

## The nature and long-term impact of social relationships

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### Abstract

Social relationships do not only play an essential role in shaping our personalities, but are also strongly tied to outcomes such as academic achievement as well as physical- and mental well being. In adolescence, social environments are gradually expanding, whereby social relationships – and the access to social capital in the form of emotional-, appraisal-, instrumental- and informational support they provide – are subject to substantial change. We introduce a framework investigating differences in structural- and relational properties of strong-, moderate-, casual- and weak-tied friendship networks as well as drivers and outcomes that are associated with changes in the strength of friendship ties. Drawing on stochastic actor-oriented network models, we analyze teenagers' friendship networks in 73 school classes on any given level of strength. First, our findings show a cohesive picture, whereby strong-, moderate-, casual- and weak-ties have their own unique nature in terms of linearly merging trust- and advice expressions, which translate into access to distinct and hybrid forms of bonding- and bridging social capital respectively. Second, this picture is reflected in a unique systemic logic that not only yields network structures, but also drives network segregation or fragmentation in ways that promote access to the corresponding forms of social capital. Third, we find that in contrast to an attenuation of social relationships in pursuit of self-protective motivations, a fortification of social relationships as guided by self-expansive motivations is associated with both higher school performance and higher life satisfaction.

**Keywords:** Nature of social relationships | Strength of ties | Impact on well-being and school performance | Stochastic actor-oriented network models | Adolescent social networks

### INTRODUCTION

Social relationships assume one of the most important roles in every sphere and across all stages of our lives. First, social relationships can affect mental health, not only by facilitating or restricting positive outcomes in terms of happiness and well-being Zika and Chamberlain 1992, but also by buffering adverse outcomes during episodes of stress Mascaro and Rosen 2006 and depression Debats, Van der Lubbe, and Wezeman 1993; Mascaro and Rosen 2005. Second, social relationships can also affect physical health by fostering or impairing healthy nutrition habits Haye et al. 2013; De la Haye et al. 2010, alcohol- Mercken et al. 2012; Osgood et al. 2013

or substance use Mercken et al. 2010; De La Haye et al. 2013, as well as healthy patterns of sleeping Mednick, Christakis, and Fowler 2010; Maume 2013 and physical activity De La Haye et al. 2011. Third, social relationships can also affect academic achievement, either by triggering or restraining the development of corresponding skills and competencies Coleman 1988, or by promoting or suppressing academic engagement and motivation Gremmen et al. 2018; Zhang et al. 2019.

Current and past decades have seen a remarkable growth in our understanding of how social relationships affect physical- and mental health, as well as academic achievement. We know that social relationships can form structures that a.) bestow a sense of meaning, purpose or belonging Baumeister and Leary 1995; Haslam et al. 2009, b.) provide access to instrumental-, informational-, appraisal- and emotional support House, Umberson, and Landis 1988, as well as c.) present modes of contact for the social validation of happiness and well-being Fowler and Christakis 2008, the transmission of stress Milkie and Warner 2011; Oberle and Schonert-Reichl 2016, the propagation of health behaviors Christakis and Fowler 2007, the spread of pathogens Hernández-Orallo et al. 2020, as well as the exchange of information and knowledge M. Granovetter 1983, or the emergence- and escalation of misunderstandings or conflicts Kindschi et al. 2019.

Adolescence is a crucial period for the formation and evolution of social relationships. Not only are adolescents heavily burdened with the expectation to accumulate human- and cultural capital, so they may find their place in society, they are also immensely preoccupied in their trials to build social capital, while exploring and consolidating social relationships in a gradually expanding social universe Shanahan 2000. Nowhere are the respective impacts of social relationships on mental health, as well as academic achievement more evident than in situations where exploring such a social universe is restricted by government social distancing mandates in order to contain the spread of pathogens, and thus relieve the burden on public health institutions Elmer, Mepham, and Stadtfeld 2020; Stadtfeld et al. 2019. This article aims to improve our understanding of the nature of social relationships, while placing particular emphasis on motivations guiding their formation and evolution, as well as their associated outcomes during adolescence.

The most prominent approach to classify social relationships according to their differential effects on teenagers' physical- or mental health, and academic achievement is a combination of the framework of the strength of ties, conceptualized as a linear combination of the level of intimacy, the degree of mutual confiding or provision of emotional support, the proportion of time spent together, and the degree of reciprocity in the provision of instrumental support M. S. Granovetter 1977 along with the typology of bonding vs. bridging or linking social capital Coleman 1988. Despite an intensive debate surrounding the conceptualization of social capital, scholars generally agree that classifying social relationships according to their nature (horizontal vs. vertical, formal vs. informal, weak vs. strong) reveals whether they provide access to instrumental- or informational- (bridging or linking), vs. appraisal- or emotional (bonding) forms of social capital Ferlander 2007. However in reality, dimensions such as the degree of intimacy, mutual confiding, the reciprocity in providing emotional or instrumental support, and the proportion of time spent together might not necessarily contribute equally to the strength of ties Krackhardt, Nohria, and Eccles 2003. Although categorizations based on the time spent together seem preferable based on their objectivity M. S. Granovetter 1977, the concept leaves considerable room for uncertainty or ambiguity as to the nature of ties at any given level of strength. Moreover, despite their overwhelming popularity across various scientific disciplines, the relational and structural implications of the strength of ties M. S. Granovetter 1977, as well as extensions in small worlds Watts and Strogatz 1998 are limited to simple contagions, such as

the propagation of job information or the spread of communicable diseases Centola and Macy 2007, and should not be generalized to complex contagions, such as joining online blogging communities Backstrom et al. 2006, solving coordination dilemmas in collective actions Macy 1990, contravening existing social norms for public health interventions Latkin 1995; Friedman et al. 1993, as well as participation in labour- Hedström 1994 and dissent movements Opp and Gern 1993; Zhao 1998 or violent revolts Gould 1993. This article provides a framework of relational and structural properties that are associated with each level of tie strength and aims to investigate whether changes in the corresponding levels of tie strength are associated with improvements or impairments in health and well-being or academic achievement - and thus tend to relieve or burden the corresponding economic and social costs Harrison et al. 2012.

