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Making and maintaining relationships through the prism of the dark triad traits: A longitudinal social network study

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Abstract

Objective: We investigated how Dark Triad traits influence the development and maintenance of social relations.

Method: Participants completed the Short Dark Triad questionnaire and a measure of social relations at three time points: at the beginning of their first year in high school, 3 months later, and at the end of their first year. We investigated whether the Dark Triad traits are stable over time using Multilevel Modeling ($N = 265$; 59.6% girls), and how Dark Triad traits predict incoming and outgoing agentic and communal relations using Temporal Exponential Random Graph Models ($N = 192$; 60.4% girls).

Results: Overall, the Dark Triad traits were stable over a one-year period. Narcissism did not predict an increase in communal and agentic relations in the short-term, but predicted slightly less incoming communal and more agentic relations in the long-term. In the short-term, Machiavellianism predicted a small increase while psychopathy predicted a small decrease in the incoming agentic and communal relations. In the long-term, however, neither Machiavellianism nor psychopathy was a significant predictor of any incoming relations.

Conclusions: Our results shed new light on the dynamics of making and maintaining social relations through the prism of the Dark Triad traits.

KEYWORDS

agency, communion, Dark Triad, longitudinal, social network

1 | INTRODUCTION

Since Paulhus and Williams (2002) first introduced the concept of the Dark Triad of personality, the topic of malevolent personality traits has gained immense interest from personality researchers. According to Google Scholar (October 31, 2019) there are 2,846 references to Paulhus and Williams's (2002) seminal paper, 464 of which are from 2018 alone.

Unfortunately, most of the research conducted on this topic is cross-sectional in nature and does not sufficiently address the development of such traits and how they influence the formation and maintenance of relations with other people. With the present study, we address this gap in the literature by investigating the developmental trajectory and examination of their impact on the dynamics of relationship forming in a naturalistic school setting.

The data and syntaxes necessary for reproduction of results reported in current paper are available at: https://osf.io/xvud9/.

1.1 | The Dark Triad of personality

The Dark Triad is a constellation of three socially malevolent subclinical personality traits (narcissism, psychopathy, and Machiavellianism; Paulhus & Williams, 2002). Narcissism, named after the Greek mythological figure of Narcissus who fell in love with his own reflection, is characterized by a sense of superiority, entitlement, and grandiosity (Krizan & Herlache, 2018; Raskin & Hall, 1979). Psychopathy, on the contrary, is characterized by thrill-seeking behavior, lack of empathy, and callousness (Hare, 1985). Finally, Machiavellianism, named after the Italian political figure—Machiavelli, who advocated for an "ends justify the means" style of ruling, is typified by manipulative tendencies, a cynical view of human nature, and lack of conventional morality (Christie & Geis, 1970). All three traits have been associated with callousness (Muris, Merckelbach, Otgaar, & Meijer, 2017) and therefore, are hypothesized to share a common dark core of social antagonism and malevolence (Moshagen, Hilbig, & Zettler, 2018; Rogoza & Cieciuch, 2020).

Despite the Dark Triad generally being seen as maladaptive, there is a large body of literature that suggests that it can be adaptive. For instance, narcissism is associated with greater satisfaction with life (Hill & Roberts, 2012). Research has also identified the personality profile of a "successful psychopath" (Mullins-Sweatt, Glover, Derefinko, Miller, & Widiger, 2010). Machiavellianism, on the contrary, has been linked to success in economic games stemming from sensitivity to social context (Czibor & Bereczkei, 2012). Still, the general trend toward adaptiveness found in longitudinal personality research (e.g., Robins, Fraley, Roberts, & Trzesniewski, 2001) may not be as easy to generalize to the realm of the Dark Triad. Muris et al. (2017) argued that research on the Dark Triad has to move away from cross-sectional research designs and toward longitudinal methods to progress our understanding of the Dark Triad traits. Within the current study, we fulfil this appeal and apply a longitudinal design to study the effects of the Dark Triad traits on the dynamics of relationship forming from short to long acquaintance, which might indicate the extent of the Dark Triad traits' adaptiveness in a real-life context.

1.2 | Agentic and communal perceptions of the Dark Triad traits

The Big Two dimensions of personality, following the seminal work of Bakan (1966), are usually referred to as agency (e.g., competence, uniqueness, ambition) and communion (e.g., warmth, relatedness, morality; Gebauer, Paulhus, & Neberich, 2013). It is generally agreed that organizing personality into two fundamental dimensions facilitate simplification and clarification of complex patterns of self-perceptions, other-perceptions, and group perceptions (Abele & Wojciszke, 2007; Fiske, Cuddy, Glick, & Xu, 2002; Paulhus & John, 1998), making it a promising approach in the assessment of the Dark Triad traits perceptions in the social context.

According to Jones and Paulhus (2010), all of the Dark Triad traits are characterized by high agency and low communion, but even so, they are differ in their intensities (Dowgwillo & Pincus, 2017). This is also apparent in the differences among the Dark Triad traits as, for example, narcissism seems to be distinct from Machiavellianism and psychopathy (Rogoza, Kowalski, & Schermer, 2019) and is perceived as more desirable and as having less negative consequences for others (Rauthmann & Kollar, 2012). In fact, some studies suggest null associations between narcissism and communion (Grove, Smith, Girard, & Wright, 2019) or argue that it could realize agentic goals through communal means (Gebauer, Sedikides, Verplanken, & Maio, 2012). There is a high discrepancy in how dark personalities see themselves and how they are seen by others (Rauthmann, 2011) and solely employing self-report methodology seems insufficient to understand the role of the Dark Triad traits on the dynamics of relationship forming. To overcome this limitation, in the current study, we not only investigated longitudinal self-report data on the Dark Triad, but more importantly, we gathered longitudinal peer-assessments of indicators of agency and communion.

1.3 | Why is it critical to understand the development of Dark Triad traits and their links with relationship functioning?

The Dark Triad traits obviously do not fully exhaust the possible catalogue of dark personality traits. Existing research also highlights such dark traits as sadism, spitefulness, or deadly sins, just to name few (Brud, Rogoza, & Cieciuch, 2020; Buckels, Jones, & Paulhus, 2013; Marcus, Zeigler-Hill, Mercer, & Norris, 2014). Nevertheless, to date the Dark Triad traits are the most commonly studied dark constructs (Furnham, Richards, & Paulhus, 2013). Many works within this field are focused only on one trait at a time, which leads to their better understanding (e.g., Krizan & Herlache, 2018 focusing on narcissism or Patrick, Fowles, & Krueger, 2009 focusing on psychopathy). Still, research employing all these traits together led to many important conclusions. For example, while callousness and manipulation account for the overlap among Dark Triad traits (Jones & Figueredo, 2013), Dark Triad traits have their own unique effects on behavior. For example, Jones and Paulhus (2017) provided evidence that Machiavellianism and psychopathy predicted cheating on a coin-flipping task. However, those who scored high on

psychopathy and only ego-depleted individuals scoring high on Machiavellianism cheated under high-risk conditions.

These unique effects are visible not only in experimental tasks, but also in everyday lives. For example, in the organizational context, Dark Triad traits predict vocational interests (e.g., it is more probable to meet a psychopath in sales), reduction of job performance, and increase in counterproductive behavior (Kowalski, Vernon, & Schermer, 2017; O'Boyle, Forsyth, Banks, & McDaniel, 2012). Although there might be some potential advantages of the Dark Triad traits (e.g., self-confidence and having grand visions), there are numerous potential disadvantages as well (Furtner, Maran, & Rauthmann, 2017). For example, understanding the difference between charisma and narcissism might lead to avoidance of many undesired narcissistic behaviors such as sense of entitlement, while keeping desired advantages such as the ability to guide others (Fatfouta, 2019; Rogoza & Fatfouta, 2020). For these reasons, it is important to understand the development of the Dark Triad traits and their links with relationship functioning. Therefore, the goal of the current study is to facilitate the understanding of how individuals with dark personalities develop and maintain social relations.

2 | CURRENT STUDY

The goal of the current paper was to examine the longitudinal dynamics of the Dark Triad traits and its effects on the development of social relations through the prism of agency and communion. For this purpose, we applied a multimethodological approach including self-report measurement of the Dark Triad traits and social network methodology which we used to assess peer reports on agency and communion indicators. Moreover, all of the employed procedures were applied longitudinally during a one-year period.

