social Psychology*, *54*, 789–797. doi:10.1037/0022-3514.54.5.789

Costa, P. T., & McCrae, R. R. (1992). Normal personality assessment in clinical practice: The NEO Personality Inventory. *Psychological Assessment*, *4*, 5–13. doi:10.1037/1040-3590.4.1.5

Dekker, D., Krackhardt, D., & Snijders, T. (2007). Sensitivity of MRQAP tests to collinearity and autocorrelation conditions. *Psychometrika*, *72*, 563–581.

Eyesenck, H. J. (1981). *A model of personality*. New York, NY: Springer.

Feld, S. L. (1981). The focused organization of social ties. *American Journal of Sociology*, *86*, 1015–1035.

Feld, S. L. (1991). Why your friends have more friends than you do. *American Journal of Sociology*, *96*, 1464–1477.

Flynn, F. J., & Wiltermuth, S. S. (2010). Who's with me? False consensus bias, social networks, and ethical decision making in organizations. *Academy of Management Journal*, *53*, 1074–1089.

Furler, K., Gomez, V., & Grob, A. (2013). Personality similarity and life satisfaction in couples. *Journal of Research in Personality*, *47*, 369–375.

Gattis, K. S., Berns, S., Simpson, L. E., & Christensen, A. (2004). Birds of a feather or strange birds? Ties among personality dimensions, similarity, and marital quality. *Journal of Family Psychology*, *18*, 564–574.

Grant, A. M. (2013). Rethinking the extraverted sales ideal: The ambivert advantage. *Psychological Science*, *24*, 1024–1030. doi:10.1177/0956797612463706

Grant, A. M., Gino, F., & Hofmann, D. (2011). Reversing the extraverted leadership advantage: The role of employee proactivity. *Academy of Management Journal*, *54*, 528–550.

Humbad, M. N., Donnellan, M. B., Iacono, W. G., McGue, M., & Burt, S. A. (2010). Is spousal similarity for personality a matter of convergence or selection? *Personality and Individual Differences*, *49*, 827–830.

Jensen-Campbell, L. A., Adams, R., Perry, D. G., Workman, K. A., Furdella, J. Q., & Egan, S. K. (2002). Agreeableness, extraversion, and peer relations in early adolescence: Winning friends and deflecting aggression. *Journal of Research in Personality*, *36*, 224–251.

John, O. P., & Srivastava, S. (1999). The Big Five trait taxonomy: History, measurement, and theoretical perspectives. In L. A. Pervin & O. P. John (Eds.), *Handbook of personality: Theory and research* (2nd ed., pp. 102–138). New York, NY: Guilford Press.

Judge, T. A., Bono, J. E., Ilies, R., & Gerhardt, M. W. (2002). Personality and leadership: A qualitative and quantitative review. *Journal of Applied Psychology*, *87*, 765–780. doi:10.1037/0021-9010.87.4.765

Kahneman, D. (2011). *Thinking fast and slow*. New York, NY: Farrar, Straus, and Giroux.

Kennedy, P. E. (1995). Randomization tests in econometrics. *Journal of Business & Economic Statistics*, *13*, 85–94. doi:10.2307/1392523

Kenny, D. A., Kashy, D. A., & Cook, W. L. (2006). *Dyadic data analysis (Methodology in the social sciences)*. New York, NY: Guilford Press.

Kleinbaum, A. M., Stuart, T. E., & Tushman, M. L. (2013). Discretion within constraint: Homophily and structure in a formal organization. *Organization Science*, *24*, 1316–1336. doi:10.1287/orsc.1120.0804

Mayer, A., & Puller, S. L. (2008). The old boy (and girl) network: Social network formation on university campuses. *Journal of Public Economics*, *92*, 329–347.

McArthur, L. Z., & Baron, R. M. (1983). Toward an ecological theory of social perception. *Psychological Review*, *90*, 215–238.

McCrae, R. R., & Costa, P. T. (1990). *Personality in adulthood*. New York, NY: Guilford Press.

McPherson, M., Smith-Lovin, L., & Cook, J. (2001). Birds of a feather: Homophily in social networks. *Annual Review of Sociology*, *27*, 418–444.

Montoya, R., Horton, R., & Kirchner, J. (2008). Is actual similarity necessary for attraction? A meta-analysis of actual and perceived similarity. *Journal of Social and Personal Relationships*, *25*, 889–922.

Ong, E. Y. L., Ang, R. P., Ho, J. C. M., Lim, J. C. Y., Goh, D. H., Lee, C. S., & Chua, A. Y. K. (2011). Narcissism, extraversion and adolescents' self-presentation on Facebook. *Personality and Individual Differences*, *50*, 180–185. doi:10.1016/j.paid.2010.09.022

Paunonen, S. V. (2003). Big Five factors of personality and replicated predictions of behavior. *Journal of Personality and Social Psychology*, *84*, 411–424.