In the following sections, we introduce the theoretical framework, from which we derive our hypotheses (Section 2) and provide more details on the design of the underlying empirical study (Section 3). Then, we describe the methodology we use to model the co-evolution of weighted friendship ties (Section 4). Finally, we present the results of our analysis (Section 5) and discuss the implications of our findings (Section 6) Feld and Carter 1998; McPherson and Smith-Lovin 1982; Hagan 1998.

## THEORETICAL FRAMEWORK AND HYPOTHESES

In our theoretical framework, the evolution of teenagers' social networks is conceptualized according to the perspective of life-cycle theory Van de Ven and Poole 1995; Levinson 1978; Nisbet 1970; Piaget 1967. In life-cycle theory, adolescent social networks are viewed as entities, which evolve according to a systemic logic that regulates the process of their transformation. Thus, social networks evolve in a sequence of stages that are unitary cumulative, such that structures and dispositions observed in earlier stages are endowments available for transformations in later stages, which eventually culminate in specific social network structures and dispositions. The underlying systemic logic can be seen as a utility function that not only drives teenagers' decision-making individually, but is collectively shared among all peers within a given context. Thus, utility functions not only determine features of the network structure or traits that teenagers consider, but also the extent to which they have an impact when teenagers select or avoid-, as well as maintain or dissolve social relationships. Contexts are defined as social, psychological, legal, or physical entities around which joint activities are organized Feld 1981.

### *Strength of ties reflecting the nature and structure of social networks*

Among all the different concepts that capture various aspects of social relationships, the concept of friendship has achieved the greatest level of popularity in both theoretical and empirical research Haynie 2002; Lin, Prabhala, and Viswanathan 2013; Hendrickson, Rosen, and Aune 2011; Selfhout et al. 2010; Krackhardt and Kilduff 1999; Mercken et al. 2010; Milardo 1982; Hallinan 1979. Given its generally objective focus on time spent in the company of peers M. Granovetter 1983, the concept of friendship has been the subject of a number of validation studies that found significant overlaps between the self-rated presence and strength of friendship ties and social interactions captured on video or using wearable proximity sensors Stehlé et al. 2011; Hoffman et al. 2020; Elmer et al. 2019. However, does the strength of friendship relationships reveal anything about their nature without knowing the resources that are exchanged, or the topics that are discussed in companionship with peers? We expect that the nature of social

relationships is revealed through the study of teenagers' strength of friendship ties M. Granovetter 1983 co-evolving with teenagers' frequency of contact to seek advice or talk about school and homework Agneessens and Wittek 2012, as well as the frequency of contact to build trust or talk about important things Van de Bunt, Wittek, and Klepper 2005 for any given level of strength. According to M. Granovetter 1983, entrainment effects, capturing the extent to which the existence of friendship ties will promote the formation of advice- or trust ties and vice versa is expected to favour strong friendship ties for the formation of trust ties and weak friendship ties for the emergence of advice ties and vice versa.

**Hypothesis 1 (H1)** *We expect that on the foundation of strong friendship ties, trust ties are more likely to form than advice ties, while in the presence of weak friendship ties, advice ties are more likely to emerge than trust ties and vice versa.*

What about the structure of ties in the corresponding networks? Reciprocity is one of the most consistently found mechanisms in friendship network dynamics. Social exchange theory Emerson 1976 suggests that people invest in relationships with expected returns. However, reciprocity does not exist by default in all friendships. Moreover, Hartup 1996 and Vaquera and Kao 2008 argue that relationships that are reciprocated are substantially different from those that are not. Reciprocated friendship relationships are significantly more likely to emerge, if one peer has previously reached out to the other as a friend, compared to the emergence of a reciprocated friendship relationship from a non-existing relationship Hallinan 1978. Built on the proposition that the amount of social capital inherent in relationships is an increasing function of the intersection of shared norms and expectations Coleman 1988, Vaquera and Kao 2008 argue that one-sided strong friendships are usually not very long-lived Hallinan 1978. Maintaining a higher level of friendship strength to someone who does not reciprocate in kind would imply that the parties involved agree as to their corresponding status difference Gould 2002, which should not be surprising, assuming that status differences are more common in weak-tied friendship networks Coleman 1988. Transitivity is another very consistently found mechanism in friendship network dynamics. Balance theory Heider 1946; Newcomb 1978 proposes that friends of friends are evaluated more positively. Using balance theory in our context suggests that teenagers prefer balanced relationships not only in terms of their sentiments, but also in terms of the underlying strengths. In a context of enmity networks, Pál et al. 2016; Fujimoto, Snijders, and Valente 2017 did not find sufficient evidence for the presence of the transitivity mechanism. Projecting these findings from the tie sentiment- to the tie strength concept, we expect transitivity to be more prominent in strong-tied networks than in weak tied networks. Moreover, Block 2015 argues that a one-sided friendship is more likely to persist if it is embedded in a transitive triad. Transitive triads provide a forum, which makes one-sided friendships less apparent than one-sided friendships outside a transitive triad Elmer, Boda, and Stadtfeld 2017; Rivas-Drake et al. 2017; Gremmen et al. 2018; Block 2015.

Sociability is consistently found to be an increasing function of the number of peers that teenagers have already nominated Elmer, Boda, and Stadtfeld 2017; Gremmen et al. 2018; Block 2015; Ellwardt, Labianca, and Wittek 2012; Kindschi et al. 2019. However, findings on the proposition that popularity is an increasing function of the number of friendship nominations that teenagers have already received are not consistent, including empirical evidence in favor Elmer, Boda, and Stadtfeld 2017; Gremmen et al. 2018 as well as in disfavor Block 2015; Kindschi et al. 2019. Assuming that teenagers' time and resources are limited, we expect teenagers' nomination-level dependent sociability and popularity to be higher in weak-tied networks than in strong-tied networks Block 2015.

