Empathy and well-being correlate with centrality in different social networks

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Individuals benefit from occupying central roles in social networks, but little is known about the psychological traits that predict centrality. Across four college freshman dorms (n = 193), we characterized individuals with a battery of personality questionnaires and also asked them to nominate dorm members with whom they had different types of relationships. This revealed several social networks within dorm communities with differing characteristics. In particular, additional data showed that networks varied in the degree to which nominations depend on (*i*) trust and (*ii*) shared fun and excitement. Networks more dependent upon trust were further defined by fewer connections than those more dependent on fun. Crucially, network and personality features interacted to predict individuals' centrality: people high in well-being (i.e., life satisfaction and positive emotion) were central to networks characterized by fun, whereas people high in empathy were central to networks characterized by trust. Together, these findings provide network-based corroboration of psychological evidence that well-being is socially attractive, whereas empathy supports close relationships. More broadly, these data highlight how an individual's personality relates to the roles that they play in sustaining their community.

social networks | empathy | well-being | centrality | personality

In a community, certain individuals take central roles and are sought out by others for advice, support, fun, and companionship. Central individuals substantially impact the health and well-being of their community (1–4), for example, by reducing stress and generating opportunities for other community members (5). Who comes to occupy these central network positions? Recent research suggests that individuals' personalities influence their ability to attract social ties (6–11),* but this personality–centrality relationship may vary depending on the type of connection that one uses to define a network. For example, extraverts become more central than introverts in networks defined by friendship (6).

Past work generally focuses on the relationship between a single personality trait (e.g., extraversion) and centrality in a single network (e.g., friendship networks). However, communities contain multiple networks that are defined by different types of relationships. Individuals might ask for advice from one subset of their community, look for companionship with another subset, and seek emotional support from a third subset (12–15). This means that an individual could occupy a central role in one type of network, but hold a more peripheral position in a different type of network (2). We study this by first mapping several networks within a community and then by assessing a person's position in a network with respect to a broad array of personality traits. This allows us to identify the features of an individual that predict their centrality in various types of networks.

Previous psychological research suggests that an individual's personality might relate to her community roles and thus to her centrality in different types of networks. For example, researchers have demonstrated that two facets of well-being—positive emotion and life satisfaction—operate independently and have dissociable effects on social relationships (16). In particular, people high in positive emotion frequently display their feelings (e.g., smiling) and disclose positive events to others, which in turn elicits matching positive emotions in interlocutors (17, 18). People high in life satisfaction likewise attract attention and alliance from peers (19, 20). As such, an individual's well-being should correlate with his or her centrality in social networks that feature shared positive experiences (e.g., fun) and companionship (21). In contrast, empathy—the ability to understand and share others' emotions—predicts responsiveness to others' needs, especially in close relationships and in times of stress (22, 23). Over time, this emotional attunement to others builds trust and intimacy between individuals (24). As such, empathic individuals might gain central positions in networks related to trust (11).

Here, we test these predictions through an integrative combination of psychological and social network techniques (25–27). We focus on first-year college dormitories, in which communities emerge de novo. We recruited students from four freshman-only dormitories at Stanford University (n = 193, 94 males, mean age = 18.27 y; see *SI Appendix*, Table S1 for details). At the start of the academic quarter, participants completed (*i*) 21 questionnaires assessing empathy, well-being (i.e., positive emotion and life satisfaction), and negative emotion (*SI Appendix*, Table S2) and (*ii*) questions related to different networks within their dorm. More specifically, participants nominated up to eight people in their dormitory in response to each of eight questions (in this order): (*i*) "Who are your closest friends?"; (*ii*) "Whom do you spend the most time with?"; (*iii*) "Whom have you asked

Significance

Which traits make individuals popular or lead others to turn to them in times of stress? We examine these questions by observing newly formed social networks in first-year college dormitories. We measured dorm members' traits (for example, their empathy) as well as their position in their dorm's social networks. Via network analysis, we corroborate insights from psychological research: people who exude positive emotions are sought out by others for fun and excitement, whereas empathic individuals are sought out for trust and support. These findings show that individuals' traits are related to their network positions and to the different roles that they play in supporting their communities.

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Data deposition: All of the data are available for downloading from Zenodo (including a readme file, data descriptions, code, and data) at https://doi.org/10.5281/zenodo.821788.

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for advice about your social life?"; (*iv*) "Who do you turn to when something bad happens?"; (*v*) "Whom do you share good news with?"; (*vi*) "Who makes you feel supported and cared for?"; (*vii*) "Who is the most empathetic?"; and (*viii*) "Who usually makes you feel positive (e.g., happy, enthusiastic)?"

In addition to collecting network data and personality profiles, we also probed how people selected others to nominate for each network. We hypothesized that some network nominations—such as sharing bad news with others—would depend on an individual's trust of a nominee (24). In contrast, other nominations—such as feeling positive around others—might depend on a nominee's ability to make others have fun and feel excited (28). To test these hypotheses, we recruited a new sample of college students at the University of Illinois at Chicago (UIC) (n = 86, 23 males, mean age = 22.16 y). We asked them to rate the extent to which they viewed (*i*) trust and (*ii*) fun and excitement on a sliding scale from 1 (not at all important) to 100 (very important) as important considerations when nominating others for each network. Five additional dimensions of relationships were also measured (*Methods* and *SI Appendix*, Fig. S5). We focus on trust and fun here because we hypothesized that empathy and well-being would most closely relate to centrality in networks that varied along these two particular dimensions. This hypothesis is consistent with new college students' lives being focused more on sociability and trust than other cognitive dimensions such as competence or assertiveness (30, 31).

Results

Psychological Traits. Factor analysis confirmed four main personality trait clusters in our sample: (*i*) empathy, (*ii*) life satisfaction, (*iii*) positive emotion, and (*iv*) negative emotion (Fig. 1 and *SI Appendix*, Table S3 for descriptive statistics). The empathy factor captures how responsive individuals are to others' emotions and needs, whereas the life satisfaction factor represents individuals' general satisfaction with life. The positive emotion factor captures individuals' tendency to seek personal and social rewards (e.g., extraversion) and to experience positive emotions. The negative emotion factor encapsulates the tendency to experience negative emotions and to avoid aversive experiences (e.g., behavioral inhibition).