2.1 | Change in the intensity of the Dark Triad traits

The research on longitudinal associations between the Dark Triad traits is limited (Muris et al., 2017). The study of Sijtsema, Garofalo, Jansen, and Klimstra (2019) examined the changes in the Dark Triad traits over the period of 2 years in a Dutch sample of young adolescents. The results revealed an increase in Machiavellianism and psychopathy, and nonlinear changes in narcissism, although there were discrepancies in the sample size reaching almost 50% between the first and last measurement occasions. Another study on Dutch children reported a slight decrease in narcissism over 2 years (Reijntjes et al., 2016). In a study of American adults, a small decrease in narcissism was found over a 10-year period (Edelstein, Newton, & Stewart, 2012). A Dutch

study spanning 10 years from childhood to emerging adulthood also revealed decreases in aggressive traits, dominance, and impulsivity, but no change in narcissism (De Clercq, Hofmans, Vergauwe, De Fruyt, & Sharp, 2017). Using parent and teacher reports, they found that interpersonal callousness was stable across a 9-year interval, from childhood to adolescence. The study of Zuckerman and O'Loughlin (2009) on American students revealed that narcissism is stable across 6 months and Chopik and Grimm (2019) provided further support of this stability across the life span. Bloningen, Hicks, Krueger, Patrick, and Iacono (2006) also revealed that psychopathic traits of fearless dominance are stable, the impulsive antisociality decreases from late adolescence to early adulthood. Lynam, Caspi, Moffitt, Loeber, & Stouthamer-Loeber (2007) supported this claim providing evidence that psychopathy scores in early adolescence predict adult psychopathy. Machiavellianism in turn, seems to increase during early adolescence (Geng et al., 2017), but seems to decrease during the transition from adolescence to adulthood (Grosz et al., 2019). Thus, overall, existing longitudinal studies suggest that the Dark Triad traits are rather stable, but tend to decrease slightly over time, and the adolescence seems to be important developmental period to observe these changes (Bloningen et al., 2006; De Clercq et al., 2017). Therefore, we expect that the Dark Triad traits will be stable over time or they will slightly decrease.

2.2 | Impact of the Dark Triad traits on the relationship formation

Less is known about the links between the Dark Triad traits to relationship functioning. Psychopaths, due to their impulsiveness, might be less likely to attain positive agentic status (Jones & Paulhus, 2011); in turn, Machiavellians due to their strategic planning, might be able to disguise themselves and attain such status (Jones & Paulhus, 2009). Finally, narcissists subjectively report higher levels of agency-related traits (as intelligence), which is inconsistent with their actual abilities (Zajenkowski & Czarna, 2015; Zajenkowski, Czarna, Szymaniak, & Dufner, 2019), but are perceived as such by others (Rauthmann & Kolar, 2013), therefore, it might be beneficial for gaining agentic status. In respect to communion, all the Dark Triad traits are socially aversive and might have a negative impact on communion-based relations (Paulhus, 1998), yet narcissism has been shown to have nonlinear effects. It has positive effects on liking and popularity (at least in experimental, but not naturalistic designs) during short-term acquaintances (Leckelt et al., 2019; Leckelt, Küfner, Nestler, & Back, 2015) but negative in the long-term (Czarna, Leifeld, Śmieja, Dufner, & Salovey, 2016). The aforementioned studies were, however, limited in capturing within-person variability, as they included only momentary

assessment of narcissism during the first measurement occasion, making an investigation of the dynamics of forming and maintaining social relationships impossible.

Therefore, in regard to agency- and communion-based relationships, psychopathy is expected to be harmful (i.e., being nominated less frequently as a leader and as a friend). On the contrary, Machiavellianism might be beneficial (i.e., being nominated more frequently as a leader or friend). As narcissists describe themselves as born leaders (Ackerman et al., 2011), we expect narcissism to have an effect on being nominated as a leader by peers. Given the fact that our research is conducted in a naturalistic setting, we expect null or weak effects of narcissism at the short-term (Leckelt et al., 2019), but we expect that in the long-term, narcissism will predict being liked less by others.

3 | METHOD

3.1 | Participants and procedure

In the current study, we present results of adolescents from three general and technical secondary schools from northeastern Poland. The main objective of this study was to examine the longitudinal change over time in terms of the Dark Triad of personality among adolescents. Participation in the study was voluntary and participants provided us with informed consent, as did their parents and school headmasters. In the study, the 10 first year high school classes comprising from 20 to 36 students ($M = 29$; $SD = 4.94$), participated. The study took place in classrooms in the schools. Data were collected by a school psychologist and a researcher (about 40 minutes per class). All of the data and syntaxes necessary for reproduction of results are available at: https://osf.io/xvud9/.

The original sample at the first wave consisted of 292 youths (60.6% girls; mean age at the first wave = 15.96; $SD = 0.22$). As some students changed schools during the project, we only included participants who had information from at least two time points. Of the original sample, 265 students satisfied this requirement (59.6% girls; mean age = 15.95; $SD = 0.23$) and their data were analyzed in the assessment of longitudinal change using multilevel modeling. There were no significant differences between participants who had information at least from two time points versus original sample (p's > .263). The first measurement was attended by 243 students, the second measurement was attended by 246 students, and the third measurement was attended by 233 students. Results of Little's MCAR test (Little, 1988) indicated that missing data were missing completely at random ($\chi^2_{(58)} = 55.75$; $p = .559$ for composite scores and $\chi^2_{(3193)} = 3291.05$; $p = .111$ for raw items). Because of absences among students, often due to illness, some of the data

has been lost. Although each student could supplement his or her answers within a week in the presence of a school psychologist, 192 students (60.4% girls) correctly completed all questionnaires during three measurement occasions and their data were used in the assessment of the development of social networks.

3.2 | Measures

3.2.1 | Dark Triad traits

We used the Short Dark Triad (SD3; Jones & Paulhus, 2014; Polish adaptation: Rogoza & Cieciuch, 2019), which is a 27-item (9 items per trait) self-report measure on which respondents rate their agreement using a 5-point Likert-type scale. Narcissism regards exaggerated self-esteem and feelings of grandiosity (sample item: *I know that I am special because everyone keeps telling me so*), psychopathy regards reflects callousness and deficits in self-control (sample item: *Payback needs to be quick and nasty*) and Machiavellianism regards having cynical worldviews, and an ability to manipulate other people (sample item: *Avoid direct conflict with others because they may be useful in the future*).

3.2.2 | Social relations

During each measurement occasion, participants were asked to nominate peers they liked the most (as an indicator of communion-based relationship) and who they perceived as a leader (agency-based relationship). Participants were presented a full list of class members (who agreed upon participation) and nominated their peers (only within their class). The list was anonymized during the coding process and apart from age and gender, no personal information was gathered. No limit on the number of nominees was imposed; that is participants could select no one from the list, or mark as many peers as they desired.

3.3 | Statistical analyses

3.3.1 | Multilevel modeling

To examine the fluctuations in Dark Triad traits over time, a two-level multilevel model with random intercepts was developed using a model-building approach for all three traits. In our models, the three non-varying time points (level-one) were nested in each participant (level-two). Time points were coded as 0, 3, and 12 to match the intervals in months of the three time points. For each Dark Triad trait, we tested three models: (a) an unconditional intercept model; (b) a random

slope model (with time in months as the level-one predictor of the Dark Triad traits with the slope of the dark trait on time correlated with the intercept of the dark trait); and (c) a random slope model (with time as a level-one predictor of the dark trait and sex of the participant as the level-two predictor of the intercept of the trait with the slope of the Dark Triad trait on time correlated with the intercept of the Dark Triad trait). Maximum likelihood estimation was used.[1] Missing data were handled using full information maximum likelihood. Both predictors were uncentered (i.e., raw scores were used). The intraclass correlations coefficients (ICC), indicating the ratio of the between-cluster variance to the total variance, and fixed and random effects from each model were examined, as well as the deviance statistics for each model. A diagram of the final model is presented in Figure 1. To assess power of the analyzed MLM models, Monte Carlo analyses were conducted.

3.3.2 | Social network analyses

To test the dynamics of forming and maintaining social relations, we applied social network analysis. Our dependant variables (liking, leadership) were relational in nature because every participant assessed his relation with every member of his/her class. Hence, we have multiple measures (values) from every participants. Furthermore, they were not independent from each other because nominations of every classmate were dependent on his/her peer's nominations (if we like our classmate depends on his/her liking toward us and other classmates that we do or do not like). For these reasons, we had to apply analytic methods suitable for dependant network data. Temporal Exponential Random Graph Models (TERGM) is an extension of the Exponential-Family Random Graph Models (ERGM) for fitting, simulating and diagnosing dynamic social network models. ERGMs represent a general class of models (similar to regression models) that enable user to simulate a pattern of dependencies between a set of covariates and participant's relations within a social network.

