Shy teens and their peers:

Shyness in respect to basic personality traits and social relations

Running head: SHY TEENS

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1   **Acknowledgements**

1   **Highlights**

2   Shyness is negatively predicted by extraversion and positively by neuroticism

3   Shyness is related to fewer outgoing ties

4   Shyness and introversion are similarly expressed in a social network

5

1 **Abstract**

2The main purpose of this paper was to examine shyness in teenagers from two perspectives: in 3terms of its relations with basic personality traits and in terms of its influence on the processes 4that occur in the social networks of high school students. First, we found that shyness was 5negatively predicted by extraversion and positively by neuroticism. Second, using exponential 6random graph models we demonstrated that shyness across network effects was similar to 7reversed extraversion (introversion): Both negatively predicted the number of outgoing 8relations, whereas they did not affect the number of incoming relations. We discuss the issue 9of locating shyness in the space of personality traits, supporting the relevance of ascribing it 10to introversion.

11*Keywords:* shyness; introversion; neuroticism; social networks; exponential random graph 12models

1**1. Introduction**

2   Adolescence is a transitional stage of development that bridges childhood and

3adulthood. A very important aspect of this period is social development, which depends to a

4large extent on the developing personality traits of the individual (Meredith, 1955). Shyness is

5one such characteristic which is crucial in terms of establishing social relations. For instance,

6shyness can make it difficult to meet new people, to make friends or to experience joy from

7potentially positive social experiences, and others may underestimate the strengths of shy

8individuals (Zimbardo, 1977). Researchers agree that shyness is a complex phenomenon

9resulting from two conflicting motivations: approach and avoidance (Asendorpf, 1990). This

10discrepancy is also present when examining shyness in relation to basic personality traits or

11broad global factors of personality. Personality traits are thought of as "the most important

12ways in which individuals differ in their enduring emotional, interpersonal, experiential,

13attitudinal, and motivational styles" (McCrae & John, 1992, p. 175) and consist of:

14extraversion, agreeableness, conscientiousness, emotional stability or neuroticism, and

15intellect/openness to experience (Costa & McCrae, 1992, 1995; Goldberg, 1999; Hofstee, de

16Raad, & Goldberg, 1992; Costa & McCrae, 1992). The main interest of the current study was

17to investigate how shyness is related to basic personality traits and whether these relations are

18reflected in the social networks of high school students.

19*1.1. Shyness and basic personality traits: Low extraversion, high neuroticism, or both?*

20   Shyness is commonly conceptualized as a temperamentally conditioned disposition

21manifesting itself in the reduced motivation for social involvement and discomfort in the

22presence of unfamiliar individuals (Asendorpf, 1990; Cheek & Buss, 1981). There has been

23much debate surrounding the location of shyness within the space of basic personality traits

24(Briggs, 1988; Cheek & Briggs, 1990; Hofstee, de Raad, & Goldberg, 1992). More

25specifically, this debate is about whether shyness falls under low extraversion (alternatively

labelled as introversion) or under neuroticism, or whether it should be located somewhere in-between these dimensions (Briggs, 1988; Cheek & Briggs, 1990; Jones, Schulkin, & Schmidt, 2014). Each of these domains represents group of traits that covary—in this vein, extraversion is a domain which covers characteristics such as warmth, gregariousness, assertiveness, activity, excitement seeking, and positive emotionality, whereas neuroticism is a domain which covers such characteristics as anxiety, hostility, depression, self-consciousness, impulsiveness, and vulnerability (McCrae & John, 1992). Shyness and basic personality traits represent different levels of trait hierarchy. According to the trait theory, in both the lexical (Goldberg, 1999) and questionnaire traditions (Costa & McCrae, 1992), basic traits represent broader personality dimensions or domains, while shyness is located under one of these domains. Depending on the tradition, this domain may be reversed extraversion (Goldberg, 1999) or neuroticism (Costa & McCrae, 1992). Within the Five Factor Model (Costa & McCrae, 1992), each trait is composed of lower-order facets, which are assumed to be independent from other basic traits, because mutually exclusive groupings are thought to be more meaningful and to provide more information than overlapping facets (Costa & McCrae, 1992; 1995). In the questionnaire tradition, shyness is located in the domain of neuroticism – close to such characteristics as worrying and anxiety (Costa & McCrae, 1995).

In the lexical tradition, however, the position of shyness seems to be unambiguous, because this approach is less restrictive and allows overlapping within the domains. This less restrictive approach is displayed by the integrative model of the Abridged Big Five-Dimensional Circumplex (AB5C; Goldberg, 1999; Hofstee et al., 1992). The AB5C taxonomy of personality traits combines each of the five broad bipolar dimensions with each other resulting in 10 circumplexes. Therefore, trait terms may be more or less related to each other. The strength of this type of model is that "by depicting facets of the Big Five as blends of two factors, the model achieves a much tighter conceptual structure than the hierarchical models"

1(Hofstee et al., 1992; p. 161). This is because it avoids the subjective nature of the imposed

2top-down models that are used in the questionnaire approach. Accordingly, the term *shy* in

3lexical studies is strictly in the centre of the facet related to reversed extraversion (which is

4also captured by adjectives such as *quiet*, *introverted*, *silent*, *untalkative*, *bashful*, *withdrawn*,

5and *inhibited*; Hofstee et al., 1992; John, 1990) and is not placed within the combined facet of

6neuroticism and reversed extraversion (which is captured by terms such as *lonely*, *weak*,

7*cowardly*, *pessimistic*, *melancholic*, *guarded*, and *secretive*; Hofstee et al., 1992).

8   Following these theoretical traditions, as opposed to the assumptions derived from

9empirical findings (e.g., Bratko, Vukosav, Zarevski, & Vranić, 2002; Briggs, 1988; Cheek &

10Briggs, 1990; Kwiatkowska, Kwiatkowska, & Rogoza, 2016), shyness, to a very great degree,

11is rooted in introversion. However, through blending with other basic traits, shyness can take

12various manifestations—including a neurotic manifestation, which seems to be the most

13noticeable by due to causing problems in social relations (Cheek & Krasnoperova, 1999;

14Jones et al., 2014). As a result of these more noticeable social difficulties, researchers may

15label shy children and teenagers as an *at-risk population* and claim that this kind of tendency

16toward social inhibition and withdrawal should be analysed in the early stages of development

17(Asendorpf, 1990), and especially during adolescence when shyness becomes more self-

18conscious and fearful (Cheek & Krasnoperova, 1999).