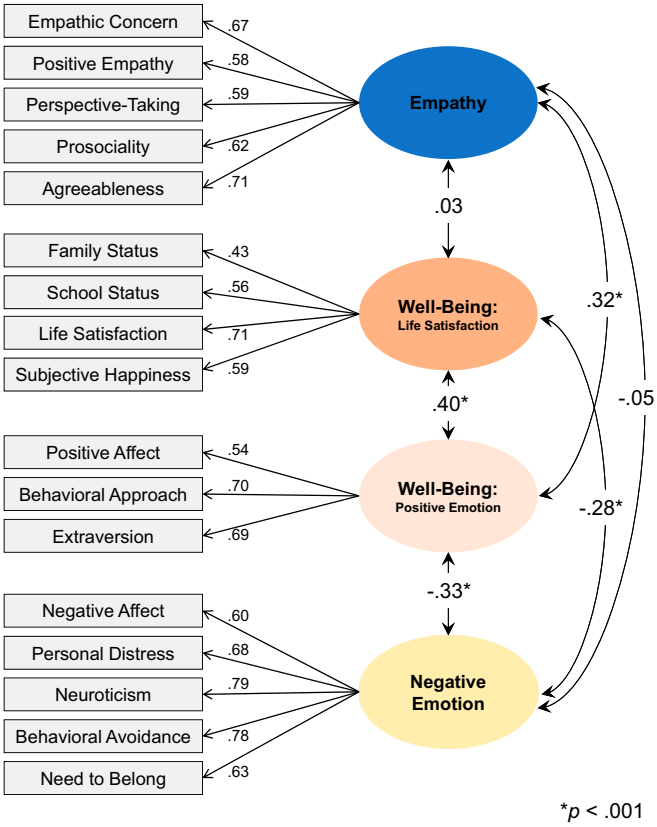

Fig. 1. Standardized factor loadings and significant factor correlations (P < 0.05) for the four-factor solution for all measures of empathy, well-being, and negative emotion.

Network Selectivity. Networks defined by each question differed in their selectivity (i.e., the average number of relationships per individual). For example, Stanford dorm residents nominated an average of 4.18 dorm members as close friends—generating the least selective network—but only nominated 1.84 dorm members as someone they would turn to with bad news—generating the most selective network (*SI Appendix*, Fig. S1). In addition, each of the eight networks showed moderate to strong correlations with each other (*SI Appendix*, Table S4), but were not redundant with each other.

Perceptions of Trust and Fun. Networks also varied in their reliance on trust and fun, as assessed by our independent UIC sample (*SI Appendix*, Fig. S4). Trust was rated as most important in networks related to friendship (M = 79.8, SE = 2.81), bad news (M = 76.64, SE = 2.87), support (M = 76.63, SE = 2.88), and empathy (M = 75.12, SE = 2.74). In contrast, fun was rated as most important for networks related to friendship (M = 74.43, SE = 3), feeling positive (M = 69.51, SE = 2.92), spending time together (M = 68.4, SE = 3.32), and support (M = 63.72, SE = 3.1).

Relationship Between Selectivity and Network Type. We also explored whether networks characterized by fun versus trust varied in their selectivity. We performed a median split and divided the networks into (*i*) lower vs. higher trust and (*ii*) lower vs. higher fun, as defined by ratings in our UIC sample. With two paired sample t tests, we then compared networks that were considered lower vs. higher on trust—and lower vs. higher on fun—in terms of the number of nominations that those networks produced in our Stanford sample. Higher-trust nominations mapped onto more selective networks (M = 2.6 nominations, SE = 0.14), whereas lower-trust nominations mapped onto less selective networks (M = 2.77, SE = 0.14) [paired-sample difference: $t(192) = -3.18$, $P < 0.01$]. In contrast, higher-fun nominations mapped onto less selective networks (M = 3.23 nominations, SE = 0.16), whereas lower-fun nominations mapped onto more selective networks (M = 2.14, SE = 0.12) [paired-sample difference: $t(192) = 13.46$, $P < 0.001$]. Thus, networks requiring trust have significantly fewer ties, whereas networks based on fun have significantly more ties (at least in these dormitories).

Personality–Centrality Relationships Across Networks. For Stanford participants, we combined individual and network levels of analysis by regressing indegree (i.e., the number of ties directed to each participant from his or her freshmen dorm members) on psychological trait clusters for each network. We used negative binomial regression to isolate the strongest trait predictor of centrality within each network, entering all four trait clusters as simultaneous predictors of centrality. [Although Poisson regression is typically used for count outcomes, we conducted negative binomial regressions because indegree for all eight networks was overdispersed (*SI Appendix*, Table S5). Critically, the negative binomial model (*i*) was a significant improvement over the Poisson model for all eight networks (*SI Appendix*, Table S6) and (*ii*) was not outperformed by alternative models (i.e., zero-inflated negative binomial model) (*SI Appendix*, Table S7).] This revealed a pattern of trait-centrality relationships

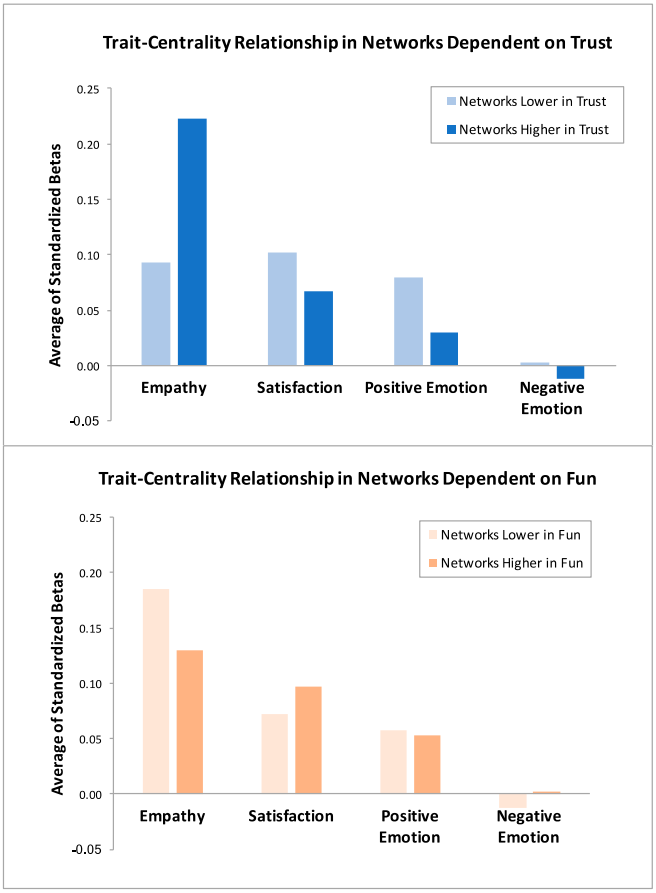

Fig. 2. (*Top*) The strength of the relationship between each trait and indegree (as indexed by the average standardized betas from Table 1) for networks that were considered higher vs. lower in trust. (*Bottom*) The strength of the relationship between each trait and indegree for networks that were considered higher vs. lower in fun and excitement.

consistent with past psychological research. People high in well-being were more central in networks characterized by fun (Fig. 2 and Table 1). For example, life satisfaction was the strongest predictor of spending time together, whereas positive emotion was the strongest predictor of making others feel positive (Fig. 3 and *SI Appendix*, Fig. S6). By contrast, empathy most strongly tracked centrality in trust-based networks (Fig. 2 and Table 1)—such as those defined by disclosing bad news (Fig. 3 and *SI Appendix*, Fig. S6) and seeking social support and empathy. However, negative emotion did not significantly relate to centrality in any of the networks.

