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Shy teens and their peers: Shyness in respect to basic personality traits and social relations

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ABSTRACT

The main purpose of this paper was to examine shyness in 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 the social networks of high school students. First, we found that shyness was negatively predicted by extraversion and positively by neuroticism. Second, using exponential random graph models we demonstrated that shyness across network effects was similar to reversed extraversion (introversion): Both negatively predicted the number of outgoing relations, whereas they did not affect the number of incoming relations. We discuss the issue of locating shyness in the space of personality traits, supporting the relevance of ascribing it to introversion.

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1. Introduction

Adolescence is a transitional stage of development that bridges childhood and adulthood. A very important aspect of this period is social development, which depends to a large extent on the developing personality traits of the individual (Meredith, 1955). Shyness is one such characteristic which is crucial in terms of establishing social relations. For instance, shyness can make it difficult to meet new people, to make friends or to experience joy from potentially positive social experiences, and others may underestimate the strengths of shy individuals (Zimbardo, 1977). Researchers agree that shyness is a complex phenomenon resulting from two conflicting motivations: approach and avoidance (Asendorpf, 1990). This discrepancy is also present when examining shyness in relation to basic personality traits or broad global factors of personality. Personality traits are thought of as “the most important ways in which individuals differ in their enduring emotional, interpersonal, experiential, attitudinal, and motivational styles” (McCrae & John, 1992, p. 175) and consist of: extraversion, agreeableness, conscientiousness, emotional stability or neuroticism, and intellect/openness to experience (Costa & McCrae, 1992, 1992, 1995; Goldberg, 1999; Hofstee, de Raad, & Goldberg, 1992). The main interest of the current study was to investigate how shyness is

related to basic personality traits and whether these relations are reflected in the social networks of high school students.

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

Shyness is commonly conceptualized as a temperamentally conditioned disposition manifesting itself in the reduced motivation for social involvement and discomfort in the presence of unfamiliar individuals (Asendorpf, 1990; Cheek & Buss, 1981). There has been much debate surrounding the location of shyness within the space of basic personality traits (Briggs, 1988; Cheek & Briggs, 1990; Hofstee et al., 1992). More specifically, 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, Schalkin, & 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

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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” (Hofstee et al., 1992; p. 161). This is because it avoids the subjective nature of the imposed top-down models that are used in the questionnaire approach. Accordingly, the term *shy* in lexical studies is strictly in the centre of the facet related to reversed extraversion (which is also captured by adjectives such as *quiet*, *introverted*, *silent*, *untalkative*, *bashful*, *withdrawn*, and *inhibited*; Hofstee et al., 1992; John, 1990) and is not placed within the combined facet of neuroticism and reversed extraversion (which is captured by terms such as *lonely*, *weak*, *cowardly*, *pessimistic*, *melancholic*, *guarded*, and *secretive*; Hofstee et al., 1992).

Following these theoretical traditions, as opposed to the assumptions derived from empirical findings (e.g., Bratko, Vukosav, Zarevski, & Vranić, 2002; Briggs, 1988; Cheek & Briggs, 1990; Kwiatkowska, Kwiatkowska, & Rogoza, 2016), shyness, to a very great degree, is rooted in introversion. However, through blending with other basic traits, shyness can take various manifestations—including a neurotic manifestation, which seems to be the most noticeable by due to causing problems in social relations (Cheek & Krasnoperova, 1999; Jones et al., 2014). As a result of these more noticeable social difficulties, researchers may label shy children and teenagers as an *at-risk population* and claim that this kind of tendency toward social inhibition and withdrawal should be analysed in the early stages of development (Asendorpf, 1990), and especially during adolescence when shyness becomes more self-conscious and fearful (Cheek & Krasnoperova, 1999).

1.2. Shy teens embedded in a social network

Shyness in adolescence is a very widely researched topic, which is especially valuable considering its applied potential including interventions in educational institutions. Preadolescent studies indicated that shy individuals are prone to a wide range of internalizing problems (Rubin, Coplan, & Bowker, 2009), and are simultaneously more likely to feel socially withdrawn, lonely, victimized, anxious, or even depressed (Coplan et al., 2013). Moreover, 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. 97). 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, Skues, & Grant, 2014; Sato, Matsuda, & Carducci, 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.

We tested our hypotheses using a multiple linear regression model in which shyness was treated as a response variable and the five basic personality traits were explanatory variables. This analysis controls for the shared variance between predictor variables. To better visualize the results in our adolescent sample, we supported linear regression by estimating the adaptive LASSO network (Zou, 2006)—a generalization of the LASSO penalty (Friedman, Hastie, & Tibshirani, 2008) which is an alternative method of analysing relations between variables that are embedded in one abstract model of a network. In this kind of a network each variable (e.g., trait, emotion, or other characteristic) is represented as a node which may be connected with other nodes through ties/edges. Each node and tie in the network serves as an information carrier and is described with reference to other nodes/ties and to the whole network. Such a network may be easily estimated on the basis of correlation coefficients. However, the main disadvantage of a simple correlation network is that they are often fully connected and generate multiple testing problems (Costantini et al., 2015). Another kind of a network is the partial correlation network which is more sparse. However, it comes at the expense of a loss of power because significance testing—by requiring arbitrary choices of significance level—may lead to different results (Costantini et al., 2015). The adaptive LASSO outperforms other networks by causing “small connections to automatically shrink to be exactly zero” (Costantini et al., 2015, p. 17) which generates a more parsimonious network. It is a “generalization of the LASSO that assigns different penalty weights for different coefficients (Zou, 2006) and outperforms the LASSO in the estimation of partial correlation networks, especially if the underlying network is sparse” (Costantini et al., 2015, p. 17; see also Zou, 2006). Therefore, the adaptive LASSO network seems to be a robust

