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Achievement in student peer networks: A study of the selection process, peer effects and student centrality

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ABSTRACT

Isolating the homophily effect from the socialization process is crucial in understanding the links between student achievement and peer performance. Then, the combined effects on student achievement of peer performance and of student centrality within a network have been scarcely studied. While friendship links have been addressed, researches rarely investigated instrumental ties. In this paper, 120 college students were asked about their friends and about their advisors. Results show a selection effect (i.e., students reassemble with friends sharing same levels of performance), and a socialization process (i.e., peer performance is significantly associated with later student achievement). While the centrality univariate effects are significant for student performance, only being a prestigious friend remains important when peer performance is taken into account.

1. Introduction

Students' peer networks are recognized as important factors in the understanding of academic performance at university (Patacchini, Rainone, & Zenou, 2011; Vaquero & Cebrian, 2013a). Many studies, covering two main research domains, investigated the relationships between student performance and the student's peer networks.

The first research domain concerns the selection effect and the socialization process. In relation with achievement, the selection effect reflects the tendency to reassemble with peers sharing same levels of performance. Several researches showed positive association between college student performance and the performance of friends (e.g., Barnes, Beaver, Young, & TenEyck, 2014; Foster, 2005; Mayer & Puller, 2008; Vaquero & Cebrian, 2013a,2013b). The socialization process or peer effect reflects the fact that a student's performance may be influenced by its network, especially by its peers' level of performance. In college settings, several studies showed that high-achieving peers tend to increase student performance (e.g., Sacerdote, 2001; Winston & Zimmerman, 2004; Woolf, Potts, Patel, & McManus, 2012), but other researches found inconclusive results (e.g., Arcidiacono & Nicholson, 2005; Stinebrickner & Stinebrickner, 2006; Zimmerman, 2003). It is therefore important to continue investigating the questions of the selection effect based on performance (Barnes et al., 2014), of how student networks emerge (Hommes et al., 2012) and of peer influence, especially in the context of higher education (Arcidiacono & Nicholson, 2005; Kretschmer, Leszczensky, & Pink, 2018; Winston & Zimmerman, 2004; Zimmerman, 2003). Few researches focused on the isolation of the selection versus the socialization processes within the same study, and the researches found in literature all concerned elementary or high school students (e.g., Kretschmer et al., 2018; Patacchini et al., 2011; Véronneau, Vitaro, Brendgen, Dishion, & Tremblay, 2010). These studies show that, among adolescents, peer performance seems an important criterion in the selection of friends, and that, through continued

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association and adjustment, this peer performance remains important over time to predict ulterior student achievement (Kretschmer et al., 2018; Ryan, 2001). Nonetheless, the differentiation between the selection effect and the socialization process has still to be thoroughly investigated in a college setting. Finally, researches dedicated to the selection effect and/or the socialization process concentrated on studying only one type of links (e.g., friends, classmates or roommates), while instrumental relations (such as strategic links) were not investigated. However, according to McPherson, Smith-Lovin, and Cook (2001), the selection process exists in several types of relationships, and ties might form between similar individuals also in the case of less intimate (e.g., professional) relationships. Therefore, studies that investigate the selection and the socialization mechanisms within several types of network should be undertaken.

The second research domain that concerns the link between student performance and student networks is related to the centrality of a student within its peer group. Most studies conducted in a college setting demonstrated positive links between student performance and centrality (e.g., Cho, Gay, Davidson, & Ingraffea, 2007; Hommes et al., 2012; Liu et al., 2018; Mushtaq, Badar, Anwar, & Abbas, 2016; Saqr, Fors, & Nouri, 2018; Vargas et al., 2018; Yang & Tang, 2003; Zwolak, Dou, Williams, & Brewe, 2017). However, other studies showed inconclusive or contradictory results (e.g., Gašević, Zouaq, & Janzen, 2013; Obadi, Drázdilová, Martinovic, Slaninová, & Snásel, 2010; Thomas, 2000). Regarding these inconsistencies, investigating who are the peers (i.e., looking into the quality or performance level of the ties) seems crucial. In addition to studying the univariate links between student performance and centrality, an integrated model would be useful to test the combined effects on academic performance of individual characteristics - the student's centrality - and of group characteristics - the network's level of performance. Finally, when studying centrality, few studies looked at different types of structural links – e.g., friendships versus strategic ties - maintained within the peer network. Tomás-Miquel, Expósito-Langa, and Nicolau-Juliá (2016)) stressed the need for pursuing research that includes different types of ties when addressing the centrality question.

The main objectives of this research are (1) to study the links between freshmen college students' achievement and their peers' performance, by isolating the selection and socialization mechanisms, and (2) to determine the relation between student performance and centrality in a peer network, when the quality of the student network (i.e., the peer performance) is taken into account. To the best of our knowledge, the combined effects of centrality and peer performance have rarely been studied. We also differentiate these effects according to two types of relations: friendship relationships and strategic (i.e., advising) acquaintances. To the best of our knowledge, currently no study compared two types of links when studying the selection and the socialization mechanisms. Finally, this research is the first in Belgium to evaluate the links between student networks and academic achievement in a college setting.

This research allowed verifying the hypotheses that concern the selection and socialization processes: results showed a selection effect for friendship ties (i.e., students tend to reassemble with friends sharing the same level of prior performance), and also a socialization effect for both friendship and strategic ties (i.e., student performance at college is significantly related to the peers' prior performance). Concerning the centrality, only the prestige as friend - the number of nominations as friend received by the peers - remains significantly and positively linked to academic success, when peer performance is included in the prediction model.

The first section of the paper presents the theoretical background and the second section the scope of the study. The third section presents the survey and the participants, and gives descriptive information about the data, and about the methods of analysis. The fourth section presents the results of the study. Finally, the last section discusses the results, the study limitations and points out the need for further research.

2. Theoretical background

2.1. Peer groups and student performance: the selection and the socialization processes

2.1.1. Resembling peers: the homophily or selection process

The first issue that concerns the links between a student's achievement and the performance of its peers is related to the homophily process. This process concerns the fact that individuals tend to form relationships with peers that share the same demographics, cultural, behavioral … characteristics, including for instance the same educational attainment (McPherson et al., 2001; Ryan, 2001). The tendency for students to select similar peers in terms of various traits (e.g., ethnicity, gender …) has been observed in various education settings (e.g. Mayer & Puller, 2008; Vaughan, Sanders, Crossley, O'neill, & Wass, 2015; Woolf et al., 2012). Then, several researches investigated the homophily process that relates specifically to academic abilities (e.g., Barnes et al., 2014; Foster, 2005; Kretschmer et al., 2018; Mayer & Puller, 2008; Patacchini et al., 2011; Véronneau et al., 2010; Vaquero & Cebrian, 2013a,2013b). Foster (2005) showed that the formation of social ties of college students - more specifically the choice of friends with whom one wishes to live during its studies - is determined, among other factors, by academic abilities. Mayer and Puller (2008) also showed that academic performance is a significant predictor of the formation of friendship ties on university campuses. More importantly, in these two studies, the coefficients remain significant when controlling for factors such as ethnicity, gender, prior high-school, family background, political orientation, extracurricular activities and institutional factors. Vaquero and Cebrian (2013a, 2013b) investigated the evolution of college student's interactions in an online learning network[1], and studied the links between changes in these interactions and achievement. They first showed that social diversity[2] is negatively linked with achievement and that high-achieving students connect to and interact more with high-achieving peers. Second, they demonstrated that through time

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[1] Moodle.

