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Review of the effects of Five Factor Model personality traits on network structures and perceptions of structure

Mary Selden*, Adam S. Goodie

University of Georgia, United States

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ABSTRACT

We review recent research on Five Factor Model personality and social network analysis to assess how structures develop and are perceived. Extraversion and agreeableness relate consistently to personal but not workplace networks. Extraverts are more likely to seek connections, whereas agreeable individuals receive connections from others. Openness predicts network diversity and is marginally related to position when groups pursue collective goals. Conscientiousness is associated with maintaining certain personal relationships, but is strongly related to central positions in workplace networks. Neuroticism has no consistent relationship with network size or composition, and is differentially related to network positions, depending on the context.

Introduction

Social network analysis (SNA) has been used to study entities (people, businesses, etc.) and the relationships between those entities (giving advice, trade, disease spread, etc.) in a variety of disciplines (Scott, 2000; Wasserman and Faust, 1994). The structure and properties of the network depend on the study design, network type, and types of relationships that are being represented. While SNA has been used extensively in fields like sociology, its increased popularity in psychology has led to a surge of studies merging the traditional structural approaches of SNA with the individual differences literature. One topic that has been only recently explored is how individual differences in personality affect network structures and perceptions. There have been few attempts (e.g., Burt et al., 2013; Fang et al., 2015; Kilduff and Tsai, 2003) to synthesize the existing research related to personality and SNA. Here we review both consistencies and inconsistencies in the literature that uses the Five Factor Model (FFM) of personality.

Incorporating personality traits into the social network paradigm

At the extreme, traditional structuralists tout that network structure is the major determinant of human interaction, and reject the suggestion that individuals have agency over their social environments (e.g., Mayhew, 1980). Kilduff and Tsai (2003) provide a detailed outline of the controversy regarding this perspective. Adherents to this "anti-categorical imperative" (Kilduff and Tsai, 2003, p. 68) doubt the efficacy of predicting human behavior using only the characteristics of individuals—of claiming dispositions drive dyadic and group behavior (Wellman, 1983). They highlight the role that networks play in creating or hindering opportunities for social interaction and resources (Kilduff and Tsai, 2003; Wellman, 1983). However, these views discount the fact that humans are active agents, and their social relationships and environments are affected by their motivations, behaviors, and personalities. The traditional structuralists' strong anti-individualist stance is not shared by all; some social network researchers have attempted to look at individual motivations and predispositions to assess how these characteristics help shape network structure (e.g., Kadushin, 2002) and explain changes in network patterns (like intransitivity; Hallinan and Kubitschek, 1988). Kilduff and Tsai (2003) describe the work of "pioneering" structuralists (p. 80; see also Burt et al., 2013). Recently, a literature has emerged to link individual differences and social networks. These authors contend, and we concur, that individual differences in personality are related to both perceptions of the network itself (e.g., Casciaro, 1998; Clifton

* Corresponding author at: Psychology Department, University of Georgia, 125 Baldwin Street, Athens, GA 30602, United States.
E-mail address: mselden19@gmail.com (M. Selden).

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and Kuper, 2011; Clifton, 2014; Lamkin et al., 2014) as well as the structure of the networks (e.g., Emery, 2012; Flynn et al., 2010; Kalish and Robins, 2006; Kalish, 2008; Selfhout et al., 2010).

While the literature suggests that personality traits may influence some social network structures, there is only one study that has meta-analytically assessed the effects of self-monitoring and the FFM personality traits on network properties (Fang et al., 2015). Fang et al. (2015) were particularly interested in how these traits influence workplace (organizational) networks, and how those structural positions then predicted job performance and career success. Their work provided new insights into how personality directly and indirectly influences work outcomes in organizational networks through advantageous network positions. However, Fang et al. (2015) only assessed the effect of traits on two types of network positions (in-degree centrality and brokerage), and limited their analysis to adult, working samples. We included studies that used a variety of samples spanning across work-related and personal networks to better evaluate the effects of personality on a variety of social relationships.

In this review paper, we catalogue and critique research that has assessed the relationships that personality traits (specifically those of the FFM) have with network structure and perceptions of the network structure across a variety of network properties. As such, we account for the potential effects of personality on other structural properties within networks, such as alternative conceptualizations of centrality (e.g., betweenness and closeness) or more complex structural formations such as transitivity. We draw conclusions about how personality contributes to understanding a variety of structural positions theoretically and practically, with special consideration to the implications of how patterns may differ between network designs (egocentric or sociocentric), types of networks (workplace or personal), and types of relationships (ties). Finally, we offer some additional suggestions for future research.

Scope and approach

Social network analysis (SNA) is a method to describe social structure in terms of networks (Marsden, 1990; Wasserman and Faust, 1994). Because SNA can be used to characterize any set of entities and the connections between those entities, it is applicable to a wide range of disciplines (Scott, 2000; Wasserman and Faust, 1994). Because the purpose of this review is to assess the effects that personality has on network perceptions and structures, we are limiting the scope to humans embedded in social contexts with other humans. The network members ("actors") are associated with others in a network based on some shared social interaction (e.g., friendship, leadership). Accordingly, articles that solely used simulated data were excluded.

Studies utilizing either sociocentric (complete network) or egocentric (networks enumerated from the perspective of one individual) designs were eligible for inclusion (Butts, 2008; Marsden, 1990; Wasserman and Faust, 1994). However, studies assessing online social networking websites (e.g., Facebook, Twitter, FourSquare) were excluded due to boundary definition issues. That is, people use social networking sites for many different reasons (Subrahmanyam et al., 2008), and can be connected to others on those sites without ever engaging in direct interactions with the individuals in their online social networks. Furthermore, the types of interactions and constraints on the nature of the interactions vary widely depending on the type of networking site (e.g., Twitter's character restrictions on tweets, FourSquare's limited purpose in providing only location-based information), which limit the comparisons that can be made with other forms of social interaction assessed here. Though personality has been linked to online social network usage (e.g., Chorley et al., 2015; Lönnqvist and Itkonen, 2014), these studies will not be discussed.

Articles must have evaluated some social network property, like size, composition, and/or structure (through the use of social network metrics) and those properties and metrics must have been related to personality in some regard (e.g., reported correlations or path coefficients). Furthermore, to be included in the review, the study must have included at least one of the traits defined by the FFM (extraversion, neuroticism, agreeableness, openness to experience, and conscientiousness), though we placed no restrictions on the instrument used to measure each trait. For example, extraversion as measured by personality scales such as the Eysenck's Personality Questionnaire – Revised (EPQ-R; Eysenck and Eysenck, 1985), International Personality Item Pool (IPIP; Goldberg et al., 2006), various versions of the NEO-PI-R (e.g., Costa and McCrae, 1992; McCrae et al., 2005), or short scales like the Ten Item Personality Inventory (TIPI; Gosling et al., 2003) were all acceptable. We excluded articles that only measured non-FFM traits (e.g., abnormal personality traits; Lamkin et al., 2014), and articles that simply used network procedures to visualize or analyze personality as a network (e.g., Costantini et al., 2015; Goekoop et al., 2012).

To find relevant literature, we used multiple search strategies. These included (a) conducting searches using the University of Georgia Multi-search Tool, which is a collection of approximately 130 databases and the UGA Library Catalog including PsycINFO, MEDLINE with Full Text, Social Sciences Citation Index, SocINDEX with Full Text, Business Source Complete, and ScienceDirect[1]; (b) consulting with a subject matter expert (SME) for recommended articles on the topic of personality and social network analysis; and (c) assessing literature listed in the reference sections of articles found using the databases and recommendations from the SME. In our database searches, we used various combinations of the following search terms: "social network;" "social network analysis;" "network analysis;" personality; "Five Factor Model;" "Big Five;" extraversion; extroversion; neuroticism; emotional stability; "openness to experience;" openness; agreeableness; conscientiousness; "NOT Facebook;" and "NOT Twitter." We also applied restrictions to include human subjects only, and sources that were peer-reviewed and published in English. Our broadest searches yielded approximately 748 articles.

After reviewing the articles based on the inclusionary and exclusionary criteria described above, our final list consisted of 30 articles. The final list is summarized in Table 1, and includes brief descriptions of the design, sample, type of relationship(s) measured, network property assessed, and traits measured in each article. In the table, we distinguish between sociocentric and egocentric designs. The data used in sociocentric designs (i.e., socionetworks or whole networks) were gathered from most or all individuals within a predefined set of boundaries, and assessments of network structures tend to reflect actual[2] positions within the network (Butts, 2008; Wasserman and Faust, 1994). Traditionally, egonetworks, as defined by Wasserman and Faust (1994), are networks whereby a focal actor ("ego") enumerates their network members ("alters") based on some predefined criteria (e.g., "important others" or "family, friends, and significant others"), and then reports the relationships (perceived ties) between each pair of alters. Reports from the ego are based on perceptions of the ego's immediate social spheres. However, in some egonetworks included

[1] A full list of databases is available at http://www.libs.uga.edu/multisearch.html.

[2] By 'actual', we mean that the networks were created using data from more than a single individual in the network. We acknowledge, however, that sociocentric design may not reflect 'objective reality', but they do rely on combining (always) or corroborating (usually) the perceptions of multiple people. As such, socionetworks are likely to be more objective than egonetworks. The primary purpose of this distinction is to differentiate how a single individual's viewpoint of their network's structure is influenced by their personality in egonetworks, and how individuals' personality influences their positions in socionetworks.

Table 1
Summary of Relevant Articles Included in this Review.

#	Short Citation	Design	Relationship (Network Boundary)	Sample	Network Properties	Traits					Other Traits
						E	N	A	O	C	
1	Baams et al. (2015)	Sociocentric (longitudinal)	Friendship (students in multiple classrooms)	Adolescent students (Netherlands)	In-degree Out-degree Homophily	X	X	X	X	X	
2	Baer (2010)	Egocentric[a] (cross-sectional)	No ties assessed (up to 25 idea discussants)	Global agricultural processing firm employees (not reported)	Size Composition				X		
3	Battistoni and Fronzetti Colladon (2014)	Sociocentric (cross-sectional)	Advice (students in one class)	College students (Italy)	Key player	X	X	X	X	X	
4	Bolger and Eckenrode (1991)	Egocentric[a] (cross-sectional)	No ties assessed (contacts in prior 2 weeks)	College students (United States)	Composition	X	X				
5	Casciaro (1998)	Sociocentric via local aggregation of egocentric perceptions (cross-sectional)	Advice at work & friendship (employees in the 3 research centers)	Employees at 3 inter-connected university research centers (Italy)	In-degree	X					Self-monitoring Need for achievement Need for affiliation
6	Daly et al. (2014)	Sociocentric (cross-sectional)	Advice/leadership (principals and district leaders in three school districts)	School administrators (United States)	In-degree Out-degree In-closeness Out-closeness	X	X	X	X	X	
7	Doeven-Eggens et al. (2008)	Egocentric[a] (cross-sectional)	No ties assessed (up to 5 family and friends)	College students (Netherlands)	Composition	X	X	X		X	Autonomy
8	Emery (2012) and Emery et al. (2013)	Sociocentric (longitudinal)	Leadership (students in study abroad program)	College students (United States)	In-degree Out-degree Reciprocity Transitivity Cyclic ties	X	X	X	X	X	
9	Feiler and Kleinbaum (2015)	Sociocentric (longitudinal)	Friendship (cohort of M.B.A. students in one university)	Graduate students (United States)	Size In-degree Out-degree Homophily	X					
10	Flynn et al. (2006)	Sociocentric (cross-sectional)	Advice (Study 4 only; cohort "clusters" of M.B.A. students in one university)	Graduate students (United States)	Size Homophily Reciprocity	X					Self-monitoring
11	Gloor et al. (2011)	Sociocentric (cross-sectional)	Communication (students in small teams in one class distributed across three countries)	College students (Italy, Germany, and Finland)	Degree Betweenness	X	X	X	X	X	
12	Hopp and Zenk (2012)	Sociocentric (cross-sectional)	Cooperation (students in 18 class project groups)	College students (Austria)	In-degree Out-degree Density					X	
13	Kalish and Robins (2006)	Egocentric (cross-sectional)	Strength of relationship—strong, weak, did not know (up to 18 important university contacts)	College students (Australia)	Size Density Triad closure	X	X				Individualism Locus of control Self-monitoring
14	Kalish (2008)	Sociocentric (cross-sectional)	Friendship (religiously diverse students in one classroom)	College students (Israel)	Brokerage	X	X				
15	Klein et al. (2004)	Sociocentric (cross-sectional)	Advice, friendship, and adversary (members randomly assigned to 96 teams)	Young adults in national, team-based service-learning program (United States)	In-degree	X	X	X	X	X	