method for analysing the structural relation between variables. It is characterized by very small likelihood of false positives and establishes stable and trustworthy results (Costantini et al., 2015; Krämer, Schäfer, & Boulesteix, 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; Korem, 2018; Nelson et al., 2008; 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.

However, the relationship between shyness and incoming relations is less clear. According to previous empirical studies, shy individuals are deemed to be less popular in comparison to their non-shy peers (Bešić et al., 2009; Van Zalk, 2010). However, that is contrary to findings for extraversion and neuroticism (the personality domains that are closest to shyness) both of which did not play a significant role in being liked by others (Selden & Goodie, 2018; Selfhout et al., 2010; van der Linden et al., 2010). Indeed, the current literature has distinguished two possible social faces of shyness. On one hand, shyness—especially during childhood and adolescence—may be associated with negative social perception, for instance, when shy behaviors are perceived as socially undesirable and inconsistent with others expectations, and then rejection, bullying, or victimization which lead to one's feeling of loneliness (Kingsbury, Coplan, & Rose-Krasnor, 2013; Korem, 2018; Markovic & Bowker, 2015; Rubin et al., 2009). On the other hand, shyness might arouse positive connotations—shy individuals are considered sensitive, empathetic, or prosocial (Kalutskaya, Archbell, Rudasill, & Coplan, 2015), and even sociable when having at least one close friend (Rubin et al., 2006). Therefore, we hypothesized shyness to be a null predictor of popularity reflected by incoming ties.

To best use our network data, we followed the recommendations of Block, Stadtfeld, and Snijders (2016), who compared various approaches for the statistical analysis of the directed social networks. We decided to apply the exponential random graph

models (ERGM; alternatively labelled as P^* models; Lusher, Koskinen, & Robins, 2013; Snijders, Pattison, Robins, & Handcock, 2006), because the nature of our network data was *binary* and in our procedure there was no constraint to how many peers a student can indicate, and we aimed to focus on the *tie/edge level* (unlike the *actor/node level*), thus, none of the actors was in a priori special position enabling to have a control over the tie. The ERGM is a statistical analysis for social networks derived from graph theory, which aims to examine underlying mechanisms of network formation with simultaneous consideration of endogenous dependencies. It focuses on the formation of deductive relations on the basis of relationships in observed network and, therefore, allows us to test hypotheses on how network relationships are formed by investigating the probability distribution of the set of all graphs with a fixed number of nodes (Jiao et al., 2017). In current paper, we aimed to test whether attributes (shyness, extraversion, and neuroticism) assigned to the nodes (individuals in the network) significantly influence the forming of relationships between nodes. In this way, node attributes in ERGM models may serve as predictor variables of outgoing or incoming ties.

All statistical analyses for social networks were carried out using R software version 3.4.3 (R Development Core Team, 2017) and following packages: *qgraph*, developed for analysing and visualising personality and psychopathology data using a network approach (Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012), and the *ergm* package, which is part of the *statnet* suite of packages (Handcock et al., 2016, 2017; Handcock, Hunter, Butts, Goodreau, & Morris, 2008) developed for estimating ERGM models. The multiple linear regression model was tested in SPSS version 24.0 (IBM Corp, 2016). For the transparency of our results, we share the codebook, data, and R codes applied in our study via the Open Science Framework platform under the following web link [the link is anonymized – after revision process please replace it for the one from the letter to the Editor]: https://osf.io/wk2bg/?view_only=414a19f879a64814aa4ddafa8803c1d4

3. Materials and methods

3.1. Participants and procedure

The study involved $N = 253$ (58% were girls) secondary school students, all 16 years of age. Due to the planned social network analysis the study enrolled a total of 10 entire school classes with the following number of pupils: $n_A = 31$, $n_B = 24$, $n_C = 19$, $n_D = 28$, $n_E = 22$, $n_F = 23$, $n_G = 21$, $n_H = 31$, $n_I = 23$, $n_J = 31$ ($M_n = 25$). The first six classes (A–F) were from technical secondary school (i.e., economic profile) and another four (G–J) from general secondary school.¹ The analyses in present paper did not include pupils absent on that particular day at school (the average percentage of absent students in a given classroom was 13%). Data were collected four months after the beginning of the school year, during one regular lesson of 45 min in which pupils were administered booklets with a set of self-report questionnaires and simple sociometric measures. The research was a part of a larger longitudinal study conducted with the consent of students, parents, and headmasters. The procedure was approved by the Cardinal Stefan Wyszyński University in Warsaw ethics board. During the research, we followed ethical standards and all personal data were anonymized prior to the analysis.