19*1.2. Shy teens embedded in a social network*

20   Shyness in adolescence is a very widely researched topic, which is especially valuable

21considering its applied potential including interventions in educational institutions.

22Preadolescent studies indicated that shy individuals are prone to a wide range of internalizing

23problems (Rubin, Coplan, & Bowker, 2009), and are simultaneously more likely to feel

24socially withdrawn, lonely, victimized, anxious, or even depressed (Coplan et al., 2013).

25Moreover, according to parent reports, shyness also directly induces peer problems which

distinguishes it from constructs such as preference for solitude, for example (Coplan et al., 2013). In combination with aggressiveness and peer rejection, shyness may lead to several risky behaviours (like arson, breaking rules or substance use; Chen, Arria, & Anthony, 2003; Santesso, Schmidt, & Fox, 2004).

Everyone regardless of their level of shyness is nested in dyadic relationships, which are embedded in some kind of social network such as family or work environments (Clifton & Webster, 2017). Following close relatives, adolescents' primary social network is their school class. The school class is an arbitrary network (i.e., group composition is top-down imposed; Clifton & Webster, 2017) in which teens spend a huge part of their time. Subsequently, the amount of time spent together including time spent performing joint activities favours the likelihood of establishing relationships—this applies to all pupils, including those more inhibited and withdrawn. Most studies examining shyness in a social network were conducted in a school environment and were based on a descriptive paradigm or individual-level analysis where the focus is on basic centrality measures assigned to the individual (Clifton & Webster, 2017). These findings suggest that shyness indeed influences the number of outgoing relations, that is the number of social tie initiations. However, it does not necessarily lead to peer rejection or the reluctance to take part in joint activities with other individuals (Ponti & Tani, 2015). Based on a subjective observer perception, i.e., in the eyes of educators, shy pupils are generally perceived as less liked, but research suggests that the relation between shyness and being liked is actually a null relationship, not a negative one(Cheung & Elliott, 2017).

To date, only one study has thoroughly examined adolescent shyness using relational-level analyses, which allow for the examination of ties between individuals (Clifton & Webster, 2017). Bešić, Selfhout, Kerr, and Stattin, (2009; see also Van Zalk, 2010) investigated how shyness influences friendships over time using a Stochastic Actor-Oriented

Model (widely known as Siena-model; Snijders, van de Bunt, & Steglich, 2010). This research was conducted on a sample of junior high school students at three measurement points across a one-year period, during which pupils already knew each other, thus the study did not capture the beginning of the relationship (Bešić et al., 2009; Van Zalk, 2010). Results suggested that shy individuals are less popular, are more selective in terms of making friends, and also tend to choose similarly shy classmates and influence each other leading to increasing shyness over time (Bešić et al., 2009; Van Zalk, 2010). Even though shyness is an indicator of fewer relationships, it does not preclude socialization processes, which merely occur in different manner compared to non-shy students.

Further insight into the network location of shy individuals in terms of likeability might be provided by findings on basic personality traits – more specifically on extraversion and neuroticism as they are the strongest predictors of shyness (Bratko et al., 2002; Kwiatkowska et al., 2016). Recently, Selden and Goodie (2018) conducted a meta-analytic review focusing on social network structures in relation to the Five Factor Model of personality which examined the impact of particular dispositional characteristics on peer perception. To a great extent, extraversion is responsible for initiating social ties and increasing out-degree relationships, especially in transitional periods when the first contacts are crucial for furthering one's position in the group. However, this effect disappears in the case of a longer acquaintanceship (Baams et al., 2015). Moreover, high extraversion does not necessarily attract other individuals to oneself and is not related to in-degree relationships (Selden & Goodie, 2018; Selfhout et al., 2010). In this vein, people low on extraversion are less likely to initiate social relations but, similarly to extraverts (e.g., Selfhout et al., 2010), do not expect to be centralized in the eyes of their peers. Neuroticism, in turn, strongly depends on the context and is thought to be detrimental in younger samples (e.g., Battistoni & Fronzetti Colladon, 2014). It weakly, if at all, affects network structures—even in the case of highly neurotic

individuals who despite "being more socially anxious and interpersonally unskilled, they are still able to establish and maintain informal social relationships" (Selden & Goodie, 2018, p. 397). These outcomes are also reflected in the results of studies focused on likeability across junior high school students—it was revealed that both extraversion and emotional stability are the attributes of highly likeable teens (van der Linden, Scholte, Cillessen, Nijenhuis, & Segers, 2010). Nonetheless, regression analyses controlling for the overlapping variance between basic personality traits showed that neuroticism no longer played a significant role in being liked by others (van der Linden et al., 2010). In the long run, considering the above-described results one might expect that shyness—rooted in introversion—should be a meaningful indicator of poorer outgoing relations. However, shyness should not affect incoming relations or general acceptance by the social group.

2. Current study

2.1. Hypotheses regarding the relations of shyness with basic personality traits

First, we intended to replicate relations between shyness and basic personality traits in adolescents; this analyses was also the basis for choosing the variables to include in further social network analyses. To date, shyness has been primarily examined through the lens of basic personality traits. While most of this research has been conducted in adults, results indicate that shyness is a specific characteristic primarily rooted in low extraversion and, to a lesser degree, in high neuroticism. In turn, the relation with other basic traits—openness to experience, agreeableness, and conscientiousness—was much less crucial as it was often null or weakly negative (Briggs, 1988; Cheek & Briggs, 1990; Kwiatkowska et al., 2016; La Sala et al., 2014; Sato et al., 2018). On the basis of previous research, which has replicated these results in adolescents (Bratko et al., 2002), we hypothesized shyness to be most strongly related to extraversion and neuroticism. We did not expect shyness to be related to openness to experience, conscientiousness, and agreeableness.

1   We tested our hypotheses using a multiple linear regression model in which shyness

2was treated as a response variable and the five basic personality traits were explanatory

3variables. This analysis controls for the shared variance between predictor variables. To better

4visualize the results in our adolescent sample, we supported linear regression by estimating

5the adaptive LASSO network (Zou, 2006)—a generalization of the LASSO penalty

6(Friedman, Hastie, & Tibshirani, 2008) which is an alternative method of analysing relations

7between variables that are embedded in one abstract model of a network. In this kind of a

8network each variable (e.g., trait, emotion, or other characteristic) is represented as a node

9which may be connected with other nodes through ties/edges. Each node and tie in the

10network serves as an information carrier and is described with reference to other nodes/ties

11and to the whole network. Such a network may be easily estimated on the basis of correlation

12coefficients. However, the main disadvantage of a simple correlation network is that they are

13often fully connected and generate multiple testing problems (Constantini et al., 2015).