Table 1 (*Continued*)

#	Short Citation	Design	Relationship (Network Boundary)	Sample	Network Properties	Traits					Other Traits
						E	N	A	O	C	
16	Lee et al. (2010)	Sociocentric via local agreement of egocentric perceptions (cross-sectional)	Friendship and knowledge-sharing (colleagues at work)	Employees in a range of industries (Taiwan)	Degree					X	
17	Liu and Ipe (2010)	Sociocentric (cross-sectional)	Advice/support at work (employees at 24 different bank branches)	International bank employees (Taiwan)	In-degree			X		X	
18	Neubert and Taggar (2004)	Sociocentric (cross-sectional)	Advice/support at work (employees in 18 teams at a manufacturing company)	Manufacturing company employees (United States)	In-degree	X	X	X	X	X	
19	Pollet et al. (2011)	Egocentric[a] (cross-sectional)	No ties assessed (relatives, friends, and acquaintances)	Young and older adults via snowball sampling (Netherlands)	Composition	X					
20	Roberts et al. (2008)	Egocentric[a] (cross-sectional)	No ties assessed (individuals contacted in prior week [support] or month [sympathy])	Adults: Community members, students, and faculty (England)	Size Composition	X	X				
21	Russell et al. (1997)	Egocentric[a] (cross-sectional)	No ties assessed (important others)	Male alcoholics in treatment unit (United States)	Size Composition	X	X				
22	Selfhout et al. (2010)	Sociocentric (longitudinal)	Friendship (students randomly assigned to groups)	College students (Netherlands)	In-degree Out-degree Homophily	X	X	X	X	X	
23	Schulte et al. (2012)	Sociocentric (cross-sectional)	Friendship, advice, and difficulty (employees randomly assigned to 69 regional teams)	Young adults in national, team-based service-learning program (United States)	In-degree Out-degree	X	X	X	X	X	
24	Stokes (1985)	Egocentric (cross-sectional)	Whether each alter pair knew one another significantly (up to 20 significant contacts)	College students (United States)	Size Composition Density	X	X				
25	Swickert et al. (2002)	Egocentric[a] (cross-sectional)	No ties assessed (social support contacts)	College students (United States)	Size	X					Neuroticism—controlled for N, but didn't report results
26	Totterdell et al. (2008)	Egocentric[a] (cross-sectional)	No ties assessed (Study 1 only; close friends and confidantes)	College students (England)	Size	X	X	X	X	X	Propensity to connect
27	Wagner et al. (2014)	Egocentric[a] (longitudinal)	No ties assessed (up to 25 close others)	High school graduates (Germany)	Size Composition	X	X	X	X	X	
28	Xia, Yuan, and Gay (2009)	Sociocentric (cross-sectional)	Adversary (students in small teams in one class)	College & graduate students (United States)	In-degree	X	X	X	X	X	
29	Zell et al. (2014)	Egocentric (cross-sectional)	Whether each alter pair knew one another (up to 20 people who provide support/advice)	College students (United States)	Size Composition Degree Density	X					
30	Zhu et al. (2013)	Egocentric[a] (cross-sectional)	No ties assessed (up to 20 social support contacts)	College students (United States)	Size Composition	X	X	X	X	X	

Note. "Relationship" refers to the tie among individuals in the network; "network boundary" refers to the individuals (other participants or alters) that compose the network. E = extraversion, N = neuroticism (low emotional stability), A = agreeableness, O = openness to experience, and C = conscientiousness.

[a] Egonetworks where participants enumerate alters, but did not report the relationships (perceived ties) among the alters.

here, the egos enumerate their alters but do not define the relationships among the alters (Marsden, 1990). Those studies are noted with a superscript 'a'.

Personal vs. workplace networks

The specific type of relationship among the individuals in the network can range widely from social support, advice, trust, communication, and leadership perceptions. Networks can also differ by the characteristics of the sample and the boundaries of the network (e.g., students, coworkers, important others). For clarity, we discuss two broad types or categories of networks, based primarily on the actors' characteristics and the presence or absence of an explicit goal for interacting: personal networks and workplace networks. Personal networks[3] (or socioemotional or "expressive" networks; Fang et al., 2015) can potentially include relationships with or among family (kin), friends, confidantes, or acquaintances. Workplace networks (or "instrumental" networks; Fang et al., 2015) can potentially include relationships with or among coworkers, supervisors and subordinates, teams or work groups, departments, or organizations. Furthermore, relationships that require collective action toward a goal, as opposed to just social-emotional relationships, were generally considered workplace networks. These differences may produce contrasting or convergent evidence as to the moderating role that network type has on the relationship between personality and the structure of the network or perceptions within the network.

However, we acknowledge that the two types of networks are not necessarily mutually exclusive (e.g., Emery, 2012; Emery et al., 2013; Mehra et al., 2009; Moore, 1990; Yan, 2014). Certain networks discussed here will fall somewhere between personal and workplace networks, based on the definition provided above. For example, advice networks where students are interacting in a classroom setting may be considered more of a "workplace" network despite the student sample if an explicit collective goal defines the nature of their interactions (e.g., to complete an assignment together). To the extent that personality is stable and expressed across a variety of relationship types and/or settings, consistent patterns should emerge. In addition, the extent to which personal and workplace networks overlap may have implications for understanding the effects of personal interactions that underlie the formal structures of organizations or work groups. Differences found among personal and workplace networks may provide insight into the contextual constraints certain network environments have on expression of personality.

Personality in social networks

The FFM of personality (sometimes referred to as the "Big Five") and self-monitoring have received the most attention from network researchers in recent years. As self-monitoring has been reviewed elsewhere (see Kilduff and Tsai, 2003, Chapter 4), we will focus on the Five Factor Model. The FFM theory includes the traits of extraversion, neuroticism, agreeableness, openness to experience, and conscientiousness (Costa and McCrae, 1992; Digman, 1990). This conceptualization of personality has been linked to differences in neurological functioning (Kunisato et al., 2011) and brain structure (Bjørnebekk et al., 2013; DeYoung et al., 2010; Xu and Potenza, 2012). Accordingly, the FFM traits are generally stable over time[4] (e.g., Klimstra et al., 2009; Wagner et al., 2014), and is related to consistent interaction patterns (Digman, 1990). Longitudinal studies have found that personality influences social relationships, while social relationships have little effect on personality traits (Asendorpf and Wilpers, 1998; Neyer and Asendorpf, 2001). Each of the five domains has been found to correlate with and predict network structures and perceptions across different types of personal and workplace networks, albeit to varying degrees. We consider each in turn, and summarize the findings in Table 2.

Extraversion

Extraversion is characterized by warmth towards others and positive emotions; preferences for social engagement, activity, and excitement; and assertiveness in social interactions (Costa and McCrae, 1992). Extraverts attend to social stimuli more readily than introverts (Fishman et al., 2011), and are better at recognizing social stimuli than introverts (Li et al., 2010). Extraverts are motivated to seek out social interaction (Smółka and Szulawski, 2011); they want to connect with others and tend to have social goals (Argyle and Lu, 1990a; McCabe and Fleeson, 2012). They also tend to have better social skills, and to feel less socially anxious than introverts (Argyle and Lu, 1990b; Furnham and Guntert, 1983; Smółka and Szulawski, 2011). Personal networks, particularly friendship networks, are predicted to be influenced by extraverts' positive affectivity (Demir and Weitekamp, 2006), and abilities to succeed in initiating and maintaining social contact (Jensen-Campbell et al., 2002; Ozer and Benet-Martínez, 2006; Smółka and Szulawski, 2011). Extraverts are socially competent in work settings where they need to interact with others to complete goals, and perform especially well when trying to gain power or influence (Barrick, 2005; Tett and Burnett, 2003).

Network size and composition

Given these basic attributes of extraversion, it is unsurprising to see that it tends to be related to larger personal networks (Feiler and Kleinbaum, 2015; Kalish and Robins, 2006; Pollet et al., 2011; Russell et al., 1997; Swickert et al., 2002; Wagner et al., 2014; Zhu et al., 2013). In two studies assessing the social support networks of college students, extraversion correlated with network size and addition of new contacts while controlling for the other Big Five traits (Zhu et al., 2013), and network size when controlling for other aspects of the relationships (i.e., frequency of contact, duration of acquaintance, and support satisfaction; Swickert et al., 2002; Zhu et al., 2013). That is, extraverts reported having more social support contacts in their networks than introverts. These cross-sectional studies are corroborated by a longitudinal study of students transitioning out of high school (Wagner et al., 2014). After leaving high school, extraversion significantly predicted increases in participants' personal network sizes over the next three years (while controlling for the other Big Five traits). First-year M.B.A. students' advice networks were larger for extraverts than introverts as well (Flynn et al., 2006). In a non-student sample, extraversion positively correlated with and predicted the size of the important people networks of alcoholic men in a treatment facility (Russell et al., 1997). Though Russell et al. (1997) sample was idiosyncratic, the personal networks of extraverted young and older adults in the

[3] We avoid using the term "personal network" for egonetworks because we use it to describe a particular type of network, namely a sociocentric or egocentric network that includes family, friends, close, or important people in the respondent's life.

[4] A small literature examines how personality change over time affect network characteristics over time (Asendorpf and Wilpers, 1998; Neyer and Asendorpf, 2001; Wagner et al., 2014), which introduces complexities that are beyond our present scope. Only one study from this literature met our inclusion criteria (Wagner et al., 2014). For this study, we report the results for the effects of personality measured at Time 1 on network characteristics and changes in network characteristics over time in order to make appropriate comparisons to the other studies.

Table 2
Summary of Results.