Discussion

These data corroborate classic findings from psychology from a network perspective. Decades of work suggest that well-being helps individuals build positive relationships (16, 31), whereas empathy fosters and maintains close relationships in particular (32, 33). In college students, we found that communities comprised multiple networks, including more selective ones dependent on trust between dorm members and broader networks dependent on shared fun. Personality interacted with these network features to predict individuals' centrality: people high in well-being were central in networks related to fun, whereas people high in empathy occupied central positions in networks based on trust. This correlation is consistent with what students told us about how they select others and raises the possibility that they tune their relationships depending on their neighbors' traits: spending time with individuals high in well-being, but targeting empathic individuals for social interchange requiring trust. Together, these findings suggest that personality relates to the varied roles that individuals play in sustaining their communities.

Our findings also provide insight into how individuals promote well-being in their social network. For example, supportive relationships buffer people from stress and its deleterious effects on health (34), whereas weak ties help individuals gain knowledge and opportunities (35, 36). However, the types of individuals who help network neighbors through these varying mechanisms were previously unclear. Our findings suggest that empathic individuals help other network members through stress buffering and that individuals high in well-being provide others with opportunities to foster positive experiences. These traits could thus differentially predict the ways in which individuals affect the mental health and well-being of their broader communities.

Methods

Stanford Dorm Study.

Participants. We recruited college freshmen at Stanford University living in freshman-only dormitories. All participants provided informed consent according to the procedures of the Stanford University Institutional Review Board. To participate, students needed to be 18 y or older, a freshman, and living in the specified dorms. The study was conducted over the course of three academic quarters with four different samples: dorm 1 from January to March 2015, dorm 2 from April to June 2015, and dorms 3 and 4 from October to December 2015. We successfully recruited 49–67% of each dorm, for a total of 197 participants across all four dorms. Four participants withdrew from the study because they became too busy with schoolwork to participate in the subsequent aspects of the study. Thus, the final sample included a relatively diverse sample of 193 participants (94 males, mean age = 18.27 y) (see *SI Appendix*, Table S1 for a more extensive description of the participants). (Participants entered whole numbers for their age, rather than birthdates. Therefore, the actual average age might be higher due to rounding down.)

Procedure. During the second week of the quarter, participants completed an online Qualtrics survey that included (*i*) social network nominations, (*ii*) 21 trait questionnaires, (*iii*) demographic questions, and (*iv*) physical health information. All measures were administered in the order listed above, but the order of the 21 trait questionnaires was randomized. At the start of the survey, participants were reminded that their responses were confidential and were asked to fill out the survey in one sitting. Typically, the survey took 40–60 min to complete.

Trait measures. Participants completed 21 trait questionnaires on empathy, prosociality, personality, well-being, and clinical disorders. *SI Appendix*, Table S2, provides a detailed list of all measures. For each measure, select items were reverse-coded according to established scoring guides. Next, all items were averaged together to create a composite score for each measure. As a data reduction step, we performed a factor analysis on all composite scores for measures of empathy, prosociality, personality, and well-being on the full sample (197 participants). We excluded any scales typically used in the assessment of clinical disorders (i.e., depression, anxiety, risk for mania, rumination, and narcissism) or that were included for scale validation (i.e., interpersonal regulation) or as a potential covariate (i.e., social desirability, physical health). Using the psych package in R, a parallel analysis (i.e., a factor retention method) recommended that we retain five factors in the exploratory factor analysis (37). As a result, we specified a five-factor model with unweighted least-squares extraction (i.e., "minres") and oblique rotation (i.e., "oblimin"), allowing the factors to correlate with each other. However, one of the five factors contained only two items with a factor loading more than 0.4 (*SI Appendix*, Table S8), making this solution less optimal. We therefore moved to a four-factor solution with unweighted least-squares extraction and oblique rotation (*SI Appendix*, Table S9). Items with low factor loadings ($-0.4 < x < 0.4$) were removed, including lay theories of empathy, conscientiousness, openness, and loneliness. After removing these items, perceived stress was also removed due to high cross-loadings on multiple factors.

For the final solution (*SI Appendix*, Table S10), we evaluated model fit with the Tucker–Lewis Index (TLI), root mean-square error of approximation (RMSEA), and standardized root mean square residual (SRSR). Generally, TLI values above 0.90, as well as RMSEA and SRSR values of 0.08 or less, indicate adequate fit (38). The four-factor solution yielded acceptable fit across all indices: TLI = 0.91, RMSEA = 0.07, and SRSR = 0.04. In addition, factor loadings

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Table 1. Negative binomial regressions with the four trait factors simultaneously predicting indegree for each of the eight networks

	Low trust/low fun		Low trust/high fun		High trust/high fun		High trust/low fun	
Indegree	Good news [β (SE)]	Social advice [β (SE)]	Feel positive [β (SE)]	Spend time [β (SE)]	Close friend [β (SE)]	Support [β (SE)]	Bad news [β (SE)]	Empathetic [β (SE)]
Empathy	0.09 (0.06)	0.11* (0.06)	0.10 (0.06)	0.07 (0.06)	0.1* (0.05)	0.25*** (0.06)	0.21*** (0.06)	0.33*** (0.08)
Life satisfaction	0.08 (0.06)	0.12* (0.07)	0.10 (0.07)	0.11* (0.06)	0.08 (0.06)	0.10 (0.07)	0.01 (0.06)	0.08 (0.08)
Positive emotion	0.06 (0.06)	0.10 (0.07)	0.16** (0.07)	0 (0.06)	0 (0.06)	0.05 (0.07)	0.03 (0.07)	0.04 (0.09)
Negative emotion	0.03 (0.03)	0.01 (0.06)	0 (0.06)	−0.03 (0.06)	−0.02 (0.06)	0.02 (0.07)	0 (0.06)	−0.05 (0.08)

β represents the standardized beta coefficient (i.e., measured in units of SD). SE is the standard error of the standardized beta coefficient. Although indegrees are treated as independent, we caution that nominations could be correlated.*$P < 0.10$, **$P < 0.05$, ***$P < 0.01$. Indegrees are treated as independent, but we caution that nominations could be correlated.

for this model indicated relatively high internal consistency, ranging from 0.43 to 0.79 (Fig. 1 and *SI Appendix*, Table S10). Overall, these analyses reveal that our trait measures emerge as four distinct factors: (*i*) empathy, (*ii*) life satisfaction, (*iii*) positive emotion, and (*iv*) negative emotion.

To compute factor scores for subsequent analyses, we multiplied each indicator (e.g., empathic concern) by its factor loading and then averaged across all items for that factor (e.g., empathy). All factors were normally distributed, except for life satisfaction. Therefore, we applied the Box–Cox transformation to life satisfaction, leading to a normal distribution. This transformed variable was used for all subsequent analyses. To more deeply understand this structure, we tested if these four factors correlated with each other across individuals (Fig. 1). Empathy positively correlated with positive emotion [$r(195) = 0.32$, $P < 0.001$]. However, empathy did not significantly correlate with life satisfaction [$r(195) = 0.03$, $P = 0.72$] or negative emotion [$r(195) = -0.05$, $P = 0.50$]. Life satisfaction positively related to positive emotion [$r(195) = 0.40$, $P < 0.001$], but negatively related to negative emotion [$r(195) = -0.28$, $P < 0.001$]. Positive and negative emotion were negatively correlated [$r(195) = -0.33$, $P < 0.001$]. Notably, all significant correlations were moderate, suggesting that these four factors represent distinct constructs that are not strongly related to each other.