14Another kind of a network is the partial correlation network which is more sparse. However, it

15comes at the expense of a loss of power because significance testing—by requiring arbitrary

16choices of significance level—may lead to different results (Constantini et al., 2015). The

17adaptive LASSO outperforms other networks by causing "small connections to automatically

18shrink to be exactly zero" (Constantini et al., 2015, p. 17) which generates a more

19parsimonious network. It is a "generalization of the LASSO that assigns different penalty

20weights for different coefficients (Zou, 2006) and outperforms the LASSO in the estimation

21of partial correlation networks, especially if the underlying network is sparse" (Constantini et

22al., 2015, p. 17; see also Zou, 2006). Therefore, the adaptive LASSO network seems to be a

23robust method for analysing the structural relation between variables. It is characterized by

24very small likelihood of false positives and establishes stable and trustworthy results

25(Constantini et al., 2015, Krämer et al., 2009). Because this analysis works very well in dense

networks with a large number of nodes— in our small six-node network we use it primarily to visualize the relationship of shyness and basic personality traits.

2.2. Hypotheses regarding the role of shyness in forming relationships between high school students

Second, we aimed to study shyness as a characteristic which might influence the processes of forming relationships in a social group, which in our study was a high school class. Additionally, we intended to compare the effects of shyness to the effects of its closest personality domains selected based on the previous analysis—such a comparison allows for additional interpretation of relations with these personality traits. In our study, we focused on shyness as a predictor of two kinds of directed ties: outgoing ties related to liking others and one's *gregariousness*, and incoming ties related to being liked by others and one's *popularity* in the network.

So far most of the social network research on shy individuals refers to their outgoing relations. Previous studies found that shyness in a social network is not conducive to having many outgoing ties (Bešić et al., 2009; Van Zalk, 2010). This may result from two kinds of motivation—on the one hand, shyness has a protective function against possible harm such as negative evaluations or social comparisons (Hauck, Martens, & Wetzel, 1986), it contributes to avoidance, postponing social activities and averting the pursuit of new stimuli and experiences (Coplan et al, 2013; Nelson et al., 2008; Korem, 2018; Spere & Evans, 2009). On the other hand, shyness is related to a lower desire for stimulation in general and instead of avoiding others it instead contributes to selectivity in establishing relationships and a focus on the quality rather than quantity of social relationships (Cheek & Buss, 1981; Nelson, 2013; Rubin, Wojslawowicz, Rose-Krasnor, Booth-LaForce, & Burgess, 2006). Therefore, we hypothesized shyness to be a negative predictor of gregariousness reflected by outgoing ties.

1   However, the relationship between shyness and incoming relations is less clear.

2According to previous empirical studies, shy individuals are deemed to be less popular in

3comparison to their non-shy peers (Bešić et al., 2009; Van Zalk, 2010). However, that is

4contrary to findings for extraversion and neuroticism (the personality domains that are closest

5to shyness) both of which did not play a significant role in being liked by others (Selden &

6Goodie, 2018; Selfhout et al., 2010; van der Linden et al., 2010). Indeed, the current literature

7has distinguished two possible social faces of shyness. On one hand, shyness—especially

8during childhood and adolescence—may be associated with negative social perception, for

9instance, when shy behaviors are perceived as socially undesirable and inconsitstent with

10others expectations, and then rejection, bullying, or victimization which lead to one's feeling

11of loneliness (Kingsbury, Coplan, & Rose-Krasnor, 2013; Korem, 2018; Markovic & Bowker,

122015; Rubin et al., 2009). On the other hand, shyness might arouse positive connotations—

13shy individuals are considered sensitive, empathetic, or prosocial (Kalutskaya, Archbell,

14Rudasill, & Coplan, 2015), and even sociable when having at least one close friend (Rubin et

15al., 2006). Therefore, we hypothesized shyness to be a null predictor of popularity reflected

16by incoming ties.

17   To best use our network data, we followed the recommendations of Block, Stadtfeld,

18and Snijders (2016), who compared various approaches for the statistical analysis of the

19directed social networks. We decided to apply the exponential random graph models (ERGM;

20alternatively labelled as *P** models; Lusher, Koskinen, & Robins, 2013; Snijders, Pattison,

21Robins, & Handcock, 2006), because the nature of our network data was *binary* and in our

22procedure there was no constraint to how many peers a student can indicate, and we aimed to

23focus on the *tie/edge level* (unlike the *actor/node level*), thus, none of the actors was in a

24priori special position enabling to have a control over the tie. The ERGM is a statistical

25analysis for social networks derived from graph theory, which aims to examine underlying

1mechanisms of network formation with simultaneous consideration of endogenous

2dependencies. It focuses on the formation of deductive relations on the basis of relationships

3in observed network and, therefore, allows us to test hypotheses on how network relationships

4are formed by investigating the probability distribution of the set of all graphs with a fixed

5number of nodes (Jiao et al., 2017). In current paper, we aimed to test whether attributes

6(shyness, extraversion, and neuroticism) assigned to the nodes (individuals in the network)

7significantly influence the forming of relationships between nodes. In this way, node

8attributes in ERGM models may serve as predictor variables of outgoing or incoming ties.

9   All statistical analyses for social networks were carried out using R software version

103.4.3 (R Development Core Team, 2017) and following packages: *qgraph*, developed for

11analysing and visualising personality and psychopathology data using a network approach

12(Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012), and the *ergm* package,

13which is part of the *statnet* suite of packages (Handcock et al., 2016, 2017; Handcock, Hunter,

14Butts, Goodreau, & Morris, 2008) developed for estimating ERGM models. The multiple

15linear regression model was tested in SPSS version 24.0 (IBM Corp., 2016). For the

16transparency of our results, we share the codebook, data, and R codes applied in our study via

17the Open Science Framework platform under the following web link: https://osf.io/wk2bg/?

18view_only=414a19f879a64814aa4ddafa8803c1d4

19**3. Materials and methods**

20*3.1. Participants and procedure*

21   The study involved $N = 253$ (58% were girls) secondary school students, all 16 years of

22age. Due to the planned social network analysis the study enrolled a total of 10 entire school

23classes with the following number of pupils: $n_A = 31$, $n_B = 24$, $n_C = 19$, $n_D = 28$, $n_E = 22$, $n_F = $

2423, $n_G = 21$, $n_H = 31$, $n_I = 23$, $n_J = 31$ ($M_n = 25$). The first six classes (A-F) were from technical

25secondary school (i.e., economic profile) and another four (G-J) from general secondary

1school.[1] The analyses in present paper did not include pupils absent on that particular day at

2school (the average percentage of absent students in a given classroom was 13%). Data were

3collected four months after the beginning of the school year, during one regular lesson of 45

4minutes in which pupils were administered booklets with a set of self-report questionnaires

5and simple sociometric measures. The research was a part of a larger longitudinal study

6conducted with the consent of students, parents, and headmasters. The procedure was

7approved by the Cardinal Stefan Wyszyński University in Warsaw ethics board. During the

8research, we followed ethical standards and all personal data were anonymized prior to the

9analysis.