[2] Social diversity was derived from several diversity metrics (see Vaquero & Cebrian, 2013b for further details).

these high-achieving students continue to interact only with peers sharing same the level of performance. Early in their academic track, high profile students seem to develop a closely knitted group, also called a "rich club", that is maintained through time by persistent interactions between the members of this group. Finally, in a high school setting, Barnes et al. (2014) also showed a positive association between student performance and the performance of its friends.

One of the proposed mechanisms behind the homophily process that relates to academic performance concerns cognitive processes and perception of cognitive ability (Barnes et al., 2014; McPherson et al., 2001). According to Huston and Levinger (1978), information received or perceptions made about someone will results in an impression of its cognitions. We know that, through shared knowledge, similarity facilitates communication and interaction (Kretschmer et al., 2018). Therefore, the impression of being cognitively similar to someone could result in being attracted to that person (Huston & Levinger, 1978). Two other reasons may explain why students seem to group with peers sharing similar levels of performance. First, following the same reasoning as Woolf et al. (2014) for the homophily by ethnicity, a student may use the cognitive level of its peers to evaluate the unobservable characteristics of those peers, such as their values, beliefs or attitudes. Shared peer performance might then act as a proxy for shared values, beliefs or attitudes, and guide – consciously or not – the choice of peers (Kretschmer et al., 2018). Second, being similar to its peers regarding intellectual skills offers some advantages. For instance, high-achieving students may group with high-achieving peers in order to get access to resources and support that are profitable for their own achievement (Kretschmer et al., 2018; Véronneau et al., 2010); in work partnership of students, similar levels of performance may have positive consequences on academic productivity (Foster, 2005); …

2.1.2. Resembling peers: the peer effect or socialization process

The second issue that concerns the links between a student's achievement and the performance of its peers is related to the socialization process, i.e., the act of influencing others over time. Here, a causal framework explains why individuals resemble their peers, the behavior of individuals - including their performance levels - being viewed as the consequence of peer influence (Barnes et al., 2014; Woolf et al., 2012; Zimmerman, 2003). Most studies, conducted either in a high school setting (e.g., Hanushek et al., 2001; Kang, 2007; Kretschmer et al., 2018; Patacchini et al., 2011; Zimmer & Toma, 2000) or in college (e.g., Sacerdote, 2001; Winston & Zimmerman, 2004; Woolf et al., 2012) demonstrated the existence of peer effects, showing that high-ability peers tend to increase student performance, while low-ability peers tend to reduce it. Nevertheless, the various mechanisms behind peer influence have been scarcely investigated (Hanushek et al., 2001; Sacerdote, 2001; Winston & Zimmerman, 2004). Kretschmer et al. (2018) summarized three main mechanisms behind the socialization process. The peer effect may appear through : (1) achievement norms or productivity standards – peer pressure about achievement - that are indicated as important among the peers; (2) the exchange of information and knowledge; and (3) the support and the resources encouraging achievement (e.g., material, homework …) that are provided (or not) by peers. Other causes behind the peer effect that were proposed are that peers act (or not) as role models and promote (or not) certain study behaviors; that high level peers facilitate the learning process inside a classroom (for instance by asking questions and providing answers) while low level peers disrupt the learning process (for instance through inappropriate behaviours such as chatting within the classroom); and that high level peers help self-efficacy through constructive feedbacks (Hanushek et al., 2001; Kang, 2007; Stinebrickner & Stinebrickner, 2006; Véronneau et al., 2010; Woolf et al., 2012).

Nonetheless, some authors (e.g., Arcidiacono & Nicholson, 2005; Stinebrickner & Stinebrickner, 2006; Véronneau et al., 2010; Zimmerman, 2003) found small peer effects or even an absence of significant impact on academic achievement. Stinebrickner and Stinebrickner (2006) tried to highlight why few significant peer effects were found in some studies, and emphasized the role, above peer performance, of prior student performance, of student involvement into studying, and of student beliefs about academic achievement in the prediction of ulterior student performance. In addition, methodological issues can explain the absence of significant impacts or inconsistent results. Among the empirical challenges encountered when studying peer effects, defining the true peers and the significant network surrounding a student is particularly important (Casquero, Ovelar, Romo, & Benito, 2015; Kang, 2007; Ryan, 2001). In the literature, the notion of peer has several definitions ranging from a 'best friend' perspective (e.g., Patacchini et al., 2011; Véronneau et al., 2010) to a very large and broadly defined network. For instance, peers have been defined as classmates (e.g., Arcidiacono & Nicholson, 2005; Zwolak et al., 2017) or as roommates (e.g., Sacerdote, 2001; Winston & Zimmerman, 2004; Zimmerman, 2003). These definitions belong to the 'whole network perspective' which links individuals to each other based on the social structures they belong to, but not on personal relationships that these individuals maintain within these global networks (Casquero et al., 2015). Those predetermined peer groups are important in the learning processes, but do not necessarily include the closest and most relevant individuals that might influence a student (Stinebrickner & Stinebrickner, 2006). Consequently, when studying peer effects, the absence of significant impacts or inconsistent results might be due to erroneous identification of the true peers of a student.

2.1.3. Differentiation between the selection and the socialization processes

Studying the links between a student's performance and the performance of its peers raises therefore a difficult but important question: the differentiation between the selection and the socialization processes. Findings that student groups are similar regarding their level of performance might be a result of the selection process (i.e., students choosing friends having the same academic abilities) and/or the socialization process (i.e., students influencing other student's grades), and most likely both (Barnes et al., 2014; Kretschmer et al., 2018; Ryan, 2001; Winston & Zimmerman, 2004; Woolf et al., 2012). The majority of studies focused on either the selection process, or either the socialization process, by means of methodological choices that do not allow confounding the two processes. For instance, Sacerdote (2001) studied the impact of roommates' performance on freshmen student's GPA. He used a setting where roommates were randomly assigned to each other in order to rule out any selection process based on academic

performance. Fewer studies focused on the differentiation of both types of processes. Véronneau et al. (2010) investigated the reciprocal connections between social experience and achievement, from elementary to high school. Using structural equation models, they demonstrated a selection process - the student performance was positively correlated with its friends' performance – but no socialization effect - the peer performance did not seem to impact student academic achievement. Patacchini et al. (2011) studied longitudinal peer effects on high school students' education outcomes. They first found positive correlations between the education attainment of a student and those of its nominated friends. Then, they developed a utility function - a model of peer effects - in order to predict the highest education level reached by a student according its peers' performance. Unlike Véronneau et al. (2010), their results showed significant effects: peer performance remains a strong indicator of the educational attainment of individuals over time. Finally, Kretschmer et al. (2018) showed that high school female students tend to reassemble with peers sharing the same levels of academic performance, and like Patacchini et al. (2011) also found peer influence over time.