Network nominations. Participants were asked to fill out the names of up to eight people in their dormitory on nine questions. Questions were always presented in the order listed above. The last question, which is not listed above, was: "Who usually makes you feel negative (e.g., stressed, angry, sad)?" This question was not included in analyses because we focused on networks related to positive relationships only. Participants were instructed to type in the names of other freshmen in the dorm or their resident assistants (i.e., undergraduate dorm staff) and to not list any names of people outside of their dorm (e.g., family, significant other, other friends on/off campus). As participants typed names in, autocompleted suggestions appeared listing people in their dormitories (based on a roster provided by dorm staff).

We calculated indegree by totaling the number of ties directed to each individual from other freshmen in the dorm. Resident assistants (i.e., sophomores) did not participate in the study due to their knowledge about study hypotheses; therefore, indegree does not include any nominations to or from dorm staff. We also calculated the pairwise internetwork correlation between each of the eight networks. To assess the significance of these correlations, we used the quadratic assignment procedure (QAP). This nonparametric method involves permuting individual rows and columns in the adjacency matrices to assess how large the correlation of the actual data are relative to the correlation of the randomly permuted matrices (www.stata.com/meeting/1nasug/simpson.pdf). We computed QAP-based *P* values using the *qaptest* function in the *sna* package for R (https://cran.r-project.org/web/packages/sna/sna.pdf).

Data and code availability. The data and code for all Stanford dorm analyses are available in a Zenodo repository at https://doi.org/10.5281/zenodo.821788.

UIC Study.

Participants. We recruited 98 introductory psychology students at UIC. All participants provided informed consent according to the procedures of the UIC Institutional Review Board. Twelve participants completed the survey unusually fast (i.e., under 15 min), so they were excluded from analysis to ensure high-quality responses. Therefore, the final sample consisted of 86 students (23 males; mean age = 22.16) with 22% white, 27% Hispanic/Latino, 9% black/African American, 5% East Asian, 15% South Asian, 2% Pacific Islander, 5% Middle Eastern, 3% other/undisclosed, and 12% mixed race.

Procedure. Participants completed an online Qualtrics survey that included relationship dimension ratings (within a larger survey). Participants were asked to imagine their relationships with fellow students when prompted with a social network question (e.g., "Who are your closest friends?"). Then, they rated how important it was that these individuals possess seven different qualities. For each social network question, they saw this prompt: "When you think about UIC students who fill this role, how important is it that…" This was followed by seven different dimensions: (*i*) "You trust them?"; (*ii*) "You share the same interests, attitudes, and values with them?"; (*iii*) "You feel

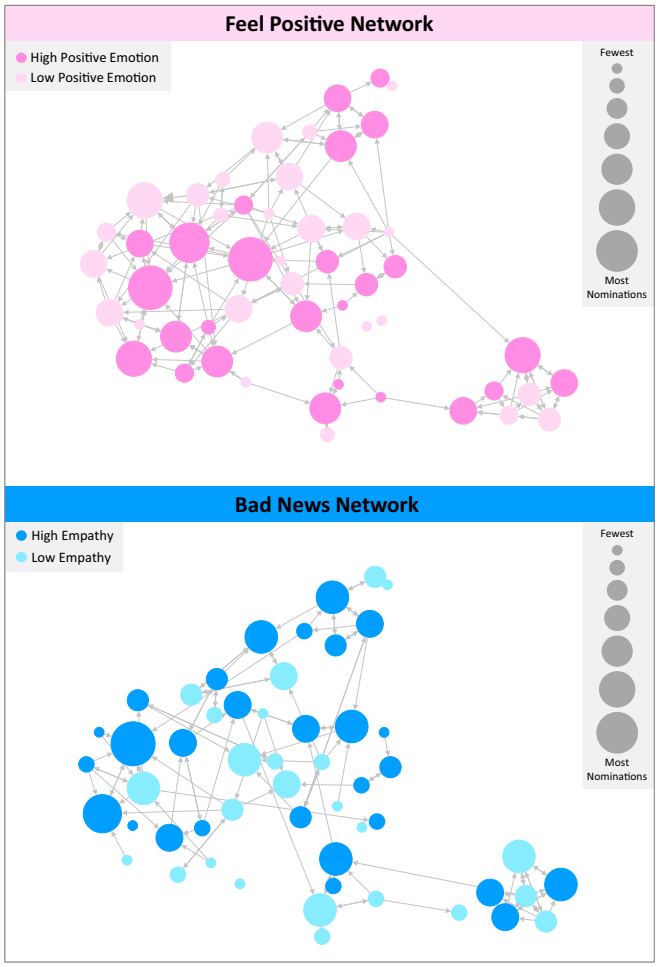

Fig. 3. (*Top*) A network map of one dorm shows that students with more nominations (i.e., larger nodes) for the question "Who usually makes you feel positive (e.g., happy, enthusiastic)?" also tend to rank higher on trait positive emotion. (*Bottom*) A network map of the same dorm shows that students with more nominations for the question "Who do you turn to when something bad happens?" also tend to rank higher on trait empathy. Note that all analyses were conducted with continuous trait measures and that median splits are used here only for illustrative purposes.

emotionally close to them?"; (*iv*) "They keep you informed of things you should know about?"; (*v*) "They have the right connections that can help with your career and future aspirations?"; (*vi*) "They have connections that can help you meet new and interesting people?"; and (*vii*) "You have fun and do exciting things together?". They made ratings on a sliding scale from 1 (not at all important) to 100 (very important). They completed these ratings for each of the eight social network nominations listed above. Ratings for each dimension were averaged across all participants.

Data and code availability. The data and code for all UIC analyses are available in a Zenodo repository, https://doi.org/10.5281/zenodo.821788.

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Supporting Information Appendix

Empathy and Well-Being Correlate with Centrality in Different Social Networks

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Table S1. Demographics of the Stanford dorm sample.

Demographics	Category	Dorm 1	Dorm 2	Dorm 3	Dorm 4	Total	% of Total
Total Dorm Residents		79	88	79	88	334	
N in study		53	43	46	51	193	
% recruited		67.1%	48.9%	58.2%	58%	57.8%	
Mean Age		18.38	18.49	18.11	18.12	18.27	
Gender							
	Male	23	19	24	28	94	48.7%
	Female	30	24	22	23	99	51.3%
Ethnicity							
	East Asian	*	*	11	*	34	17.6%
	Black/African American	*	*	*	*	12	6.22%
	White/Caucasian	21	14	14	19	68	35.2%
	Hispanic/Latino/a	*	*	*	*	19	9.84%
	South Asian	*	*	*	*	*	4.66%
	Other	*	*	*	*	*	3.63%
	Mixed Race	12	14	*	11	44	22.8%

Note. Any entries in the table with fewer than 10 respondents are reported as * to preserve privacy.

Table S2. A list of all trait questionnaires.