10*3.2. Measures*

11   For the purposes of present study, pupils were administered two short self-report

12measures: the RCBS (Cheek, 1983; Cheek & Buss, 1981; Polish adaptation: Kwiatkowska et

13al., 2016) and the Big Five Inventory-15 (BFI; Lang, John, Lüdtke, Schupp, & Wagner, 2011;

14Polish adaptation: Strus, Cieciuch, & Rowiński, 2017), to which participants responded using

15a 5-point Likert-type response scale (1 = *strongly disagree*; 5 = *strongly agree*). The RCBS

16consists of 13 test items related to the general discomfort or inhibition in social contexts

17(sample item: *It is hard for me to act natural when I am meeting new people*) and is

18considered to be an invariant measure of shyness across adults and adolescents (Kwiatkowska

19& Rogoza, 2017). The BFI contains 15 items, three per each of the five scales: neuroticism

20(sample item: *I see myself as someone who ...worries a lot*), extraversion (sample item: *...is*

21*outgoing, sociable*), openness to experience (sample item: *...is original, comes up with new*

22*ideas*), agreeableness (sample item: *...has a forgiving nature*), and conscientiousness (sample

23item: *...does things efficiently*). In addition to these self-report measures, we obtained a

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3[1] The difference between these two types of secondary schooling is that: (1) technical school lasts four years in
4overall (currently, in line with the newly introduced reform by Polish government, it lasts five years), and (2) the
5students of technical school receives apprenticeship depending on the school's profile. In contrast, General
6secondary schooling lasts three years (four years according to the previously mentioned reform), does not have
7an apprenticeship, and prepares students for further education at university.

1likeability assessment derived using a sociometric approach. Each pupil was given a roster,

2(i.e., a full list of a class members), and could indicate an unlimited number of classmates he

3or she liked, which also referred to the extent of liking and social acceptance towards others.

4These data were recoded into binary matrices where the value of "1" reflected one's

5indication (liking the other pupil), while "0" reflected no indication (which meant the absence

6of liking, not to be confused with disliking). Such matrices, created separately for each class,

7were the basis for social network analyses within the ERGM approach. In order to deal with

8missing network data, we removed all data related to non-responders.

9**4. Results**

10*4.1. Adolescent shyness with respect to basic personality traits*

11   Preliminary data checks and descriptives statistics for shyness and the BFI personality

12traits are presented in Table 1.

13Table 1

14*Reliability estimates, distribution and descriptive statistics, and assessment of gender*
15*differences*

Variable	Reliability		Distribution statistics		Descriptive statistics		Gender differences	
	α	ω	S	K	M	SD	t	p
Shyness	.85	.88	0.11	0.61	2.66	0.62	−0.20	.843
Neuroticism	.54	.59	−0.09	−0.16	3.25	0.82	−4.32	.001
Extraversion	.55	.67	−0.31	0.39	3.14	0.73	−2.54	.012
Openness to experience	.74	.75	−0.15	−0.04	3.54	0.77	−1.04	.301
Agreeableness	.44	.48	−0.01	−0.02	3.33	0.68	−1.11	.269
Conscientiousness	.46	.67	0.15	−0.17	3.27	0.62	−1.16	.247

16*Note*. A negative result of *t* test indicates a lower mean score in boys.

17   The measurement of shyness displayed very good reliability, however, some BFI scales

18had poor reliability, which may be explained by the broadness of constructs such as basic

19personality traits (Lang et al., 2011). The skew and kurtosis statistics show that all variables

20had distributions close to normal. *T*-tests for independent samples showed significant gender

21differences for neuroticism and extraversion: girls ($M_{\text{neuroticism}} = 3.44$; $M_{\text{extraversion}} = 3.24$)

22reported significantly higher scores than boys ($M_{\text{neuroticism}} = 2.99$; $M_{\text{extraversion}} = 3.01$).

1   To examine the relations between shyness and the basic personality traits, we applied a

2multiple linear regression model, in which shyness was a response variable and all five basic

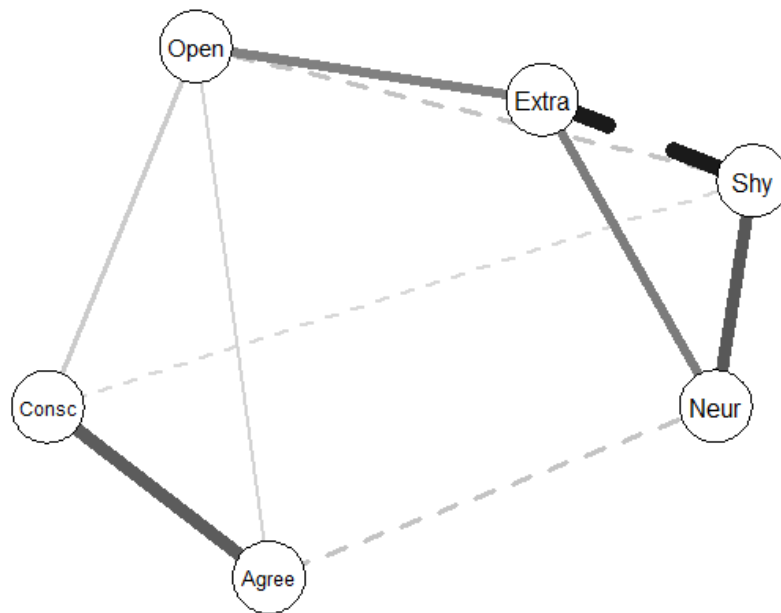3personality traits were explanatory variables. The results are presented in Table 2.

4Table 2

5*The results of multiple linear regression model of shyness regressed on personality traits*

	B	SE_B	β	t	p
Neuroticism	0.22	0.04	.29	5.30	.001
Extraversion	−0.37	0.05	−.43	−7.60	.001
Openness to experience	−0.09	0.05	−.11	−1.92	.056
Agreeableness	0.03	0.05	.03	0.51	.610
Conscientiousness	−0.09	0.06	−.09	−1.66	.099

6*Note.* The above regression pattern was the same for both boys and girls, except for openness,

7which significantly predicted shyness in girls.