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

3.2. Measures

For the purposes of present study, pupils were administered two short self-report measures: the RCBS (Cheek, 1983; Cheek & Buss, 1981; Polish adaptation: Kwiatkowska et al., 2016) and the Big Five Inventory-15 (BFI; Lang, John, Lüdtke, Schupp, & Wagner, 2011; Polish adaptation: Strus, Cieciuch, & Rowiński, 2017), to which participants responded using a 5-point Likert-type response scale (1 = *strongly disagree*; 5 = *strongly agree*). The RCBS consists of 13 test items related to the general discomfort or inhibition in social contexts (sample item: *It is hard for me to act natural when I am meeting new people*) and is considered to be an invariant measure of shyness across adults and adolescents (Kwiatkowska & Rogoza, 2017). The BFI contains 15 items, three per each of the five scales: neuroticism (sample item: *I see myself as someone who ... worries a lot*), extraversion (sample item: *... is outgoing, sociable*), openness to experience (sample item: *... is original, comes up with new ideas*), agreeableness (sample item: *... has a forgiving nature*), and conscientiousness (sample item: *... does things efficiently*). In addition to these self-report measures, we obtained a likeability assessment derived using a sociometric approach. Each pupil was given a roster, (i.e., a full list of a class members), and could indicate an unlimited number of classmates he or she liked, which also referred to the extent of liking and social acceptance towards others. These data were recoded into binary matrices where the value of “1” reflected one's indication (liking the other pupil), while “0” reflected no indication (which meant the absence of liking, not to be confused with disliking). Such matrices, created separately for each class, were the basis for social network analyses within the ERGM approach. In order to deal with missing network data, we removed all data related to non-responders.

4. Results

4.1. Adolescent shyness with respect to basic personality traits

Preliminary data checks and descriptives statistics for shyness and the BFI personality traits are presented in Table 1.

The measurement of shyness displayed very good reliability, however, some BFI scales had poor reliability, which may be explained by the broadness of constructs such as basic personality traits (Lang et al., 2011). The skew and kurtosis statistics show that all variables had distributions close to normal. *T*-tests for independent samples showed significant gender differences for neuroticism and extraversion: girls ($M_{\text{neuroticism}} = 3.44$; $M_{\text{extraversion}} = 3.24$) reported significantly higher scores than boys ($M_{\text{neuroticism}} = 2.99$; $M_{\text{extraversion}} = 3.01$).

To examine the relations between shyness and the basic personality traits, we applied a multiple linear regression model, in which shyness was a response variable and all five basic personality traits were explanatory variables. The results are presented in Table 2.

The model was well-fitted to the data ($F_{(5,247)} = 21.51$; $p < .001$). Only two out of five standardized regression coefficients were significant. Shyness was most strongly negatively predicted by extraversion, followed by a positive relation with neuroticism. To increase the power of the significance test, we compared the absolute values of the regression coefficients via Eid, Gollwitzer, and Schmitt (2011, p. 548) *Z*-test. As a result, we found that extraversion was a significantly stronger predictor of shyness in adolescents compared with neuroticism ($Z = 1.75$; $p < .05$). Thus, our hypothesis for the relations between shyness and basic personality traits was supported.

In order to further test and visualize this relation we estimated the adaptive LASSO network which is depicted in Fig. 1.

Table 1
Reliability estimates, distribution and descriptive statistics, and assessment of gender differences.

| Variable | Reliability | | Distribution statistics | | Descriptive statistics | | Gender differences | |
|------------------------|-------------|----------|-------------------------|-------|------------------------|------|--------------------|-------|
| | α | ω | S | K | M | SD | t | p |
| Shyness | 0.85 | 0.88 | 0.11 | 0.61 | 2.66 | 0.62 | −0.20 | 0.843 |
| Neuroticism | 0.54 | 0.59 | −0.09 | −0.16 | 3.25 | 0.82 | −4.32 | 0.001 |
| Extraversion | 0.55 | 0.67 | −0.31 | 0.39 | 3.14 | 0.73 | −2.54 | 0.012 |
| Openness to experience | 0.74 | 0.75 | −0.15 | −0.04 | 3.54 | 0.77 | −1.04 | 0.301 |
| Agreeableness | 0.44 | 0.48 | −0.01 | −0.02 | 3.33 | 0.68 | −1.11 | 0.269 |
| Conscientiousness | 0.46 | 0.67 | 0.15 | −0.17 | 3.27 | 0.62 | −1.16 | 0.247 |

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

Table 2
The results of multiple linear regression model of shyness regressed on personality traits.

| | B | SE_B | β | t | p |
|------------------------|-------|--------|---------|-------|-------|
| Neuroticism | 0.22 | 0.04 | 0.29 | 5.30 | 0.001 |
| Extraversion | −0.37 | 0.05 | −0.43 | −7.60 | 0.001 |
| Openness to experience | −0.09 | 0.05 | −0.11 | −1.92 | 0.056 |
| Agreeableness | 0.03 | 0.05 | 0.03 | 0.51 | 0.610 |
| Conscientiousness | −0.09 | 0.06 | −0.09 | −1.66 | 0.099 |

Note. The above regression pattern was the same for both boys and girls, except for openness, which significantly predicted shyness in girls.