All Scales Included in Initial Factor Analyses		
Scale Name	**Variable in Data File**	**Citation**
Interpersonal Reactivity Index Empathic Concern Perspective Taking Personal Distress	 IRI_EC IRI_PT IRI_PD	Davis, M. H. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of Personality and Social Psychology*, *44(1)*, 113.
Positive Empathy	PosEmp_avg	Morelli, S. A., Lieberman, M. D., Telzer, E. H., & Zaki, J. (under review). Positive empathy: Its structure and relation to prosociality, social connection, and well-being.
Lay Theories of Empathy Scale	LTES_avg	Schumann, K., Zaki, J., & Dweck, C. S. (2014). Addressing the empathy deficit: beliefs about the malleability of empathy predict effortful responses when empathy is challenging. *Journal of Personality and Social Psychology*, *107(3)*, 475.
Prosocialness Scale for Adults	PSA_avg	Caprara, G. V., Steca, P., Zelli, A., & Capanna, C. (2005). A new scale for measuring adults' prosocialness. *European Journal of Psychological Assessment*, *21*(2), 77-89.
Big Five Inventory Extraversion Agreebleness Conscientiousness Neuroticism Openness	 BFI_e BFI_a BFI_c BFI_n BFI_o	John, O. P., & Srivastava, S. (1999). The Big Five trait taxonomy: History, measurement, and theoretical perspectives. *Handbook of personality: Theory and research*, *2*, pp. 102-138.
Behavioral Activation System Reward Fun Drive	BAS_avg BAS_reward BAS_fun BAS_drive	Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: the BIS/BAS scales. *Journal of Personality and Social Psychology*, *67*(2), 319.
Behavioral Inhibition System	BIS_avg	Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: the BIS/BAS scales. *Journal of Personality and Social Psychology*, *67*(2), 319.
Need to Belong	NTB_avg	Baumeister, R. F., & Leary, M. R. (1995). The need to belong: desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, *117*(3), 497.

All Scales Included in Initial Factor Analyses		
Positive and Negative Affect Scale Positive Affect Negative Affect	 PANAS_PosAvg PANAS_NegAvg	Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology*, *54*(6), 1063.
Satisfaction with Life Scale	SWLS_avg	Diener, E. D., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of Personality Assessment*, *49*(1), 71-75.
Subjective Happiness Scale	SHS_avg	Lyubomirsky, S., & Lepper, H. S. (1999). A measure of subjective happiness: Preliminary reliability and construct validation. *Social Indicators Research*,*46*(2), 137-155.
UCLA Loneliness Scale	Loneliness_avg	Russell, D. W. (1996). UCLA Loneliness Scale (Version 3): Reliability, validity, and factor structure. *Journal of Personality Assessment*, *66(1)*, 20-40
Perceived Stress Scale	PSS_avg	Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, 385-396.
Family Social Status Ladder	FmlyStatus	Adler, N. E., Epel, E. S., Castellazzo, G., & Ickovics, J. R. (2000). Relationship of subjective and objective social status with psychological and physiological functioning: Preliminary data in healthy, White women. *Health Psychology*, *19*(6), 586.
School Social Status Ladder	SSS_Stnfrd	Adler, N. E., Epel, E. S., Castellazzo, G., & Ickovics, J. R. (2000). Relationship of subjective and objective social status with psychological and physiological functioning: Preliminary data in healthy, White women. *Health Psychology*, *19*(6), 586.

Table S3. Descriptive statistics for the four trait factors.

Factor	Mean	SD	Min	Max
Empathy	6.15	0.997	4.02	8.4
Life Satisfaction	7.21	2.89	0	15
Positive Emotion	2.1	0.323	1.33	2.87
Negative Emotion	3.22	0.701	1.44	4.81

Table S4. Correlation matrix for the 8 networks.

Network	Close Friend	Spend Time	Social Advice	Bad News	Good News	Support	Empathetic
Close Friend	-	-	-	-	-	-	-
Spend Time	0.833 (0)	-	-	-	-	-	-
Social Advice	0.621 (0)	0.642 (0)	-	-	-	-	-
Bad News	0.612 (0)	0.633 (0)	0.707 (0)	-	-	-	-
Good News	0.735 (0)	0.751 (0)	0.671 (0)	0.72 (0)	-	-	-
Support	0.658 (0)	0.658 (0)	0.645 (0)	0.689 (0)	0.709 (0)	-	-
Empathetic	0.521 (0)	0.521 (0)	0.544 (0)	0.596 (0)	0.552 (0)	0.628 (0)	-
Feel Positive	0.596 (0)	0.571 (0)	0.501 (0)	0.54 (0)	0.592 (0)	0.587 (0)	0.522 (0)

Notes. p-values based on the Quadratic Assignment Procedure (QAP) are in parentheses.

Table S5. Statistics describing the dispersion in indegree for each of the 8 networks. The dispersion parameter quantifies how much larger the variance is than the mean. All 8 networks were over-dispersed (i.e., dispersion parameter > 1).

Indegree	Mean	Variance	Dispersion parameter (θ)
Close Friends	4.18	8.64	2.01
Spend Time	3.60	6.91	1.85
Social Advice	2.01	2.77	1.32
Bad News	1.84	2.42	1.24
Good News	2.75	4.02	1.45
Support	2.40	4.36	1.63
Empathetic	1.96	4.45	1.93
Feel Positive	2.73	5.47	1.75

Notes. The dispersion parameter was obtained from a quasi-Poisson model in R with the glm function.

Table S6. Results of the likelihood ratio tests comparing a negative binomial model to a poisson model. Both models include the four trait factors predicting indegree for each network. For all 8 outcomes, a significant deviance statistic indicates that the negative binomial model was a significant improvement over the poisson model.

Indegree	Deviance
Close Friends	58.9*
Spend Time	43.01*
Social Advice	7.06*
Bad News	4.02*
Good News	13.14*
Support	25.22*
Empathetic	55.41*
Feel Positive	36.97*

Notes. *$p < .05$. The deviance statistic was compared to a χ^2 distribution with 1 degree of freedom.

Table S7. Results of the Vuong tests comparing a negative binomial (Model 1) to a zero-inflated negative binomial model (Model 2). Both models include the four trait factors predicting indegree for each network. A large, positive test statistic provides evidence of the superiority of Model 1 over Model 2, while a large, negative test statistic is evidence of the superiority of Model 2 over Model 1. Overall, the models were either indistinguishable (i.e., not significantly different) or the negative binomial model was superior (see BIC-corrected statistic).

Indegree	Raw Vuong z-statistic	AIC-corrected Vuong z-statistic	BIC-corrected Vuong z-statistic
Close Friends	1.08	1.68*	2.66*
Spend Time	1.12	1.82*	2.97*
Social Advice	-1.52	-0.32	1.65*
Bad News	-1.24	0.59	3.56*
Good News	-1.06	0.27	2.42*
Support	-0.04	1.11	2.99*
Empathetic	0.21	1.10	2.55*
Feel Positive	0.56	1.53	3.10*

Notes. *$p < .05$. AIC = Akaike Information Criterion. BIC = Bayesian information criterion. The z-statistic is asymptotically distributed standard normal under the null that the models are indistinguishable.

Table S8. Standardized factor loadings for the initial five-factor model.