8   The model was well-fitted to the data ($F_{(5,247)} = 21.51$; $p < .001$). Only two out of five

9standardized regression coefficients were significant. Shyness was most strongly negatively

10predicted by extraversion, followed by a positive relation with neuroticism. To increase the

11power of the significance test, we compared the absolute values of the regression coefficients

12via Eid, Gollwitzer, and Schmitt's (2011, p. 548) Z-test. As a result, we found that

13extraversion was a significantly stronger predictor of shyness in adolescents compared with

14neuroticism ($Z = 1.75$; $p < .05$). Thus, our hypothesis for the relations between shyness and

15basic personality traits was supported.

16   In order to further test and visualize this relation we estimated the adaptive LASSO

17network which is depicted in Figure 1.

1

2*Figure 1*. Network of shyness and basic personality traits. Nodes represent traits as follows: 3Shy = Shyness, Extra = Extraversion, Open = Openness to experience, Neur = Neuroticism, 4Agree = Agreeableness, Consc = Conscientiousness. Solid lines represent positive 5connections and dashed lines represent negative connections. Thicker and darker lines 6represent stronger connections, while thinner and lighter lines represent weaker connections.

7   The network has 10 edges, of which six are positive and four are negative. In our 8network, positive edges are associated with slightly larger weights ($M = .21$, $SD = .12$) than 9the negative edges ($M = .18$, $SD = .18$). However, a *t*-test indicates that this difference is non-10significant, $t_{(8)} = 0.381$, $p = .713$. According to *strength centrality*—the estimate which 11reflects summed weights of each path of a unitary length incidental to the node of interest 12(Barrat, Barthelémy, Pastor-Satorras, & Vespignani, 2004; Borgatti, 2005; Costantini et al., 132015; Newman, 2004)—in the network of shyness and basic personality traits, the strength of 14the nodes is as follows: > 0.90 for shyness and extraversion, 0.67 for neuroticism, and ≤ 0.53 15for openness to experience, agreeableness, and conscientiousness. The more a node is 16strength-central, the more this trait "is one that can influence many other personality 17characteristics (or be influenced by them) directly, without considering the mediating role of 18other nodes" (Costantini et al., 2015, p. 18). Therefore, shyness, extraversion, and neuroticism

are the traits which are the most central in our network. In order to not arbitrarily choose those

traits which are the closest to shyness as variables of interest, we examined the length of the

paths to determine the shortest paths, as shown in Figure 1 and Table 3.

Table 3

Shortest path lengths in a network of shyness and basic personality traits

	1	2	3	4	5	6
1. Extraversion	–					
2. Openness to experience	4.19	–				
3. Neuroticism	4.05	8.24	–			
4. Agreeableness	12.97	12.05	8.92	–		
5. Conscientiousness	14.40	10.21	12.18	3.26	–	
6. Shyness	**2.32**	6.51	**3.19**	12.11	13.47	–

Note. This table contains the shortest path lengths of each pairs of nodes. These path lengths
are based on the inverse of the absolute edge weights. The shortest paths for shyness are
bolded.

In sum, as the result of the adaptive LASSO penalty, we found that in a joint network

with the basic personality traits, shyness is most strongly related to extraversion and

neuroticism. The network approach also suggested a weak relation with openness to

experience and conscientiousness; however, if examined in a regression analysis, these results

may be statistically significant.

4.2. Social network preliminary results

Network descriptive statistics, gender distributions, and mean shyness, neuroticism, and

extraversion scores for each class are presented in Table 4.

Table 4

Network descriptive statistics across school classes

	Class A	Class B	Class C	Class D	Class E	Class F	Class G	Class H	Class I	Class J	*M*
n	31	24	19	28	22	23	21	31	23	31	25
Gender											
Boys (%)	6 (19)	4 (17)	10 (53)	12 (43)	7 (32)	6 (26)	5 (24)	22 (71)	14 (61)	20 (65)	10 (40)
Girls (%)	25 (81)	20 (83)	9 (47)	16 (57)	15 (68)	17 (74)	16 (76)	9 (29)	9 (39)	11 (35)	15 (60)
Mean scores											
Shyness	2.69	2.51	2.77	2.53	2.64	2.75	2.82	2.76	2.36	2.75	2.66
Extraversion	3.26	3.28	3.23	3.25	3.26	3.39	3.03	2.80	3.20	2.87	3.16
Neuroticism	3.29	3.15	3.19	3.06	3.42	3.55	3.70	3.10	3.20	3.05	3.27
Social network											
No. of edges	223	167	163	215	106	107	94	219	135	263	169
Density	.24	.30	.48	.28	.23	.21	.22	.24	.27	.28	.28
Reciprocity	.32	.36	.30	.33	.35	.39	.35	.28	.35	.33	.34
Transitivity	.65	.53	.71	.55	.56	.67	.72	.45	.46	.53	.58

1   The classes differed from each other in terms of sex distribution. Six classes had more

2girls than boys, while three other classes had more boys than girls, and in one class there were

3an equal number of both genders (i.e., Class C). Thus, overall the majority of our sample was

4female. This is common for secondary schools in the Polish education system because boys

5choose to study at vocational schools and in the more technical profiles (e.g., mechanical,

6electronic, etc.) at secondary schools more often than girls. Next, we conducted an analysis of

7variance (ANOVA) to examine differences between the classes on shyness, extraversion, and

8neuroticism. There were no significant differences on shyness ($F_{(9,243)} = 1.355$, $p = .210$) or

9neuroticism ($F_{(9,243)} = 1.740$, $p = .081$) but there were significant differences on extraversion

10($F_{(9,243)} = 2.052$, $p = .035$). However, Tukey's post hoc test revealed that the mean score for

11Class F was not significantly higher than for Class H ($p = .078$).

12   Social network information varied by class in terms of connectivity, i.e., number of ties

13and density (the proportion of existing connections to the maximum number of possible

14connections for the number of actors present in the network). Networks were characterized by

15more or less the same amount of reciprocity (also referred as mutuality – the tendency to

16reciprocate the bond), although they differed in terms of transitivity, i.e. the proportion of

17closed triangles—triads in which we observe all three connections—to the total number of

18both opened and closed triads. Network descriptive statistics did not exceed the value of |1|,

19indicating that models showed an acceptable fit in reflecting network features.