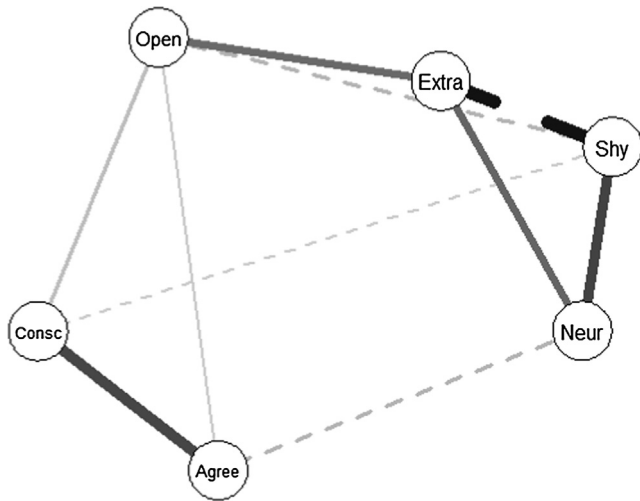


Fig. 1. Network of shyness and basic personality traits. Nodes represent traits as follows: Shy = Shyness, Extra = Extraversion, Open = Openness to experience, Neur = Neuroticism, Agree = Agreeableness, Consc = Conscientiousness. Solid lines represent positive connections and dashed lines represent negative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

The network has 10 edges, of which six are positive and four are negative. In our network, positive edges are associated with slightly larger weights ($M = 0.21$, $SD = 0.12$) than the negative edges ($M = 0.18$, $SD = 0.18$). However, a t -test indicates that this difference is non-significant, $t_{(8)} = 0.381$, $p = .713$. According to *strength centrality*—the estimate which reflects summed weights of each path of a unitary length incidental to the node of interest (Barrat, Barthélemy, Pastor-Satorras, & Vespignani, 2004; Borgatti, 2005; Costantini et al., 2015; Newman, 2004)—in the network of shyness and basic personality traits, the strength of the nodes is as follows: >0.90 for shyness and extraversion, 0.67 for neuroticism, and ≤ 0.53 for openness to experience, agreeableness, and conscientiousness. The more a node is strength-central, the more this trait “is one that can influence many other personality characteristics (or be influenced by them) directly, without considering the mediating role of other 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 Fig. 1 and Table 3.

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.

The classes differed from each other in terms of sex distribution. Six classes had more girls than boys, while three other classes had more boys than girls, and in one class there were an equal number of both genders (i.e., Class C). Thus, overall the majority of our sample was female. This is common for secondary schools in the Polish education system because boys choose to study at vocational schools and in the more technical profiles (e.g., mechanical, electronic, etc.) at secondary schools more often than girls. Next, we conducted an analysis of variance (ANOVA) to examine differences between the classes on shyness, extraversion, and neuroticism. There were no significant differences on shyness ($F_{(9,243)} = 1.355$, $p = .210$) or neuroticism ($F_{(9,243)} = 1.740$, $p = .081$) but there were significant differences on extraversion ($F_{(9,243)} = 2.052$, $p = .035$). However, Tukey's post hoc test revealed that the mean score for Class F was not significantly higher than for Class H ($p = .078$).

Social network information varied by class in terms of connectivity, i.e., number of ties and density (the proportion of existing connections to the maximum number of possible connections for the number of actors present in the network). Networks were characterized by more or less the same amount of reciprocity (also referred as mutuality – the tendency to reciprocate the bond), although they differed in terms of transitivity, i.e. the proportion of closed triangles—triads in which we observe all three connections—to the total number of both opened and closed triads. Network descriptive statistics did not exceed the value of 1],

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.

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 |
|-----------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <i>n</i> | 31 | 24 | 19 | 28 | 22 | 23 | 21 | 31 | 23 | 31 | 25 |
| <i>Gender</i> | | | | | | | | | | | |
| 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) |
| <i>Mean scores</i> | | | | | | | | | | | |
| 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 |
| <i>Social network</i> | | | | | | | | | | | |
| No. of edges | 223 | 167 | 163 | 215 | 106 | 107 | 94 | 219 | 135 | 263 | 169 |
| Density | 0.24 | 0.30 | 0.48 | 0.28 | 0.23 | 0.21 | 0.22 | 0.24 | 0.27 | 0.28 | 0.28 |
| Reciprocity | 0.32 | 0.36 | 0.30 | 0.33 | 0.35 | 0.39 | 0.35 | 0.28 | 0.35 | 0.33 | 0.34 |
| Transitivity | 0.65 | 0.53 | 0.71 | 0.55 | 0.56 | 0.67 | 0.72 | 0.45 | 0.46 | 0.53 | 0.58 |

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

4.3. Shyness within exponential random graph modelling

We tested three ERGM models for each class: (1) Model 0 (null model) which is equivalent to the density of the graph, i.e., it takes into account only the number of edges; (2) Model 1 in which shyness is a predictor of outgoing and incoming ties (relations); and (3) Model 2 in which extraversion and neuroticism are predictors of outgoing and incoming ties.² Before running the ERGM models, all the attribute variables (shyness, extraversion, and neuroticism) were standardized so that estimates did not exceed a value of |1| for better comparison and interpretation of results. Subsequently, each of the coefficients was averaged. The estimated model parameters and mean scores for each attribute variable are displayed in Table 5.