**Hypothesis 2 (H2)** *We expect that on the local level, teenagers' preference for reciprocity and cohesion in friendship ties increases with each level of friendship strength, and that on the global level, teenagers' sociability and popularity based on the number of friendship nominations they issued and received so far, decreases with each level of friendship strength.*

What about the formation of clusters or communities? According to McPherson, Smith-Lovin, and Cook 2001; Lazarsfeld, Merton, et al. 1954, adolescents prefer their friends to be similar on various salient dimensions, a tendency that is known as homophily. However, are teenagers' preferences for similarity in strong-tied networks more pronounced than in weak-tied networks? Strong- and weak ties are often used as synonyms for bonding- and bridging ties respectively Lin 1999; Van Oorschot, Arts, and Gelissen 2006. While these concepts are undoubtedly overlapping and congruent as to their predicted implications, they are not synonymous. Whereas bonding ties are connecting peers who are similar in terms of various salient dimensions, strong ties connect peers that are emotionally close, yet both predict a tendency to provide emotional or appraisal support and are thus described as vital for 'getting by'. While bridging ties are connecting peers who are different, weak ties connect peers who are emotionally distant, yet both are seen as crucial for 'getting ahead' as they predict the tendency to provide informational and instrumental support Ferlander 2007; Souza Briggs 1998. Due to their salience in the formation of friendship relationships Kindschi et al. 2019, the focus of our theoretical framework is on ascribed- or inherited socio-demographic traits, according to which teenagers are socialized, before they are organized into the structured social environment of their schools.

In general, populations appear almost perfectly heterogeneous as far as gender is considered, with men and women making up almost equal-sized groups. However, in most contexts where social networks have been studied, including work environments Bielby and Baron 1986; Kalleberg et al. 1996; Ellwardt, Labianca, and Wittek 2012, voluntary organizations McPherson and Smith-Lovin 1982, 1987; Popielarz 1999 and schools Friemel 2012; Kindschi et al. 2019, populations are segregated in rather homogeneous clusters. Therefore, it is not surprising that the networks formed in these settings display a significant amount of baseline gender homophily. When children enter school, they are bound to have learned that gender is a permanent feature of their identity and are likely to have been subject to socialization regarding the preference for same-sex ties outside of their family environments Maccoby 1998; Marsden 1987. Previous empirical research suggests that this preference is stronger in networks based on intimate friendship ties loaded with aspects of trust and emotional support compared to ephemeral ties loaded with aspects of advice, mentoring and instrumental support Ibarra 1002, 1997; Lincoln and Miller 1979; Mayhew et al. 1995.

In a similar way, many contexts, including neighbourhoods, work environments, and voluntary organizations, display considerable homogeneity with respect to age. The fact that schools are forming classrooms according to students level of maturity induces a strong component of baseline age homophily, although this tendency weakens as children move from early to later grades Shrum, Cheek Jr, and MacD 1988. Empirical research conducted in these contexts suggests that age homophily is more pronounced if ties are relatively superficial, such as those formed around hobbies, which are characterized by general sociability and support at work and around the neighborhood Feld 1982. Conversely, age homophily was found to be less pronounced in contexts, where ties are close, personal Fischer 1982, and characterized by longevity and reliability, or involve deeper discussions about worldviews Marsden 1987; Feld 1984.

Unlike gender and age, to a large extent, the baseline homophily created by ethnic origin or residential area is strongly associated with the position of the corresponding groups on other dimensions, such as parents' education and occupation. However, while gender and age are

generally ascribed at birth, attachment to one's ethnicity or residential area, as well as exposure to parents education and -occupation are inherited and socialized in the family context throughout childhood. The social class of one's family often determines neighbourhood residence, school environments, as well as membership in voluntary associations and the personal prejudices that often result from the latter to create a highly visible segregation. Previous research found strong homophily on ethnicity and residential area in a wide array of relationships, including the most intimate such as marriage Kalmijn 1995 and confiding Marsden 1987, friendship in school classes Shrum, Cheek Jr, and MacD 1988, acquaintanceship Mayhew et al. 1995; Lawrence 2006 or collaboration at work Lincoln and Miller 1979; Ibarra 1995. While previous research found substantial preferences for homophily based on parental education, -occupation, and -social class in intimate- and confiding relationships like marriage, there is some evidence that preferences for such similarity also exist in ephemeral ties Verbrugge 1977; Louch 2000.

**Hypothesis 3 (H3)** *In strong-tied friendship networks, we expect teenagers to show homophilous tendencies in terms of gender, residential area and ethnicity, as well as parental education and -occupation, while in weak-tied friendship networks, homophilous tendencies are expected in terms of age, residential area and ethnicity.*

#### *Drivers for changes in the strength of friendship relationships*

According to our theoretical framework, teenagers' preferences regarding the strength of their outgoing friendship ties depend on their value priorities. Values are defined as trans-situational goals, which vary in importance and serve as guiding principles for groups or in an individual's life Schwartz 1992; Bardi and Schwartz 2003; Skimina et al. 2018, and can be structured according to two motivational dimensions, which are cast in terms of conflicts and fundamental human problems that need to be solved Schwartz et al. 2012. The first dimension highlights the conflict between conservation and openness to change. Conservation is defined as the motivation to "preserve the status quo and the certainty it provides in relationships with close others, institutions, and traditions" (p. 43) and encompasses the values "security", "conformity" and "tradition". Openness to change is defined as the motivation to "follow one's own intellectual and emotional interests in unpredictable and uncertain directions" (p. 43) and is composed of "self-direction" and "stimulation" values. The second dimension relates to the conflict between self-enhancement and self-transcendence. Self-enhancement is defined as the motivation to "enhance one's own personal interests, (even at the expense of others)" (p.44) and entails the importance assigned to "achievement" and "power" values. Self-transcendence is defined as the motivation to "transcend selfish concerns and promote the welfare of others, close and distant, and of nature" (p.44) and is composed of "benevolence" and "universalism" values. For a detailed description of these values, we refer to Tables 1 and 2 of the Online Supplemental Information. The second dimension classifies values according to the interests that are pursued when they are expressed. Self-enhancement and openness to change values primarily regulate the expression- and pursuit of personal interests, whereas self-transcendence and conservation values primarily regulate social relationships to others and the pursuit of their interests Schwartz et al. 2012.