	Extraversion	Neuroticism	Agreeableness	Openness	Conscientiousness
NETWORK COMPOSITION & SIZE					
Network Composition					
Egocentric	+: 4, 7, 19, 27, 30 –: ns: 4, 21, 24, 29	+: 4, 20 –: 21[a] ns: 4, 7, 24, 27	+: 27 –: ns: 7, 30	+: 2, 27, 30 –: ns:	+: 7, 27 –: ns: 30
Network Size					
Sociocentric	+: 9, 10 –: ns:	+: –: ns:	+: –: ns:	+: –: ns:	+: –: ns:
Egocentric	+: 13, 21, 25, 27, 30 –: ns: 20, 26, 29	+: –: ns: 20, 21, 24, 26, 27	+: 27, 30 –: ns: 26	+: 27 –: ns: 2, 26, 30	+: –: ns: 26, 27, 30
CENTRALITY & HOMOPHILY					
Degree Centrality					
Degree					
Sociocentric	+: –: ns: 11	+: –: ns:11	+: 11 –: ns: 17	+: 11 –: ns:	+: 16_F[b] –: ns: 11, 16_K, 17
In-degree					
Sociocentric	+: 8_R[c], 8_T, 9, 18, 15_N[d], 23_A[e], 23_D –: 23_F ns: 1, 5, 15_A, 15_F, 22, 28	+: 6, 15_N, 28 –: 15_A, 15_F ns: 1, 8_R, 8_T, 18, 22, 23_F, 23_A, 23_D	+: 22 –: 15_N ns: 1, 6, 8_R, 8_T, 15_A, 15_F, 18, 28, 23_F, 23_A, 23_D	+: 15_N, 18 –: 8_R, 8_T, 15_F, 28 ns: 1, 6, 15_A, 22, 23_F, 23_A, 23_D	+: 8_R, 8_T –: ns: 1, 6, 12, 15_A, 15_F, 15_N, 18, 22, 23_F, 23_A, 23_D
Egocentric	+: 29 –: ns:	+: –: ns:	+: –: ns:	+: –: ns:	+: –: ns:
Out-degree					
Sociocentric	+: 9, 22, 23_A, 23_F –: ns: 1, 8_R, 8_T, 23_D	+: 6, 23_D –: 8_R, 23_F, 23_A ns: 1, 8_T, 22	+: 23_F, 23_A –: 8_R, 23_D ns: 1, 6, 22	+: 1, 8_R, 23_D –: ns: 6, 8_T, 22, 23_F, 23_A	+: 1, 8_T, 12, 23_F –: ns: 6, 8_R, 22, 23_A, 23_D
Closeness Centrality					
In-closeness					
Sociocentric	+: 6 –: ns:	+: 6 –: ns:	+: –: ns: 6	+: –: ns: 6	+: 6 –: ns:
Out-closeness					
Sociocentric	+: 6 –: ns:	+: 6 –: ns:	+: –: ns: 6	+: –: ns: 6	+: 6 –: ns:
Betweenness Centrality					
Sociocentric	+: –: ns: 11	+: –: ns: 11	+: 11 –: ns:	+: 11 –: ns:	+: –: ns: 11
Homophily					
Sociocentric	+: 9, 22 –: 10 ns: 1, 8_R, 8_T	+: –: ns: 1, 8_R, 8_T, 22	+: 22 –: 1, 8_R, 8_T ns:	+: 8_R, 22 –: ns: 1, 8_T	+: –: ns: 1, 8_R, 8_T, 22
NETWORK STRUCTURE					
Bridging/ Brokerage					
Sociocentric	+: –: ns: 14	+: –: 3, 14 ns:	+: –: ns:	+: –: ns:	+: –: ns:

Transitivity (Cyclic Ties)					
Egocentric	+: 13	+:	+:	+:	
	–:	–: 13	–:	–:	
	ns:	ns:	ns:	ns:	
Key Player					
Sociocentric	+:	+:	+: 3_B	+:	+: 3_C, 3_B, 3_P
	–:	–: 3_C, 3_I, 3_B	–:	–:	–:
	ns: 3_C[f], 3_B, 3_I, 3_P	ns: 3_P	ns: 3_C, 3_I, 3_P	ns: 3_C, 3_B, 3_I, 3_P	ns: 3_I
Density					
Sociocentric	+:	+:	+:	+:	+:
	–:	–:	–:	–:	–:
	ns:	ns:	ns:	ns:	ns: 12
Egocentric	+:	+:	+:	+:	+:
	–:	–:	–:	–:	–:
	ns: 13, 24, 29	ns: 13, 24	ns:	ns:	ns:

Note. The following network properties were not assessed in any of the reviewed articles, and therefore are not reported here. Research in these areas could be valuable: Network composition (sociocentric); degree and out-degree centrality (egocentric); in-closeness and out-closeness centrality (egocentric); betweenness centrality (egocentric); bridging/brokerage (egocentric); transitivity (sociocentric); homophily (egocentric); key player (egocentric).

[a] Russell et al. (1997) found that neuroticism negatively predicted the number of positive network members they listed in their network, but was unrelated to the number of negative network members.

[b] Lee et al. (2010) assessed friendship and knowledge-sharing networks. F = friendship, K = knowledge-sharing.

[c] Emery et al. (2013; data also used in Emery, 2012) assessed in-degree, out-degree, and homophily effects for both relationship and task leaders. R = relationship leader networks, T = task leader networks.

[d] Klein et al. (2004) assessed three different networks. A = advice, F = friendship, N = adversarial (negative relationships).

[e] Schulte et al. (2012) assessed three different networks. For out-degree centrality, correlations were reported. For in-degree centrality, results were from regression analyses controlling for various personality and individual difference variables. F = friendship, A = Advice, D = difficulty (negative relationships).

[f] Battistoni and Fronzetti Colladon (2014) assessed the effects of personality on four different types of key player positions in classroom advice networks. C = central connectors (high in- and out-degree), B = boundary spanners (connect clusters), I = information brokers (fragment network if removed), P = peripheral specialist (high in-degree and low out-degree).

Netherlands were also larger than the networks of introverts (even after controlling for age and gender; Pollet et al., 2011).

However, three studies did not find extraversion to be related to network size. In United States college students' support/advice networks, extraverts and introverts' egonetworks did not differ in size (Zell et al., 2014). In another university student sample, extraversion was predicted to be a distal predictor of egonetwork size, and would be mediated by people's propensity to connect to others. Extraversion did not significantly predict network size when propensity to connect others was included in the model (Totterdell et al., 2008). These results are corroborated by an egonetwork study using a representative sample of adults (in England) that found extraversion to be unrelated to support and sympathy network size when participants' age was controlled for (Roberts et al., 2008). Given the preponderance of evidence, extraversion appears to be related to network size across samples and designs with few exceptions.

Extraversion also has differential effects on network composition. Extraverts included more people in their support, sympathy, and "outer" layers of their personal networks than introverts (Pollet et al., 2011). In college students' recent contact networks, extraversion was related to greater integration with friends and neighbors, marginally related to greater integration with leisure and religious groups, but unrelated to work and school contacts and kin (Bolger and Eckenrode, 1991). Similarly, when asked to list their five most "focal core" (i.e., important) network members, extraverts were more likely to include friends (as opposed to family) in their "core" networks (Doeven-Eggens et al., 2008). In the longitudinal study introduced above, the larger networks report by extraverted students transitioning from high school was primarily due to increases in non-family members into the network over time (Wagner et al., 2014).

Only one study found extraversion to be unrelated to composition in students' support/advice egonetworks at school when controlling for other network properties (i.e., tie strength, degree, and density; Zell et al., 2014). Extraverts did not differ from introverts in the number of friends, family, classmates, faculty, staff, or other contacts they reported in their networks. Similarly, extraverts did not include more family relations in their significant people egonetworks than introverts in another college student sample (Stokes, 1985). In a sample of male alcoholics at a treatment clinic, extraversion did not predict who was more likely to include positive relations, negative relations, or alters who exist in multiple support roles in their important people network (Russell et al., 1997).

The studies described above all assessed network size and composition in egonetworks, which are useful for understanding how an ego *perceives* his or her network (Borgatti et al., 2013). It could be argued that extraverts merely perceive their networks as larger, or are more willing to include "friends" with whom they have weaker ties into their network. And in fact, based on these results presented above, composition differences in the networks of extraverts and introverts are primarily from extraverts' willingness to include friends and other non-family relations in their networks. Using an egocentric design limits conclusions about network structure based on each actor's objective affiliation with every other person in the network. However, the results of the egonetwork studies are supported by a sociocentric study that also assessed the effects of extraversion on friendship networks (Feiler and Kleinbaum, 2015). Similarly to Wagner et al. (2014), Feiler and Kleinbaum (2015) studied newly-forming friendship networks in university students who were transitioning into their M.B.A. program. They used a sociocentric network where each actor reported on his or her interactions with each other actor in the program, and thus could draw conclusions about the complete structure of the network. Participants rated friendship ties five weeks after they arrived, and then again

at 11 weeks. Extraverts were connected to more cohort members than introverts at both time points. These effects were stronger at 11 weeks, indicating that extraverts were more able to connect with more people throughout the first weeks of their interaction, leading to larger friendship networks over time. Thus, Feiler and Kleinbaum (2015) provide additional support for the effects of extraversion on network size.

Centrality and homophily

Feiler and Kleinbaum's (2015) complete network also allowed them to assess how extraversion may affect the structure of the network, specifically how extraversion relates to actors' positions within the network (i.e., centrality) and friendship selection processes (i.e., homophily). First, extraverts tended to form more ties than introverts, and occupied more central positions in the friendship network. Extraverts not only nominated more people as friends (high out-degree centrality), but were also nominated as friends more often (high in-degree centrality). In-degree centrality was associated with popularity, which provided extraverts with more influence and power over communication in the network, and more access to resources (Freeman, 1978). Out-degree centrality was associated with activity, and, unsurprisingly, extraverts tended to be among the most active actors in the network. This is consistent with the sociability aspect of the trait, as extraverts tend to list more people as being their friends than introverts do.

The second link that extraversion has to network structure was through friendship formation, and especially friendship formation through homophily. Homophily refers to the tendency for people to associate with others who are similar to them on some characteristic (McPherson et al., 2001). Feiler and Kleinbaum (2015) found that the more similar a pair of actors were in extraversion, the more likely it was that they would become friends. Similar results were found in a longer longitudinal study, which assessed the effects of personality and personality similarity on the formation of friendship ties over four months (Selfhout et al., 2010). Like Feiler and Kleinbaum (2015), the design was sociocentric; unlike Feiler and Kleinbaum's (2015) single socionetwork, Selfhout et al. (2010) looked at the effects of personality on friendship formation across 10 separate groups. New students were recruited in their first weeks at the university and randomly assigned to be in large "introduction groups" that met weekly. FFM personality was assessed at time one, and friendship ties within each group were measured at all four later time points. Extraversion predicted out-degree centrality (i.e., extraverts nominated more friends over time), but did not predict in-degree centrality (i.e., extraverts were not more likely to be nominated as friends by others over time). Similarity (homophily) effects were found for extraversion, such that actors with similar extraversion scores tended to be become friends over time. Extraversion appears to be related to both centrality (particularly out-degree centrality) and homophily in these newly forming friendship networks.

A third longitudinal study contradicts the findings of both Feiler and Kleinbaum (2015) and Selfhout et al. (2010). Baams et al. (2015) assessed the socionetworks of adolescent students in the Netherlands over a year and a half. They found that extraversion was unrelated to in-degree, out-degree, or homophily. That is, extraverted adolescents were not more likely to choose others as friends, be chosen as friends, or make friends with similar or dissimilar levels of extraversion. Unlike Feiler and Kleinbaum (2015) and Selfhout et al. (2010) newly forming friendship networks, these students were well-acquainted with one another, and generally stayed with the same class over the course of the study. These conflicting results may suggest that extraversion is more useful in the formation of new friendship ties, but less necessary for the maintenance of ties once friendships have been established.