Model fit was assessed by approximate maximum likelihood estimates, which were computed using Markov Chain Monte Carlo—a stochastic simulation algorithm (Hunter, Handcock, Butts, Goodreau, & Morris, 2008).³ As a result, within each class both models were better fitted to the data than the null models and their Akaike information criterion (AIC) and Bayesian information criterion (BIC) fit indices values were lower. The *Edge* term was negative meaning that ties are not likely to be formed at random. Within the ERGM, models included several endogenous effects, such as the *Reciprocity* term, a parameter of endogenous network statistics, which corresponds to a mutuality in liking nominations and a high probability that a tie will be reciprocated. Moreover, models included the *Gender: node match* term, which reflects the ten-

dency of classmates of the same gender to tie to each other more likely than expected by chance. Across endogenous effects both models revealed that students were homophilic regarding gender, and within each class there was a tendency for reciprocity of established ties.

Across the exogenous effects in Model 1, most cases confirmed our assumptions regarding direction and strength of shyness effects.⁴ On one hand, shyness was a significant predictor of fewer outgoing relations. On the other hand, it was not significantly linked to receiving liking ties. It is noteworthy, however, that on average the *Receiver* effect for shyness was positive. In sum, shy individuals are neither particularly liked nor disliked by their peers (non-significant *Receiver* effect), but they are more selective in liking others and have fewer outgoing ties (significant negative *Sender* effect), which confirms our hypotheses.

The results of Model 2 indicate that extraversion is mostly a significant predictor of having more outgoing relations, but does not predict incoming ties. Neuroticism, however, did not show a consistent, repeatable pattern of relations as both of the effects (*Sender* and *Receiver*) were null or suppressed within the analysed samples. In conclusion, the pattern of extraversion-related effects is closer to the pattern of effects associated with shyness than to those of neuroticism. Fig. 2A and B visualize the relations of shyness, extraversion, and neuroticism with outgoing and incoming ties.

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.,

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

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

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

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 |
|----------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|--------------|
| <i>Model 0</i> | | | | | | | | | | | |
| 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 | – |
| <i>Model 1</i> | | | | | | | | | | | |
| 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 | – |
| <i>Model 2</i> | | | | | | | | | | | |
| 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. Standard deviations of network effects are provided in parentheses. *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.