The main goal of ERGM modeling is to understand an observed network structure and to find underlying processes creating and maintaining the network-based social system. Unlike GLM, Exponential Random Graph Models are modeling whole matrices of relations ($n \times n$ matrix), not individual scores, so the GLM's basic assumption of independency is superseded by the assumption of dependency between cases (Cranmer & Desmarais, 2011). For example, liking relation between Kate and Tom depends on Kate's and Tom's relations (if they are liking or disliking the same or different peers). The classic ERGM treats a network as a single multivariate observation in which the relations in the group (as a whole) depend on internal and external covariates (Lusher, Koskinen, & Robins, 2013; Robins, Pattison, Kalish, & Lusher, 2007). The TERGM is a temporal or multigroup extension of the ERGM when the single model is fitted to more than one network (Hanneke, Wu, & Xing, 2010; Krivitsky & Handcock, 2014). It could be that one group is investigated in subsequent time points, but it also possible to investigate groups in a cross-sectional pattern. In our study, we joined these two options in longitudinal multigroup pattern. The TERGM was chosen over a competing model: the stochastic actor-oriented models (SAOM, Snijders, van de Bunt, & Steglich, 2010). SAOM is used to model dependence relation between two or more time points of a single network. In our case, we had 10 independent classes in three time points and the TERGM algorithm allowed us to model both independency of networks and time dependency of multiple measurements.

ERGM (and TERGM) are models of relations within a group depending on internal (endogenous) and external (exogenous) covariates. The latter takes its name from being external from the relation that creates the network. These
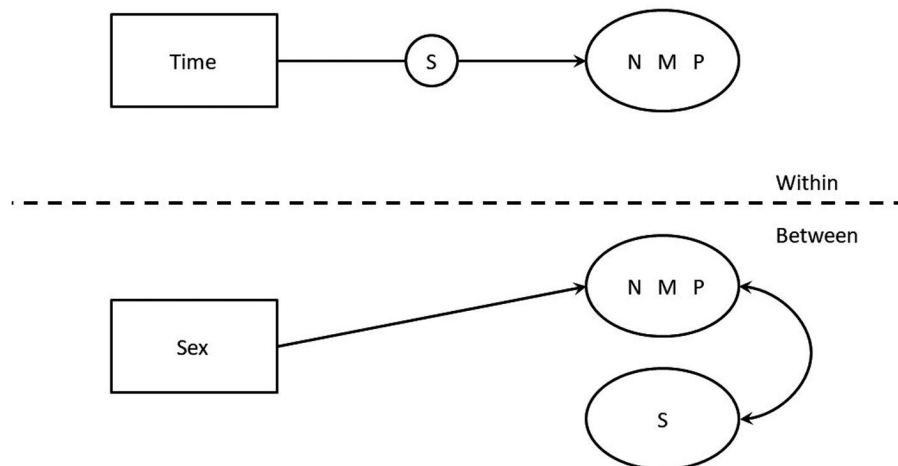

FIGURE 1 Diagram of final multilevel models. M, machiavellianism; N, narcissism; P, psychopathy; S, slope

could be individual characteristics of a network's nodes (like in our study) or another type of relation (connections between the nodes, i.e., family ties, trust etc.). Individual characteristics can be included in ego or alter perspective, to verify if some characteristics influence nominating (ego—sender) or being nominated (alter—receiver). As main variables, we entered Dark Triad in an alter (receiver) perspective as well as its interaction with the time factor (between 1–2 wave and 2–3 wave in separate analyses). A significant interaction would mean that the influence of a particular malevolent personality trait on relations changes over time (between time waves). In the analyzed TERGM model, we also included exogenous control variables: the Dark Triad in ego (sender) perspective with its time interaction, sole time factor, and sex similarity factor. For the latter, statistical significance of the term means that sharing the same sex increases probability of forming relation between the actors. In the preliminary analysis, we checked the potential effects of school nesting, finding that school affiliation did not change the probability of tie formation among classes. Based on this, we excluded school affiliation from subsequent analyses.

For every study on social networks, apart from specific exogenous covariates, there is also a necessity to consider some endogenous network parameters based on a general network theory (Scott, 2000; Wasserman & Faust, 1994), which we also included in the analyzed model. Within a network, there is a common tendency to reciprocate relations (i.e., reciprocity parameter) and to create triads (there is a high probability that the friend of my friend will become a friend of mine, that is, the Geometrically Weighted Edgewise Shared Partner distribution term; GWESP, see: Hunter, 2007). Ignoring these trends might lead to overestimated selection effects (Steglich, Snijders, & Pearson, 2010). We also decided to include a Geometrically Weighted Out-Degree distribution term (GWODegree) as some people have lower thresholds of liking others and calling them "friends" than other people (the tendency to like "almost everyone").

All available nomination data were utilized and no missing values (nominations made to and by group members who were absent at the moment of the measurement) were imputed. Due to limitation of TERGM algorithm for mixed design (several temporal steps × multigroup pattern), we conducted our analysis in two steps, creating two models: first for wave 1–2 dynamics and second for wave 2–3 dynamics.[2] All the Dark Triad traits were entered simultaneously to the TERGM model. The TERGM formula was estimated using Markov Chain Monte Carlo Maximum Likelihood Estimation (MCMC-MLE) that is implemented in the *xergm* package for the R statistical environment (Leifeld, Cranmer, & Desmarais, 2018; R Core Team, 2015).

3.3.3 | Goodness-of-fit assessment

ERGMs (and TERGMs) can be seen as good (generative) models of tie formation processes within networks if they are able to reproduce the observed global network properties that are not included in the model. The idea behind examining the quality of ERGM (or TERGM) models is to choose network statistics that are not in the model and compare the value of these statistics observed in the original network to the distribution of values we get in simulated networks from our model (Hunter, Goodreau, & Handcock, 2008). One of the most common network statistics used for goodness-of-fit assessment are: dyad-wise shared partners, edge-wise shared partners, geodesic distances, in-degree relations, out-degree relations, and triad census. Dyad-wise shared partners are dyads of nodes with exactly k shared partners. Edge-wise shared partners are edges whose endpoints both share edges with exactly k other nodes. Geodesic distances between two nodes equal the length of the shortest path joining those two nodes (or infinity if there is no such path). In-degree relations are nodes with exactly k in-edges and out-degree relations are nodes with k out-edges. Triad census is a number of every from the 16 possible types of triads within the network categorized by Davis and Leinhard (1972). In a good-fitted model, those parameters for the observed network should not be different from the mean values obtained in the set of simulated networks (based on the model).

3.3.4 | Power assessment

In ERGM (and TERGM) modeling, estimated coefficients for covariates can be directly interpreted as effects on the conditional log-odds of tie being present within a network. Therefore, they could be recounted as odds-ratios. This is the most immediate and natural notion of effect size in TERGM. To assess power, confidence intervals for coefficients (i.e., odds-ratios) are computed. If there is very little power for estimating an effect, the range of values that cannot be excluded is very large (i.e., the confidence intervals are wide). In turn, if the confidence intervals are small, it means that there is enough precision to exclude all values (at least in terms of rejection of the associated null hypothesis test). Practically, if the confidence interval of obtained odds-ratio contains 1 it is possible that the effect in population is absent or might have the opposite direction (i.e., there is less power for estimation of this effect).

4 | RESULTS

The descriptive statistics, reliability estimates, and intercorrelations between subsequent measurement occasions are presented in Table 1.

Reliability estimates were acceptable for all analyzed scales across all measurement occasions. Some of the correlations between subsequent measurement points were low (e.g., between psychopathy time 2 and psychopathy time 3), which might be due to changes in the sample size and the limitations of Pearson's correlation. Therefore, we further rely on ICC, which is deemed as a more adequate measure (Aldridge, Dovey, & Wade, 2017).

4.1 | Multilevel models

The results of the multilevel analyses are presented in Table 2.

4.1.1 | Narcissism

The ICC for the intercept model (1) indicated that approximately 57% of the variability in narcissism scores occurred between subjects. The intercept-only model estimated the intercept at 2.83 indicating the mean of narcissism scores across time points and participants. This estimate changes little in the subsequent models. The within-person residual was significant and indicated the amount of variance in narcissism scores. The residual variance of intercepts was significant, indicating that participants varied in their initial states. When the random slope of narcissism on time was added to the model (2), the slope of narcissism on time was a significant but weak negative predictor of narcissism, indicating that participants tended to become slightly less narcissistic during their first year in secondary school, our hypothesis.