On the one hand, teenagers emphasizing openness to change values are likely to appreciate the access to different perspectives provided by weak ties. However, weak ties are meaningless if different perspectives do not surface due to their superficial nature Perry-Smith and Shalley 2003. On the other hand, teenagers prioritizing conservation values are likely to appreciate the cohesive- and impermeable nature of strong-tied clusters, which prevent perspectives that do not conform with existing norms from entering and spreading within Zhou et al. 2009. Moreover,

strong-tied- and cohesive networks are also contexts that foster cooperation and allow teenagers with socially oriented self-transcendence values to monitor teenagers with personally oriented self-enhancement values more effectively, and trigger incentive- or sanction mechanisms if necessary, compared to weak-tied networks Roos et al. 2014.

**Hypothesis 4 (H4)** *We expect teenagers emphasizing socially oriented values to have a preference to create stronger friendship ties or to increase the strength of their existing friendship ties, while teenagers emphasizing personally oriented values are expected to have a preference for creating weaker friendship ties or decreasing the strength of their existing friendship ties.*

#### *Outcomes associated with changes in the strength of friendship relationships*

The framework of social support Cohen 2004; House, Landis, and Umberson 1988 suggests that teenagers' preferences regarding the strength of their outgoing ties are also associated with some key outcomes such as academic achievement as well as mental health and well-being, as both outcomes are likely to be socially facilitated. On the one hand, the academic achievements of teenagers are often evaluated in a social context and related to the performance of their peers. On the other hand, well-being in the form of life satisfaction is often defined as the degree to which teenagers evaluate the quality of their lives favourably, either in the cognitive context of their own lifetime experiences, or experiences to which they are exposed in their social contexts Veenhoven and Ehrhardt 1995. Adolescents may be considered benefactors and beneficiaries in the provision of different forms of social support for each other. Peers who are different on a number of salient dimensions may be emotionally distant, but can exchange their perspectives through weak ties. Although the corresponding access to different perspectives favors the exchange of instrumental and informational support, a certain strength of ties is required in order for such perspectives to surface. Likewise, peers who are similar may also be emotionally close, and thus exchange emotional or appraisal support through strong ties Ferlander 2007; Souza Briggs 1998. According to Kadushin 1982, friends are not only more likely to exchange information about their well-being and, when necessary, seek appropriate forms of social support if they are connected through strong ties, spending more time with each other also puts them in a better position to provide effective and adequate forms of social support.

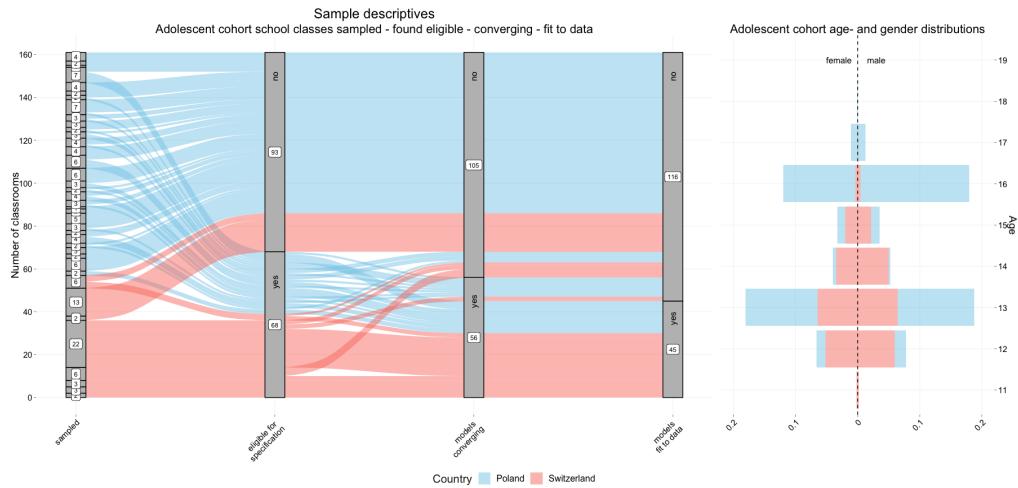
**Hypothesis 5 (H5)** *We expect that higher academic achievement is associated with a preference for weak- rather than strong friendship ties, while higher life satisfaction is associated with a preference for strong- rather than weak friendship ties.*

#### DATA AND METHOD

Our study is designed as a longitudinal, three-wave panel with two cohorts. From November 2015 until November 2016, we commissioned three waves of surveys with students from both Switzerland and Poland who transitioned to lower- (7th grade) and higher secondary education (9th grade) at the age of 12 or 13 and 15 or 16 respectively. Thus, for all students participating in the study, the observation period starts at a point when they are reassembled in new classes and / or assigned new teachers, such that – overall – they are equally exposed to a new pool of peers.

## Sites and samples

The waves of our longitudinal design correspond to the schedule according to which students were interviewed. The dynamics of the processes under consideration in this study are expected to be highest at the beginning of the group formation process Friemel 2012. Thus, the timing of the administration of the surveys to students is designed with proportionally increasing time windows between waves of data collection. Furthermore, the longitudinal design is intended to limit the exposure of respondents to surveys while ensuring that all dynamics in the processes under consideration are captured. Samples and cohorts are visualized in Figure 2.