Paunonen, S. V., & Ashton, M. C. (2001). Big Five factors and facets and the prediction of behavior. *Journal of Personality and Social Psychology*, *81*, 524–539. doi:10.1037/0022-3514.81.3.524

Reagans, R., & McEvily, B. (2003). Network structure and knowledge transfer: The effects of cohesion and range. *Administrative Science Quarterly*, *48*, 240–267.

Seder, J., & Oishi, S. (2009). Ethnic/racial homogeneity in college students' Facebook friendship networks and subjective well-being. *Journal of Research in Personality*, *43*, 438–443.

Selfhout, M., Branje, S., Raaijmakers, Q., & Meeus, W. (2007). Similarity in adolescent best friendships: The role of gender. *The Netherlands Journal of Psychology*, *63*, 50–57.

Sherif, M. (1936). *The psychology of social norms*. Oxford, England: Harper.

Shipilov, A., Labianca, G., Kalnysh, V., & Kalnysh, Y. (2014). Network-building behavioral tendencies, range, and promotion speed. *Social Networks*, *39*, 71–83. doi:10.1016/j.socnet.2014.03.006

Wooldridge, J. M. (1997). Quasi-likelihood methods for count data. In H. Pesaran & P. Schmidt (Eds.), *Handbook of applied econometrics* (Vol. 2, pp. 352–406). Oxford, England: Blackwell.

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Supplemental Online Materials

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Popularity, Similarity, and the Network Extraversion Bias

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Table A-1. Descriptive statistics of Individual-level variables. Outdegree is the number of friends a given person named. Indegree is the number of others who named a given person as their friend.

	Mean	SD	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Extraversion (standardized)	0	1	-2.50	1.92	1							
(2) Network Extraversion	0.122	0.330	-1.21	1.31	0.196*	1						
(3) Indegree	26.9	14.4	1	81	0.34*	0.353*	1					
(4) Outdegree	26.9	24.9	2	184	0.203*	0.2*	0.448*	1				
(5) Female	0.342	0.475	0	1	0.018	0.058	0.018	-0.045	1			
(6) On Campus	0.518	0.500	0	1	0.084*	-0.002	0.227*	0.135*	0.146*	1		
(7) U.S. Citizen	0.651	0.477	0	1	0.166*	0.29*	0.287*	0.091*	0.122*	0.018	1	
(8) Racial Minority	0.482	0.500	0	1	-0.126*	-0.242*	-0.236*	-0.124*	-0.027	0.086*	-0.654*	1
(9) Age	28.360	2.331	24	42	-0.031	-0.071	-0.177*	-0.093*	-0.172*	-0.149*	-0.149*	0.131*

Figure A-2. Histograms showing the distribution of outdegree (the number of friends a given person named) and indegree (the number of others who named a given person as their friend) in the pooled data, the Time 1 data, and the Time 2 data. Please note the different scales of the x-axes.