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

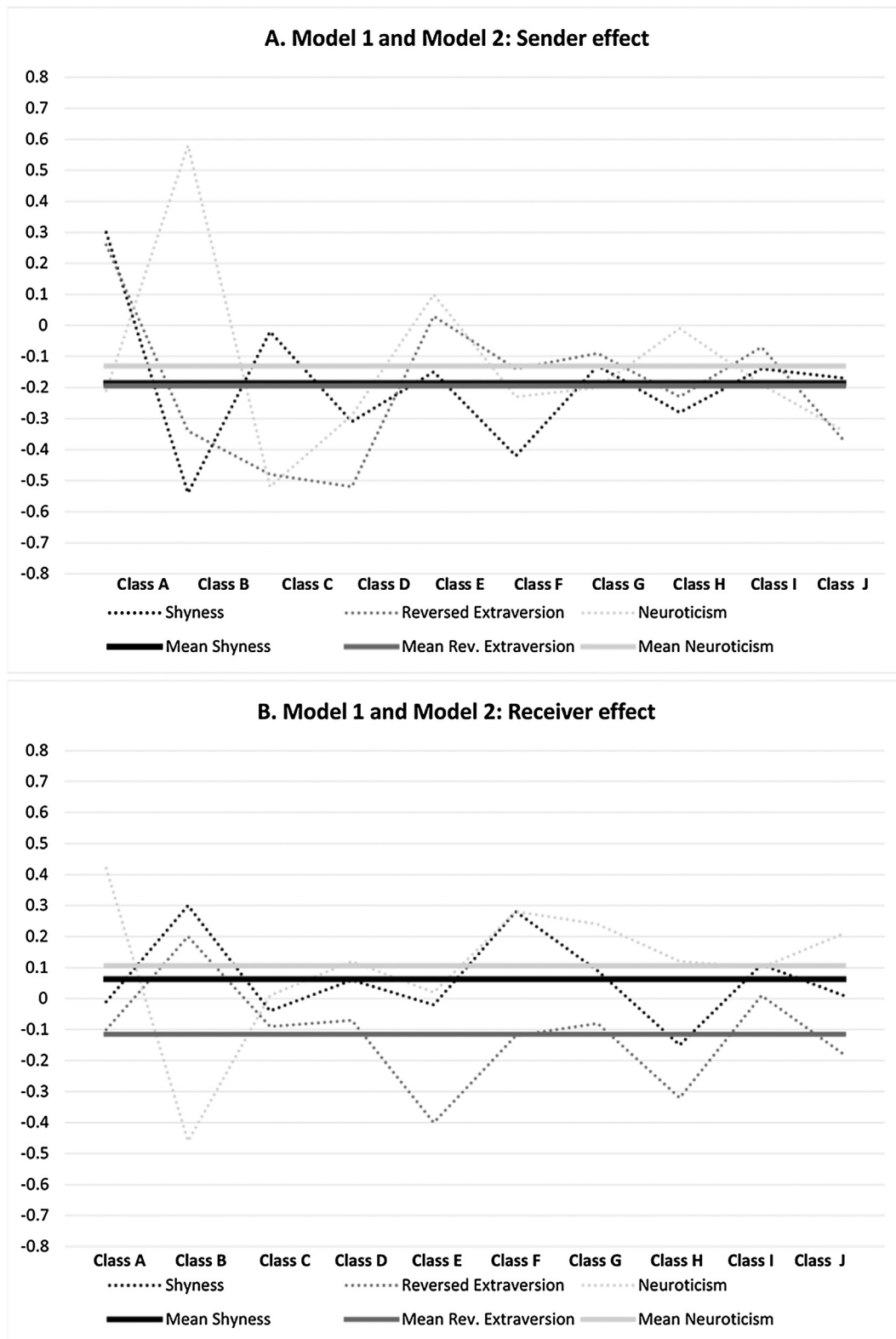


Fig. 2. The estimated results of the *Sender* effect (which refers to gregariousness) and the *Receiver* effect (which refers to popularity) parameters for Model 1 and Model 2. Dotted lines represent scores for each trait in each class, while the thick lines represent the mean scores for each trait in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

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 been tested (Zarevski & Vukosav, 1999). In sum, similar to the results from adult samples, we found that shyness in adolescence is mostly related to introversion and in a lesser extent to neuroticism. Still, we do not claim to ascribe shyness to low extraversion directly. Following John (1990) assumptions, shyness is instead one of these traits which are the blend of two or more of the five dimensions, creating obstacles for researchers trying to grasp personality structure. Taking this into consideration, we can only modestly state on the basis of our results that shyness is probably a complex blend of higher-order traits or a facet which might be simultaneously located under two separate domains. Nevertheless, it does seem likely that extraversion plays a stronger role than neuroticism in this blend of traits. The inconsistent results (stronger vs weaker) regarding neuroticism and shyness throughout the literature may result from the nature of aspects of neuroticism which can be moderated by one's experiences, social relations, but also one's therapy or deep work on oneself and emotion regulation (Korem, 2018). In this vein, shyness has two possible developmental paths emerging from early temperamental dispositions and exposure to more or less adaptive environmental factors such as parenting styles, culture, peer relationships which may either weaken or strengthen self-conscious and neurotic aspects of shyness (Schmidt & Poole, 2018). This twofold perspective of shyness has great potential to be the subject of future research.

The second stage of our analyses was focused on shyness, extraversion, and neuroticism in a social network. As hypothesized, we found that shyness negatively predicted the number of outgoing relations, but did not affect the number of incoming relations. Our results fully replicated the results of previous studies on shyness and social relations examined at the individual level (e.g., Cheung & Elliott, 2017; Ponti & Tani, 2015). However, discrepancies regarding popularity emerged when compared to previous research at the relational-level of analysis (Bešić et al., 2009; see also Van Zalk, 2010). According to our results, shy teenagers are *neither liked nor disliked* by their classmates, whereas previously shyness was found to be a negative predictor of making friends (i.e., peers of shy teens are unlikely to be friends with them; Bešić et al., 2009; Van Zalk, 2010). This discrepancy may be due to the fact that we allowed students to indicate an unlimited number of classmates, thus possibly taking both close friends and teenagers generally liked in the classroom into account. Based on our results, decreased social closeness or fewer ties is the result of the subjective attitude of shy individual rather than real environ-

mental obstacles to making friends (such as lack of peer acceptance). However, bearing in mind that shyness is predicted by low extraversion and neuroticism—both separately or combined (Briggs, 1988; Cheek & Briggs, 1990; Jones et al., 2014)—the withdrawn behavior of shy teens might be due to a lower need for affiliating with others and/or due to being anxious because of the possibility of being evaluated, for example (Cheek & Buss, 1981; Hauck et al., 1986; Nelson, 2013; Rubin et al., 2006). In this vein, we expanded our network analysis to examine whether popularity and gregariousness are affected by extraversion and neuroticism in a similar manner to shyness. In doing so, we found that our results for shyness are quite similar to the network characteristics for the opposite of extraversion, which indeed is marked by significant lack of gregariousness as measured by outgoing ties and no particular relation with popularity as measured by incoming ties (Selden & Goodie, 2018; Selfhout et al., 2010). Additionally, the impact of neuroticism was not consistent for outgoing or incoming ties, which is also in line with prior research (Battistoni & Fronzetti Colladon, 2014; Selden & Goodie, 2018; van der Linden et al., 2010).