Composite Score	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
IRI - Perspective Taking	-0.07	0.58	-0.08	-0.03	0.31
IRI - Empathic Concern	0.21	0.65	-0.03	0.12	0.14
IRI - Personal Distress	0.65	-0.07	0.03	-0.1	-0.24
Positive Empathy	0.03	0.54	-0.04	0.37	0
Lay Theories of Empathy	-0.21	0.1	-0.08	0.03	0.06
Prosocialness Scale for Adults	-0.03	0.55	-0.1	0.24	0.19
Need to Belong	0.59	0.16	-0.03	0	-0.29
Family Social Status Ladder	0.07	-0.04	0.54	-0.06	-0.02
School Social Status Ladder	0.03	-0.12	0.82	0.02	0.13
Positive Affect Scale	-0.05	0.17	0.23	0.57	0.03
Negative Affect Scale	0.71	-0.19	-0.22	0.23	0.09
BFI - Extraversion	-0.09	-0.01	-0.04	0.79	0.01
BFI - Agreeableness	-0.09	0.71	-0.03	-0.07	-0.17
BFI - Conscientiousness	-0.13	0.33	0.24	0.02	-0.08
BFI - Neuroticism	0.86	-0.04	0.08	-0.11	0.13
BFI - Openness	-0.03	0.26	0.16	0.08	0.64
Behavioral Activation System	0.11	0	-0.03	0.72	0.05
Behavioral Inhibition System	0.74	0.28	0.04	-0.1	-0.19
UCLA Loneliness Scale	0.25	-0.16	-0.26	-0.39	0.1
Satisfaction with Life Scale	-0.09	0.1	0.43	0.22	-0.41
Subjective Happiness Scale	-0.27	0.1	0.23	0.48	-0.3
Perceived Stress Scale	0.65	-0.07	-0.12	-0.03	0.27

Notes. IRI = Interpersonal Reactivity Index; BFI = Big Five Inventory. Cells highlighted in green are greater than .4 or less than -.4.

Table S9. Standardized factor loadings for the initial four-factor model.

Composite Score	Factor 1	Factor 2	Factor 3	Factor 4
IRI - Perspective Taking	-0.09	0.63	-0.25	0
IRI - Empathic Concern	0.21	0.68	-0.06	0.1
IRI - Personal Distress	0.68	-0.12	0.15	-0.11
Positive Empathy	0.05	0.56	0.08	0.31
Lay Theories of Empathy	-0.22	0.13	-0.09	0.02
Prosocialness Scale for Adults	-0.05	0.61	-0.14	0.22
Need to Belong	0.63	0.11	0.19	-0.06
Family Social Status Ladder	0.06	-0.11	0.37	0.02
School Social Status Ladder	-0.03	-0.17	0.43	0.15
Positive Affect Scale	-0.05	0.17	0.26	0.55
Negative Affect Scale	0.66	-0.14	-0.31	0.24
BFI - Extraversion	-0.13	0.06	0.05	0.73
BFI - Agreeableness	-0.03	0.69	0.2	-0.16
BFI - Conscientiousness	-0.09	0.28	0.32	0
BFI - Neuroticism	0.8	-0.05	-0.14	-0.03
BFI - Openness	-0.12	0.31	-0.34	0.21
Behavioral Activation System	0.09	0.04	0.04	0.69
Behavioral Inhibition System	0.78	0.22	0.16	-0.13
UCLA Loneliness Scale	0.23	-0.14	-0.38	-0.35
Satisfaction With Life Scale	0	-0.02	0.76	0.15
Subjective Happiness Scale	-0.22	0.06	0.52	0.38
Perceived Stress Scale	0.58	-0.01	-0.42	0.05

Notes. IRI = Interpersonal Reactivity Index; BFI = Big Five Inventory. Cells highlighted in green are greater than .4 or less than -.4.

Table S10. Standardized factor loadings for the final four-factor model.

	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**
IRI - Perspective Taking	-0.08	0.59	-0.25	0.03
IRI - Empathic Concern	0.2	0.67	-0.08	0.1
IRI - Personal Distress	0.68	-0.11	0.13	-0.1
Positive Empathy	0.04	0.58	0.11	0.28
Prosocialness Scale for Adults	-0.07	0.62	-0.14	0.19
Need to Belong	0.63	0.12	0.12	-0.04
Family Social Status Ladder	0.1	-0.12	0.43	-0.03
School Social Status Ladder	0.02	-0.2	0.56	0.06
Positive Affect Scale	-0.06	0.15	0.28	0.54
Negative Affect Scale	0.6	-0.14	-0.34	0.28
BFI - Extraversion	-0.17	0.08	0.07	0.7
BFI - Agreeableness	-0.03	0.71	0.19	-0.17
BFI - Neuroticism	0.79	-0.07	-0.16	-0.02
Behavioral Activation System	0.06	0.02	0.06	0.69
Behavioral Inhibition System	0.78	0.21	0.09	-0.1
Satisfaction With Life Scale	0	0.01	0.71	0.1
Subjective Happiness Scale	-0.21	0.09	0.59	0.32

Notes. IRI = Interpersonal Reactivity Index; BFI = Big Five Inventory. Cells highlighted in green are greater than .4 or less than -.4.

Figure S1. Histograms of indegree for each of the 8 networks, collapsed across all the dorms. Indegree is the total number of ties *directed to* each individual from other participants in the dorm.