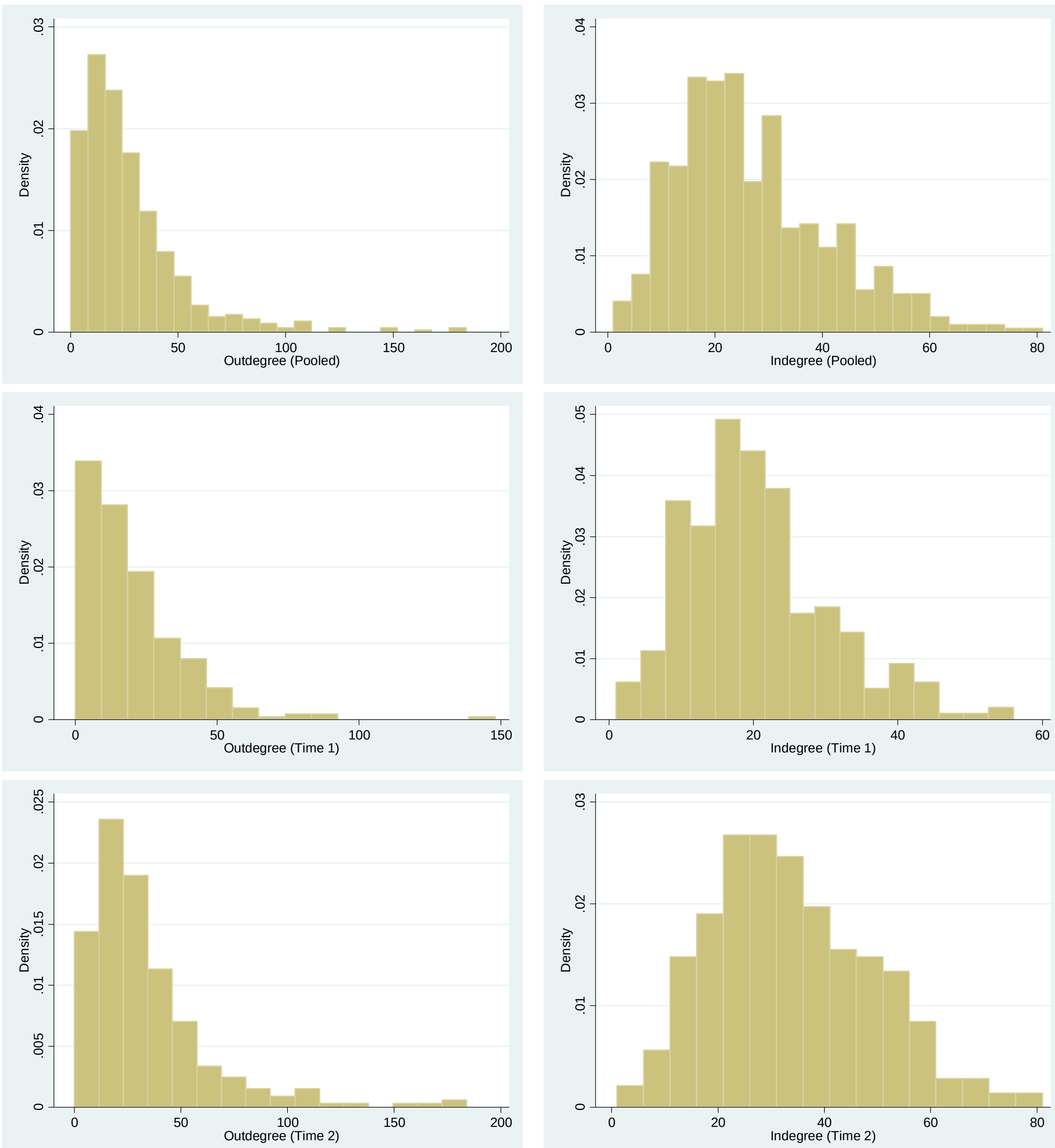

Figure A-3. Histograms showing the distributions of (time-invariant) extraversion (prior to being standardized; the standardized variable has the same distribution, but a mean of 0 and a standard deviation of 1) and of network extraversion in the time-pooled sample.