In workplace networks, the results are less consistent. In a cohort first-year M.B.A. students at a United States university, Flynn et al. (2006) found extraversion had generally consistent correlations with team and race heterophily in three advice networks. While there was some weaker evidence of a relationship with sex homophily, these results provide some evidence suggesting extraverts may try to connect with others when they need advice, and are sought out despite boundaries when advice is needed. In a longitudinal study, Emery et al. (2013; Emery (2012) assessed the leadership networks of a large cohort of students studying abroad, and found extraversion to be partially related to actors' position in the networks. As part of the program, students were required to complete various group tasks with their classmates. The students' perceptions of one another as task and relationship leaders were measured once a month for four months. Even while controlling for common network patterns such as reciprocity and transitive triplets, as well as prior friendships and advice networks, extraversion predicted being nominated as both task and relationship leaders over time (in-degree centrality). Unlike Feiler and Kleinbaum (2015) and Selfhout et al. (2010)'s friendship networks, or Flynn et al.'s advice networks, however, there were no effects of extraversion on out-degree leadership centrality, nor did they find personality homophily effects (Emery et al., 2013).

Past research has shown that friendship networks often overlap with leadership networks, and that being a person's friend makes one more likely to nominate that person as a leader at a later time (though not vice versa; Mehraet al., 2009). In Emery et al.' studies (Emery, 2012; Emery et al., 2013), friendship networks were controlled for in the analyses. Thus, if the friendship networks were confounded with the leadership network, then it is possible that extraversion would be more consistent with Selfhout et al.'s (2010) results. However, this possibility was not tested. Still, the results illustrate that extraverts' typical position in a network depends on the type of network in question. Their outgoing tendencies may make them more likely to send and receive ties in friendship networks, but only receive ties in leadership networks.

One cross-sectional study found extraversion to be unrelated to any type of key player positions in a classroom advice network (Battistoni and Fronzetti Colladon, 2014). Similarly, extraversion was unrelated to degree centrality and betweenness centrality in a collaborative team communication network where the students' communication occurred entirely through email (Gloor et al., 2011). However, the sample for this study was unique, with teams comprised of students from at least three different countries. Such a distinctive sample may not generalize broadly, and may be one reason why the results are inconsistent with most other evidence presented here.

The studies reported above all used student samples; however, the results of workplace network studies using non-student sample are less consistent. One cross-sectional study shows extraversion was unrelated to both friendship and advice in-degree centrality among employees at three Italian research centers who worked in close proximity (Casciaro, 1998). In another cross-sectional study of service-learning teams, extraversion was unrelated to in-degree in advice and friendship socionetworks (Klein et al., 2004). A separate cross-sectional study of service-learning teams found that extraversion negatively predicted friendship in-degree centrality, and positively predicted advice in-degree centrality (Schulte et al., 2012). The samples of these two studies were similar: young adults, whole networks of non-military service-learning teams, each group randomly assigned 9–12 members, and whose goals were to provide community services. Schulte et al. (2012) controlled for reciprocity and transitivity in each network, as well as whether or not the members were designated as the formal leader of the group. While both studies controlled for personal characteristics (e.g., gender and age in-degree, out-degree, and/or homophily),

Schulte et al. only controlled for the FFM traits and that were significant in their control models. Klein et al. (2004) assessed all of the FFM traits in each analysis.

Thus, in these service-learning work-teams, there exists some evidence that extraversion tends to be somewhat negatively related to receiving friendship ties, though extraverts may be seen as useful sources of advice. Results from other studies—with different non-student samples—are consistent with Schulte et al.'s (2012) findings. Daly et al. (2014) gathered sociocentric data on the advice network of school administrators to assess how these people become advice leaders in their districts. Extraverted individuals had more indirect connections (high in- and out-closeness), and thus were more efficiently connected to many others. In terms of position, this means that they could both receive and provide advice more efficiently in the network, even when controlling for position, education, and years of experience as an administrator. Extraversion was also related to in-degree centrality in advice/support networks of 18 teams at one manufacturing United States company, such that those who were more extraverted tended to be nominated as sources of advice and support by others on the team (Neubert and Taggar, 2004). While the data remain mixed in terms of workplace networks, they more strongly suggest that extraversion is related to central positions within both personal and workplace networks, at least in terms of degree and closeness centrality.

Three studies have assessed the relationship between personality and members' positions in networks measuring negative relationships ("adversarial" or "difficulty" networks). Extraversion was negatively correlated with in-degree centrality in an adversarial network of students working on class projects in small teams, but did not predict centrality when controlling for previous work experiences and previous work relationships with other team members (Xia et al., 2009). In two separate non-student samples of young adults working in service-learning teams, extraversion predicted in-degree in adversarial (Klein et al., 2004) and difficulty networks (Schulte et al., 2012). Thus, extraverts were more likely to be rated as difficult to interact with in the larger, nonstudent teams, but not in smaller student teams.

The differences could be due in part to the characteristics of the samples, or the differences in control variables. For example, only Schulte et al. (2012) controlled for agreeableness, neuroticism, network structures (i.e., reciprocity and transitivity), formal leader positions in the teams, and personal variables (i.e., age and gender degree centrality) that could influence the interactions within teams. Xia et al. (2009) did not control for demographics or the other FFM traits in their analyses, while Klein et al. (2004) controlled for personal characteristics like age, sex and education, as well as demographic and similarity in values among members. The conflicting results may also be due to the differences in the sizes and numbers of groups in each study. Xia et al. (2009) had between 6 and 10 groups (exact number not reported) with 4–7 members in each group. Both Klein et al. (2004) and Schulte et al. (2012) had both more teams (96 and 69 teams, respectively) and the teams were larger (between 9 and 12 members each). Finally, the goals and environments of the groups differed as well. Xia et al. (2009) used groups from a single class working on class projects, while Klein et al. (2004) and Schulte et al. (2012) used groups from a service-learning program where members worked in difficult conditions (e.g., disaster relief) and were rewarded for working together. With few studies to drawn from, these trends and considerations are speculative, but provide initial evidence for extraversion's role in negative relationships.

Network structures

The results thus far show that extraverts perceive their personal networks as larger than introverts do, tend to be more directly and indirectly connected to other individuals within their friendship and leadership/advice networks, and tend to connect to individuals who share their traits in friendship networks. However, one remaining issue is whether extraversion influences higher order clustering, particularly transitivity. That is, since extraverts tend to be directly connected to many others, are their network members also more likely to be connected with one another? Are they loosely connected, or unconnected? Kalish and Robins (2006) offered two plausible, opposing hypotheses: extraverts may act as social coordinators and introduce unacquainted alters at social events (producing more transitive triads), or they may have too large of networks to support the creation of transitive ties among the many various alters. The evidence on this question is mixed (Kalish, 2008; Kalish and Robins, 2006; Zell et al., 2014).

Kalish and Robins (2006) and Zell et al. (2014) both found some support for the first hypothesis. In an egocentric study on university students, Kalish and Robins (2006) assessed how various personality traits (including the Big Five, self-monitoring, locus of control, and individualism-collectivism) influence the perceptions of various types of triad formations within participants' personal networks. They defined nine possible triad formations based on all permutations of strong ties, weak ties, and absent ties that could exist among alters. The diverse formations allowed them to examine how much network closure was occurring (i.e., seeing completely connected or transitive triads). Like Selfhout et al.' (2010) study, these data were collected at the beginning of the students' first semester at university in order to examine newly-forming social structures. Students were not limited to including friends—they could list anyone they considered important to their university life across a variety of settings. This allowed the researchers to assess both strong and weak ties between alters in the network.

Kalish and Robins (2006) found that extraverts had a tendency to have denser networks (though the density results were not significant when controlling for other personality traits, demographic characteristics, aspects of identity). (Dense networks have high proportions of ties compared to the total number of ties possible among all alters.) Thus, they tend to see those individuals as more connected overall. More importantly, extraversion was positively related to network closure for triads with strong ties and negatively related to network closure for triads with weak ties. This indicates that extraverts see clusters of alters as being more strongly connected to one another, thereby perceiving fewer structural holes in their networks. Similarly, another egonetwork study found that extraverts (college students) perceive their alters as being more embedded (higher in-degree centrality) in their support/advice networks, and found that extraverts reported stronger affective connections to their alters than introverts (Zell et al., 2014). Extraverts did not differ from introverts, however, in the strength of their reported relationships with their alters based on behavioral metrics like frequency of conversations, duration of relationship, advice reciprocity, or intimacy (sharing personal information). Like Kalish and Robins (2006), Zell et al. (2014) and Stokes (1985) also found that extraverts did not have denser networks than introverts in support/advice networks or "significant others" networks, respectively.

Because Kalish and Robins (2006) used cross-sectional data, they could assess perceptions of closure within the network at this particular time point when the network was just forming, but not the actual effect that extraversion had on the development of closure. Thus, closure may or may not exist, but the participant believes the closure exists. More recently, Kalish (2008)

tested the effects of extraversion and neuroticism, among other individual difference measures, on brokerage roles in a network (Fernandez and Gould, 1994), using sociocentric methods within a small, religiously diverse class in a university. They assessed the motivational factors behind actors' willingness to position themselves as friendship brokers between the religious subgroups in the network, as well as the personality traits that influence their motivations. The author hypothesized two different tie formation motivations, and that these motivations would be associated differently with the various types of brokers. Kalish (2008) claimed that entrepreneurial-oriented actors would bridge between groups of similar (homophilous) others to enhance their power between groups, while relationship-orientated actors to build relationships will bridge between groups of dissimilar (heterophilous) others to increase transitivity among the groups. Though they found significant effects for other personality traits (namely neuroticism, see below), extraversion and brokerage motivation were unrelated. Thus, extraverts did not attempt to bridge structural holes between the different groups.

Since only one classroom network with a unique sample was used in this study, the results may not generalize to other types of networks. Flynn et al. (2006) found that extraversion was consistently correlated with advice reciprocity in a cohort of M.B.A. first-year students. This does not completely contradict the findings of Kalish (2008), though the results suggest that connections in extraverts' advice networks in Flynn et al.'s study were less limited by social boundaries than Kalish's (2008) friendship networks.

Conclusions

Taken together, there is a large, diverse and consistent literature to suggest that an extraverted personality is related to larger friendship network size, in both egocentric and sociocentric studies and in a broad variety of network settings (Feiler and Kleinbaum, 2015; Russell et al., 1997; Zhu et al., 2013). Extraverts are also more integrated with friends, forming more ties than introverts and occupying more central positions (Neubert and Taggar, 2004). Extraverts also incorporate friends in closer proximity in both static, cross-sectional studies and in the development of relationships and networks in longitudinal studies (Doeven-Eggens et al., 2008; Selfhout et al., 2010; Wagner et al., 2014). These effects are considerably attenuated in workplace networks based on leadership rather than friendship. In workplace leadership networks, extraverts nominate more others than do introverts, but are not nominated more by others (Emery, 2012; Emery et al., 2013). The literature suggests that extraverts do not systematically use their larger networks to foster more ties among their alters, resulting in networks that are not denser than introverts' networks (Kalish and Robins, 2006; Stokes, 1985; Zell et al., 2014).