2.2. Peer groups and student performance: the student centrality inside the peer network

As defined by Freeman (1979), the centrality degree of a node within a network corresponds to the number of links or edges that are adjacent to this node. The number of outgoing links or nominations that are made by a node towards the other nodes that compose the network (i.e., the centrality out- degree) represents the level of sociability or influence of this node. On the other hand, the number of incoming ties or nominations received by a node from the other nodes in the network (i.e., the centrality in- degree) represents the level of popularity, prestige or attraction potential of this node (Liu et al., 2018; Lü et al., 2016; Saqr et al., 2018; Thomas, 2000; Wasserman & Faust, 1994; Yang & Tang, 2003; Zwolak et al., 2017). Nodes with high levels of degree centrality - nodes that entertain large numbers of links to other actors - are more able to influence their neighbors (Lü et al., 2016; Vargas et al., 2018), and are shown to have advantageous positions and easier access to information (Obadi et al., 2010). Several studies investigated the relations between student degree centrality in the peer network and academic performance (e.g., Baldwin, Bedell, & Johnson, 1997; Cho et al., 2007; Obadi et al., 2010; Gašević et al., 2013; Hommes et al., 2012; Liu et al., 2018; Mushtaq et al., 2016; Saqr et al., 2018; Tomás-Miquel et al., 2016; Thomas, 2000; Vargas et al., 2018; Yang & Tang, 2003; Zwolak et al., 2017). Central students can be viewed as holding more diverse and novel information, resources, knowledge (e.g., by acceding to the reasoning of their relations), academic benefits and power (Gašević et al., 2013; Thomas, 2000; Tomás-Miquel et al., 2016; Vargas et al., 2018; Zwolak et al., 2017), which in turn can lead to better performance (Aral & Van Alstyne, 2007; Castilla, Lan, & Rissing, 2013,2013b; Gašević et al., 2013; Tomás-Miquel et al., 2016; Vargas et al., 2018). Most studies (e.g., Hommes et al., 2012; Mushtaq et al., 2016; Vargas et al., 2018; Zwolak et al., 2017) revealed that prestigious and/or social students (i.e., with high levels of degree centrality) tend to have better grades, more success at college and/or higher persistence. Mushtaq et al. (2016) investigated the effects of centrality degree on academic performance of female college students. Using correlation and classic regression analysis, they showed that centrality degree has a positive and significant impact on GPA. Zwolak et al. (2017) studied the effect of centrality on persistence, which was measured as the act of pursuing from an introductory physics course to a next one. They showed that in- and out-centrality degrees are significantly and positively related to positive outcomes, i.e., increase the probability to persist in the learning program. According to them, students with high levels of in- degree centrality are strongly solicited by others because of their knowledge or the support that they provide, and students with high levels of out- degree centrality establish contact with many others in order to get or to give help, to discuss and to reassert their knowledge. Vargas et al. (2018) studied a collaboration network, composed of college students registered in three physics courses. They measured the out-degree centrality (that they call out-strength) as 'the number of peers a student helps with homework' (p.2) and the in-degree centrality (that they call in-strength) as 'the number of students that help a particular student with homework' (p.2). They found positive and significant correlations between centrality and homework grades (for both types of strength and for all of the three courses that were investigated). Then, concerning the exams scores, results indicates significant and positive links between, on the one hand, the in-strength and the exam performance for one of the three courses, and, on the other hand, the out-strength and the exam performance for two of the three courses. Finally, positive links between degree centrality and education outcomes such as performance were also found in online education settings (e.g., Cho et al., 2007; Liu et al., 2018; Saqr et al., 2018; Yang & Tang, 2003).

However, other studies conducted in traditional (e.g., Thomas, 2000) or online (e.g., Obadi et al., 2010; Gašević et al., 2013) networks showed different results. First, Thomas (2000) investigated the impact of freshmen college students' centrality in- and out-degree on their performance. No significant relationship was found between a students' prestige and it's GPA, and a significant but negative association was found between the number of nominations made and GPA. Second, Obadi et al. (2010) showed that central students within an eLearning platform[3] have average academic grades, while students with either low or high performance have a more peripheral position. Third, Gašević et al. (2013) showed no significant links between the centrality degree and the performance of college students registered in online courses. These studies seem to indicate that being central does not always matter for academic performance, or at least not necessarily in a positive way. One of the possible explanations behind this phenomenon might concern the level of performance of the peer group in which the student evolves. One might expect that connecting to many high-achieving peers has not the same effect on performance as entertaining many relations with low-achieving peers. For instance, Vaquero and Cebrian (2013a) showed that low-achieving students initiate many interactions over a large number of neighbors, but that these interactions are not targeted to some particular categories of peers, as in the case of high-achieving students who associate with high-achieving peers. Moreover, the quality of the information received and transmitted and the efficiency of the information chains are

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[3] Moodle.

related to the homophily process that regards performance: high-achieving groups are more efficient than low-achieving groups in the transmission and sharing of valuable knowledge, information or resources, and low-achieving students are disadvantaged, because excluded from these effective information chains (McPherson et al., 2001; Vaquero & Cebrian, 2013a; Vaughan et al., 2015).

2.3. Types of relationships: friends versus advisors

According to several studies conducted in organizational context (e.g., Castilla, Lan, & Rissing, 2013; Cross & Cummings, 2004; Mizruchi, Stearns, & Fleischer, 2011; Sosa, 2011), different types of relationships (e.g., strong links versus weak ties, expressive versus instrumental connections, advice or information network versus support links …) seem to have different impacts on organizational outcomes such as work performance. In educational context, few studies looked at different types of structural links - more specifically friendships versus strategic ties - maintained within the peer network. Since friendship relations are social-oriented, while strategic ties are instrumental-oriented (Baldwin et al., 1997; Hommes et al., 2012; Tomás-Miquel et al., 2016; Yang & Tang, 2003), we might expect that, as in organizational setting, different types of relations will have different links with academic outcomes (Baldwin et al., 1997; Tomás-Miquel et al., 2016).