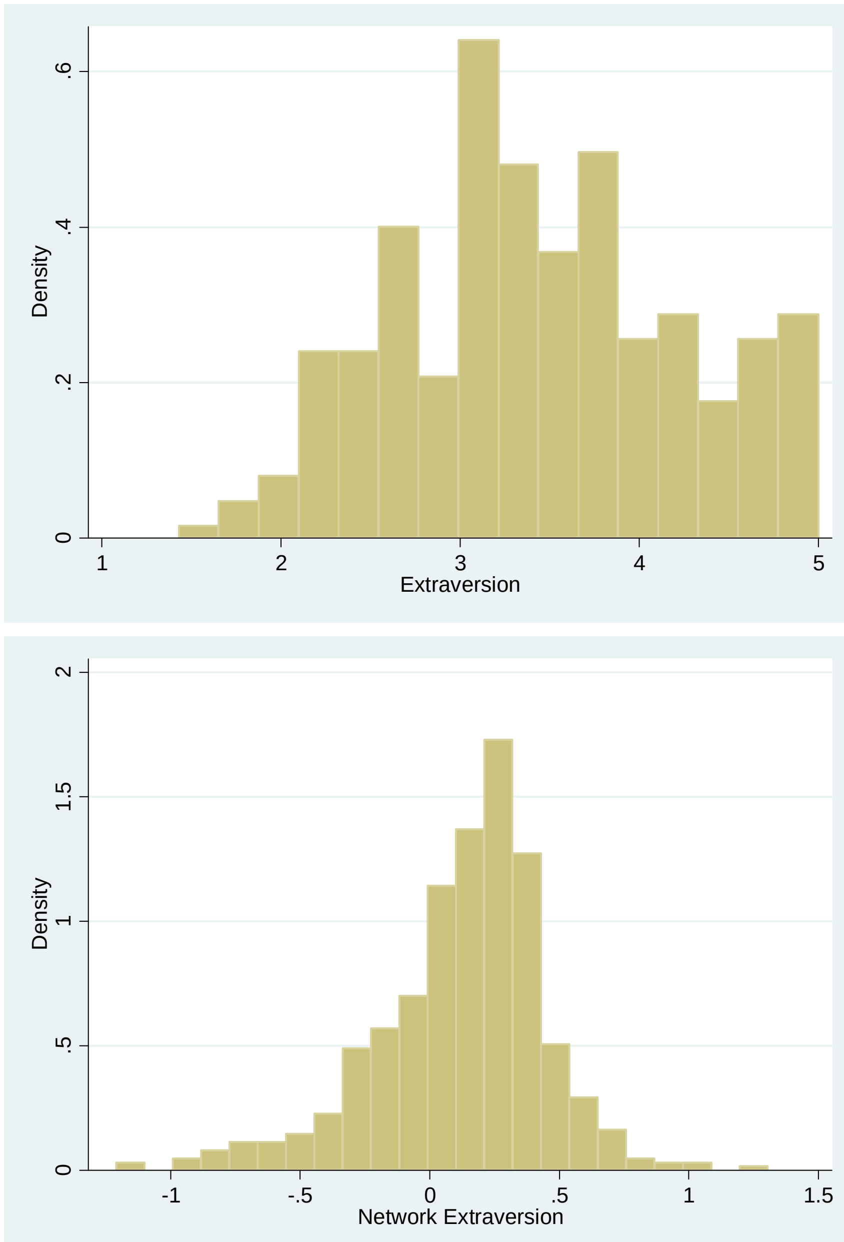

Table A-4. Dyad-level models of network ties. These models replicate Models 1-4 in the manuscript, using abbreviated extraversion scales in place of the full, 8-item measure. Several items in the full extraversion scale are explicitly related to having friends. To ensure that our results are not tautological, we created two abbreviated extraversion scales, based on those items least related to how many friends one listed. The 3-item subscale includes the items "is full of energy," "generates a lot of enthusiasm," and "has an assertive personality" (Cronbach's alpha = .66). The 5-item subscale adds to these "is talkative" and "tends to be quiet (R)" (Cronbach's alpha = .75). All patterns of significance hold with the 3- and 5-item measures of extraversion.

	(1-Ex3)	(2-Ex3)	(3-Ex3)	(4-Ex3)	(1-Ex5)	(2-Ex5)	(3-Ex5)	(4-Ex5)
Extraversion Measure	**3-item Subscale**				**5-item Subscale**			
***i* Fixed Effects**			Incl.	Incl.			Incl.	Incl.
***j* Fixed Effects**	Incl.	Incl.			Incl.	Incl.		
***i*'s Extraversion**	0.012	0.011			0.015	0.011		
	(0.004)**	(0.004)**			(0.004)**	(0.004)**		
***j*'s Extraversion**			0.011	0.010			0.015	0.011
			(0.003)**	(0.002)**			(0.003)**	(0.002)**
Time Indicator	0.023	0.023	0.023	0.023	0.022	0.022	0.023	0.023
	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**
***i*'s Extraversion × Time Indicator**	0.009	0.009			0.009	0.009		
	(0.002)**	(0.002)**			(0.003)**	(0.003)**		
***j*'s Extraversion × Time Indicator**			0.004	0.004			0.005	0.005
			(0.001)**	(0.001)**			(0.001)**	(0.001)**
Same Section		0.038		0.038		0.038		0.038
		(0.004)**		(0.003)**		(0.004)**		(0.003)**
Same Study Group		0.452		0.452		0.452		0.452
		(0.020)**		(0.020)**		(0.020)**		(0.020)**
Both On Campus		0.055		0.053		0.055		0.052
		(0.010)**		(0.007)**		(0.010)**		(0.007)**
Same Gender		0.042		0.040		0.042		0.040
		(0.004)**		(0.003)**		(0.004)**		(0.003)**
Same Race		0.069		0.065		0.070		0.065
		(0.007)**		(0.007)**		(0.007)**		(0.007)**
Same Nationality		0.039		0.051		0.037		0.049
		(0.009)**		(0.007)**		(0.009)**		(0.007)**
Age Difference (logged)		-0.019		-0.016		-0.019		-0.016
		(0.004)**		(0.004)**		(0.004)**		(0.004)**
Constant	0.095	0.015	0.095	0.010	0.095	0.016	0.095	0.011
	(0.004)**	(0.007)*	(0.002)**	(0.007)	(0.004)**	(0.007)*	(0.002)**	(0.007)
Observations	156,240	156,240	156,240	156,240	156,240	156,240	156,240	156,240
R-squared	0.03	0.10	0.07	0.14	0.03	0.10	0.07	0.14

Robust standard errors in parentheses, clustered by sender, recipient, and undirected sender-recipient pair.
* significant at 5%; ** significant at 1%

Table A-5. Poisson models of popularity as a function of extraversion. These models replicate models 7-10 in the manuscript using the 3-item and 5-item extraversion measures in place of the full 8-item scale. As described in Table A-1 above, the items selected were those least related to how many friends one listed in the network survey. All patterns of significance hold with the 3- and 5-item measures of extraversion.