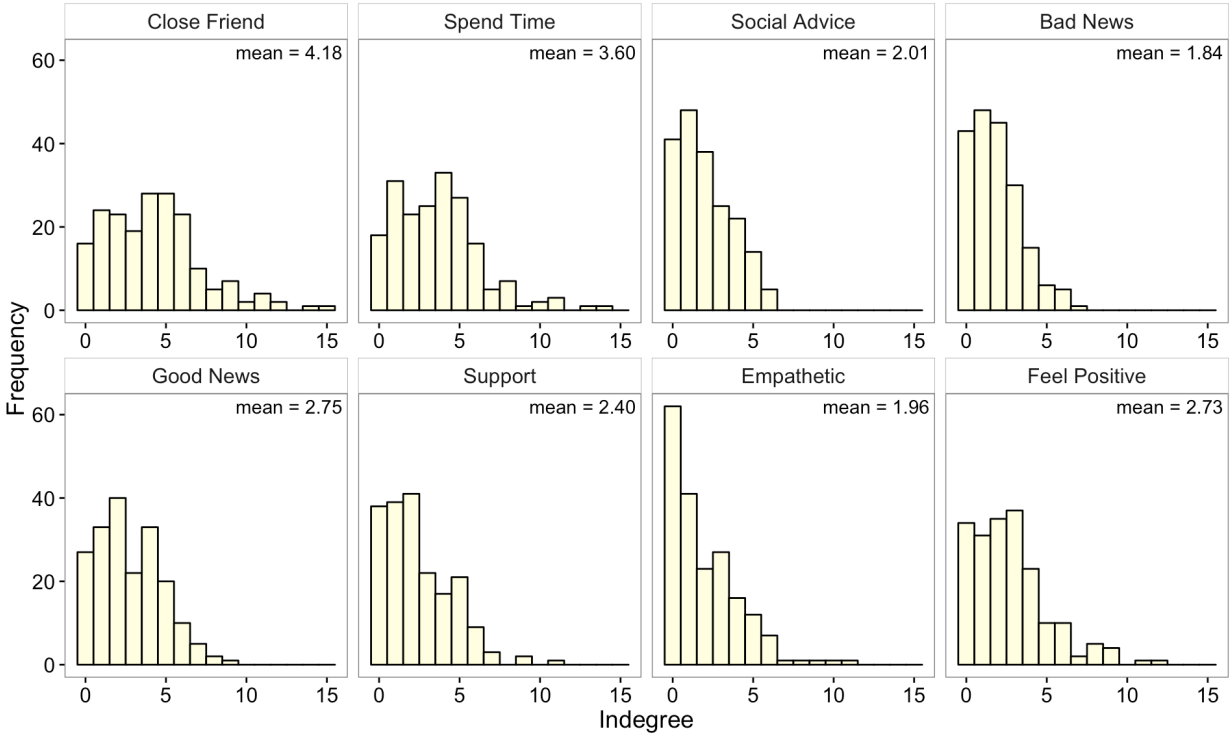

Figure S2. Histograms of outdegree for each of the 8 networks, collapsed across all the dorms. Outdegree is the total number of ties *from* each individual to other participants in the dorm.

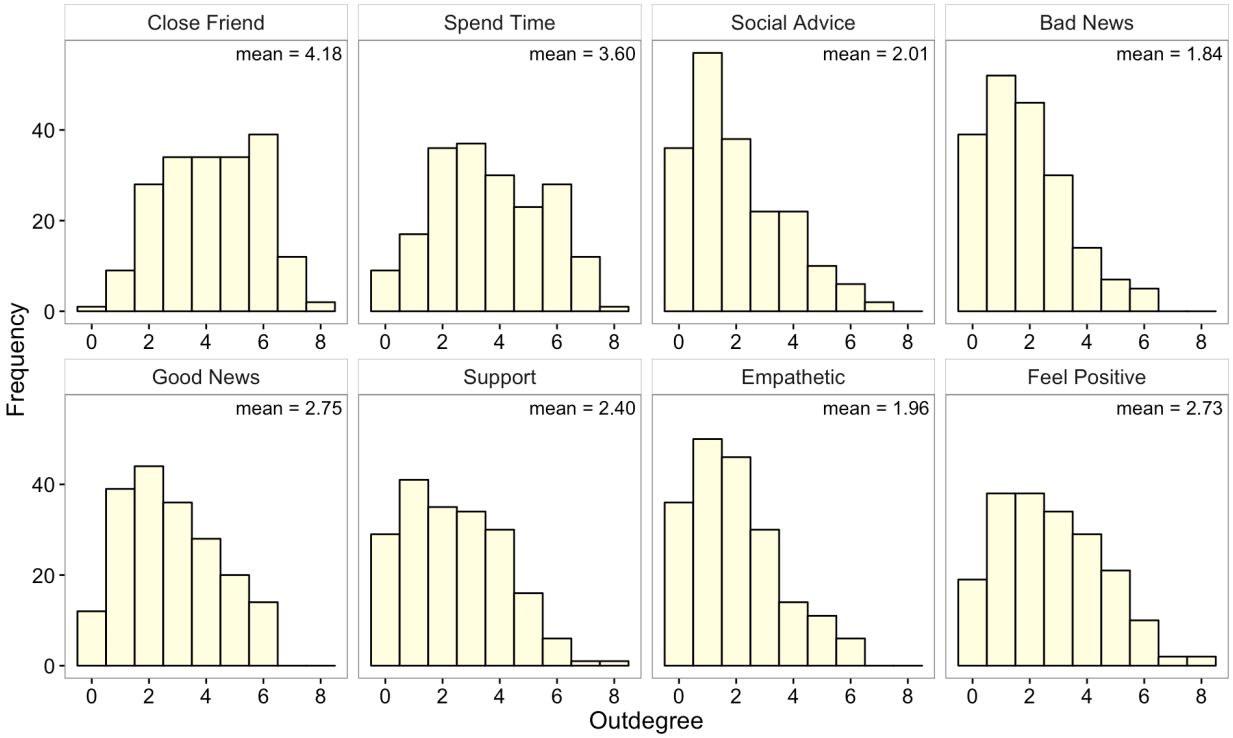

Figure S3. Histograms of reciprocal ties for each of the 8 networks, collapsed across all the dorms. Reciprocal ties are when two participants in the dorm direct a tie to each other. The histograms represent the average number of reciprocal ties *per individual*. So, if Person A nominates Person B and Person B nominates Person A, then this tie would be separately counted as a reciprocal tie for Person A *and* a reciprocal tie for Person B.

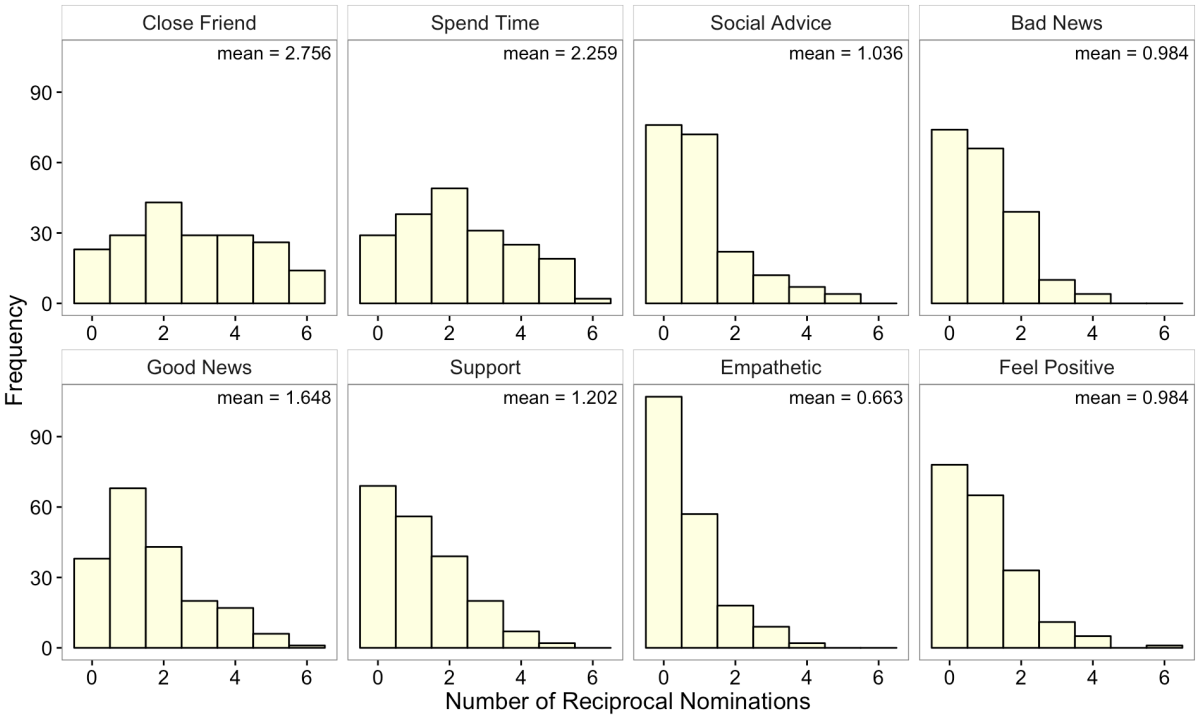

Figure S4. Average ratings (across the UIC participants) on the importance of trust and fun/excitement for each type of network, using a scale from 1 (*not at all important*) to 100 (*very important*).