In the student networks literature, student' friends are described as the 'persons with whom students spend personal time, with whom they interact on regular basis (in face to face, by phone or on online social medias), that they see outside classes, that they trust, and/or with whom they share their personal issues' (Baldwin et al., 1997; Cho et al., 2007; Hommes et al., 2012; Huston & Levinger, 1978; Ryan, 2001; Thomas, 2000). Being central in friendship networks would increase the access to information, knowledge and resources that are valuable for academic achievement (Baldwin et al., 1997; Yang & Tang, 2003) and would promote passive mechanisms of knowledge diffusion (Baldwin et al., 1997; Hommes et al., 2012). Also, friends might be the source of social support, which in turn might enhance performance through a positive social climate (Baldwin et al., 1997; Hommes et al., 2012; Tomás-Miquel et al., 2016). Then, the strategic relationships of students - the students' advisors - are described as the 'people they would seek advice or assistance from and ask questions about their studies' (Baldwin et al., 1997; Yang & Tang, 2003). Having many advisors or strategic links would increase the chances of giving and getting information, knowledge and resources that are valuable in problem-solving processes and competitive environments such as college (Baldwin et al., 1997; Yang and Tang, 2003; Tomás-Miquel et al., 2016). Comparing traditional face-to-face education and online education settings, Yang and Tang (2003) studied the links between the number of nominations received by students - either as friend or as advisor - and performance. They showed that the overall grade of a student (i.e., composed of the classroom grade and of the forum performance) was positively and significantly related to its popularity as friend and as advisor. However, only the centrality as advisor remained significant in the prediction model of the overall grade. In a traditional education setting, Hommes et al. (2012) used a student's network who consisted of (1) the nominated friends (i.e., the friendship out-degrees), (2) the nominated peers from whom the student received college-related information (i.e., the strategic out-degrees), and (3) the nominated peers to which the student gave college-related information (i.e., also the strategic out-degrees). They showed that for the three types of networks, centrality degree significantly increased student performance. The coefficients for the two information networks (i.e., the strategic out-degrees) were higher than the coefficient for the friendship network. Other authors (e.g., Baldwin et al., 1997; Tomás-Miquel et al., 2016) also worked on friendship and strategic ties, but with different measurements of centrality. Baldwin et al. (1997) tested the embededness – i.e., the closeness centrality that represents the distance or proximity of an individual to all other members in network (Cho et al., 2007; Gašević et al., 2013; Mushtaq et al., 2016; Saqr et al., 2018; Zwolak et al., 2017) - within friendship and communication (i.e., strategic) networks, for students registered in business and administration. They showed that only the centrality in the communication network was significantly and positively associated with overall performance. Higher student proximity in its friendship network did not seem to be related to higher levels of performance. Tomás-Miquel et al. (2016) investigated the role of centrality on college student performance. They studied the relation between GPA and the student proximity or closeness to the core of its network, for both types of network: academic (i.e. strategic) and friendship networks. For the students that were registered in a 'non-creative discipline'[4], they found a positive and significant relation between GPA and the proximity to the core of the strategic network, this proximity probably giving students access to support and knowledge in a more efficient way. Concerning the friendship ties, the closeness to the core of the network was significantly and negatively associated with performance, maybe through the time and energy spent by students in too many relationships. They concluded by pointing out that strategic links might be more important for academic achievement than friendships ties, even if other authors (e.g., Baldwin et al., 1997) proposed that both types of networks are essential for educational outcomes.

3. Scope of the present study

Our first goal is to determine whether selection effects, for two types of networks, play when entering university. More specifically, we want to test whether high school performance could be linked to the constitution of friendship and strategic groups at college. The following two hypotheses (see Figs. 1 and 2) are derived from the theoretical background related to the selection process:

(Hyp.1.a) A student's prior performance (i.e., in high school) is positively linked to its friends' prior performance, and

(Hyp.1.b) A student's prior performance (i.e., in high school) is positively linked to its advisors' prior performance.

Our second goal is to examine the socialization process, i.e., the influence of the average level of performance of the peer group on

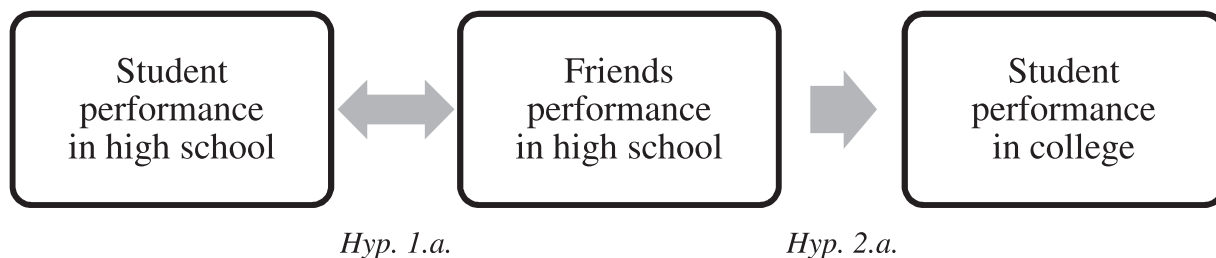---

[4] Business Administration & Management.

Fig. 1. The selection effect versus the socialization process: hypotheses for the friendship relations.
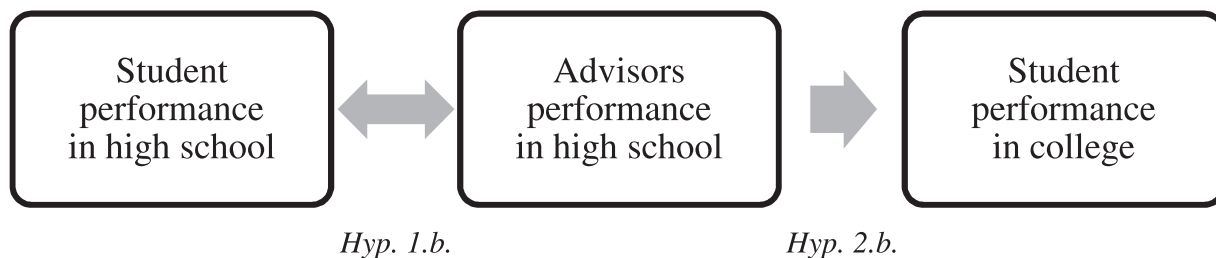

Fig. 2. The selection effect versus the socialization process: hypotheses for the strategic relations.

a student's academic achievement in college, also for two types of relationships. The two following hypotheses (see Figs. 1 and 2) are derived from the theoretical background related to socialization process:

(Hyp.2.a) A student's academic achievement is positively related to the high school performance of its friends, and

(Hyp.2.b) A student's academic achievement is positively related to the high school performance of its advisors.

Our third goal is to study how students' out- and in- centrality degrees in the two types of networks are related to academic achievement. The following hypotheses that concern the univariate links between centrality and performance have been derived from the theoretical background:

(Hyp.3.a) The number of declared friends (i.e., the centrality out-degree for friendship relations, representing the level of sociability in friendship relations), is positively related to academic achievement.

(Hyp.3.b) The number of declared advisors (i.e., the centrality out-degree for strategic relations, representing the level of strategic sociability), is positively related to academic achievement.