Our results should be interpreted in light of some important limitations. First, the network effects presented in our study were mostly weak or modest which is a bias resulting from our procedure in which each student could indicate unlimited number of peers in their class. The strength of such a solution is that the number of peers the respondent wants to indicate is not controlled by the method but is rather their own free choice. However, this can also 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 conceptualization 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 adolescence 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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Appendix

We decided not to include all three variables in one model because they represent different levels of trait hierarchy. Our assumption stems from the trait theory where, in both the lexical (Goldberg, 1999) and the questionnaire tradition (Costa & McCrae, 1992), extraversion and neuroticism (vs emotional stability) represent broader personality dimensions or domains, while shyness represents a narrow facet located under these domains. This location determines a strong relation of between shyness as a facet and the domain to which it belongs. Depending on the tradition, this domain may be reversed extraversion (Goldberg, 1999) or neuroticism (Costa & McCrae, 1992).

Therefore, placing shyness in a model with extraversion and neuroticism would not be in line with the top-down approach suggested by theory. Sleep, Lynam, Hyatt, and Miller (2017) argue that a zero-order approach should be prioritized over a multivariate approach when studying overlapping constructs, because one could look at the scale items to understand the constructs, and to avoid suppression in which a relation that did or did not exist at the zero-order level is “revealed” after removal of the shared variance. Because shyness is strongly embedded within both extraversion and neuroticism structures, we believe that including it in the same model could bias the observed results. (See Table 6.).

However, we did test a Model 3 with all three variables to see if the effects of shyness would indeed be significantly blurred when the effects of extraversion and neuroticism were included. The estimated model parameters and mean scores for each attribute variable are displayed in Table 1 and Fig. 3A and B.

Consistent with our assumptions, in Model 3 shyness ceased to be a significant predictor of outgoing relations as the mean results are no longer negative but now close to zero. In terms of the basic personality traits, the mean effect of reversed extraversion was the strongest negative predictor, similar to Model 2, while the mean effect of neuroticism was more negative than in Model 2. These results highlight the blur effect when shyness is analysed at the same level as its closest personality domains. Because shyness represents a blend of both of extraversion and neuroticism introducing new theoretical quality, we believe that it should be analysed separately from these traits to avoid problems with partialing (Sleep et al., 2017).

Nevertheless, we decided that presenting these results and this blurring effect could be interesting to readers, addressing any curiosity one may have had regarding the potential of this model, and may also be inspiring for further research. However, to avoid confusion, we decided added this Model 3 from the ERGM network analysis as supplementary material.

Table 6
Estimates of the exponential random graph model including shyness, extraversion, and neuroticism.

| | Class A | Class B | Class C | Class D | Class E | Class F | Class G | Class H | Class I | Class J | M |
|---------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|-------------|
| Model 3 | | | | | | | | | | | |
| Edge | -2.61 (0.18)*** | -2.95 (0.27)*** | -0.88 (0.21)*** | -2.32 (0.17)*** | -2.72 (0.24)*** | -3.31 (0.29)*** | -2.56 (0.25)*** | -2.79 (0.18)*** | -2.51 (0.21)*** | -2.29 (0.15)*** | - |
| Gender | 0.43(0.15)** | 0.76 (0.22)*** | 0.82 (0.23)*** | 0.82 (0.15)*** | 0.60(0.21)** | 0.51(0.19)** | 0.24(0.22) | 1.50 (0.19)*** | 0.79 (0.19)*** | 0.68 (0.14)*** | - |
| Reciprocity | 3.09 (0.31)*** | 3.67 (0.44)*** | 0.82(0.36) | 2.38 (0.30)*** | 3.10 (0.43)*** | 4.39 (0.53)*** | 3.29 (0.44)*** | 1.66 (0.27)*** | 2.81 (0.37)*** | 2.50 (0.27)*** | - |
| Shyness | | | | | | | | | | | |
| Sender | 0.70 (0.15)*** | -0.59 (0.13)*** | 0.56 (0.16)*** | 0.05(0.12) | -0.18(0.16) | -0.53 (0.23)* | -0.03(0.20) | -0.28 (0.13)* | -0.11(0.13) | -0.03(0.10) | - |
| Receiver | -0.43 (0.17)* | 0.36(0.14)** | -0.01(0.16) | 0.05(0.12) | 0.16(0.16) | 0.47(0.22)* | 0.13(0.20) | 0.10(0.13) | 0.09(0.13) | -0.01(0.10) | 0.04 |
| Extraversion | | | | | | | | | | | |
| Sender | 0.20(0.13) | 0.21(0.14) | 0.76 (0.16)*** | 0.54 (0.12)*** | -0.11(0.19) | -0.21(0.24) | 0.07(0.20) | 0.02(0.14) | 0.06(0.13) | 0.36 (0.10)*** | 0.19 |
| Receiver | -0.17(0.14) | -0.13(0.13) | 0.09(0.16) | 0.09(0.11) | 0.47(0.19)* | 0.41(0.23) | 0.15(0.19) | 0.41(0.14)** | 0.01(0.13) | 0.18(0.10) | 0.15 |
| Neuroticism | | | | | | | | | | | |
| Sender | -0.58 (0.13)*** | 0.62 (0.14)*** | -0.78 (0.16)*** | -0.30 (0.11)** | 0.11(0.18) | 0.04(0.22) | -0.19(0.16) | 0.06(0.10) | -0.17(0.14) | -0.33 (0.10)*** | - |
| Receiver | 0.65 (0.13)*** | -0.52 (0.15)*** | 0.01(0.15) | 0.10(0.10) | 0.01(0.18) | 0.05(0.21) | 0.21(0.16) | 0.09(0.10) | 0.09(0.14) | 0.21(0.09)* | 0.15 |
| AIC | 865.6 | 539.0 | 425.4 | 747.2 | 412.5 | 400.6 | 387.7 | 858.1 | 497.9 | 938.8 | - |
| BIC | 909.1 | 577.8 | 459.9 | 788.8 | 449.7 | 438.7 | 424.0 | 901.6 | 536.0 | 980.3 | - |