*Figure 1: Sample descriptives:* Alluvium charts (left panels) show that 42% of all adolescents' 161 school classes that were sampled in this study (stratum 1) are found eligible for model specification (stratum 2: below 50% missing observations - eligible, above 50% - not eligible), and while 83% of all models that were eligible for model estimation show adequate convergence (stratum 3: convergence below 0.25 - yes, above 0.25 - no) goodness of fit parameter simulations are sufficiently close to the observed data for 84% of all models that were included in the meta-analysis (stratum 4:  $\chi^2$  test probability below 0.05 - good fit, above 0.05 - insufficient fit). Colors show the trajectories of 57 vs. 104 school classes of the adolescent cohorts from Switzerland (salmon) vs. Poland (skyblue) across these stages. Bar charts (right panels) show age pyramids of 1'193 Swiss- and 2'743 Polish adolescents that were sampled in this study by gender (female - left, male - right) and country (Poland - skyblue, Switzerland - salmon)

## Procedures

All procedures contributing to this work are in compliance with the ethical standards of the relevant national and institutional committees. The surveys commissioned in the various school classes were supervised by trained student assistants. Across the entire schedule in each cohort, data were collected in the controlled environment of school classes during a full school period of 45 minutes. To eliminate method bias, data were collected using the same method across all waves for each student. Respondents assessed in Switzerland were provided with questionnaires in paper and pencil form, whereas the surveys commissioned in Poland were administered on-line. Students and their parents were informed about the design and purpose of the study several weeks before data collection started. Due to different regulations concerning data protection, we used

different approaches to obtain parents' active consent for the participation of Swiss and Polish students in our study. Parents in Switzerland were provided with an opt-out possibility. Of the 1,193 adolescents sampled in Switzerland, none of the parents made use of that possibility. Parents in Poland were specifically asked to opt-in. From a total of 2,743 adolescents sampled in Poland, approximately 68% of parents provided their active consent.

To make the school classes in the two countries comparable in terms of participation rates, we excluded 103 secondary school classes, where absentees in any given wave exceeded 50% due to the opt-in and opt-out procedures. The result of this process can be seen in Figure 2. The sample we used for our analyses includes 68 secondary school classes from Switzerland and Poland.

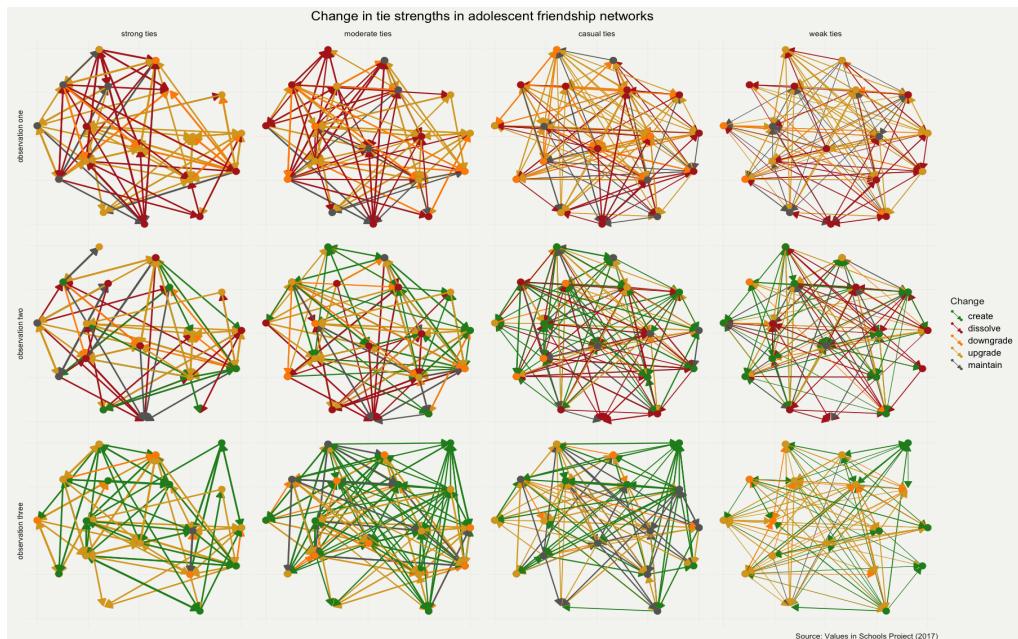
### Measures

To investigate the formation- and evolution of friendship network structures among youth at school, this study combines information on students' value priorities, identity formation modes and social network structures with information on a variety of students' socio-demographic traits as well as outcomes such as academic achievement and well-being.



*Value priorities and identity formation modes.* In order to collect data on adolescents' value priorities, our study used two versions of the Portrait Value Questionnaire (PVQ) Schwartz et al. 2012. The original version contains 58 items from which 13 items are extracted in a short version. In both versions of the PVQ, respondents are asked to compare themselves to people described in brief statements and to evaluate how similar they are to these persons on a six-point scale ranging from "not similar at all" to "very similar" Beierlein et al. 2014. To assess adolescents' identity formation modes, our study uses a short version of the Circumplex of Identity Formation Modes (CIFM) Topolewska-Siedzik and Cieciuch 2018, which contains 16 items asking respondents to read brief statements about themselves and evaluate the extent to which they agree with these statements on a six-point scale ranging from "totally disagree" to "totally agree".

*Social relationships.* Data on friendship networks were collected with a roster design. The names of all students in each class were displayed in a roster, including those who did not participate in the survey or students that were absent from class on the dates scheduled for data collections. Students were asked "How strong is your friendship with your classmates?" They responded on a six-point scale ranging from "no friendship at all" to "very close friends". According to the companionship dimension of friendship M. S. Granovetter 1977, students were instructed to think about their total leisure time and assign levels to their classmates according to the average time they currently spend with each other. As the methodology we used in our analyses assumes binary network data, adolescents' tie strengths were grouped in four categories. Based on prior research in this context, ties with strengths on levels 5 & 6 are labeled "strong ties". In addition, ties with strengths on levels 4 & 5, 3 & 4, as well as 2 & 3 are classified as "moderate ties", "casual ties" and "weak ties" respectively. Consequently, by modelling the co-evolution of friendship networks on two adjacent levels of strength, students' decisions are not restricted to 4 options, whereby ties in focal networks can be created vs. avoided or maintained vs. dissolved, but rather  $4^2 - 4$  options in 2 networks – whereby weak-, casual-, or moderate ties can also be upgraded to strong ties by creating vs. avoiding ties in networks on higher- and/or maintaining vs. dissolving ties in networks on lower levels of strength, or whereby strong-, moderate-, or casual ties can also be downgraded to weak ties by maintaining vs. dissolving ties in networks on higher- and/or creating vs. avoiding ties in networks on lower levels of strength. Using this measurement, we can map friendship network evolution among youth on a more detailed level.