(Hyp.3.c) The number of nomination as friends (i.e., the centrality in-degree for friendship relations, representing the level of popularity as friend), is positively related to academic achievement.

(Hyp.3.d) The number of nomination as advisor (i.e., the centrality in-degree for strategic relations, representing the level of popularity as advisor), is positively related to academic achievement.

Our fourth, and final, goal is to investigate whether data augmentation by means of network variables – i.e., student centrality - can significantly improve the prediction of academic achievement when the peer or network level of performance is taken into account (i.e., within an integrated model). Since the quality of the information and the efficiency of the information chain both depend on peer performance levels, and since centrality is related to the reception and the transmission of information inside a network, we expect some changes in the relation between centrality and student performance within the integrated model.

4. Methods

4.1. Survey and participants

The data have been collected in October 2016 at Saint-Louis University in Brussels, Belgium, during academic lectures. The University is specialized in the first three years of college studies and proposes the following curricula: economy; management sciences; law; literature, philosophy & history; communication, political & social sciences; and translation & interpretation studies[5]. Saint-Louis University welcomes a few less than 4000 students per year, with over 70 nationalities, and students issued from different socioeconomic backgrounds. It was therefore a pertinent choice regarding the heterogeneity of information that would be gathered. First generation freshmen students (i.e., students registered in their first year of studies and for the first time) either enrolled in Economics or in Management[6] participated in the study. A total of 242 first generation students were registered in those two curricula. Data collection took place during an accounting lecture, and 120 students (49.59 % of the population) completed the survey. The survey took place in the third week of the academic year, since the first objective of the research was to determine if students

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[5] Except for translation & interpretation, all curricula are located on the same campus, in the Centrum of Brussels.
[6] The two curricula being almost identical in regard to the administered courses.

Table 1

Educational attainment of the mother, of the father and of the Belgian population: Frequencies, percentages and comparisons.

	Educational Attainment					
	High school (lower cycle)	High school (superior cycle)	Higher education (short type)	Higher education (long type, including college)	PhD	Miss.
Mother n	10	24	30	32	14	10
%	9.09	21.82	27.27	29.09	12.73	
Father n	10	20	18	37	25	10
%	9.09	18.18	16.36	33.64	22.73	
Belgian Population %	34.37	35.7	15.3	14.6		
Chi-Square (p-value) Mother vs. Belgian Pop.	89.05 (< 0.001)					
Father vs. Belgian Pop.	151.37 (< 0.001)					

reassemble from the start according to their prior performance. Regarding the second purpose, i.e. the study of the socialization process, Woosley and Miller (2009) showed that measuring social integration in the third week of the first semester in the first year of college is pertinent in the prediction of performance.

4.2. Data

In order to control for students characteristics, we added control variables (specifically the gender, the parents' levels of education, the students' extracurricular activities and the prior high school performance). The inclusion of the prior high school performance in addition to the academic performance measured in college also allowed differentiating the selection effect from the socialization process.

4.2.1. Socio-demographic characteristics

The survey included questions about the gender and the student mother and father's education levels. The comparison of the gender distribution between the student population and the sample shows that female students were significantly overrepresented within the respondents (49.17 % of female students in the sample versus 39.67 % in the population, χ^2 = 4.52, p-value = 0.04). The parents' levels of education were categorized according to comparable levels of educational attainment used by the Belgian government agency SPF Economie, whose responsibilities includes statistical analysis of federal data, including the level of education of the Belgian population. Table 1 shows the SPF's categories, together with the distribution of the parents' levels of education. The data show that for both parents, each level of educational attainment is represented within the sample. However, we observe that a majority of students enjoys a significantly privileged environment in relation to the parents' level of education. Compared to 29.9 % in the Belgian population (SPF Economie, 2016), 69.09 % (resp. 72.73 %) of respondents declared that their mother (resp. their father) obtained at least a short type higher education degree (χ^2 = 89.05 for the mother and χ^2 = 151.37 for the father, p-values < 0.001).

4.2.2. Student leisure and activities

Students were asked to note their participation level (ranging from 1: minimum one time a week, to 5: never) to eight types of activities: student parties, sport, concerts, cinema, cultural activities (museum and exhibitions), theatre, youth movements and volunteering. Some levels were strongly underrepresented, and consequently were grouped. The categories that were used for further analysis, together with the statistics associated, are presented in Table 2.

Data show that students enjoy going to concerts (81.67 %) and to the theatre (68.33 %), that they participate in cultural activities (75 %) and that they practice sport at minimum once a month (66.67 %). About half of the student (resp. 54.17 % and 53.33 %) take part to student parties and/or are involved in volunteering activities. Finally, 30.83 % are engaged in youth movements, and 25.83 % are going at minimum once a month to movie theatres.

4.2.3. Prior high school performance

Students were asked about the final grade they obtained when they left high school, just before entering college (see Table 3). Missing values (n = 5) were replaced by the sample average high school performance, the mean substitution being a pertinent imputation technique when the level of missing data is low (Hair, Black, Babin, & Anderson, 2010). In average, students declared finishing high school with 68.78 points on 100.

4.2.4. Popularity and sociability: centrality in- and out-degree

In order to avoid working with the 'whole network perspective', instead of the personal ties that students maintain within the

Table 2
Student leisure and activities: Frequencies and percentages.

	Student leisure and activities	
	No	Yes
Student parties (%)	55 (45.83)	65 (54.17)
Concerts (%)	22 (18.33)	98 (81.67)
Cultural activities (%)	30 (25.00)	90 (75.00)
Theatre (%)	38 (31.67)	82 (68.33)
Youth movements (%)	83 (69.17)	37 (30.83)
Volunteering (%)	56 (46.67)	64 (53.33)
	Student leisure and activities	
	Rarely	Often
Sport (%)	40 (33.33)	80 (66.67)
Cinema (%)	89 (74.17)	31 (25.83)

Table 3
High school performance, sociability, popularity, proportion of ties from same high school & academic performance: Moments & quantiles.