20*4.3. Shyness within exponential random graph modelling*

21   We tested three ERGM models for each class: (1) Model 0 (null model) which is

22equivalent to the density of the graph, i.e., it takes into account only the number of edges; (2)

23Model 1 in which shyness is a predictor of outgoing and incoming ties (relations); and (3)

24Model 2 in which extraversion and neuroticism are predictors of outgoing and incoming ties.[2]

3[2] At the request of the Reviewer, we also tested Model 3 which includes all three variables in predicting outgoing
4and incoming ties. These results can be found in the Appendix.

1Before running the ERGM models, all the attribute variables (shyness, extraversion, and

2neuroticism) were standardized so that estimates did not exceed a value of $|1|$ for better

3comparison and interpretation of results. Subsequently, each of the coefficients was averaged.

4The estimated model parameters and mean scores for each attribute variable are displayed in

5Table 5.

Table 5.

Estimates of the exponential random graph models

	Class A	Class B	Class C	Class D	Class E	Class F	Class G	Class H	Class I	Class J	M
Model 0											
Edge	−1.15(0.08)***	−0.84(0.09)***	−0.09(0.11)	−0.92(0.08)***	−1.21(0.11)***	−1.32(0.11)***	−1.24(0.12)***	−1.18(0.08)***	−1.01(0.10)***	−0.93(0.07)***	–
AIC	1027.0	678.7	475.4	904.7	499.7	524.1	448.6	1017.0	589.0	1110.0	–
BIC	1031.0	683.1	479.2	909.4	503.8	528.3	452.7	1022.0	593.2	1115.0	–
Model 1											
Edge	−2.40(0.16)***	−2.71(0.24)***	−0.86(0.20)***	−2.21(0.15)***	−2.70(0.23)***	−3.24(0.27)***	−2.55(0.25)***	−2.69(0.17)***	−2.51(0.20)***	−2.15(0.14)***	–
Gender	0.45(0.15)**	0.81(0.20)***	0.75(0.21)***	0.74(0.15)***	0.69(0.20)***	0.53(0.19)**	0.27(0.22)	1.38(0.19)***	0.81(0.18)***	0.52(0.13)***	–
Reciprocity	2.64(0.27)***	3.13(0.38)***	0.84(0.33)*	2.38(0.28)***	3.05(0.40)***	4.26(0.49)***	3.24(0.43)***	1.69(0.26)***	2.80(0.37)***	2.48(0.25)***	–
Shyness											
Sender	0.30(0.09)**	−0.54(0.12)***	−0.02(0.12)	−0.31(0.10)**	−0.15(0.13)	−0.42(0.17)*	−0.13(0.15)	−0.28(0.09)**	−0.14(0.13)	−0.17(0.09)	**−0.19**
Receiver	−0.01(0.09)	0.30(0.13)*	−0.04(0.12)	0.06(0.10)	−0.02(0.14)	0.28(0.17)	0.09(0.15)	−0.15(0.09)	0.11(0.13)	0.01(0.09)	**0.06**
AIC	891.6	554.7	459.8	781.2	416.5	400.1	383.6	865.2	491.6	971.6	–
BIC	915.8	576.2	479.0	804.3	437.2	421.2	403.8	889.4	512.7	995.8	–
Model 2											
Edge	−2.47(0.17)***	−2.72(0.25)***	−0.86(0.21)***	−2.32(0.17)***	−2.69(0.23)***	−3.17(0.27)***	−2.55(0.25)***	−2.77(0.18)***	−2.50(0.21)***	−2.30(0.15)***	–
Gender	0.39(0.15)**	0.71(0.21)***	0.79(0.22)***	0.83(0.15)***	0.59(0.20)**	0.52(0.19)**	0.22(0.21)	1.50(0.20)***	0.79(0.18)***	0.68(0.13)***	–
Reciprocity	2.86(0.28)***	3.29(0.40)***	0.81(0.35)*	2.38(0.30)***	3.05(0.42)***	4.11(0.48)***	3.28(0.44)***	1.64(0.27)***	2.80(0.36)***	2.51(0.26)***	–
Extraversion											
Sender	−0.26(0.09)**	0.34(0.13)**	0.48(0.13)***	0.52(0.10)***	−0.03(0.17)	0.14(0.18)	0.09(0.16)	0.23(0.09)*	0.07(0.13)	0.37(0.10)***	**0.20**
Receiver	0.10(0.09)	−0.20(0.12)	0.09(0.13)	0.07(0.10)	0.40(0.17)***	0.12(0.17)	0.08(0.16)	0.32(0.10)***	−0.01(0.13)	0.18(0.09)	**0.12**
Neuroticism											
Sender	−0.21(0.10)*	0.58(0.14)***	−0.52(0.13)***	−0.29(0.10)**	0.10(0.18)	−0.23(0.19)	−0.20(0.16)	−0.01(0.09)	−0.19(0.14)	−0.34(0.09)***	**−0.13**
Receiver	0.42(0.10)***	−0.46(0.14)**	0.01(0.13)	0.12(0.10)	0.02(0.17)	0.28(0.18)	0.24(0.16)	0.12(0.09)	0.10(0.13)	0.21(0.09)*	**0.11**
AIC	883.2	555.2	434.9	743.7	410.3	402.0	384.2	858.7	494.9	933.4	–
BIC	917.0	585.3	461.8	776.1	439.2	431.6	412.5	892.5	524.5	967.2	–

Note. AIC = Akaike information criterion; BIC = Bayesian information criterion. *Sender* effect refers to gregariousness, while *Receiver* effect to popularity. Because general dependencies are the main interest of current study, we bold mean results for each model.

* $p < .05$; ** $p < .01$; *** $p < .001$

1   Model fit was assessed by approximate maximum likelihood estimates, which were

2computed using Markov Chain Monte Carlo—a stochastic simulation algorithm (Hunter,

3Handcock, Butts, Goodreau, & Morris, 2008).[3] As a result, within each class both models

4were better fitted to the data than the null models and their Akaike information criterion (AIC)

5and Bayesian information criterion (BIC) fit indices values were lower. The *Edge* term was

6negative meaning that ties are not likely to be formed at random. Within the ERGM, models

7included several endogenous effects, such as the *Reciprocity* term, a parameter of endogenous

8network statistics, which corresponds to a mutuality in liking nominations and a high

9probability that a tie will be reciprocated. Moreover, models included the *Gender: node*

10*match* term, which reflects the tendency of classmates of the same gender to tie to each other

11more likely than expected by chance. Across endogenous effects both models revealed that