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.

* $p < .05$;

** $p < .01$;

*** $p < .001$.

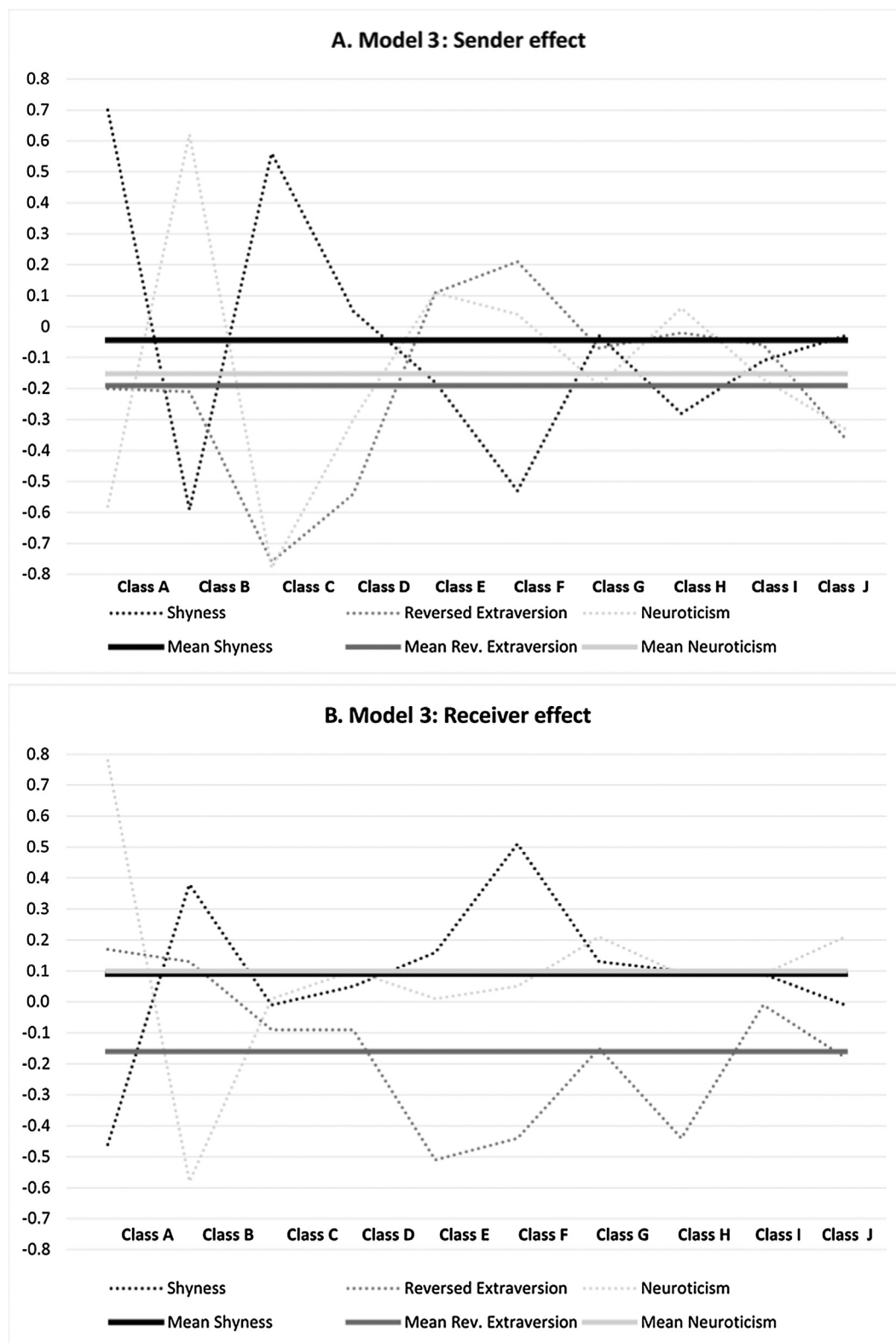


Fig. 3. The estimated results of *Sender* effect (which refers to gregariousness) and *Receiver* effect (which refers to popularity) parameters for Model 3. Dotted lines represent scores for each trait in each class, while thick lines represent mean scores for each trait in all 10 classes. For better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

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jrp.2019.03.005>.

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