	(7-Ex3)	(8-Ex3)	(9-Ex3)	(10-Ex3)	(7-Ex5)	(8-Ex5)	(9-Ex5)	(10-Ex5)
Extraversion Measure	**3-item Subscale**				**5-item Subscale**			
Extraversion	0.118	0.097	0.114	0.096	0.160	0.123	0.138	0.111
	(0.027)**	(0.023)**	(0.041)**	(0.038)*	(0.026)**	(0.023)**	(0.044)**	(0.040)**
Time Indicator	0.242	0.242	0.235	0.235	0.241	0.241	0.234	0.235
	(0.008)**	(0.008)**	(0.023)**	(0.023)**	(0.008)**	(0.008)**	(0.024)**	(0.024)**
Extraversion ×	0.011	0.010	0.073	0.071	0.012	0.012	0.061	0.060
Time Indicator	(0.008)	(0.008)	(0.023)**	(0.022)**	(0.008)	(0.008)	(0.025)*	(0.024)*
Female		-0.042		-0.133		-0.036		-0.127
		(0.046)		(0.084)		(0.045)		(0.084)
U.S. Citizen		0.245		0.008		0.213		-0.023
		(0.072)**		(0.116)		(0.071)**		(0.115)
On Campus Residence		0.230		0.261		0.220		0.254
		(0.046)**		(0.089)**		(0.046)**		(0.089)**
Racial Minority		-0.111		-0.229		-0.106		-0.226
		(0.065)		(0.104)*		(0.063)		(0.104)*
Constant	3.259	3.241	3.258	3.242	3.254	3.238	3.255	3.242
	(0.026)**	(0.024)**	(0.044)**	(0.043)**	(0.025)**	(0.024)**	(0.045)**	(0.044)**
Observations	566	566	566	566	566	566	566	566

Robust standard errors in parentheses
* significant at 5%; ** significant at 1%

Table A-6. Poisson models of popularity as a function of extraversion. The first model in each trio replicates the model in the paper with the same number. In Models 7 and 8, popularity is measured as indegree, the number of other people citing the focal individual as their friend; in Models 9 and 10, popularity is measured as outdegree, the number of friends the focal individuals cites. Control variables are excluded from Models 7 and 9 and included in Models 8 and 10. Given the skewed distributions in the number of friends, we assessed the robustness of our results to outliers. The second and third models in each trio exclude outliers by successively broader definitions. Models ending in "-p99" exclude people whose Time 1 outdegree places them above the 99th percentile of the sample; "-p95" models exclude observations above the 95th percentile of the sample. Additional analyses, available from the authors, replicate these results when excluded outliers were defined instead in terms of outdegree at Time 2; indegree at Time 1; or indegree at Time 2.

	Indegree			**Indegree**			**Outdegree**			**Outdegree**		
	(7)	**(7-p99)**	**(7-p95)**	**(8)**	**(8-p99)**	**(8-p95)**	**(9)**	**(9-p99)**	**(9-p95)**	**(10)**	**(10-p99)**	**(10-p95)**
Extraversion	**0.175**	**0.167**	**0.157**	**0.142**	**0.136**	**0.125**	**0.173**	**0.167**	**0.117**	**0.145**	**0.147**	**0.098**
	(0.024)**	**(0.024)****	**(0.024)****	**(0.022)****	**(0.022)****	**(0.022)****	**(0.040)****	**(0.040)****	**(0.037)****	**(0.039)****	**(0.039)****	**(0.036)****
Time indicator	0.241	0.241	0.241	0.241	0.241	0.241	0.235	0.219	0.201	0.235	0.219	0.201
	(0.008)**	(0.008)**	(0.008)**	(0.008)**	(0.008)**	(0.008)**	(0.024)**	(0.023)**	(0.023)**	(0.024)**	(0.023)**	(0.023)**
Extraversion ×	0.010	0.011	0.012	0.010	0.011	0.012	0.043	0.023	0.021	0.042	0.023	0.021
Time indicator	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.024)	(0.019)	(0.020)	(0.024)	(0.019)	(0.020)
Female				-0.041	-0.027	-0.013				-0.121	-0.067	-0.013
				(0.044)	(0.044)	(0.045)				(0.083)	(0.081)	(0.075)
U.S. Citizen				0.178	0.177	0.188				-0.023	-0.035	-0.025
				(0.066)**	(0.067)**	(0.068)**				(0.116)	(0.115)	(0.111)
Campus Resident				0.208	0.193	0.206				0.270	0.212	0.196
				(0.045)**	(0.045)**	(0.045)**				(0.086)**	(0.081)**	(0.074)**
Racial Minority				-0.121	-0.109	-0.099				-0.249	-0.203	-0.200
				(0.061)*	(0.061)	(0.062)				(0.105)*	(0.102)*	(0.096)*
Constant	3.258	3.250	3.246	3.243	3.238	3.233	3.243	3.218	3.154	3.227	3.210	3.147
	(0.025)**	(0.025)**	(0.025)**	(0.023)**	(0.023)**	(0.024)**	(0.043)**	(0.041)**	(0.039)**	(0.041)**	(0.040)**	(0.039)**
Observations	560	554	534	560	554	534	560	554	534	560	554	534