12students were homophilic regarding gender, and within each class there was a tendency for
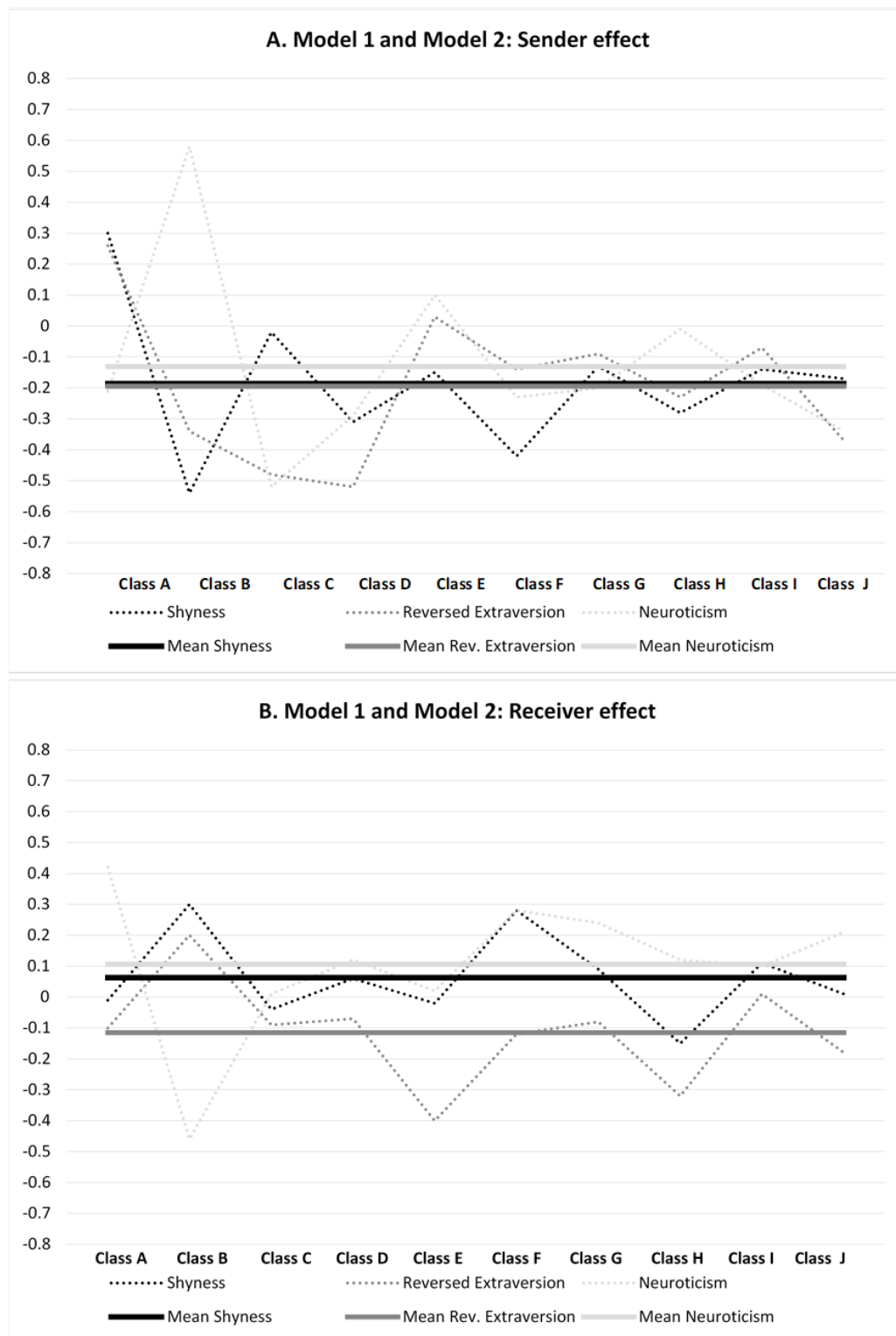
13reciprocity of established ties.

14   Across the exogenous effects in Model 1, most cases confirmed our assumptions

15regarding direction and strength of shyness effects.[4] On one hand, shyness was a significant

16predictor of fewer outgoing relations. On the other hand, it was not significantly linked to

17receiving liking ties. It is noteworthy, however, that on average the *Receiver* effect for

18shyness was positive. In sum, shy individuals are neither particularly liked nor disliked by

19their peers (non-significant *Receiver* effect), but they are more selective in liking others and

20have fewer outgoing ties (significant negative *Sender* effect), which confirms our hypotheses.

21   The results of Model 2 indicate that extraversion is mostly a significant predictor of

22having more outgoing relations, but does not predict incoming ties. Neuroticism, however, did

23not show a consistent, repeatable pattern of relations as both of the effects (*Sender* and

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3[3] While replicating results with the same data, note that a stochastic algorithm makes the results similar but not
4the same by every run (Hunter et al., 2008).

5[4] Except Class A, which had the opposite results across all variables (for both extraversion and neuroticism) in
6comparison to the other classes.

1*Receiver*) were null or supressed within the analysed samples. In conclusion, <u>the pattern of</u>

2extraversion-related effects is closer to the pattern of effects associated with shyness than to

3those of neuroticism. Figure 2A and 2B visualize the relations of shyness, extraversion, and

4neuroticism with outgoing and incoming ties.

2*Figure 2*. The estimated results of the *Sender* effect (which refers to gregariousness) and the
3*Receiver* effect (which refers to popularity) parameters for Model 1 and Model 2. Dotted lines
4represent scores for each trait in each class, while the thick lines represent the mean scores for
5each trait in all 10 classes. For better comparison purposes, we decided to reverse the scores
6for extraversion.

5. Discussion

The main purpose of this paper was to examine shyness among teenagers from two perspectives: in terms of its relations with basic personality traits and in terms of its influence on the processes that occur in social networks. Both of these aspects have been widely studied in previous research on shyness (Bešić et al., 2009; Bratko et al., 2002; Briggs, 1988; Cheek & Briggs, 1990; Kwiatkowska et al., 2016; La Sala et al., 2014; Sato et al., 2018; Van Zalk, 2010). However, our work is the first attempt to analyze the relation between shyness and its closest personality domains—extraversion and neuroticism—through the lens of patterns which they adopt in their social networks, namely outgoing relations which reflect gregariousness and incoming relations which reflect popularity.