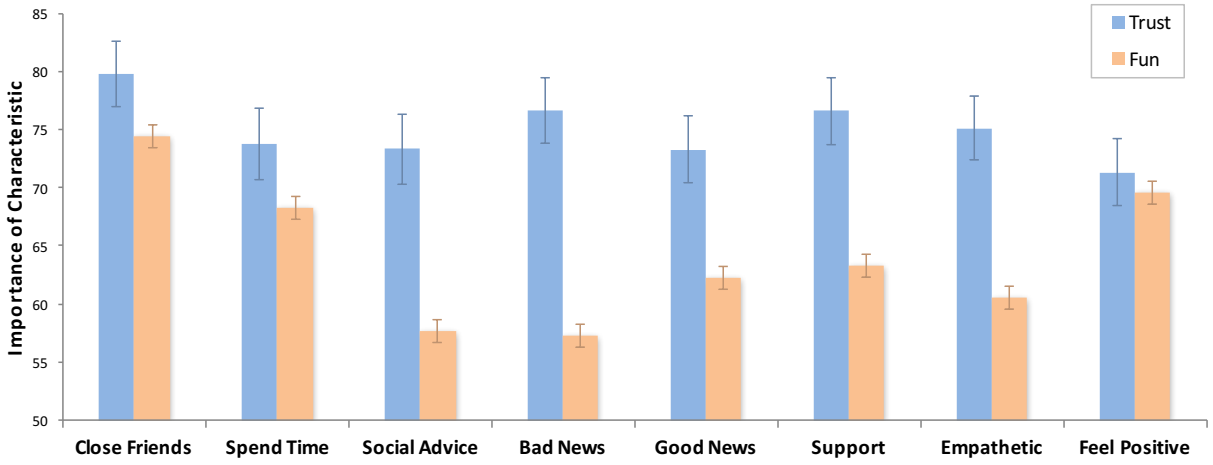

Figure S5. For each type of network, average ratings (across UIC participants) on the importance of (i) emotional closeness, (ii) shared interests, attitudes, and values, (iii) hearing information, (iv) meeting new people, (v) and maintaining connections for a future career, using a scale from 1 (*not at all important*) to 100 (*very important*).

Figure S6. In the left column, network maps of the four dorms showing that students with more nominations (i.e., larger nodes) for the question "Who usually makes you feel positive (e.g., happy, enthusiastic)?" also tend to rank higher on trait positive emotion. In the right column, network maps of the four dorms showing that students with more nominations for the question "Who do you turn to when something bad happens?" also tend to rank higher on trait empathy. Note that all analyses were conducted with continuous trait measures, and median splits are used here only for illustrative purposes.

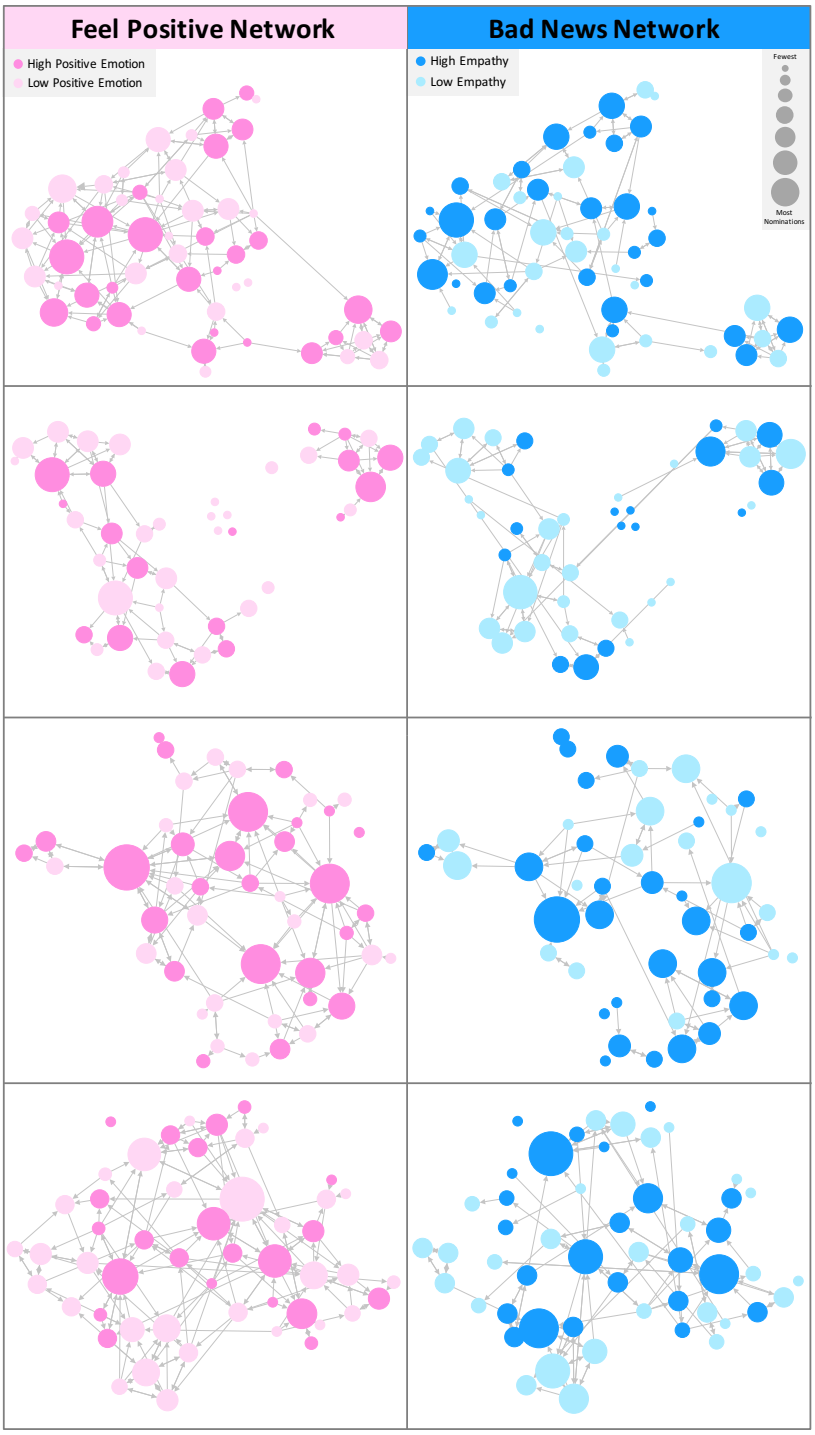

Figure S7. The relationship between each trait and indegree (as indexed by the average standardized betas from Table 1) for high vs. low-selectivity networks.