Robust standard errors in parentheses
* significant at 5%; ** significant at 1%

Table A-7. Ordinary least squares models of network extraversion bias as a function of one's own extraversion. The first model in each trio replicates the model in the paper with the same number. Control variables are excluded from Models 11 and 13 and are included in Models 12 and 14. The second model in each trio re-estimates the network extraversion variable by omitting outlying extraverts from each person's network. Models ending in "-p99" and "-p95" exclude from each person's network those contacts whose Time 1 outdegree score places them above the 99^{th} and the 95^{th} percentile of the sample, respectively. Note that in this analysis, the set of observations included in the model does not vary; rather, we vary the composition of each person's network and the resulting value of the network extraversion variable to examine the robustness of the core result to the exclusion of outliers. Additional analyses, available from the authors, replicate these results when excluded outliers were defined instead in terms of outdegree at Time 2; indegree at Time 1; or indegree at Time 2.

	(11)	**(11-p99)**	**(11-p95)**	**(12)**	**(12-p99)**	**(12-p95)**	**(13)**	**(13-p99)**	**(13-p95)**	**(14)**	**(14-p99)**	**(14-p95)**
Extraversion							**0.065**	**0.063**	**0.062**	**0.050**	**0.050**	**0.049**
							(0.016)**	**(0.016)****	**(0.016)****	**(0.015)****	**(0.015)****	**(0.015)****
Time indicator	0.014	0.013	0.016	0.014	0.013	0.017	0.014	0.013	0.017	0.014	0.013	0.017
	(0.009)	(0.010)	(0.009)	(0.009)	(0.010)	(0.009)	(0.009)	(0.010)	(0.009)	(0.009)	(0.010)	(0.009)
Extraversion ×							-0.001	-0.002	-0.001	-0.001	-0.002	-0.002
Time indicator							(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Female				0.019	0.018	0.021				0.021	0.020	0.022
				(0.034)	(0.034)	(0.033)				(0.033)	(0.033)	(0.032)
U.S. Citizen				0.157	0.153	0.148				0.142	0.138	0.134
				(0.049)**	(0.049)**	(0.049)**				(0.047)**	(0.047)**	(0.047)**
Campus Resident				0.002	0.003	0.003				-0.007	-0.006	-0.006
				(0.033)	(0.033)	(0.032)				(0.033)	(0.033)	(0.032)
Racial Minority				-0.062	-0.047	-0.051				-0.057	-0.043	-0.047
				(0.041)	(0.041)	(0.041)				(0.039)	(0.039)	(0.039)
Constant	**0.122**	**0.108**	**0.074**	**0.120**	**0.107**	**0.072**	0.122	0.108	0.074	0.120	0.107	0.072
	(0.017)**	**(0.017)****	**(0.017)****	**(0.016)****	**(0.016)****	**(0.016)****	(0.017)**	(0.017)**	(0.016)**	(0.016)**	(0.016)**	(0.016)**
Observations	560	560	559	560	560	559	560	560	559	560	560	559
	0.00	0.00	0.00	0.09	0.08	0.09	0.04	0.04	0.04	0.11	0.10	0.11

Robust standard errors in parentheses
* significant at 5%; ** significant at 1%

Table A-8. Ordinary least squares models of network extraversion bias as a function of one's own extraversion. The first model in each trio replicates the model in the paper with the same number. Control variables are excluded from Model 13 and included in Model 14. The second and third models in each trio exclude outliers, by successively broader definitions. Models ending in "-p99" exclude the 8 people who share the maximal extraversion score; "-p95" models exclude 5% of observations with the highest extraversion scores in the sample. In this analysis, we make no changes to the network extraversion variable; rather, we vary the set of observations included in the model based on the individual's own extraversion to examine the robustness of our results to the exclusion of outliers. Because Models 11 and 12 excluded extraversion as a covariate, it was unnecessary to assess their robustness to its outliers.