The within-person residual estimated dropped by approximately 34%, but was still significant and indicated the amount of within-person variance in narcissism still unaccounted for.

The residual intercept variance became slightly larger, as is typical in longitudinal multilevel models (Hox, Moerbeek, & van de Schoot, 2018, p. 79). The residual variance of the slope was significant, indicating that individuals differed in their rates of change (though negligibly). The intercept of narcissism was negligibly but significantly correlated with the slope of narcissism on time. The deviance statistic improved from the first model, indicating a better fit to the data. In the final narcissism model (3; with sex added as a predictor), the effect of the slope of narcissism on time remained the same. As expected, being male significantly predicted higher levels of narcissism. As for the random part of the model, the within-subject residual variance was identical to the second model. The intercept residual variance was slightly reduced and still significant, indicating that participants differed in their initial states, adjusted for predictors. The slope residual variance was identical to the second model—negligible, but significant. As well, the correlation between the intercept of narcissism and the slope of narcissism on time was negligible, but negative and significant. The addition of sex as a predictor to the model only slightly improved the deviance statistic.

4.1.2 | Psychopathy

The ICC for the intercept model (1) indicated that 52% of the variability in psychopathy scores occurred between subjects. In the unconditional model, the intercept was estimated at 2.29 indicating the mean psychopathy score across all participants and time points. The intercept estimate changed slightly in the subsequent model, and more strongly in the final model with all predictors added. In the random part of the unconditional model, the within-person residual variance

TABLE 1 Descriptive statistics, internal consistencies, and intercorrelations of the dark triad traits across one-year ($N_{time1} = 243$; $N_{time2} = 246$; $N_{time3} = 233$)

	M	*SD*	1	2	3	4	5	6	7	8	*α*
1. Narcissism time 1	2.90	0.58									.71
2. Narcissism time 2	2.83	0.54	0.69								.71
3. Narcissism time 3	2.71	0.62	0.53	0.54							.71
4. Psychopathy time 1	2.35	0.67	0.40	0.26	0.28						.74
5. Psychopathy time 2	2.24	0.63	0.24	0.31	0.28	0.63					.75
6. Psychopathy time 3	2.24	0.74	0.26	0.19	0.46	0.49	0.49				.79
7. Machiavellianism time 1	3.16	0.63	0.48	0.31	0.35	0.54	0.34	0.41			.71
8. Machiavellianism time 2	3.10	0.61	0.34	0.32	0.29	0.45	0.53	0.36	0.65		.75
9. Machiavellianism time 3	2.98	0.73	0.31	0.17	0.40	0.39	0.33	0.60	0.54	0.57	.79

Note: All correlations were significant at $p < .001$.

TABLE 2 Fixed and random effects (standard error) for models with dark triad traits as criterion ($N = 265$)

	Unconditional			Adding random slope			Level-2 predictor of intercepts		
	Narc	Psych	Mach	Narc	Psych	Mach	Narc	Psych	Mach
Fixed effects									
γ_{00}	2.826^{**} (0.031)	2.287^{**} (0.035)	3.090^{**} (0.034)	2.898^{**} (0.034)	2.318^{**} (0.039)	3.164^{**} (0.036)	2.690^{**} (0.093)	1.945^{**} (0.104)	2.631^{**} (0.098)
γ_{10}				-0.015^{**} (0.003)	-0.007 (0.004)	-0.016^{**} (0.004)	-0.015^{**} (0.003)	-0.007 (0.004)	-0.016^{**} (0.004)
γ_{01}							0.148^{*} (0.062)	0.265^{**} (0.069)	0.380^{**} (0.065)
Random effects									
σ^2	0.148^{**} (0.010)	0.222^{**} (0.015)	0.192^{**} (0.013)	0.097^{**} (0.009)	0.157^{**} (0.015)	0.130^{**} (0.012)	0.097^{**} (0.009)	0.156^{**} (0.015)	0.130^{**} (0.012)
τ_{00}	0.192^{**} (0.022)	0.240^{**} (0.029)	0.241^{**} (0.027)	0.233^{**} (0.028)	0.282^{**} (0.036)	0.255^{**} (0.031)	0.229^{**} (0.027)	0.268^{**} (0.035)	0.225^{**} (0.029)
τ_{11}				0.001^{**} (0.001)	0.002^{**} (0.001)	0.001^{**} (0.001)	0.001^{**} (0.001)	0.002^{**} (0.001)	0.001^{**} (0.001)
τ_{01}				-0.005^{*} (0.002)	-0.006^{*} (0.003)	-0.003 (0.002)	-0.005^{*} (0.002)	-0.007^{**} (0.003)	-0.003 (0.002)
Model summary									
Deviance	1,068.960	1,323.432□	1,256.786	1,021.214	1,300.048	1,210.210	1,015.486	1,285.668	1,178.362
k	3			6			7		

Abbreviations: k, number of estimated parameters; Mach, Machiavellianism; Machiavellianism ICC, 0.557; Narc, narcissism; Narcissism ICC, 0.565; psych, psychopathy; psychopathy ICC, 0.520; γ_{00}, intercept; γ_{10}, slope on time; γ_{01}, sex predicting intercept; τ_{00}, intercept; σ^2, residual; τ_{11}, slope variance; τ_{01}, correlation intercept with slope.

$^*p < .05$; $^{**}p < .001$.

was significant and indicated the amount of within-person variance in psychopathy. The intercept residual variance was significant and indicated that participants differed in their initial psychopathy scores. In the second model (2), the random slope of psychopathy on time was nonsignificant and indicated that participants' psychopathy scores did not change linearly over time.

Adding sex to the model (3; final model) did not affect this result. The within-subject residual variance was reduced relative to the intercept-only model, but was still significant. As occurred in the narcissism models, the residual variance of the intercept grew relative to the first model. The slope residual variance was small, but significant, indicating small differences in rates of change across participants. The correlation of the slope of psychopathy on time and the intercept was negative and small, but significant. Compared to the intercept-only model, the deviance statistic somewhat improved. In the final model, the independent effect of sex was significant and indicated that being male independently predicted higher levels of psychopathy (as expected). The residual level-one variance fell by negligibly from the previous model and was still significant, indicating that there was still within-person variance that was unaccounted for in psychopathy. The residual variance in the intercept slightly fell as a result of adding sex to the model, indicating that there was still a substantial amount of variance in psychopathy unaccounted for between participants. The residual variance in slopes remained unchanged from the previous model. The correlation between the slope of psychopathy on time and psychopathy intercepts increased negligibly relative to the previous model. The deviance statistic in the final model improved somewhat from the previous model.

4.1.3 | Machiavellianism

The ICC for the intercept-only model (1) indicated that approximately 56% of the variability in Machiavellianism scores occurred between subjects. The intercept was estimated to be 3.09, indicating the mean of Machiavellianism across all participants and time points. The intercept estimate was marginally higher in the subsequent model and was reduced substantially when the effect of sex was introduced in the final model. The level-one residual variance estimate was significant and indicated the amount of within-subject variance in Machiavellianism that was present. The residual intercept variance was significant and indicated that initial states differed among participants. In the subsequent model (2), the random slope of time was added as a predictor; the effect was negative and small, but significant and was not affected when sex was added as a predictor in the final model. This indicated that participants'

Machiavellianism scores were slightly reduced over time, supporting our hypothesis.

The residual level-one variance in the second model was significant, but was reduced by approximately 32% compared to the first model; it did not change as a result of adding sex as a predictor in the final model. Again, the residual intercept variance grew with the introduction of the level-one predictor, but fell by approximately 12% when sex was added (3) as a predictor in the final model. The slope residual variance was small, but significant, indicating that effect of time on psychopathy scores differed little across participants. This estimate did not change in the third model. The relationship between the slope of Machiavellianism on the intercept was nonsignificant and remained this way in the final model. In the final model, the effect of sex was estimated at 0.38, indicating that being male predicted higher scores of psychopathy (confirming our hypothesis). Deviance statistics consistently improved somewhat after each predictor was added, indicating better fit.