Variable	Min	Max	Mean	Q25	Q50	Q75
High school perf. (%)	50	94	68.78	64.00	69.00	75.00
N. of nominated (Out- degree) friends	0	9	2.14	0.00	2.00	3.00
N. of received nominations (In- degree) as friend	0	9	2.14	1.00	2.00	3.00
N. of nominated (Out- degree) strategic ties	0	9	0.82	0.00	0.00	1.00
N. of received nominations (In- degree) as strategic ties	0	8	0.82	0.00	0.00	1.00
% of friends from same high school	0.00	100.00	25.63	0.00	0.00	50.00
% of strategic relations from same high school	0.00	100.00	24.46	0.00	0.00	50.00
Academic performance : Score in Accounting (/20)	0.00	19.00	9.53	7.00	10.00	13.00

student network, students were asked to cite zero to ten friends, and zero to ten strategic relations. Free recall (i.e., no complete list of students was provided in the questionnaire, and respondents generated themselves the list of their relations) is pertinent when there are many nodes (i.e., n = 242 - the total number of students registered in Economics and in Management) in the complete network. Free choice (i.e., there was no constraint regarding the minimum number of ties that a student could choose) avoids measurement errors (Wasserman & Faust, 1994), i.e., a gap between the true number of relations and the declared ones, which occurs when the respondents entertain less relations than the number that is asked. The possible maximum of nominations was fixed at ten in both types of relation, since according to Steinberg (1999) (cited in Ryan, 2001, p.1137): 'generally, peer groups are conceptualized as having 2–12 members'. For both types of relations, the nodes graph, i.e., the student network, was drawn from the collected information, and the total numbers of nominations declared and received by each student were computed. Since we choose free recall and since the survey was not mandatory, students who did not participate in the survey could nevertheless be cited as friendship ties or strategic relations. According to Wasserman and Faust (1994), methods that are used in social network analysis require the complete recording of ties and interactions between actors belonging to the studied network. For both types of relations, the number of out- degrees was therefore recalculated: the nominations of students who did not respond to the survey were not taken into account for further analysis. Table 3 shows for both types of relations the descriptive statistics associated with the smoothed number of out-degrees and the number of in- degrees for our sample. On average, students nominated 2.14 friends and 0.82 strategic relations. For both types of ties, the average number of in- degrees is identical to the average number of out- degrees, since on a network's graph, the total number of outgoing links equals the total number of incoming links.

4.2.5. Proportion of nominations from the same high school

For both types of relations, the proportion of nominations coming from same high school was computed. The objective was to control for pre-existing ties (i.e., students that might know each other from same high school, and then pursue a relationship in college), and consequently to control for shared socio economic environments that might lead to high correlations between own and peer performance. Table 3 shows that on average, only 25.63 % (resp. 24.46 %) of declared friends (resp. advisors) came from the same high school. Moreover, for half of respondents who declared at least one tie, their relations came from different scholar establishments that the one they were attending.

4.2.6. Academic performance: score in accounting

The score obtained in the accounting exam was chosen to represent the student performance. The accounting lecture is a compulsory course for all first-year Economics and Management students, whose program is very similar regardless of the University of belonging. The accounting exam took place in January 2017 and was scored on a scale that ranged from 0/20 to a theoretical

maximum of 20/20. Score were retrieved from the exam records. The average score of our sample (9.53/20, see Table 3) was not significantly different (t-value = −0.50; p-value = 0.62) from the average score of all 215 students who took the exam (9.76/20).

4.3. Data analysis

All data management and data analysis operations were carried out with the free statistical software SAS University Edition, and with SPSS® Statistics 23.

Hypotheses 1a and 1b that concern the selection effect were tested with simple linear regression analysis. The study of regression residuals was then used in order to verify the impact of pre-existing ties on the relation between a student's high school performance and the average prior performance of its peers.

For hypotheses 2a and 2b that concern the socialization effect, and hypotheses 3a to 3d that concern the sociability impact and the popularity effect, we first analyzed the univariate relations between on the one hand each of the control and independent variables, and on the other hand the score in accounting. Then, multiple linear regression was used to determine the impact of each variable on the accounting score when other features are also part of the model. Since the significant power of variable varies with the inclusion of other(s) features(s) in a regression model (Malhotra, Décaudin, & Bouguerra, 2007; Tufféry, 2012), we used the backward stepwise selection method proposed in SAS PROC REG in order to select the final set of significant variables for the prediction of the accounting score. In this approach, the regression starts with the full model, then variables with the highest p-value (or the lowest t-statistics) are removed, until only variables with a p-value inferior to a critical threshold (e.g., 0.05) are included in the model. Variables that are deleted can be added again.

5. Results

5.1. The selection effect: do students reassemble in college according to their high school performance?

The first goal of this research was to investigate whether or not students, when they enter college, 'choose' friends and strategic peers according to the high school performance of those relations. In other words, we wanted to study if a student's high school performance could be linked to the average prior performance of its ties. 31 (resp. 64) students declared no friends (resp. no strategic links). Therefore, we first analyzed if the student high school average performance was significantly different between students who did not have any friendship links (average performance = 69.71 %) and those who nominated at least one friend (average performance = 68.45 %), or significantly different between students who declared no strategic ties (average performance = 68.77 %) and those who nominated at least one advisor (average performance = 68.79 %). Results from analyses of variance do not show any statistical differences, neither for friendship ties (F-Stat = 0.60, p-value = 0.44) nor for strategic relations (F-Stat = 0.00, p-value = 0.99). These results show that engaging (or not) in relationships upon arrival college does not seem to be related to the student past performance. Then, the average prior performance of nominated friends (resp. of nominated strategic relations) was computed for students that declared at least one friend (resp. at least one advisor). Table 4 shows the regression models both for friendship and strategic relations of peers' average previous performance by students' high school performance.

The results show that the average prior performance of friends is significantly (t-value = 1.97, p-values = 0.05) and positively linked to the performance of students that nominated these friends. These results confirm hypothesis 1.a., i.e., students tend to select friends sharing the same level of prior performance. Concerning the strategic relations, the data fails to prove a selection effect (t-value = 0.99, p-value = 0.33). Therefore, a student's prior performance appears to be positively linked to the prior performance of its relations, but only for friendship ties.

Then, we investigated whether the positive relation that was found between the student past performance and the average prior performance of its nominated friends could be explained by higher provenance of the same schools, and therefore by shared socio-economic backgrounds. The residuals from the friends' prior performance modeling were regressed according to the proportion of nominated friends coming from same scholar establishments. Results did not show significant impacts (t-value = −1.43, p-value = 0.16), i.e., they did not demonstrate that the proportion of shared schools altered the links between the average performance of friends and student performance.

5.2. Peer performance, popularity, sociability and the grade in accounting

The first objective was to investigate the effect of high school peer performance on student later achievement in college (i.e., the

Table 4
Models of peers' average performance by student performance.

Model	Dependent Variable	R^2	β	Std. Error	t-value	p-value
Student high school performance	Mean high school performance of friends	0.04	0.16	0.08	1.97	0.05
	Mean high school performance of strategic relations	0.02	0.11	0.11	0.99	0.33

Table 5

Average prior performance of nominated friends and nominated strategic relations: Categories and frequencies.

	Friends		Strategic relations	
	N.	Pct.	N.	Pct.
Zero tie	31	25,83%	64	53,33%
Average perf. between 50 and 65%	21	17,50%	8	6,67%
Average perf. between 65 and 70%	33	27,50%	24	20,00%
Average perf. higher than 70%	35	29,17%	24	20,00%
Total	120	100,00%	120	100,00%

socialization effect). As explained before, average prior performances of nominated ties (i.e., the independent variables in this case) could not be computed if students declared no friends (n = 31) or no strategic relations (n = 64). However, it was important to include those students who didn't declare any ties in further analyses. The average prior performances of nominated friends and of nominated strategic relations were therefore transformed into categorical variables, with the modalities of reference being respectively 'zero friends' or 'zero strategic relations'. Table 5 shows the categories and statistics associated to these variables.