Neuroticism

Neuroticism is characterized by tendencies to feel negative emotions such as anxiety, depression, and anger; as well as impulsivity and vulnerability to stress (Costa and McCrae, 1992; Digman, 1990). People high in neuroticism tend to be socially anxious and lack social skills (Argyle and Lu, 1990b; Furnham and Guntert, 1983; Smółka and Szulawski, 2011), and to report more negative affect (Demir and Weitekamp, 2006) than people who are more emotionally stable. They are often viewed negatively by others, which has been previously shown to hinder their abilities to initiate and maintain relationships, especially friendships (Creed and Funder, 1998; Demir and Weitekamp, 2006). Neuroticism also predicts the number of friendship conflicts (Berry et al., 2000; Demir and Weitekamp, 2006). This could have negative implications for the size of the personal—particularly friendship—networks and for the structure to contain fewer ties. In workplace settings, people who are low in neuroticism are likely to perform well in situations where they have multiple responsibilities, and they are able to handle uncertainty well (Tett and Burnett, 2003). Given these patterns, we would expect neuroticism to consistently predict poorer relationship outcomes. However, the current literature hints at a more mixed and subtle relationship between neuroticism, interpersonal interaction, and the structure of the personal and workplace networks.

Network size and composition

Prior research using person-centered designs (not relationship-centered like social network analysis) suggests that neuroticism influences friendship selection in networks, especially ones that are in the early stages of formation. However, in their cross-sectional network study, Totterdell et al. (2008) found that neuroticism did not predict friendship egonetwork size, even though neuroticism was negatively correlated with the propensity to connect to others, specifically, the "making friends" factor. Zhu et al. (2013) found neuroticism did not predict network size in college students' social support egonetworks or number of new contacts made over the year (though the number of new contacts was negatively correlated with neuroticism). Similarly, neuroticism was unrelated to network size and percentage of relatives in their "significant people" networks in another sample of college students (Stokes, 1985).

These results are corroborated by a longitudinal study conducted with students transitioning out of high school (Wagner et al., 2014), which examined how personality relates to both changes in personal network size and composition. Like Totterdell et al. (2008), Wagner et al. (2014) assessed egonetworks, though they allowed participants to list anyone the participant considered to be significant in their lives. Participants also reported the type of relationship they shared with each alter (e.g., parent, partner, acquaintance). Neuroticism was unrelated to network size or composition. Similarly, when looking at the "focal" five most important people with whom participants discussed important matters, Doeven-Eggens et al. (2008) saw no differences in the proportions of friends versus family in students' self-reported egonetworks. In a more representative sample of adults in a cross-sectional study, neuroticism was not correlated with the size of either the sympathy or support groups of people's networks (Roberts et al., 2008).

Very few studies have found differences in network composition based on neuroticism. College students who score high on neuroticism were more likely to include kin in their personal networks than those low in neuroticism, though they were not more likely to include people from work, school, leisure or religious groups, or friends and neighbors (Bolger and Eckenrode, 1991). In a non-student sample of alcoholic men in treatment, neuroticism negatively predicted the number of positive relationships they listed, but was unrelated to the number of negative relationships and people who provide multiple avenues of support, as well as the size of their "important people" network (Russell et al., 1997). One other study found that women who score higher on neuroticism tend to have more step-relatives, in-laws, and close female kin in their support and sympathy networks (Roberts et al., 2008). Despite these few significant results, the studies presented here provide consistent evidence (utilizing different criteria) that neuroticism is unrelated to both perceptions of egonetwork size and network composition.

Centrality and homophily

These egocentric studies show that individuals higher in neuroticism perceive differences in the structure of how their alters

are connected, but not the overall size and composition of their networks. They also do not provide insight into how neuroticism may affect the actor's position within the structure of the network. Two longitudinal sociocentric studies assess friendship networks in college students (Selfhout et al., 2010) and adolescents (Baams et al., 2015). In Selfhout et al. (2010) assessed how friendships developed over months among new college students. The students were randomly assigned to "introduction groups" that met throughout the semester. Contrary to expectations, neuroticism was unrelated to both in-degree and out-degree measures. (There were no consistent effects of neuroticism on being chosen or actively choosing friends within the network.) People with similar levels of neuroticism were also not more likely to become friends over time (i.e., no homophily effects for neuroticism). Similarly, Baams et al. (2015) found neuroticism to be unrelated to in-degree, out-degree, and homophily over time in adolescents' friendship networks in multiple classes.

Unlike Selfhout et al. (2010) and Baams et al. (2015), Kalish (2008) found low neuroticism predicted friendship brokerage in a group of religiously diverse group of university students. Kalish (2008) also assessed the motivation behind participants' willingness to become different types of brokers in one class's friendship socionetwork. Actors with low neuroticism tended to be motivated to build friendship ties between classmates with different religious beliefs (bridge non-homophilous groups), not for the personal gain of connecting similar others (entrepreneurial motivation). Thus, the results of these sociocentric friendship networks seem to indicate that neuroticism influences how individual's perceive the structure of their personal networks, but not the actual size, composition, or their position within the structure of those networks.

Selfhout et al.' (2010) and Baams et al.' (2015) results using friendship networks are consistent with one study of service-learning teams (Schulte et al., 2012). Though neuroticism was negatively correlated with friendship out-degree (and very inconsistently related to advice out-degree), neuroticism did not predict friendship or advice centrality when controlling for agreeableness, extraversion, reciprocity, transitivity, leadership positions, and personal traits (age and gender in- and out-degree). However, these results are contradicted by the findings of multiple other studies where the networks were more goal-directed. Klein et al. (2004) found that neuroticism was significantly related to in-degree in a different sample of service-learning team networks. Specifically, neuroticism negatively predicted in-degree centrality in both the advice and friendship networks, such that those who scored lower in neuroticism were more sought out as friends and for advice. Unsurprisingly, neuroticism also positively predicted higher in-degree centrality in team adversarial networks in one non-student sample of service-learning teams (Klein et al., 2004), but was nonsignificant in another sample of service-learning teams. Consistent with Klein et al.'s (2004) results, neuroticism also predicted in-degree in the adversarial networks of college students working on group projects in teams (Xia et al., 2009). Thus, those that scored higher on neuroticism were generally considered difficult to work with. Differences in the results could be due to the control variables. In Klein et al.'s (2004) study, they controlled for personal characteristics (age and gender) and other FFM traits. Schulte et al. (2012) controlled for agreeableness, extraversion, formal leader position, gender and age in- and out-degree, as well as reciprocity and transitivity in the adversarial networks. Xia et al. (2009) only controlled for previous work experience.

Emery et al. (Emery et al., 2013; Emery, 2012) found that neuroticism significantly predicted out-degree centrality in the leadership networks of study abroad students, albeit only in the case of nominating relationship leaders. Neuroticism was negatively related to out-degree for relationships leaders, such that individuals with higher neuroticism scores were less likely to choose relationship leaders over time. However, consistent with Selfhout et al.'s (2010) and Baams et al.'s (2015) friendship networks, Emery et al. (Emery et al., 2013; Emery, 2012) did not find in-degree or homophily effects for either task or relationship leadership nominations for neuroticism.

Unlike the leadership networks in Emery et al.'s studies (Emery et al., 2013; Emery, 2012), neuroticism has been found to influence centrality in advice networks in college students (Battistoni and Fronzetti Colladon, 2014) and school administrators (Daly et al., 2014). However, the results contradict one another, and are not easily reconciled. In a non-student sample of school administrators, neuroticism was *positively* related to in-degree and out-degree centrality, as well as in-closeness and out-closeness centrality (Daly et al., 2014). This indicates that administrators who scored higher on neuroticism (controlling for the other FFM traits, tenure, and position) were more likely to ask for and give advice, and were more efficiently connected in the network such that they could ask for and receive advice of many others within the network easily. Contrary to Daly et al.' results, Battistoni and Fronzetti Colladon (2014) found that students *low* in neuroticism were "central connectors" in an informal advice socionetwork assessed in a large university class. Central connectors are actors who have both high in-degree and high out-degree centrality compared to others in the network (Cross and Prusak, 2002). Thus, in Battistoni and Fronzetti Colladon's (2014) cross-sectional study, students with low neuroticism were highly active and popular in the advice network.

However in a non-student sample at a manufacturing organization, neuroticism was unrelated to in-degree centrality in advice/support networks of teams (Neubert and Taggar, 2004). The conflicting results of these leadership and advice networks could be due to the differences in the samples; neuroticism may confer particular disadvantages in adolescence that are attenuated with experience and/or brain development, although this is speculative.

Finally, neuroticism was not related to communication degree or betweenness centrality in diverse, distributed classroom teams working toward a creative goal together (Gloor et al., 2011). Like Kalish (2008), the teams were diverse; however, their results directly contradict those of both Kalish (2008) and Battistoni and Fronzetti Colladon (2014). The results could be attributable to the medium, as members of each group were located in multiple countries and only able to communicate via email with the other group members. It is possible that the social anxieties associated with neuroticism are easier to modulate when communication is mediated through technology (Rice and Markey, 2009), so that neuroticism has less of an effect on social relationships.

Network structures

Neuroticism does seem to influence how individuals perceive the structure of the relationships within their networks. Kalish and Robins (2006) asked first year students to report whom they felt were important to their lives at their university across a variety of settings early in their first semester. Participants then reported the strength of the relationship between each pair of alters, and between themselves and each alter. Among strong ties in socionetworks, the presence of transitive triads are normative in network structures (Wasserman and Faust, 1994). However, neurotic individuals reported more structural holes among triads where two of three individuals were strongly connected, and fewer structural holes when ties among the triads were weak (Kalish and Robins, 2006). That is, they perceived their strongest social relationships as less transitive and more disconnected, but their weakest relationships as more transitive and connected. Furthermore, neuroticism was unrelated to density—thus, those high and low in neuroticism do not differ in the amount of (overall) connectedness they

perceived in their networks. These results are corroborated by another cross-sectional study, where neuroticism was unrelated to perceptions of density in college students' "significant people" egonetworks (Stokes, 1985).

In egonetworks, people tend to assume transitivity (Krackhardt, 1987), even when transitivity does not exist (Flynn et al., 2010; Kilduff et al., 2008). Furthermore, lack of transitivity could indicate a few different processes. One possibility is that neurotic individuals are more accurate at assessing structural holes within their networks, in contrast with the usual tendency for people to assume transitivity. A second possibility is that they see themselves as bridge that completes the triad (Marsden, 2002). A third possibility is that neurotic people try to structure their networks with more structural holes, providing themselves with more power and control in their networks due to increased betweenness centrality (Burt, 2001). With the present egocentric designs, however, the motivations behind their perceptions were not assessed.

One sociocentric study assessed how neuroticism related to actual positions within the network. Battistoni and Fronzetti Colladon (2014) further found that those low in neuroticism were also more likely to be "information brokers" in advice networks. Information brokers are actors who link subgroups together, may have few direct ties, but have many indirect ties. If they are removed from the network, the network would become less dense and connected, and the information flow would be broken between subgroups (Cross and Prusak, 2002). In advice networks, central connectors and information brokers hold positions of power where they can control the flow of information. Thus, more emotionally stable students were positioned in powerful positions for controlling information (Battistoni and Fronzetti Colladon, 2014).

Conclusions

Taken together, these results suggest that being more emotionally stable (low in neuroticism) helps people maintain effortful and powerful positions in workplace networks (Battistoni and Fronzetti Colladon, 2014; Klein et al., 2004), and that they are motivated to build relationships between disconnected people (Battistoni and Fronzetti Colladon, 2014; Kalish, 2008). The sociocentric research reviewed here also provides possible insight into the results of Kalish and Robins's (2006) egocentric transitive triad study. Highly neurotic individuals may be accurately reporting the lack of network closure in their egonetworks; however, they may not be motivated to bridge those holes and create transitivity in their networks the way more emotionally stable individuals do. Why this may be the case is uncertain.