4.1.4 | Power assessment

For the narcissism model, all parameters surpassed 80% power except for the correlation between the intercept of narcissism and slope of narcissism on time (59%) and the effect of narcissism on sex (66%). As for the psychopathy model, all parameters surpassed 80% except for the correlation between the intercept of psychopathy and slope of psychopathy on time (52%) and the slope of psychopathy on time (31%). As for the Machiavellianism model, all parameters surpassed 80% power except for the correlation between the intercept of Machiavellianism and the slope of Machiavellianism on time (17%).

4.2 | Longitudinal social network analyses

4.2.1 | Goodness-of-fit assessment

To examine the quality of TERGM model fit one hundred new networks were simulated based on the model parameters and covariates and compared with the observed networks. The frequency distribution of six basic network parameters are presented on Figures 2–5.

The observed distributions of the same statistics match the simulated ones well (grey boxplots represent the simulations and the solid and dashed black lines represent the median and the mean of the observed networks). These results suggest that the model quality is satisfactory (Hunter, Goodreau, & Handcock, 2008). Thus, the estimated model parameters from the analyzed TERGM models are presented in Tables 3 and 4.
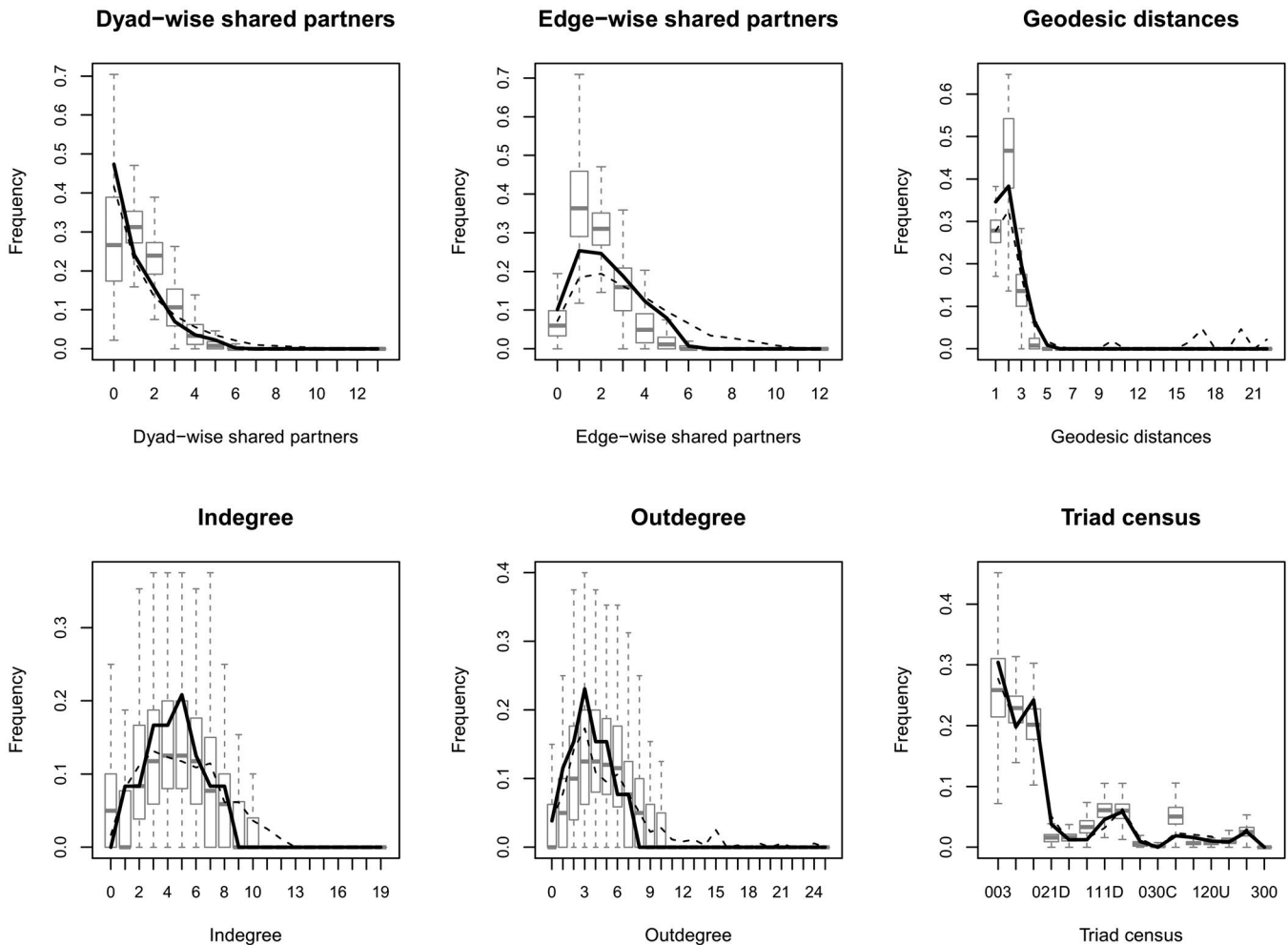
FIGURE 2 The goodness-of-fit assessment for the TERGM—communion model short-term

4.2.2 | Main effects

As for main effects, we considered the incoming relations, that is—how dark personalities are seen by others. Two groups of main effects could be distinguished: how individual differences in personality predict the probability of being selected as a leader/friend and how this probability changes over time. For narcissism, there were no significant effects in the short-term perspective, nor in how narcissism predicted incoming relations, and there was no change over time. In turn, in the long-term perspective, narcissism predicted being a leader and simultaneously being less liked by others (at the level of tendency). Psychopathy and Machiavellianism in the short-term had opposing effects, that is: while psychopathy (at the level of tendency) predicted being nominated less as a leader and being liked less, Machiavellianism significantly predicted being seen as a leader and (at the level of tendency) being liked more. Interestingly, we also observed an ongoing change increasing perceived leadership and liking for psychopathy and decreasing for Machiavellianism. In the long-term, these changes resulted in no significant predictions at all, that is—neither psychopathy nor Machiavellianism

predicted being seen as a leader nor being liked. Thus, our hypotheses were fully confirmed for narcissism, and for psychopathy and Machiavellianism—they were confirmed only for the short-term.

4.2.3 | Exogenous control variables

Narcissistic individuals, both in the short- and long-term, selected more friends than those who were average on this trait. In the short-term, they nominated (at the level of tendency) more leaders, but there were no differences in selecting leaders in the long-term. Similarly to the main effects, we also observed opposing effects for psychopathy and Machiavellianism in how they nominated their peers. In the short-term, those scoring high on psychopathy (at the level of tendency) indicated more leaders, while those scoring high on Machiavellianism indicated less leaders and they reported having less friends than average. Observed change was in contrary to that, leading to null and nonsignificant results in the long-term (except for Machiavellians still selecting less friends).
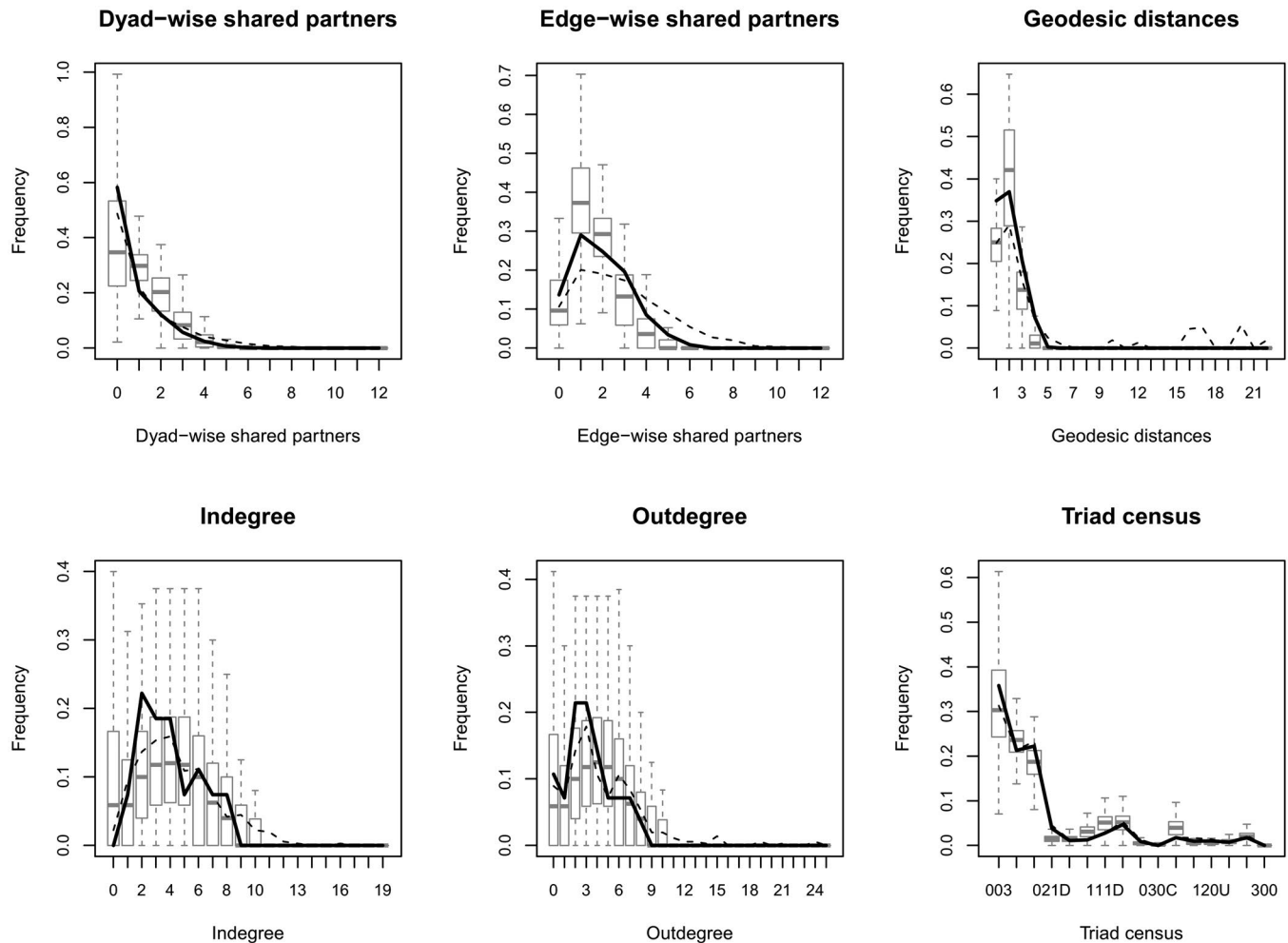
FIGURE 3 The goodness-of-fit assessment for the TERGM—communion model long-term