	(13)	**(13-p99)**	**(13-p95)**	**(14)**	**(14-p99)**	**(14-p95)**
Extraversion	**0.065**	**0.068**	**0.068**	**0.050**	**0.053**	**0.053**
	(0.016)**	**(0.016)****	**(0.017)****	**(0.015)****	**(0.015)****	**(0.016)****
Time indicator	0.014	0.013	0.013	0.014	0.013	0.013
	(0.009)	(0.009)	(0.010)	(0.009)	(0.009)	(0.010)
Extraversion ×	-0.001	-0.004	-0.003	-0.001	-0.004	-0.003
Time indicator	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Female				0.021	0.018	0.019
				(0.033)	(0.034)	(0.035)
U.S. Citizen				0.142	0.142	0.143
				(0.047)**	(0.047)**	(0.048)**
Campus Resident				-0.007	-0.004	-0.004
				(0.033)	(0.033)	(0.034)
Racial Minority				-0.057	-0.060	-0.061
				(0.039)	(0.039)	(0.040)
Constant	0.122	0.123	0.122	0.120	0.122	0.121
	(0.017)**	(0.017)**	(0.017)**	(0.016)**	(0.016)**	(0.017)**
Observations	560	554	534	560	554	534
R-squared	0.04	0.04	0.04	0.11	0.12	0.12

Robust standard errors in parentheses
* significant at 5%; ** significant at 1%

Table A-9. Dyad-level models of network ties. These models replicate Models 1-6 in the manuscript, using reciprocated network ties as the dependent variable. A tie is defined to take a value of 1 if both individuals cited the other as a friend and a value of 0 otherwise. The results are substantively the same, indicating their robustness against alternative specifications of the dependent variable. Note also that Models 1-R and 2-R are identical to Models 3-R and 4-R, respectively, because when the network tie is undirected, each individual appears as both an *i* and a *j*.

	(1-R)	(2-R)	(3-R)	(4-R)	(5-R)	(6-R)
***i* Fixed Effects**			**Incl.**	**Incl.**	**Incl.**	**Incl.**
***j* Fixed Effects**	**Incl.**	**Incl.**			**Incl.**	**Incl.**
***i*'s Extraversion**	**0.010 (0.002)****	**0.008 (0.002)****				
***j*'s Extraversion**			**0.010 (0.002)****	**0.008 (0.002)****		
Extraversion Similarity					**0.007 (0.002)****	**0.005 (0.002)***
Time indicator	0.013 (0.001)**	0.013 (0.001)**	0.013 (0.001)**	0.013 (0.001)**	0.014 (0.002)**	0.014 (0.002)**
i's Extraversion × Time indicator	0.004 (0.001)**	0.004 (0.001)**				
j's Extraversion × Time indicator			0.004 (0.001)**	0.004 (0.001)**		
Extraversion Similarity × Time indicator					0.001 (0.001)	0.001 (0.001)
Same Section		0.020 (0.003)**		0.020 (0.003)**		0.020 (0.003)**
Same Study Group		0.298 (0.020)**		0.298 (0.020)**		0.300 (0.020)**
Both On Campus		0.029 (0.005)**		0.029 (0.005)**		0.039 (0.006)**
Same Gender		0.026 (0.002)**		0.026 (0.002)**		0.027 (0.003)**
Same Race		0.040 (0.005)**		0.040 (0.005)**		0.043 (0.005)**
Same Nationality		0.025 (0.005)**		0.025 (0.005)**		0.053 (0.008)**
Age Difference (logged)		-0.011 (0.003)**		-0.011 (0.003)**		-0.009 (0.003)**
Constant	0.048 (0.002)**	0.000 (0.004)	0.048 (0.002)**	0.000 (0.004)	0.045 (0.004)**	-0.037 (0.007)**
Observations	156,240	156,240	156,240	156,240	78,120	78,120
R-squared	0.024	0.079	0.024	0.079	0.040	0.096

Robust standard errors in parentheses, clustered by sender, recipient, and undirected sender-recipient pair.
* significant at 5%; ** significant at 1%

Table A-10. Dyad-level models of network ties at Time 2, re-estimated using the Quadratic Assignment Procedure to account for structural dependencies in the dyadic data, rather than using multi-way clustering. QAP cannot be estimated on pooled data, but substantially the same results obtain in Time 1 data. QAP also calculates p-values directly and does not report standard errors, which are therefore omitted from the table. The substantive findings of Models 1-6 in the manuscript are fully replicated using this alternative specification.

	(1-QAP)	**(2-QAP)**	**(3-QAP)**	**(4-QAP)**	**(5-QAP)**	**(6-QAP)**
***i* Pseudo Fixed Effects**			***Incl.***	***Incl.***	***Incl.***	***Incl.***
***j* Pseudo Fixed Effects**	***Incl.***	***Incl.***			***Incl.***	***Incl.***
***i*'s Extraversion**	***0.026******	***0.023******				
***j*'s Extraversion**			***0.022******	***0.019******		
Extraversion Similarity					**0.009****	**0.007****
Same Section		0.052**		0.052**		0.052**
Same Study Group		0.504**		0.504**		0.502**
Both On Campus		0.046**		0.044**		0.031**
Same Gender		0.049**		0.046**		0.045**
Same Race		0.073**		0.070**		0.067**
Same Nationality		0.024**		0.032**		0.018**
Age Difference (logged)		-0.018**		-0.015**		-0.009**
Constant	0.0001	-0.058**	-0.0001	-0.080**	-0.109**	-0.171**
Observations	78,120	78,120	78,120	78,120	78,120	78,120
R-squared	0.033	0.110	0.103	0.180	0.126	0.195

* significant at 5%; ** significant at 1%

Table A-11. Individual-level models of popularity and network extraversion in the reciprocated ties network. These models test the robustness of the popularity effect and network extraversion bias with an alternative form of the dependent variable. A tie takes a value of 1 if each individual cited the other as a friend and a value of 0 otherwise.