The literature thus far seems to indicate that neuroticism is less related to composition and size of the network, and is more related to perceptions of structure in egonetworks and the network positions that actors occupy. Moreover, low neuroticism seems to be related more strongly to maintaining social connections in goal-directed networks (Battistoni and Fronzetti Colladon, 2014; Kalish, 2008; Kalish and Robins, 2006; Klein et al., 2004), and less to the initiation of social connections or position in purely personal networks (Selfhout et al., 2010; Stokes, 1985; Wagner et al., 2014). However, contrary to the studies using younger samples, neuroticism was unrelated to advice centrality in one workplace advice network (Neubert and Taggar, 2004) and positively predicted greater direct and indirect connections in another workplace advice network (Daly et al., 2014). Though few, these results could indicate that neuroticism can become less detrimental to relationships in adulthood, and may even be beneficial in specific work settings.

Agreeableness

Agreeableness is characterized by trust, sympathy, and concern towards others, as well as modesty and amiability (Costa and McCrae, 1992). In adolescents, agreeableness relates to friendship and being liked, as well as to less bullying over time (Jensen-Campbell et al., 2002). Agreeableness can help assuage difficult or frustrating social relationships; people high in agreeableness are less likely to perceive conflict in situations, elicit conflict in others, or to counter conflict with assertions of power (Graziano et al., 1996). Similarly, agreeableness predicts less friendship conflict and better friendship quality in young adults (Demir and Weitekamp, 2006). One longitudinal study assessing the effects of personality on dyadic perceptions of friendships found that friends of agreeable participants feel less irritated with the participants than friends of less agreeable people (Berry et al., 2000).

Interpersonal relationships are likely to go smoothly for agreeable individuals, helping them to build and maintain social relationships with peers (Ozer and Benet-Martínez, 2006), and thus influence the size and composition of their personal networks. It is less clear how agreeableness might produce changes in the structure of their personal social networks, particularly with regard to their position within the network. Agreeableness shows similar effects in the workplace: highly agreeable individuals are themselves cooperative, are skilled at conflict resolution, and flourish in situations where people are interacting (Barrick, 2005; Neuman and Wright, 1999). We find the relationships among agreeableness and network characteristics to be mixed, particularly for the effects of agreeableness on workplace networks.

Network size and composition

Agreeableness was unrelated to friendship egonetwork size in one cross-sectional study of college students (Totterdell et al., 2008). Another cross-sectional studied showed no difference in composition of college student's core personal networks (five most important individuals) between high and low agreeable participants; that is, participants were no more likely to have primarily friends, family, or mixed core egonetworks (Doeven-Eggens et al., 2008). However, a third cross-sectional study of college students' social support egonetworks found that agreeableness was correlated with network size, but was not related to new contacts in the network (Zhu et al., 2013). In a longitudinal study of students transitioning from high school, agreeableness predicted larger personal egonetwork size and was related to multiple compositional differences (Wagner et al., 2014). Agreeable individuals listed more family in their networks and had larger nonkin networks compared to less agreeable individuals. They also tended to have the most stable networks over time, naming nearly the same alters at each of the three time points. These results are not entirely consistent, but seem to suggest that agreeableness has some effect on perceptions of size and composition in the network.

Centrality and homophily

Agreeableness also relates to individuals' positions in personal social networks, although longitudinal studies show conflicting results. In the friendship networks of new college students, agreeable people were more likely to be chosen as friends by others (high in-degree), but there was no effect of agreeableness on nominating others as friends (out-degree; Selfhout et al., 2010). However, in service-learning teams, agreeableness correlated with friendship in-degree, but did not predict friendship in-degree when controlling for the other Big Five traits (Klein et al., 2004). Similarly, in the friendship networks of adolescents, agreeableness was not related to in-degree or out-degree (Baams et al., 2015). Further-

more, for college students, highly agreeable individuals tended to become friends with other agreeable individuals (homophily; Selfhout et al., 2010), but for adolescent students, agreeable individuals tended to stay friends with disagreeable others (heterophily; Baams et al., 2015). For personal networks, then, agreeableness may be important for *initiating* personal relationships in new environments (Klein et al., 2004; Selfhout et al., 2010; Wagner et al., 2014; cf. Zhu et al., 2013), and may also help in *maintaining* personal relationships over time, especially with kin (Wagner et al., 2014; cf. Baams et al., 2015).

In groups where the students must work together to complete a joint goal, the results show that agreeableness influences position in the network. Gloor et al. (2011) found agreeableness to be related to position in team-based communication networks. In this study, teams were composed of students who lived in different countries and needed to communicate via email to complete a creative, collaborative group task. They found that agreeable team members had more direct communication ties to other team members (high degree centrality) and acted as bridges between unconnected team members (high betweenness centrality).

In a cohort of students studying abroad, Emery et al. (Emery, 2012; Emery et al., 2013) assessed the effects of agreeableness on nominations of leaders whose leadership behaviors fit either a task-oriented or relationship-oriented leadership style. Agreeableness was only marginally (positively) related to relationship leadership emergence (in-degree), and abjectly unrelated to task-oriented leadership emergence. They found agreeableness negatively related to out-degree centrality for relationship leaders. That is, more agreeable individuals were less likely to nominate others as relationship leaders. Emery et al. also found a heterophily effect for agreeableness on both task and relationship leaders, where leadership nominations were based on *dissimilarities* in levels of agreeableness between the actors. This study did not explore the motives behind students' leadership choices, but perhaps in leadership networks, those low in agreeableness are less committed to the group goals and tend to engage in counterwork behaviors. This may make them less willing to choose relationship leaders who may try to discourage their outspokenness and encourage cooperation (Barrick, 2005). The results conflict with the friendship networks assessed above. This could be due to the nature of the networks: in both Baams et al.'s (2015) and Emery et al.'s (Emery, 2012; Emery et al., 2013) study, the students were acquainted with one another before the study started. In Selfhout et al. (2010), the students were unacquainted, the networks were just starting to form.

The effects of agreeableness on network position in workplace networks in non-student samples are generally consistent. Agreeableness did not predict in-degree centrality in the advice networks of service-learning teams (Klein et al., 2004) or advice/support networks in manufacturing organization teams (Neubert and Taggar, 2004). Similarly, agreeableness was unrelated to both degree and closeness centrality in the advice networks of school administrators (Daly et al., 2014). Though agreeableness correlated positively with friendship and advice out-degree in another sample of service-learning teams, it did not predict centrality for either network (Schulte et al., 2012). Only one study showed that agreeableness was correlated with work advice/support network in-degree centrality (in Taiwanese bank employees), but the effect of agreeableness on centrality was fully mediated by interpersonal citizenship behaviors (employee behaviors that benefit other employees; Liu and Ipe, 2010). Thus, agreeableness seems to be unrelated to workplace network positions, at least in terms of advice and support networks in non-student samples.

In adversarial networks, networks of negative relationships, the results are not consistent. In service-learning teams, agreeableness negatively predicted in-degree centrality in young adult adversarial networks, such that those who were high in agreeableness were less likely to be rated as difficult to work with (Klein et al., 2004). However, another study utilizing service-learning teams found agreeableness was somewhat negatively correlated with out-degree centrality in difficulty networks, but did not predict in-degree centrality (Schulte et al., 2012). Similarly, in a college classroom adversarial network, agreeableness was unrelated to in-degree centrality in small group project teams (Xia et al., 2009). Though the samples in Klein et al. (2004) and Schulte et al. (2012) are very similar, there are many differences between these and Xia et al.'s (2009) study that could account for the conflicting results, including sample characteristics (older vs. younger), responsibilities and tasks (disaster relief vs. classroom project), and number of individuals per group (9–12 vs. 4–7), among others. With few studies, the exact nature of the relationship cannot be determined, though it seems likely that agreeableness may reduce negative social relationships or experiences and facilitate stable relationships, particularly when interactions are prolonged (e.g., Selfhout et al., 2010; Wagner et al., 2014).

Network structures

Only one study has assessed the relationship between agreeableness and its relationship to more global network structuring. In informal advice networks of college students in Italy, agreeableness predicted actors' roles as key players (Battistoni and Fronzetti Colladon, 2014). Agreeable individuals tended to be boundary spanners, key players who foster connections between their local cluster and other disconnected groups (Battistoni and Fronzetti Colladon, 2014; Cross and Prusak, 2002). These results are consistent with other studies with goal-oriented workplace-type groups of college students (Gloor et al., 2011; Xia et al., 2009), but are not consistent with workplace networks using non-college student samples (Daly et al., 2014; Klein et al., 2004; Neubert and Taggar, 2004; Schulte et al., 2012).

Conclusions

More research needs to be done to ascertain the effects that agreeableness has on network positions within different types of networks. Though the results are inconsistent, these studies hint at situations where agreeableness may affect perceptions and structure within the networks. The strongest findings occur in personal networks, especially when they are changing. The egocentric (Wagner et al., 2014) and sociocentric (Selfhout et al., 2010) longitudinal studies provide evidence that agreeableness is associated with network composition in both maintaining prior ties (family ties) and developing new ties (friendship ties). The formation of new ties seems to be due mainly to others selecting the agreeable individuals (Gloor et al., 2011; Selfhout et al., 2010). However, the strength of these findings is tempered by longitudinal (Baams et al., 2015) and cross-sectional studies (Doeven-Eggens et al., 2008; Totterdell et al., 2008) that found nonsignificant effects on personal network size and composition.

The sociocentric studies show that agreeableness is related to positions in personal and advice networks, and may be useful for developing relationships with disparate groups (Battistoni and Fronzetti Colladon, 2014; Gloor et al., 2011). It is unclear whether agreeable individuals' existence in those structural holes is due to purposeful positioning (e.g., to gain power; Burt, 2001; Fernandez, 1991; Freeman, 1978) or merely a byproduct of being preferentially selected as friends or communication partners by others. Workplace studies utilizing non-student samples, however, do not support the effects of agreeableness on network positions (e.g., Daly et al., 2014; Klein et al., 2004; Neubert and Taggar, 2004; Xia et al., 2009). Whether these null results are due to properties of the

network or differential effects that agreeableness has in divergent situations is not clear at this point.

Openness to experience

Openness to experience (or simply "openness") is characterized by imaginativeness and creativity; appreciation of aesthetics; acceptance of fantasy, feelings and emotions; and intellectual curiosity (Costa and McCrae, 1992). Openness tends to be the most controversial trait in the Big Five, with definitions characterized by a broad range of traits from intellect to creativity (Digman, 1990). Unlike other traits, openness to experience does not have a strong theoretical and empirical body of literature explicating its effect on social relationships, although it is sometimes related to workplace outcomes. In young adults, openness has been unrelated to friendship quality and conflict (Demir and Weitekamp, 2006), friendship closeness and irritation, and number of conflicts between friends over time (Berry et al., 2000). In the workplace, openness becomes salient when tasks require creativity and ability to adapt to change, as well as when the norms of the group appreciate diversity (Barrick, 2005; Tett and Burnett, 2003). Despite the inconsistent evidence, it seems likely that openness may influence network size, composition, and structure to the extent that those social network characteristics reflect propensities toward new interpersonal experiences. The evidence seems to support this supposition.