4.2.4 | Endogenous network dependencies

In terms of liking, there were highly significant positive *Reciprocity* terms that indicate that liking nominations were more mutual than expected by chance in both time perspectives. On the contrary, leadership nominations were significantly non-mutual—youths that were nominated as leaders were not nominating back (were not choosing their nominators). It is not very surprising having in mind that leadership relations reflect hierarchical patterns within a group. A general tendency toward transitivity within networks was also present (GWESP). In the short-term perspective, a significant GWODegree term shows that some people have lower thresholds of calling others "leaders" and a slightly less robust tendency to nominate them "friends." In the longer time perspective, such "generosity" was not observed for liking, but was maintained for leaders, probably because the better people know each other, their initial generalized impulses toward the other are verified during interactions.

5 | DISCUSSION

Within the current study, we have examined change in the intensity of the Dark Triad traits over the course of 1 year and we assessed how these traits influence the development and maintenance of the social relations in short- and long-term perspectives in adolescents. The body of literature on the Dark Triad is constantly growing (Furnham et al., 2013) and new meta-analyses are being reported (e.g., Kowalski, Di Pierro, Plouffe, Rogoza, & Saklofske, 2019), however—the amount of longitudinal studies, crucial for moving the field forward (Muris et al., 2017) is limited. Therefore, the current study aimed to fill this gap.

5.1 | Longitudinal change in the intensity of the Dark Triad traits

Time was a weak, but statistically significant linear predictor of narcissism, psychopathy, and Machiavellianism, though
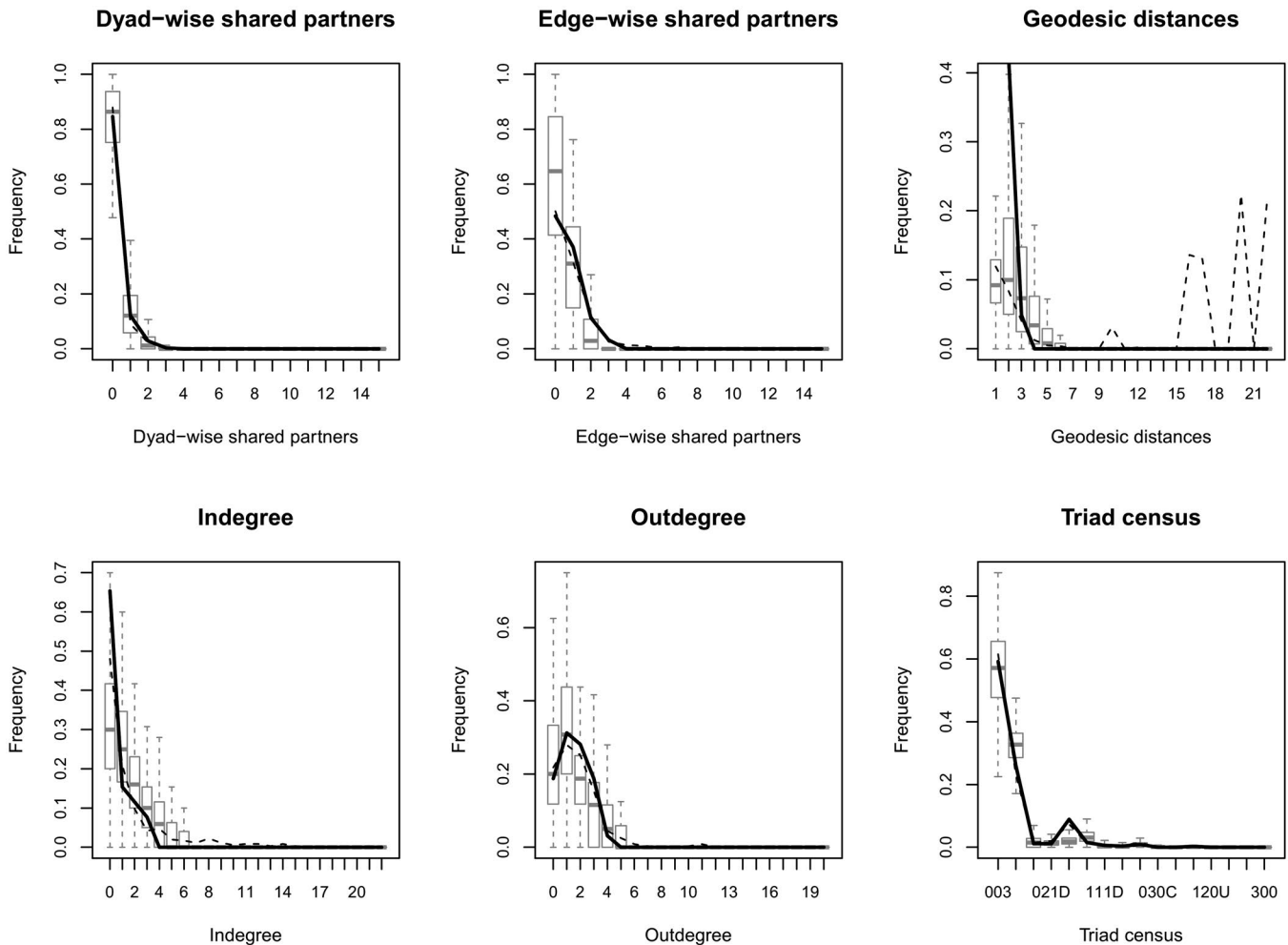
Dyad−wise shared partners