DV	**Popularity: Reciprocated Ties**		**Network Extraversion**			
Specification	**Poisson**		**Ordinary Least Squares**			
	(7-R)	**(8-R)**	**(11-R)**	**(12-R)**	**(13-R)**	**(14-R)**
Extraversion	**0.198**	**0.168**			**0.090**	**0.075**
	(0.034)**	**(0.033)****			**(0.019)****	**(0.018)****
Time Indicator	0.266	0.266	0.026	0.026	0.026	0.026
	(0.016)**	(0.016)**	(0.011)*	(0.011)*	(0.011)*	(0.011)*
Extraversion ×	0.027	0.026			0.003	0.003
Time indicator	(0.019)	(0.019)			(0.011)	(0.011)
Female		-0.055		0.012		0.016
		(0.063)		(0.043)		(0.042)
U.S. Citizen		0.081		0.171		0.171
		(0.090)		(0.062)**		(0.058)**
On Campus		0.181		0.025		0.016
Resident		(0.066)**		(0.041)		(0.041)
Racial Minority		-0.217		-0.058		-0.035
		(0.081)**		(0.052)		(0.048)
Constant	2.553	2.538	**0.119**	**0.116**	0.116	0.113
	(0.033)**	(0.032)**	**(0.021)****	**(0.020)****	(0.021)**	(0.020)**
Observations	560	560	558	558	554	554
Pseudo / R-squared	0.15	0.18	0.00	0.07	0.06	0.11

Robust standard errors in parentheses
* significant at 5%; ** significant at 1%

Table A-12. Dyad-level models of network ties to test whether agreeableness, rather than extraversion, yielded popularity and homophily effects. We found weak and inconsistent evidence of a popularity effect. We found no statistically significant effect of agreeableness on the number of others one cites as a friend (i.e., outdegree). Agreeable people are more likely to be cited as friends by others, but the effect sizes are small and their statistical significance depends on particular configurations of control variables. Finally, we found no evidence of agreeableness homophily: dyads with similar levels of agreeableness were not more likely to be friends. Without these building blocks, there is no network agreeableness bias. This provides some evidence that our theory does not simply apply to all socially positive traits.

	(1-Agree)	**(2-Agree)**	**(3-Agree)**	**(4-Agree)**	**(5-Agree)**	**(6-Agree)**
***i* Fixed Effects**			**Incl.**	**Incl.**	**Incl.**	**Incl.**
***j* Fixed Effects**	**Incl.**	**Incl.**			**Incl.**	**Incl.**
***i*'s Agreeableness**	**0.003 (0.004)**	**0.006 (0.004)**				
***j*'s Agreeableness**			**0.003 (0.002)**	**0.005 (0.002)***		
Agreeableness Similarity					**0.001 (0.002)**	**0.000 (0.002)**
Time indicator	0.023 (0.003)**	0.023 (0.003)**	0.023 (0.003)**	0.023 (0.003)**	0.025 (0.003)**	0.025 (0.003)**
i's Agreeableness × Time indicator	0.004 (0.003)	0.004 (0.003)				
j's Agreeableness × Time indicator			0.001 (0.001)	0.001 (0.001)		
Agreeableness Similarity × Time indicator					0.002 (0.002)	0.002 (0.002)
Same Section		0.038 (0.004)**		0.038 (0.003)**		0.038 (0.004)**
Same Study Group		0.452 (0.020)**		0.452 (0.020)**		0.455 (0.020)**
Both On Campus		0.058 (0.010)**		0.055 (0.007)**		0.061 (0.008)**
Same Gender		0.042 (0.004)**		0.040 (0.003)**		0.042 (0.004)**
Same Race		0.070 (0.007)**		0.065 (0.007)**		0.072 (0.008)**
Same Nationality		0.041 (0.010)**		0.052 (0.008)**		0.088 (0.011)**
Age Difference (logged)		-0.018 (0.004)**		-0.014 (0.004)**		-0.014 (0.004)**
Constant	0.096 (0.004)**	0.012 (0.008)	0.096 (0.002)**	0.007 (0.007)	0.050 (0.004)**	-0.083 (0.010)**
Observations	156,240	156,240	156,240	156,240	156,240	156,240

Robust standard errors in parentheses, clustered by sender, recipient, and undirected sender-recipient pair.
* significant at 5%; ** significant at 1%