*Figure 2: Strength of ties: Friendship networks of an exemplary school class are arranged in facets according to the time they were observed ( $t_1$  - upper panel,  $t_2$  - intermediary panel,  $t_3$  - lower panel) and the strength of their underlying ties (strong- [5,6], moderate- [4,5], casual- [3,4] and weak ties [2,3] - from left to right panels). Colors indicate changes in tie strengths between observations: avoidance- vs. creation- or maintenance- vs. dissolution-, as well as upgrade- vs. downgrade of friendship ties.*

To capture the nature according to which ties can be expressed, we additionally collected data on advice- and trust networks with a similar design. First, students were shown the names of all peers in their class in a roster. Second, students were asked "How often did you contact your classmates to ask their advice about school or homework?" or "How often did you contact your classmates to talk about important matters?" respectively. Each of these inquiries were answered on a six-point scale ranging from "never" to "constantly", essentially yielding weighted advice- and trust network data. Because the methodology assumes binary network data, adolescents' advice- and trust tie strengths were dichotomized with levels 1-3 "never", "almost never" and "occasionally, less often than not" indicating an absence- and levels 4-6 "frequently, more often than not", "almost every time" and "constantly, whenever given the chance" indicating a presence of a tie. This cut-off level was chosen according to prior research investigating weighted communication networks Agneessens and Wittek 2012; Van de Bunt, Wittek, and Klepper 2005.

*Demographics.* Based on the size of the sample for which data are available, demographics can be grouped into three categories. First, data on students' age and gender were collected in both Switzerland and Poland. To determine students' age and gender, participants were asked to report the dates when they were born and whether they identify themselves as "0-male" or "1-female". Second, data on students' migration status and residential area were collected via schools' administrative records for Swiss participants. While some schools granted unrestricted access to their administrative data, including parents' religion, country of origin and home address, other schools restricted access to specific data that we requested, such as students' migration status with the distinction "0-domestic" vs. "1-foreign" origin or residential area as specified by zip codes. Third, data on parental educations and -occupations were self-reported by Polish participants. While data on parental education was collected according to a 3-point scale indicating "1-basic and lower secondary plus vocational tracks", "2-higher secondary plus lower tertiary tracks" as well as "3-higher tertiary plus academic tracks" Erola, Jalonen, and Lehti 2016, participants were asked to report their parents' occupations in their own words without restrictions imposed by predefined categories. The data on occupations was then categorized according to the 10 major groups of the international standard for the classification of occupations (ISCO) "0-armed forces", "1-managers", "2-professionals", "3-technicians and associate professionals", "4-clerical support workers", "5-services and sales workers", "6-skilled agricultural, forestry and fishery workers", "7-craft and related trades workers", "8-plant and machine operators and assemblers", "9-elementary occupations" Ganzeboom and Treiman 1996.

*Outcomes.* In the Swiss sample, data on academic achievement was collected via schools' administrative records. While some schools granted full access to the corresponding administrative records, other schools restricted access to records on specific subjects we requested, such as "Mathematics", "German", as well as "Overall performance". In the Polish sample, participants were asked to self-report data on their academic achievement for the corresponding subjects "Mathematics", "Polish" and "Overall performance". Considering the variety of systems for the evaluation of school performance across European countries, the grading systems in Switzerland and Poland show a remarkable similarity and are thus assumed to be sufficiently comparable. To assess students' well-being, participants were asked to think about their own lives in general at this moment in time and evaluate the extent to which they were satisfied with their lives on a scale from "1-not satisfied at all" to "12-completely satisfied Constanze Beierlein et al. 2014.