In the first stage of our analyses, we found support for our hypothesis on the relations between shyness and basic personality traits. A multiple linear regression model, supported by the adaptive LASSO network, showed that shyness is significantly predicted by two traits – extraversion and neuroticism, with extraversion having the strongest effect. In addition, the relations with the other traits – openness, agreeableness and conscientiousness – were non-significant. This replicates the results of previous studies on shyness, including those in adolescents (Bratko et al., 2002). However, in our study extraversion was a stronger predictor of shyness compared to neuroticism, while Bratko et al. (2002) found that the strength of the relation with extraversion and neuroticism were similar. These discrepancies may be the result of using different conceptualizations and measurement approaches. In the current paper, shyness was measured with the RCBS scale, which is characterized by a well-analyzed structure and invariance in adolescents and adults (Kwiatkowska & Rogoza, 2017). Bratko et al. (2002), applied the USA (*Upitnik Sramežljivosti i Asertivnosti*)—a 50-item instrument measuring shyness in combination with assertiveness adapted for a Croatian population. The USA was initially developed for adults however its equivalence in younger samples has not

1been tested (Zarevski & Vukosav, 1999). In sum, <u>similar to the results from adult samples</u>, we

2found that shyness in adolescence is mostly related to introversion and in a lesser extent to

3neuroticism. Still, we do not claim to ascribe shyness to low extraversion directly. Following

4John's (1990) assumptions, shyness is instead one of these traits which are the blend of two or

5more of the five dimensions, creating obstacles for researchers trying to grasp personality

6structure. Taking this into consideration, we can only modestly state on the basis of our results

7that shyness is probably a complex blend of higher-order traits or a facet which might be

8simultaneously located under two separate domains. Nevertheless, it does seem likely that

9extraversion plays a stronger role than neuroticism in this blend of traits. The inconsistent

10results (stronger vs weaker) regarding neuroticism and shyness throughout the literature may

11result from the nature of aspects of neuroticism which can be moderated by one's experiences,

12social relations, but also one's therapy or deep work on oneself and emotion regulation

13(Korem, 2018). In this vein, shyness has two possible developmental paths emerging from

14early temperamental dispositions and exposure to more or less adaptive environmental factors

15such as parenting styles, culture, peer relationships which may either weaken or strengthen

16self-conscious and neurotic aspects of shyness (Schmidt & Poole, 2018). This twofold

17perspective of shyness has great potential to be the subject of future research.

18   The second stage of our analyses was focused on shyness, extraversion, and neuroticism

19in a social network. As hypothesized, we found that shyness negatively predicted the number

20of outgoing relations, but did not affect the number of incoming relations. Our results fully

21replicated the results of previous studies on shyness and social relations examined at the

22individual level (e.g., Cheung & Elliott, 2017; Ponti & Tani, 2015). However, discrepancies

23regarding popularity emerged when compared to previous research at the relational-level of

24analysis (Bešić et al., 2009; see also Van Zalk, 2010). According to our results, shy teenagers

25are *neither liked nor disliked* by their classmates, whereas previously shyness was found to be

1a negative predictor of making friends (i.e., peers of shy teens are unlikely to be friends with

2them; Bešić et al., 2009; Van Zalk, 2010). This discrepancy may be due to the fact that we

3allowed students to indicate an unlimited number of classmates, thus possibly taking both

4close friends and teenagers generally liked in the classroom into account. Based on our

5results, decreased social closeness or fewer ties is the result of the subjective attitude of shy

6individual rather than real environmental obstacles to making friends (such as lack of peer

7acceptance). However, bearing in mind that shyness is predicted by low extraversion and

8neuroticism—both separately or combined (Briggs, 1988; Cheek & Briggs, 1990; Jones et al.,

92014)—the withdrawn behavior of shy teens might be due to a lower need for affiliating with

10others and/or due to being anxious because of the possibility of being evaluated, for example

11(Cheek & Buss, 1981; Hauck et al., 1986; Nelson, 2013; Rubin et al., 2006). In this vein, we

12expanded our network analysis to examine whether popularity and gregariousness are affected

13by extraversion and neuroticism in a similar manner to shyness. In doing so, we found that

14our results for shyness are quite similar to the network characteristics for the opposite of

15extraversion, which indeed is marked by significant lack of gregariousness as measured by

16outgoing ties and no particular relation with popularity as measured by incoming ties (Selden

17& Goodie, 2018; Selfhout et al., 2010). Additionally, the impact of neuroticism was not

18consistent for outgoing or incoming ties, which is also in line with prior research (Battistoni &

19Fronzetti Colladon, 2014; Selden & Goodie, 2018; van der Linden et al., 2010).

20   Our results should be interpreted in light of some important limitations. First, the

21network effects presented in our study were mostly weak or modest which is a bias resulting

22from our procedure in which each student could indicate unlimited number of peers in their

23class. The strength of such a solution is that the number of peers the respondent wants to

24indicate is not controlled by the method but is rather their own free choice. However, this can

25also lead to indicating a large number of peers as the result of social desirability, as opposed

to actual liking. Therefore, this procedure contributes to network density and increases the probability that all nodes are connected to each other. Second, in the ERGM models, while we did include basic network terms such as reciprocity, we did not include more advanced effects such as centralization or triadic closure. We did so because our networks were newly formed, rather small and connected. Third, the measurement of basic personality traits was very short and only took personality domains into account. Future research on shyness and basic personality traits might focus on the role of particular personality facets, such as assertiveness under extraversion or self-consciousness under neuroticism, and make attempts to examine potential mechanisms that are key for shyness (for example through the LASSO network procedure). In the light of these limitations, we encourage researchers to replicate our results.

6. Conclusions

What does it mean to be a shy during adolescence and how does shyness impact social relations within a school class? Researchers indicated that shyness may be related to poor mental functioning of children and teenagers due to negative emotionality (Asendorpf, 1990; Cheek & Krasnoperova, 1999; Rubin et al., 2009). Based on the original conceputalization of extraversion and neuroticism as core attributes of shy individuals (Cheek & Briggs, 1990; Hofstee et al., 1992), the current study aimed to examine whether shyness in adolesence is dominated by neuroticism or low extraversion and which of these basic traits resembles shyness within the social network. By integrating these results, we found that shyness in adolescence is closer to low extraversion—both through the lens of self-report personality traits and by examining the actual status of the individual within their social network (i.e., their school class). This research contributes to the long-standing discussion on the placement of shyness in the space of personality traits. Is this relevant for understanding the life of shy teenagers? Our research modestly suggests that such individuals are less sociable, driven by a lower need for social relations rather than by negative emotionality and a sense of inferiority.

Shy teens are not particularly popular within their peers, but they also do not strive for this

popularity. Therefore, future research on the social functioning of shy adolescents should

focus on their close intimate relationships, which may be more important for their well-being.

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