The second objective was to determine the links between centrality and academic achievement. Using simple linear regression, we first studied the relations between on one hand each control and independent variables, and on the other hand the score in accounting. Then, a multiple regression modeling using the backward elimination process allowed selecting the final set of significant and pertinent features (among the control variables, the peer performance and the centrality) in the explanation of the accounting score. Table 6 shows the results of each univariate model and shows the multivariate final regression model. As showed in previous studies (Balyer & Gunduz, 2012; Cassidy, 2012; Dupont, De Clercq, & Galand, 2016; Gerber, 1996; Hansen, Wallman, Teshome, & Sporrong, 2017; Hattie, 2009; Massoni, 2011; Richardson & Woodley, 2003; Richardson, Abraham, & Bond, 2012; Robbins et al., 2004; Seow & Pan, 2014; Thiele, Singleton, Pope, & Stanistreet, 2016), higher levels of student prior performance, being a female student, higher mother's level of education, participating in cultural activities, engaging in scout movements, doing some

Table 6

Univariate & multivariate regression models for the accounting score, using control and independent variables.

	Univariate Models : Control variables		Univariate Models : Peer performance		Univariate Models : Centrality		Multivariate Model: Backward selection	
	β	p-value	β	p-value	β	p-value	β	p-value
Intercept							−9.29	0.05
Student prior performance	0.18	0.00					0.19	< .001
Female student	2.42	0.01					1.56	0.05
Mother's level of education: high school, superior cycle	4.93	0.01					3.53	0.00
Mother's level of education: higher education, short type	5.50	0.00					3.01	< .001
Mother's level of education: higher education, long type	6.85	< .0001					4.07	< .0001
Mother's level of education: PhD	5.74	0.00						
Mother's level of education: missing	3.30	0.12						
Father's level of education: high school, superior cycle	−2.75	0.15						
Father's level of education: higher education, short type	−0.58	0.76						
Father's level of education: higher education, long type	0.01	0.99						
Father's level of education: PhD	1.52	0.41						
Father's level of education: missing	−0.50	0.82						
Student leisure : parties	−1.30	0.15					−1.36	0.09
Student leisure : volunteering	1.87	0.04						
Student leisure : cultural activities	2.53	0.01					1.63	0.07
Student leisure : concerts	3.21	0.01						
Student leisure : theatre	1.47	0.13						
Student leisure : youth movements	3.18	< .001					1.80	0.05
Student leisure : sport (frequently)	1.25	0.19						
Student leisure : cinema (frequently)	0.67	0.52						
% of friends from same high school	−1.09	0.42						
% of strategic relations from same high school	−0.23	0.88						
Average friends' prior perf. : 50 to 65%			−0.38	0.78				
Average friends' prior perf. : 65 to 70%			2.74	0.02			1.87	0.03
Average friends' prior perf. : higher than 70%			3.56	0.00				
Average advisors' prior perf. : 50 to 65%			−2.11	0.25			−3.64	0.02
Average advisors' prior perf. : 65 to 70%			1.77	0.13				
Average advisors' prior perf. : higher than 70%			2.30	0.05				
N. of nominated friends					0.71	0.00		
N. of nominated strategic ties					0.58	0.11		
N. of received nominations as friend					0.72	0.00	0.45	0.03
N. of received nominations as advisor					1.20	< .001		

volunteering and going to concerts are significantly and positively related to the score in accounting. It should be noted that the effects of music and volunteering disappear in the multivariate model. On the other hand, a negative relation with participating to student parties appears in the full model. Finally, the percentage of friends and of strategic peers coming from same high schools does not significantly impact the score in accounting, showing on one hand that maintaining relations from high school versus making new acquaintances does not seem to impact later performance, and on the other hand that shared socio economic backgrounds have no significant links with academic achievement.

Concerning the peer effect, the prior performance of relations remains significant, even when controlling for the student own prior performance. First, a student's performance is significantly higher in case of well-performing close friends. The full model shows that in comparison with having no friends, being surrounded by peers whose average high school performance is between 65 and 70 percent leads to a significant increase of 1.87 points in the final grade in accounting (p-value = 0.03). However, while results shows a significant and positive univariate effect of a friends' average performance that is higher than 70 percent, this variable is not significant anymore in the full model. Although results shows that the high school performance of friends is positively related to student achievement (hypothesis 2.a.), a ceiling effect of peer performance seems to operate. Second, the full model demonstrates that it might be better for a student to be alone than to be surrounded by advisors who show low levels of prior performance: compared to maintaining no strategic relation, when the advisors average performance is lower than 65 percent, the accounting score significantly decreases of 3.64 points (p-value = 0.02). Results do not confirm the hypothesis 2.b., i.e., do not show that the high school performance of advisors is positively related to student achievement in college. Instead, they demonstrate a negative socialization effect, i.e., a negative link with achievement of the performance level of strategic peers.

Finally, concerning the centrality question, univariate models show positive and significant relations between performance and (1) the out-degree centrality within friendship ties (hypothesis 3.a.) and (2) the in-degree centrality that concerns both types of relations (hypotheses 3.c. and 3.d.). However, results also show that the multivariate model selects the network performance over the student centrality. When other variables including peer performance are taken into account, only the positive relation with the number of nominations received as friend remains significant - each additional nomination significantly increasing the accounting score of 0.45 points (p-value = 0.03). Therefore, when we consider peer performance, only being a prestigious friend remains significant for academic achievement.

6. Discussion

6.1. Contributions and main results

The objectives of this paper were to (1) determine the links between freshmen college students' academic achievement and their peers' performance, and (2) to determine the relationship between student centrality and academic achievement. The results show that students 'choose' their peers based on shared performance levels, but also that the peers' school grades remain important for future student performance. Additionally, as the centrality of a student inside its network seems to be related to achievement, the results show that the network level of performance might shape the link between student's centrality and student's achievement.

First, concerning the selection effect, the results demonstrate that when students enter college, they tend to group with friends who share the same performance levels, which is in accordance with the literature (e.g., Barnes et al., 2014; Foster, 2005; Kretschmer et al., 2018; Mayer & Puller, 2008; Patacchini et al., 2011; Véronneau et al., 2010; Vaquero & Cebrian, 2013a, 2013b). Nevertheless, like Barnes et al. (2014) we believe this process to be unconscious, i.e., students probably do not form their friendships in an opportunistic way. Then, the formation of strategic ties does not seem to be subject to the selection process. We might argue that the perception of cognitive ability or similarity with someone might be less trivial in instrumental ties than in friendship relations, although this hypothesis needs to be verified. A methodological issue might also explain the absence of homophily in strategic relations: linear regression requires a minimum sample of 50 units and the small sample size for the advisors' prior performance modeling might have led to a type II error, i.e., little statistical power and insignificant results, despite real effects (Hair et al., 2010).