Network size and composition

Two cross-sectional studies found that openness was unrelated to the size of both friendship egonetworks (Totterdell et al., 2008) and social support egonetworks (Zhu et al., 2013). However, openness was correlated with number of new contacts in the network gained since entering their university (Zhu et al., 2013). Furthermore, openness predicted the size of the network and number of nonkin included over time in students' "close other" networks when transferring into university (Wagner et al., 2014). That is, more open individuals had larger social networks, and their networks tended to include people they were not related to (there was no difference in reports of kin). There is only one study that assessed size and composition in workplace networks. In a large global agricultural processing firm, workers who scored high in openness did not list more formal and informal idea consultants (no effect on network size), but did list more diverse individuals in their idea egonetworks than those low in openness (Baer, 2010). Though somewhat contradictory, these results generally support the assertion that openness influences network size and composition mainly when the personal networks are in flux, and there are opportunities for new contacts with nonkin to form.

Centrality and homophily

The effects of openness on actual position and structure of the networks are less clear. In adolescent friendship networks, openness predicted out-degree centrality, but not in-degree centrality over time (Baams et al., 2015). There were no homophily effects either. Interestingly, although Selfhout et al. (2010) found openness to be unrelated to degree and betweenness centrality in college friendship networks over time, openness did show a significant homophily effect for friendship. Together, these results suggest that openness may be important for initiating friendships with others in adolescents, but more important for maintaining friendship over time in young adults.

In Gloor et al.'s (2011) small group communication networks, where students were located in different countries and were required to communicate via email to the other group to complete a task, openness significantly related to degree centrality and betweenness centrality. Thus, in these distributed communication networks, open individuals tended to have more communication partners and tended to act as bridges between disconnected actors in the network. Consistent with Gloor et al.'s (2001) results, Emery et al. (Emery, 2012; Emery et al., 2013) found openness to predict nominations for both task and relationship leaders in a large cohort of students studying abroad (in-degree). That is, open individuals were more likely to be nominated as both task and relationship leaders over time. Open individuals were also less likely to follow relationship leaders (negative out-degree). Emery et al. (2013) also found a homophily effect for both task and relationship leadership emergence. Thus, students were more likely to choose leaders who had similar levels of openness over time. Only two studies found openness to be unrelated to occupying key player positions in an informal classroom advice network (Battistoni and Fronzetti Colladon, 2014), and advice in-degree in service-learning teams (Klein et al., 2004).

The Gloor et al. (2011), Battistoni and Fronzetti Colladon (2014), and Emery et al. (Emery, 2012; Emery et al., 2013) studies were similar in that they were assessing a single college class, though Battistoni and Fronzetti Colladon (2014) and Emery et al. (Emery, 2012; Emery et al., 2013) used much larger classes. The contradictory findings among these studies could be due to the fact that Gloor et al.'s (2001) and Emery et al.'s (Emery, 2012; Emery et al., 2013) networks were formed to assist with collective goal pursuits (group project and team planning, respectively), which can be construed as closer to a workplace network rather than a small classroom advice networks used by Battistoni and Fronzetti Colladon (2014). The smaller advice networks in Gloor et al. (2011) may be more similar to the small friendship networks of Selfhout et al. (2010) and Baams et al. (2015). Given the similarities of these sets of studies, and the egonetwork studies' results previously discussed, the pattern of results would suggest that openness facilitates connections with new people, as well as connections where individuals are in new situations and must interact and communicate in order to reach shared goals.

Four studies have assessed the effects of openness to experience in workplace networks using non-student samples. The results are generally consistent with the student sample networks, despite the difference in network types. In the advice/support networks of teams in a manufacturing organization, openness to experience correlated with in-degree centrality (Neubert and Taggar, 2004). Thus, more open individuals were sought out for advice and support in those organizations. In school administrators' advice networks, openness was significantly correlated with in- and out-degree and in- and out-closeness, but did not significantly predict any of the structural properties of the networks when the model controlled for the other FFM traits, education, position, years of experience, and leadership and management efficacy (Daly et al., 2014). Similarly, in two studies utilizing service-learning teams, openness did not predict advice in-degree centrality (Klein et al., 2004), or friendship and advice degree centrality (Schulte et al., 2012).

In the three studies that assessed adversarial networks, the results for in-degree contradict one another. Openness positively predicted in-degree in adversarial networks among service-learning teams, which indicates that people high in openness were rated as more difficult to work with than those low in openness (Klein et al., 2004). Openness was unrelated to difficulty network positions in another study using service-learning teams (Schulte et al., 2012). However, openness negatively predicted in-degree in adversarial networks of students in small groups working on projects (Xia et al., 2009). Thus, within the groups, individuals who were more open were rated as easier to work with than those low in openness. With so few studies, it is difficult to draw clear con-

clusions. Given that Klein et al. (2004) also found openness to be unrelated to advice in-degree and negatively related to friendship in-degree in their service learning teams, this could indicate that open individuals were harder to work with when trying to reach the goals of teams. Thus, they may have been rated less favorably overall. However, this explanation is speculative given how few studies have assessed these types of networks, and the multiple differences between the two studies that could also explain the results.

Conclusions

Taken together, the results indicate that openness may be related to network size and composition, particularly during transitional periods when connecting to new people involves being more open to new social experiences. They may also gravitate towards others who share their similar openness tendencies (Emery et al., 2013; Selfhout et al., 2010), potentially leading to more diversity in their personal and work networks (Baer, 2010; Zhu et al., 2013). Openness seems to be inconsistently related to position within networks across samples, particularly in cases where the individuals in the network are very diverse or working toward a shared goal. For leader emergence and when teams must communicate over long distances, openness may be helpful (Emery, 2012; Emery et al., 2013; Gloor et al., 2011; Xia et al., 2009). However, openness has been found to be detrimental to some relationships (Klein et al., 2004), and generally unrelated to advice networks across samples (Battistoni and Fronzetti Colladon, 2014; Daly et al., 2014; Klein et al., 2004; cf. Neubert and Taggar, 2004). Finally, there have been no studies looking at how openness may relate to higher order structuring within the networks, such as transitivity, density, or bridging/brokerage. Given that open individuals like to connect to others, bridging/brokerage tendencies may be a fruitful next step in understanding how openness plays a role in higher order structuring.

Conscientiousness

Conscientiousness is characterized by self-discipline, orderliness, competence, motivation, and dependability (Costa and McCrae, 1992). Like openness to experience, the relationship between conscientiousness and personal relationships is inconsistent. Conscientiousness has been linked to self-control and predictability (Costa and McCrae, 1995; Roberts et al., 2014), and some posit that conscientiousness could be helpful for maintaining relationships (e.g., Wagner et al., 2014). Conscientiousness correlated with friendship quality and decreased relationship conflict in one cross-sectional sample of young adults (Demir and Weitekamp, 2006), but did not predict closeness, irritation, or number of conflicts between friends in a longitudinal study looking at dyadic perceptions of friendship in young adults (Berry et al., 2000). Based on these results, conscientiousness could have some effect on social network relations, but the effects are likely not as strong or reliable as those of extraversion, agreeableness, and neuroticism. However, conscientiousness is strongly linked to workplace outcomes, particularly when specific goals need to be accomplished, order is required, and product of the interaction needs to be high quality (Neuman and Wright, 1999; Tett and Burnett, 2003). Conscientious individuals do not perform as well in situations where the communication structure is not formalized (Tett and Burnett, 2003).

Network size and composition

Doeven-Eggens et al. (2008) and Wagner et al. (2014) found that conscientiousness predicted more family members being named in actors' core ("focal five") egonetworks and in reports of most significant social relationships, respectively. Likewise, Wagner et al. (2014) found that family was more consistently mentioned across time in the egonetworks of conscientious individuals. That is, their kin list was more stable across time, and they had less nonkin overlap between time points. However, conscientiousness did not predict the size or number of new contacts in college students' social support egonetworks (Zhu et al., 2013), the size of college students' friendship networks (Totterdell et al., 2008), or the size of high school graduates' "close other" egonetworks over time (Wagner et al., 2014). Thus, these studies provide some evidence that conscientiousness promotes familial relationships, though this may not impact the overall size of personal networks. Again, these studies' egocentric designs provide insight into the perceptions participants have of their networks, but not the networks' actual structure.

Centrality and homophily

In two longitudinal studies on the effects of personality on friendship networks, conscientiousness predicted out-degree centrality in adolescent friendship networks (Baams et al., 2015), but was unrelated to both in-degree and homophily. In college students, conscientiousness was unrelated to friendship in-degree, out-degree, and homophily (Selfhout et al., 2010). Thus, conscientiousness may increase adolescent students' willingness to make friends with others, but may not impact who chooses them as friends in return. However, in college students, conscientious people are not more likely to nominate friends, be nominated as friends, or become friends with others who had similar conscientiousness scores. Similarly, conscientiousness was positively correlated with friendship in-degree in service-learning teams, but the relationship became non-significant when the model predicting in-degree centrality controlled for the other FFM traits (Klein et al., 2004).

In the same sociocentric study of service-learning teams, conscientiousness was unrelated to in-degree in advice and adversarial networks (Klein et al., 2004). In another study utilizing service-learning teams, conscientiousness was positively correlated with friendship network out-degree, but did not predict centrality in friendship, advice, and difficulty networks (Schulte et al., 2012). Conscientiousness was also unrelated to both degree and betweenness centrality in Gloor et al.'s (2011) communication network. However, four other studies found conscientiousness to be significantly related to position within the network.

Similarly, (Emery, 2012; Emery et al., 2013) found that conscientiousness predicted leadership nominations (in-degree), such that those who were high in conscientiousness were more likely to be nominated as both relationship and task leaders. Conscientious individuals were also more likely to follow task-oriented leaders (out-degree). In leadership/advice teams, there was no similarity (homophily) effect for conscientiousness (Emery et al., 2013). Finally, in cooperation networks, conscientiousness was unrelated to in-degree but was positively correlated with out-degree centrality (Hopp and Zenk, 2012). Thus, the results are varied and contradictory, though there is some evidence that conscientiousness is beneficial in workplace networks using student samples.

In non-student samples, the results are similarly conflicting. In the advice networks of school administrators, those who were conscientious tended to be more efficiently connected within the network (high in- and out-closeness; Daly et al., 2014). Though they had more indirect ties, they were not more likely to have direct ties to other individuals in the network (unrelated to degree centrality). In the socionetworks of employees across 17 different industries, conscientiousness was significantly correlated with degree centrality in work friendship networks, as well as degree centrality in the knowledge sharing networks (Lee et al., 2010). However, conscientiousness did not predict degree centrality in the knowl-

edge sharing network in a model controlling for the participants' demographic characteristics (e.g., age, sex, and education) and friendship in-degree. Among Taiwanese bank employees, conscientiousness was significantly correlated with in-degree centrality in work advice/support networks, but the effects of conscientiousness on centrality were fully mediated by interpersonal citizenship behaviors (Liu and Ipe, 2010). Conscientiousness was also unrelated to advice/support in-degree centrality in manufacturing organization teams (Neubert and Taggar, 2004).

Network structures

Conscientiousness and higher order network structures have rarely been studied together. Battistoni and Fronzetti Colladon (2014) showed that in informal advice networks, highly conscientious students were more likely to hold key player positions. Those high in conscientiousness tended to be either central connectors or periphery specialists. Central connectors, with the highest in- and out-degree centrality, frequently give and receive advice to many people in the network. Periphery specialists have high in-degree centrality and low out-degree centrality. They are sought out frequently, usually for their expertise, but rarely need to ask advice of others (Cross and Prusak, 2002). Only one study assessed the relationship between conscientiousness and density in a student cooperation network, but the results were non-significant (Hopp and Zenk, 2012).