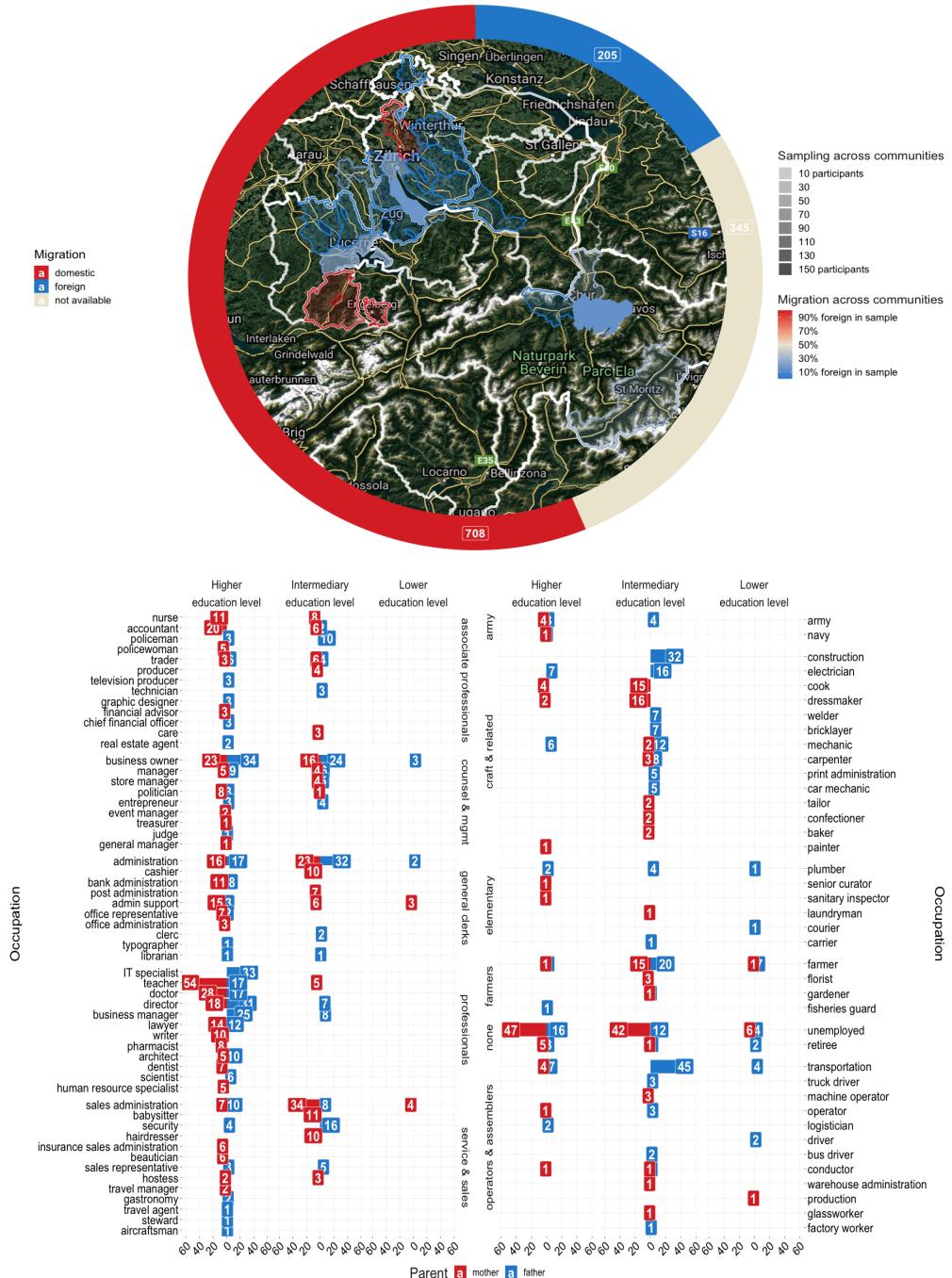
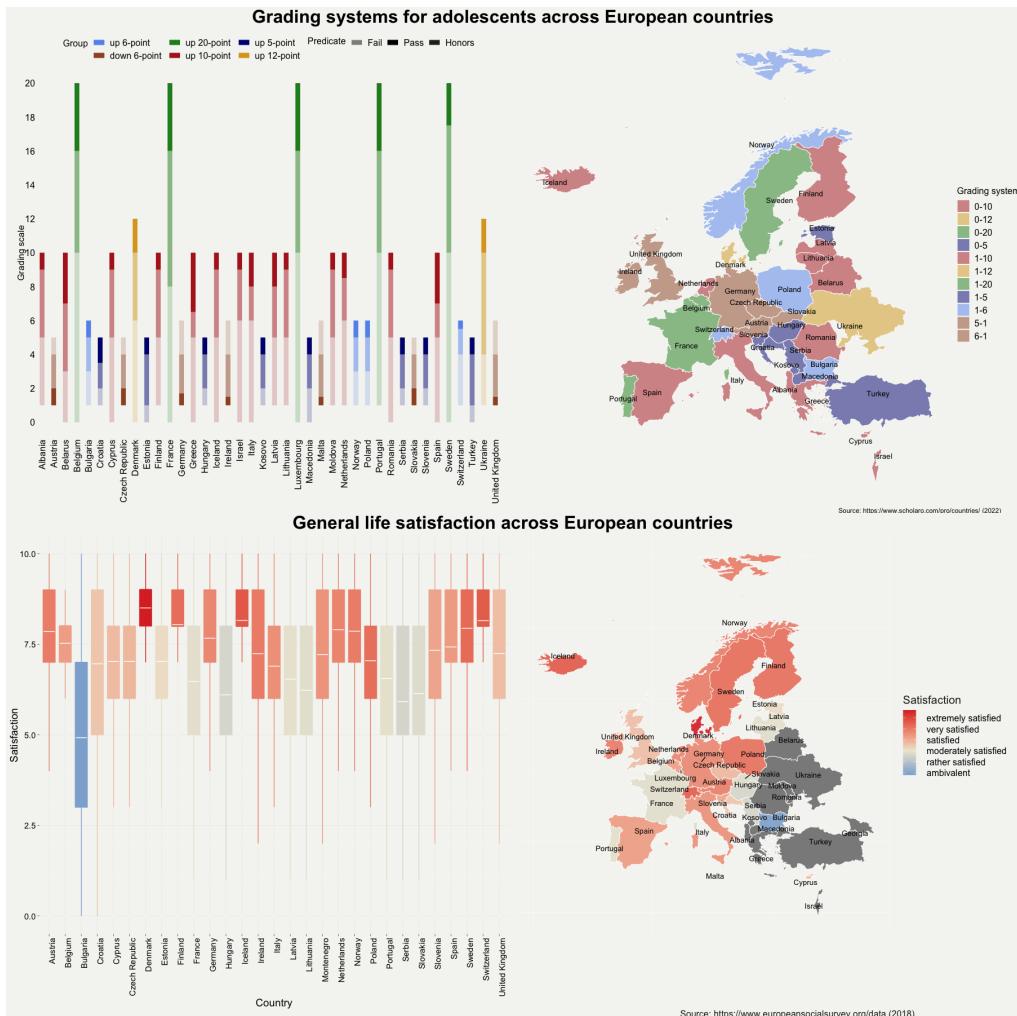


Figure 3: Demographics: Doughnut chart (top panel) shows adolescents' migration status and their residential areas across Swiss cantons. Colors show the number of participants with domestic- (red) or foreign (blue) origin, and areas where they predominantly live. Bar charts (bottom panels) show frequencies for combinations of parental educations (horizontal facets) and occupations (vertical facets) to occur among Polish adolescents. Colors indicate maternal (red) vs. paternal (blue) educations and occupations.