Second, the results confirm that the prior performance levels of peers are significant for the prediction of a students' future performance. Therefore, the results substantiate the socialization process. Furthermore, they show that the relationship between peer performance and the accounting score is different according to the nature of the student ties. Whereas being surrounded by well-achieving friends is positively related with academic performance, it seems preferable for a student not to have advisors, than to maintain strategic relationships with low-achieving peers.

Third, in line with prior research on college students' centrality (e.g., Cho et al., 2007; Hommes et al., 2012; Mushtaq et al., 2016; Liu et al., 2018; Saqr et al., 2018; Vargas et al., 2018; Yang & Tang, 2003; Zwolak et al., 2017), the results show positive and significant links between performance and either sociability (but only for friendship relations) either prestige (for both types of relations). However, in the multivariate model above, the relationship between peer performance and student performance seems to outweigh the relationship between student centrality and performance. Concerning the in-degree centrality, only the popularity as friend remains significant when peer performance is taken into account. Concerning the out-degree centrality, the relationship between the a student's sociability and academic success is no longer significant when the performance of the nominated friends is taken into account. We might argue that (1) since the quality of the information that circulates within a peer group depends on the performance of the peers that compose the group (McPherson et al., 2001; Vaquero & Cebrian, 2013a; Vaughan et al., 2015), (2) since a node's centrality determines the level of information to which this node has access (Gašević et al., 2013; Obadi et al., 2010; Thomas, 2000; Tomás-Miquel et al., 2016; Vargas et al., 2018; Zwolak et al., 2017), and (3) since student achievement is related to the tacit information and knowledge that a student possesses (e.g., Siegler et al., 2012; Somech & Bogler, 1999; Thompson & Zamboanga,

2004), the out- degree centrality might lose its significance for achievement when peer performance - and therefore the accuracy and quality of the information received by a student - are taken into account. In other words, the performance level of peers nominated by a student and from which he or she receives information might moderate the relationship between a student's sociability and its achievement, through the quality of the information that is received from the nominated peers. However, a methodological issue might also explain the centrality's loss of significance in the multivariate model. As explained earlier, social network analysis methods led us to work with 'complete-case analysis' (i.e., we deleted the declared nominations corresponding to students who did not respond to the survey). A thorough analysis of the number of deleted nominations reveals a substantial loss of information. 127 students that were nominated at least one time did not respond to the survey. These students would likely also have declared some ties, which in turn would have increased the number of nominations received by the 120 respondents. Consequently, the computed in-degrees were more than likely underestimated. Moreover, both types of relation confounded, the complete-case method led to a total loss of 43.6 % of the out-degrees (i.e., a deletion of 275 nominations over the 630 initially declared ties). Several authors (e.g., Huisman, 2009; Žnidaršič, Ferligoj, & Doreian, 2012) showed that high levels of survey non-response impact the structural properties of social networks, and might cause underestimation of the computed coefficients (e.g., the mean out-degree) (Kossinets, 2006). Furthermore, computations made with the respondent only approach can produce biased estimates (Gile & Handcock, 2006, 2017; Huisman, 2009). These methodological issues might explain the lack of explanatory and significant power of the sociability as a friend and of the popularity as an advisor in the full model, since the number of out-degrees and of in-degrees were significantly affected by the methodological choice (i.e., 'complete-case analysis').

6.2. Limitations

In addition to the sample size, and to the issue of missing values, two other limitations must be mentioned. Our first concern is related to the representativeness of our sample. Even though the data were collected in a heterogeneous environment, a majority of the respondents seems to enjoy a privileged environment regarding the parents' level of education. Additionally, we collected our data in only two curricula, and the results could be different for other curricula. It is therefore crucial to generalize the results of this research with other courses and student groups. The second limitation relates to absence of information concerning friendship ties existing prior to entering college. Some ties that were declared might be relationships that already existed in high school. Therefore, the results related to the selection effect for friendship relations should be considered with care. However, the data show that respondents do not seem to limit their friendships to students that went to the same high school, the proportion of declared ties belonging to the same high school - among all other declared connections - being equal to 25.63 % in average. Furthermore, due to large school sizes, it is plausible that two students from the same school and that declared ties in college never met before. Then, Mayer and Puller (2008) showed that academic performance remains significant in the selection of college friends even when sharing the same high school. Our results also show that the proportion of shared high schools do not alter the significant links that were found between the average performance of friends and student performance. Finally, for students that knew each other before entering college, our analysis shows that these students tend to stay with friends sharing similar levels of prior performance.

6.3. Future researches

From an empirical perspective, future studies could consider the following points. First, more studies could be undertaken to understand the underlying processes and mechanisms that might explain the links between peer group and performance (Cho et al., 2007; Hanushek, Kain, Markman, & Rivkin, 2001; Hommes et al., 2012; Sacerdote, 2001; Wang, 2004; Wentzel, 2003; Vaquero & Cebrian, 2013a, 2013b; Zwolak et al., 2017). Second, additional studies concerning the roles of different student network types (e.g., strong versus weak ties …) on academic achievement should be undertaken, these questions having been parsimoniously addressed in the educational context. For instance, it is important to understand why the peer effect seems behave differently for social-oriented and instrumental-oriented relationships. Third, we could address research questions about student centrality in the light of the groups' characteristics (e.g. the performance level) in which student are embedded. For instance, future research could examine the mechanisms and variables (including the level of performance of the network) that might moderate the relationship between student centrality and student performance, and could test those moderation effects.

Additionally, future research could take into account of the following methodological issues. First, it seems crucial to impute the missing ties for the students that are nominated but who do not participate to the survey. Several imputation techniques exist, from simple methods, for instance the imputation by reconstruction (see Stork & Richards, 1992), to more complex techniques such as the Exponential Random Graph Models – based imputation (e.g., Gile & Handcock, 2017; Robins, Pattison, & Woolcock, 2004; Wang, Butts, Hipp, Jose, & Lakon, 2016). Second, we would like to stress the importance of conducting research on personal networks instead of more global structures.

7. Conclusion

This paper shows that when entering college, students tend to reassemble with friends that share similar levels of performance and that in return the performance of these ties remains important in the prediction of students' future academic success. Then, although the selection process does not seem to play a role in the choice of strategic ties, a negative socialization effect seems to occur - lower student scores being significantly linked to low levels of advisors' prior performance. These combined results tend to suggest that the selection effect would precede the socialization impact, and that these two processes would combine within a single more

global mechanism. Even if students "choose" their peers based on a shared achievement history, the performance levels of these ties remain important for future student achievement. Additionally, the centrality of a student inside its peer network seems to be related to its achievement, although only the popularity as friend remains significant when the performance level of the peer network is taken into account. The results suggest that the network characteristics impact the link between student centrality and student achievement, and that these characteristics must be integrated in the study of centrality.

Acknowledgements

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