Edge−wise shared partners

Geodesic distances

Indegree

Outdegree

Triad census

FIGURE 4   The goodness-of-fit assessment for the TERGM—agency model long-term

the relationship became nonsignificant when sex was added as a predictor for psychopathy. With regards to sex, our findings also supported our hypotheses. For all three dark traits, sex was a predictor independent from the effect of time. This result is somewhat unsurprising considering men have consistently been found to be higher in dark traits (e.g., Kowalski et al., 2017; Szabó & Jones, 2019). Our finding that time negatively predicted dark personality traits in adolescents may seem intuitive, as research has already suggested that dark traits are negatively correlated with age (Barlett & Barlett, 2015), but most of the studies investigating the relationship of age and dark traits is cross-sectional, and thus, limited in interpretability (i.e., do people become less "dark" as they become older, or is this a purely generational phenomenon?). Additionally, even if Dark Triad scores generally tend to drop slightly over the lifetime, there is research to suggest that personality is less stable in earlier stages of life. For example, Costa and McCrae (1994) posited that personality is "set like plaster" by age 30 (although this assertion has been the subject of debate), but Robins and colleagues (2001) have found that prior to this age (early adulthood), though

personality traits are still relatively stable, they do change in systematic ways, especially in the light of important life events (Schuster, Pinkowski, & Fisher, 2018). Our results are in alignment with claims stating that changes in personality usually go toward improved psychological functioning (i.e., lower neuroticism, higher openness, higher Agreeableness, and higher Conscientiousness; Roberts et al., 2017; Robins et al., 2001). As adolescence is described as a peak moment for the intensity of the dark personality traits (Brummelman, Thomaes, & Sedikides, 2016; Foster, Campbell, & Twenge, 2003), our results, although the study was conducted only in a period of 1 year, fall within this trend. Entering high school might be seen as an important life event similar to entering college (Bardi, Lee, Hofmann-Towfigh, & Soutar, 2009). Students are similarly forced to adjust to different social surrounding and create new relations. They use different self-presentation strategies, some of which might lead to an increase of their social potential, and some of which might not. We investigated this problem through the assessment of development of the agentic and communal relations between peers.
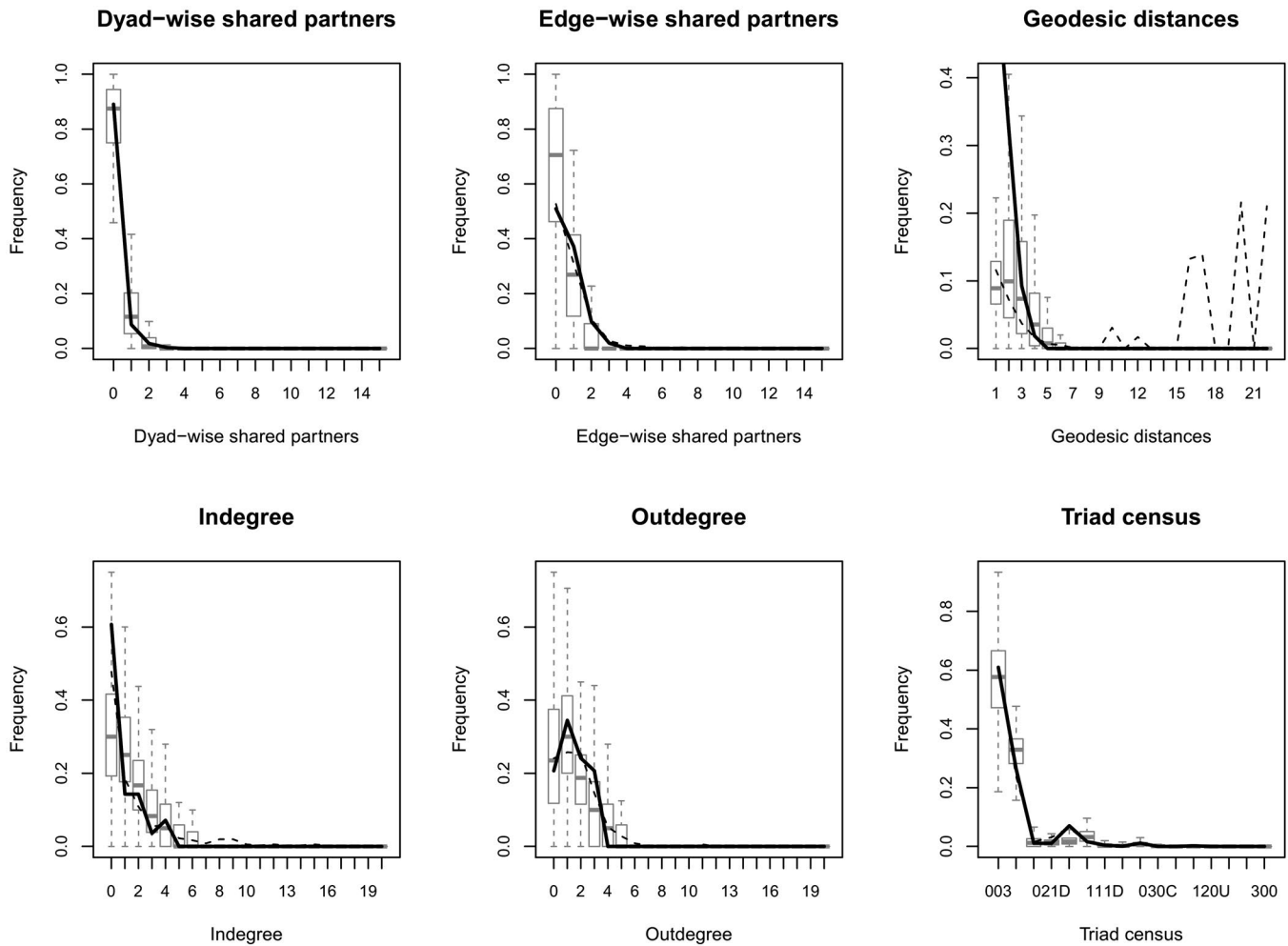
FIGURE 5 The goodness-of-fit assessment for the TERGM—agency model long-term

5.2 | The dynamics of peer relationships through the prism of the Dark Triad traits

Usually, at least in regard to narcissism, researchers are interested in its effects on being liked and popular (Czarna et al., 2016; Leckelt et al., 2019; Rentzsch & Gebauer, 2019). However, we believe this reflects only one side of the coin as it regards communal-based relations, while nothing is known about agency-based relations, which are qualitatively different (Abele & Wojciszke, 2007). The importance of this differentiation is visible in how people reciprocate their relations. While we found support for the tit-for-tat hypothesis for communal-based relations (i.e., there is a higher probability that if A likes B, B also likes A), we not only found evidence to reject it for agency-based relations, but also to negate it (i.e., there is a higher probability that if A sees B as a leader, B does not see A as such). Our approach seems, therefore, to be theoretically more convincing and more complete than those present within the literature. Especially, as the effects of this

distinction is also visible on the empirical results concerning the impact of the Dark Triad traits on the social relations.

Literature reported that narcissism ultimately leads to a decrease in being liked by others (Czarna et al., 2016; Leckelt et al., 2015); however, these effects are stronger in experimental rather than naturalistic designs (Leckelt et al., 2019). Given the fact that we studied students in classrooms and we did not introduce any experimental manipulations, it was not surprising that the effects in the short-term perspective were nonsignificant. In the long-term, narcissists were liked less, which is in accordance to the aforementioned literature. Similarly, there were no significant effects on narcissists being selected as leaders in the short-term, but there were significant effects for the long-term perspective. Among all of the Dark Triad traits, narcissism is the only one to be related to peer-reported agency (Rauthmann & Kolar, 2013), which is in line with our results. Although narcissists do not possess extraordinary agentic traits such as intelligence (Zajenkowski et al., 2019), they use different self-presentation techniques

TABLE 3 Estimates of the temporal exponential random graph model (TERGM) for communion relation (liking; $N = 192$)

	Short-term (Wave 1–2)			Long-term (Wave 1–3)		
	TERGM (*SE*)	OR	95% CI	TERGM (*SE*)	OR	95% CI
Main effects						
Narcissism: receiver	−0.25 (0.20)	0.78	[0.52, 1.16]	−0.37 (0.21)[†]	0.69	[0.46, 1.05]
Psychopathy: receiver	−0.28 (0.16)[†]	0.76	[0.53, 1.08]	−0.18 (0.19)	0.84	[0.58, 1.20]
Machiavellianism: receiver	0.34 (0.19)[†]	1.41	[0.93, 2.14]	0.14 (0.10)	1.15	[0.95, 1.38]
Narcissism: receiver × time	0.17 (0.13)	1.18	[0.92, 1.52]	0.30 (0.13)[*]	1.35	[1.04, 1.75]
Psychopathy: receiver × time	0.15 (0.12)[†]	1.16	[0.92, 1.47]	0.12 (0.11)	1.12	[0.90, 1.40]
Machiavellianism: receiver × time	−0.20 (0.13)	0.82	[0.63, 1.06]	−0.06 (0.07)	0.94	[0.82, 1.08]
Exogenous control variables						
Narcissism: sender × time	−0.23 (0.13)[†]	0.80	[0.61, 1.03]	−0.46 (0.13)[***]	0.63	[0.48, 0.82]
Psychopathy: sender × time	−0.15 (0.12)	0.86	[0.68, 1.09]	−0.01 (0.11)	0.99	[0.80, 1.23]
Machiavellianism: sender × time	0.18 (0.13)	1.21	[0.93, 1.57]	0.11 (0.07)	1.12	[0.98, 1.28]
Narcissism: sender	0.62 (0.21)[**]	1.85	[1.23, 2.79]	0.85 (0.21)[***]	2.34	[1.55, 3.53]
Psychopathy: sender	0.28 (0.18)	1.32	[0.92, 1.89]	0.02 (0.19)	1.02	[0.71, 1.48]
Machiavellianism: sender	−0.49 (0.21)[*]	0.61	[0.40, 0.92]	−0.30 (0.10)[**]	0.74	[0.61, 0.89]
Time period	0.24 (0.30)	1.27	[0.71, 2.28]	−0.08 (0.30)	0.92	[0.51, 1.67]
Sex: node match	0.49 (0.05)[***]	1.63	[1.49, 1.78]	0.52 (0.05)[***]	1.69	[1.55, 1.84]
Endogenous network dependencies						
Edges[a]	−4.40 (0.47)[***]			−3.78 (0.49)[***]		
Reciprocity	2.05 (0.09)[***]	7.79	[6.47, 9.37]	2.06 (0.10)[***]	7.82	[6.45, 9.47]
GWESP	1.30 (0.10)[***]	3.69	[3.06, 4.45]	1.06 (0.08)[***]	2.89	[2.45, 3.41]
GWODegree	0.52 (0.28)[†]	1.68	[0.98, 2.89]	−0.05 (0.21)	0.95	[0.62, 1.45]