Conclusions

Together, these results suggest that conscientiousness is not related to the size of personal networks as a whole (Totterdell et al., 2008; Wagner et al., 2014; Zhu et al., 2013), but is related to relationships with certain groups within their personal networks. For personal networks, it seems most related to maintaining family ties (Doeven-Eggens et al., 2008; Wagner et al., 2014), but unrelated to friendship ties (Baams et al., 2015; Selfhout et al., 2010). In workplace networks, collapsing across samples, the results are more consistent. Conscientiousness may be related to occupying key player or efficiently connected positions where knowledge, reliability, and performance are important to the relationships among the actors within the network (Battistoni and Fronzetti Colladon, 2014; Daly et al., 2014; Emery, 2012; Emery et al., 2013). But these few significant results are tempered by many other studies, utilizing diverse samples across many types of organizations and situations that find conscientiousness to be unrelated to degree centrality in advice and support networks in the workplace (e.g., Daly et al., 2014; Klein et al., 2004; Neubert and Taggar, 2004), especially when controlling for more proximal work behaviors (Lee et al., 2010; Liu and Ipe, 2010).

Discussion

The research assessing the effects of personality on social networks has flourished recently, despite initial trepidation as to the usefulness of exploring individual difference variables within the context of social network analyses. Our critical literature review contributes to the discourse by examining the nuanced relationships that personality has across the contexts outlined, even where small numbers of studies have examined a particular network property. As additional studies fill in the gaps we identify, meta-analytic procedure will become appropriate to determine the strength of the relationships each of the Five Factor Model personality traits have on social networks. As this review shows, Five Factor Model personality traits have been found to be meaningfully associated with network perceptions and structure across a variety of methodologies, network types, relationships, and samples.

Extraversion and agreeableness seem to relate to social relationships (particularly in personal networks) in broadly different ways. Research on both extraversion and agreeableness indicates that those traits are important for connecting directly to others. The evidence on extraversion suggests that extraverts focus on initiating ties to others, but others are no more or less willing to initiate contact with them. Extraversion is most related to network size and composition, notably when the individual is in a transitional period where new social opportunities are occurring and creating new social ties may be necessary. The expansion of their networks seems due mainly to the inclusion of new, nonkin ties (Bolger and Eckenrode, 1991; Doeven-Eggens et al., 2008; Feiler and Kleinbaum, 2015; Pollet et al., 2011; Wagner et al., 2014). Extraversion is more useful in the formation of new friendship and support ties (Feiler and Kleinbaum, 2015; Selfhout et al., 2010), but less necessary for the maintenance of ties once relationships have been established (Baams et al., 2015). These results were supported using multiple methods: cross-sectional egocentric designs (Pollet et al., 2011; Swickert et al., 2002; Zhu et al., 2013), a longitudinal egocentric design (Wagner et al., 2014), and longitudinal sociocentric designs (Feiler and Kleinbaum, 2015; Selfhout et al., 2010). This is consistent with past literature showing that the expression of extraversion is goal-related (McCabe and Fleeson, 2012): extraverts, in these transitional stages, may be more motivated than introverts to make connections with other, new people.

In contrast, evidence is mixed for the effects of agreeableness on network size and composition, though the results generally indicate that agreeableness is unrelated to size and composition in cross-sectional studies (Doeven-Eggens et al., 2008; Totterdell et al., 2008; Zhu et al., 2013). However, agreeableness seems to be related to stability over time, with more agreeable individuals reporting larger family and friends in their networks (Wagner et al., 2014). For personal networks, agreeableness seems to be most important for *initiating* personal relationships in new environments (Klein et al., 2004; Selfhout et al., 2010; Wagner et al., 2014), and may also help in *maintaining* personal relationships over time, especially with kin (Wagner et al., 2014; cf. Baams et al., 2015). In workplace networks, there is some evidence that agreeable individuals connect unconnected actors, but only in studies using student samples (Battistoni and Fronzetti Colladon, 2014; Gloor et al., 2011). Agreeableness does not influence social relations using non-student samples (Daly et al., 2014; Klein et al., 2004; Neubert and Taggar, 2004). This lends support to assertions by both Wagner et al. (2014) and Selfhout et al. (2010) that extraversion is more important for the formation of ties whereas agreeableness is more important for the maintenance of ties after formation. Neither extraversion nor agreeableness is consistently related to positions in workplace networks.

Based on these results, openness may be more related to developing new relationships with others, while conscientiousness seems more generally related to maintaining existing relationships. Openness to experience is consistently related to creating new connections to diverse others in both personal and workplace networks (Baer, 2010; Gloor et al., 2011; Wagner et al., 2014; Zhu et al., 2013), especially when the networks are changing. Though cross-sectional studies show no difference in reports of the size of their networks (Totterdell et al., 2008; Zhu et al., 2013), one longitudinal study found open individuals to have larger networks (Wagner et al., 2014). In friendship networks, openness tends to be due to open individuals reaching out to others in adolescents (Baams et al., 2015) and staying friends in older students (Selfhout et al., 2010). Of special note, individuals tend to be drawn to others who have similar levels of openness. This result was found in two longitudinal studies utilizing both a friendship and a leadership network (Emery et al., 2013; Selfhout et al., 2010). Conscientious people also do not perceive differences in the size of their personal net-

works (Totterdell et al., 2008; Wagner et al., 2014; Zhu et al., 2013), though they do show somewhat consistent tendencies to maintain ties with family more so than with nonkin (Doeven-Eggens et al., 2008; Wagner et al., 2014).

There are mixed results regarding how openness effects how actors are positioned within networks. There is evidence that openness is useful for gaining advantageous position in groups with diverse individuals, or creative goals to meet in some student samples (Emery, 2012; Emery et al., 2013; Gloor et al., 2011) but not others (Battistoni and Fronzetti Colladon, 2014; Klein et al., 2004). In samples of older working individuals, openness may be related to beneficial positions in advice and support networks (Daly et al., 2014; Neubert and Taggar, 2004). Overall, openness seems important for developing new and diverse social connections in work and friendship, though the relationships to different positions within those networks seem more dependent on the context.

Conscientiousness seems to be especially relevant in workplace networks. Being conscientious relates to assuming advantageous positions in advice and leadership networks in students (Battistoni and Fronzetti Colladon, 2014; Emery, 2012; Emery et al., 2013), and advice and friendship networks in older samples of adults in working relationships (Daly et al., 2014; Lee et al., 2010). However, these results are tempered by other workplace research that shows null results (Gloor et al., 2011; Klein et al., 2004; Neubert and Taggar, 2004). Thus, the skills and tendencies that conscientious individuals exhibit may be deployed more in pursuing formal goals, and less during informal interactions.

Neuroticism has little or no effect on network size and composition, which seems to contradict the social anxiety aspect of this trait. These results are consistent in both cross-sectional (Roberts et al., 2008; Stokes, 1985; Totterdell et al., 2008; Zhu et al., 2013) and longitudinal research (Wagner et al., 2014), with few exceptions (Bolger and Eckenrode, 1991; Russell et al., 1997). People higher in neuroticism do not differ in friendship selection either (Baams et al., 2015; Selfhout et al., 2010), but do tend to connect to dissimilar others (Kalish, 2008). These results indicate that, athough people high in neuroticism report being more socially anxious and interpersonally unskilled, they are still able to establish and maintain informal social relationships.

Further, the research thus far clearly indicates that neuroticism is related to positions in advice and workplace networks, although whether neuroticism is beneficial or detrimental seems to depend on the context. There is some evidence that neuroticism may be detrimental to working relationships in younger samples (Battistoni and Fronzetti Colladon, 2014; Klein et al., 2004), but the effects may be attenuated or become adaptive in adulthood (Daly et al., 2014; Neubert and Taggar, 2004). Individuals low in neuroticism become more advantageously positioned in workplace networks (Battistoni and Fronzetti Colladon, 2014; Daly et al., 2014; Emery et al., 2013; Emery, 2012; Kalish, 2008), and they seem to do so because they are motivated to connect others and close structural holes (Kalish, 2008).

Future directions

To be sure, the effects of social structure on human interaction are profound, and structuralists' concerns regarding personality effects are not trivial. As Kalish and Robins (2006) state the case, "one needs to be careful about reducing what is a relational process (at the least, dyadic) into a solely individualist explanation, viewed from the perspective of one partner only" (p. 57). However, at this point the evidence is compelling that individual personality factors play multiple roles in diverse social network types, casting doubt on the extreme structuralist stance. There is some evidence that personality is a distal predictor of network perceptions and structure (e.g., Liu and Ipe, 2010; Totterdell et al., 2008), which suggests that assessing potential mediators could be fruitful to understanding the complex ways in which personality influences network structures and perceptions in diverse contexts.

For researchers who wish to incorporate network methods with individual difference theories, the context of the interactions is vitally important. The environment and situation can constrain how personality is expressed (Barrick, 2005), making it important to clarify the contextual constraints when assessing the effects of personality on network structures, especially the formation of network structures. Similarly, normative life events, such as transitions into and out of college, have been shown to have consistent effects on network size and composition changes throughout the lifespan (Wrzus et al., 2012). Some of the studies have not controlled for naturally occurring network phenomena that affect structure in specific types of networks. For example, there is strong support for racial and gender homophily (McPherson et al., 2001) and transitivity (Holland and Leinhardt, 1970) on friendship formation. The evidence presented here shows that the effects of personality on network size and composition are substantial, with personality correlating with and predicting network size and composition changes beyond what would be expected on the basis of normative life events or naturally occurring network structure alone.

The current literature also provides a solid foundation for future research. For example, Battistoni and Fronzetti Colladon (2014) posit that key roles in network are probably due more to profiles of personality than single traits. It is likely that the interplay of various traits, as well as skills and expertise, better predict actual behavior. Examining full personality profiles may provide new insights into the complex results discovered thus far, particularly in the case of neuroticism and agreeableness.

Another promising direction is to better assess how different types of networks relate. Workplace networks often overlap with personal networks (Emery, 2012; Emery et al., 2013; Mehra et al., 2009; Moore, 1990; Yan, 2014). Individuals' relationships are never one-dimensional. They may have different experiences with the same alters across types of interactions (Yan, 2014). They may also develop informal personal relationships with others at work (Moore, 1990). People may be more or less inclined to connect to others across formal or informal settings, depending on their personality or personality profile.

Finally, negative interactions are likely to affect personal and workplace relationships. To date, two studies have assessed the effects of FFM personality in networks where the interactions were negative (Klein et al., 2004; Xia et al., 2009). Not all social interactions are positive or pleasant, and unpleasant interactions could hinder the formation of positive network ties. Future studies on adversarial networks could provide useful insight in how and personality influences more than just positively valenced networks, and may help explain some of the conflicting results found in this review.

Conclusion

A substantial and diverse literature now supports the conclusion that individual characteristics are important for understanding perceptions of network properties, and not only structural characteristics of the network. With respect to the Five Factor Model of personality, the literature most clearly demonstrates that extraversion is related to both size and composition of networks, mainly due to additional inclusion of nonkin ties. Agreeableness is positively related to network centrality in personal networks, but is generally unrelated to positions in workplace networks. Openness and conscientiousness have received less research attention but show promising results for networks spanning dissimilar others and workplace networks, respectively. Neuroticism shows notably little relation to network character-

istics in terms of size and composition, which is surprising in light of its strong association with social anxiety. This review has allowed for the weighing of a variety of features, including sample type, type of network, relationships among network members, differences between egonetwork and socionetwork designs, and more. Taken together, the relationships between personality and network positioning show important, albeit sometimes conflicting, patterns that suggest it can be either beneficial or detrimental, depending on personality trait of interest and the context.

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