[a]*Edges* term depicts a number of relations between actors within a network and plays in ERGM formula a role that is similar to intercept in classic regression.

[†]$p < .100$; [*]$p < .05$; [**]$p < .01$; [***]$p < .001$.

(Kowalski, Rogoza, Vernon, & Schermer, 2018), which ultimately may confirm one of the items from the Narcissistic Personality Inventory—that they are "born leaders" (Raskin & Hall, 1979).

The results concerning psychopathy and Machiavellianism were largely consistent to their phenotypical descriptions. Specifically, psychopaths were disliked and not nominated as a leader, presumably due to their callous, impulsive, and explicitly immoral behavior, while Machiavellians, presumably to their ability to regulate impulses and risk avoidance were liked and nominated as leaders (Furnham et al., 2013; Jones & Paulhus, 2009; Paulhus & Williams, 2002; Rogoza & Cieciuch, 2020). However, it should be noted that this is true only in the short-term perspective, as in the long run, they were neither liked nor selected as leaders more frequently than any other student in the class. Machiavellianism is assumed to reflect a strategically minded dark personality, which is especially interested in realizing long-term goals (Jones & Paulhus, 2009). Although Machiavellianism is associated with higher fluid

intelligence (Kowalski, Kwiatkowska, et al., 2018), the ability to plan long-term goals would require other abilities as well, which may not be present in the general population to such a high extent as to enable its capture in group studies. Although we do not neglect the possibility that such a personality exists, in naturalistic settings Machiavellianism appears to be associated with visible benefits, but in the short-term only.

Interestingly, neither psychopathy nor Machiavellianism predicted being disliked in the long-term, as narcissism, at least partially, did. This, at least partially, questions whether it is malevolence which leads to being less liked? Existing studies clearly point out that psychopathy and Machiavellianism are more oriented toward antagonism than is narcissism (Rogoza et al., 2019); however, only the latter is disliked. Potentially, narcissists might be disliked, not because of their malevolent character, but because of their leadership abilities as agentic relations are conversely reciprocated. However, future experimental studies are needed to address this issue in greater detail.

TABLE 4 Estimates of the temporal exponential random graph model (TERGM) for agency relations (leadership; $N = 192$)

	Short-term (Wave 1–2)			Long-term (Wave 1–3)		
	TERGM (SE)	OR	95% CI	TERGM (SE)	OR	95 % CI
Main effects						
Narcissism: receiver	0.07 (0.22)	1.07	[0.69, 1.66]	0.43 (0.18)**	1.54	[1.19, 2.18]
Psychopathy: receiver	−0.26 (0.15)†	0.77	[0.63, 1.01]	0.06 (0.19)	1.06	[0.73, 1.55]
Machiavellianism: receiver	0.65 (0.22)**	1.92	[1.24, 2.97]	0.16 (0.22)	1.17	[0.76, 1.82]
Narcissism: receiver × time	0.22 (0.15)	1.24	[0.93, 1.66]	−0.13 (0.08)†	0.88	[0.76, 1.05]
Psychopathy: receiver × time	0.36 (0.12)**	1.44	[1.13, 1.84]	0.04 (0.12)	1.04	[0.82, 1.33]
Machiavellianism: receiver × time	−0.52 (0.14)***	0.60	[0.45, 0.79]	−0.01 (0.14)	0.99	[0.75, 1.31]
Exogenous control variables						
Narcissism: sender × time	−0.28 (0.16)†	0.75	[0.55, 1.03]	0.02 (0.15)	1.02	[0.75, 1.39]
Psychopathy: sender × time	−0.40 (0.14)**	0.67	[0.51, 0.89]	0.11 (0.13)	1.12	[0.86, 1.45]
Machiavellianism: sender × time	0.28 (0.15)***	1.90	[1.41, 2.56]	−0.24 (14)	0.79	[0.58, 1.07]
Narcissism: sender	0.47 (0.25)†	1.59	[0.97, 2.61]	0.15 (0.24)	1.17	[0.72, 1.88]
Psychopathy: sender	0.39 (0.22)†	1.48	[.96, 2.27]	−0.12 (0.21)	0.88	[0.58, 1.35]
Machiavellianism: sender	−0.64 (0.24)**	0.53	[0.33, 0.85]	0.25 (0.24)	1.29	[0.80, 2.07]
Time period	−0.14 (0.50)	0.87	[0.32, 2.33]	0.73 (0.48)	2.07	[0.80, 5.33]
Sex: node match	0.16 (0.07)*	1.18	[1.02, 1.36]	−0.01 (0.08)	0.99	[0.84, 1.16]
Endogenous network dependencies						
Edges	−5.35 (0.77)***			−6.04 (0.79)***		
Reciprocity	−0.73 (0.21)***	0.48	[0.32, 0.73]	−0.77 (0.21)***	0.46	[0.31, 0.70]
GWESP	1.41 (0.09)***	4.11	[3.45, 4.90]	1.25 (0.09)***	3.51	[2.95, 4.17]
GWODegree	0.89 (0.19)***	2.43	[1.68, 3.53]	0.54 (0.19)**	1.72	[1.19, 2.47]

†$p < .100$; *$p < .05$; **$p < .01$; ***$p < .001$.

5.3 | Conclusion

The current study provided further support for the claim that the Dark Triad traits are relatively stable over time, with a slight tendency to decrease. Moreover, we presented the first to-date investigation of agency-based social relations. Our results revealed that psychopaths and Machiavellians are perceived as they are theoretically defined, but only in the short-term. Afterward, their peers might become accustomed to their behavior and are perceived as any other member of the social network. Interestingly, we did not notice such acclimation effect for narcissists, that is, they were less effective in the short-term, but were able to gather leadership positions within the period of 1 year, which comes at the cost of being disliked. Narcissism is the only trait within the Dark Triad which comprises, not only antagonistic, but also agentic features (Rogoza et al., 2019), which might potentially explain the different dynamics of maintaining social relations. Due to this agentic behavioral pathway, narcissists potentially might sneak out of this acclimation process. For example, people who self-enhance on agentic attributes (such as e.g., intelligence; Zajenkowski et al., 2019) are seen as cold and

untrustworthy (Dufner, Gebauer, Sedikides, & Denissen, 2019). Zajenkowski and Dufner (2020) asked whether narcissists' self-perceived grandiosity leads to social problems in longer acquaintance contexts. Our research provides an answer to this question as we found that along with the increase of being seen a leader, the popularity of narcissists declined. Hence, our results seem to not only support the notion that narcissism has its benefits, but also some costs (Fatfouta, 2019; Leckelt et al., 2019). However, future in-depth longitudinal research is needed to address this hypothesis in greater detail.

CONFLICT OF INTEREST
The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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ENDNOTES

[1] We also used maximum likelihood estimation with robust means and standard errors, but there were no differences in the results.

[2] The TERGM algorithm interprets entering multiple networks as a subsequent temporal steps or as independent networks. For mixed design it is only possible to enter multiple networks and define time factors as a pseudo dummy variable (see: Czarna et al., 2016).

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