*Figure 4: Outcomes:* Bar charts (left panels) show the most prevalent grading systems as well as clusters with similar average life satisfaction among residents across European countries. Grades are translated to predicates that are identified with alpha levels ("Honors" - "very good & outstanding" - [colored bars], "Pass" - "satisfactory & good" - [opaque bars], as well as "Fail" - "unsatisfactory" - [transparent bars]. Countries with similar grading systems are classified using colors (up 6-point scale including Switzerland and Poland [cornflowerblue], down 6-point scale including Germany and Austria [maroon], up 20-point scale including France and Sweden [forestgreen], up 10-point scale including Spain and Italy [firebrick], up 5-point scale including Hungary and Turkey [navyblue], up 12-point scale including Ukraine and Denmark [goldenrod]) and visualized on a map (right panel). Similarly, countries with similar average life satisfaction are classified using colors ranging from "extremely-" or "very satisfied" [red] to "ambivalent" or "neither satisfied nor dissatisfied" [blue], and highlighted on a map (right panel).

### *Analytical approach*

In this section, we provide an overview of the stochastic actor-oriented modeling approach. Using stochastic actor-oriented models (SAOMs), we can overcome three major restrictions of earlier approaches to model friendship selection and social influence through their global conception of network structure and macro-level behavioral or attribute changes as the accumulation of micro-level decisions by individual actors. Alternative approaches Hanneke and Xing 2007; Robins and Pattison 2001; Frank and Strauss 1986 conceptualize each observation as a single discrete "event" and model the probability of observing a network with a given structure in relation to every possible permutation using a set of statistics. In SAOMs, panel waves are viewed as "snapshots" of an underlying process of continuous social change – meaning that differences between successive observations can be explained by any given network transformation or attribute change over time. The process of change is disassembled into the smallest possible components, referred to as "microsteps". In any given "microstep", a single actor is probabilistically selected to receive an adjustment opportunity – either on the network structure (tie creation, - dissolution or maintenance of the current structure) or attributes (level increase, -decrease or maintenance of the current level). At any given "microstep", no more than one adjustment can be made. Thus, each actor's decisions include the corresponding social context summarizing decisions made by other actors. The estimation procedure is meant to imitate the process whereby friendships evolve. In a first stage, rate functions specify the frequency and order of receiving adjustment opportunities. Although they may depend on individual attributes or network positions, we assume that both frequency and order are equally distributed among all actors for each transition between waves. In a second stage, an objective function – a selection of goals that the selected actors tend to pursue when opportunities to evaluate potential adjustments in their network- and attribute space present themselves – needs to be specified. The first component for decisions regarding network structures is given as  $e_i^{net}(x) = \sum_k \gamma_k^{net} s_{ik}^{net}(x)$ . In Equation 1,  $e_i^{net}(x)$  is the value of the objective function for actor  $i$  depending on the network state  $x$  and behavioural- or attitudinal state  $z$  of all network members.  $s_{ik}^{net}(x)$  are effects that correspond to possible objectives or norms an actor might follow when changing a network tie, and  $\gamma_k^{net}$  are corresponding effect strengths. Following theoretical considerations based on previous research, we consider "network endogeneous" effects such as reciprocity, triadic closure (the tendency of friends-of-friends to become friends), and preferential attachment (the tendency for actors with many existing ties to become more sociable or attractive), and "assortative" effects reflecting homophily based on gender, age, migration- or socioeconomic status and value priorities, as well as gregariousness and popularity (the tendency for students with specific value priorities to become more sociable or attractive). Formulae for all effects are presented in the Appendix.

In order to investigate the coevolution of network- and value priorities, effects that specify how the evolution of network structures depends on students' sociocultural- or socioeconomic traits and value priorities, must be complemented with effects for decisions regarding changes in value priorities, which is given as  $e_i^{att}(x, z) = \sum_m^{M-1} \sum_i^n \beta k^{att} s_{ik}^{att}(x(t_{m+1}) - x(t_m), z)$ . Instead of specifying the goals by which actors make decisions regarding their network structures, effects in Equation 2 drive actors' choices with respect to changes in value priorities. Effects  $s_{ik}^{att}(x, z)$  reflect the various goals, according to which actors might choose to adapt their value priorities, and  $\beta k^{att}$  are effect strengths. These effects include linear- and quadratic terms, controlling for the tendency to change value priorities in general and depending on the current level, a term specifying the tendency of students with different demographic traits (boys vs. girls, students with foreign- vs. domestic- as well as rich vs. poor socioeconomic backgrounds) to change value priorities, a term specifying peer influence conceptualized as students' tendency to converge

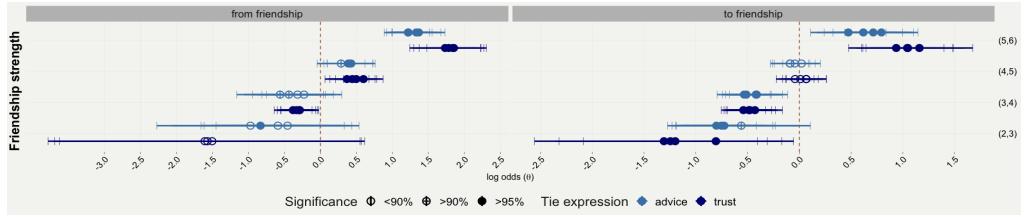
towards the value priorities of their friends. In summary, when given the opportunity to make an adjustment, actors will tend to emphasize goals that maximize the value of the relevant objective function. In the network structure component, students can do so by forming new ties, dissolving existing ties, or doing nothing; and in the behavioral component, they can do so by increasing- or decreasing their value priorities, or maintaining their current levels. The study's multi-level research design calls for a two-stage procedure. First, an unconventional Method of Moments is used to separately estimate parameters for each school class, while goodness-of-fit tests are used on data that is simulated on auxiliary statistics. To compare simulated- and observed data, auxiliary statistics cannot be compiled from the set that is used to estimate parameters. Complying with the guidelines for publications using SAOMs, adequate fit is required for auxiliary statistics on distributions of indegrees, outdegrees and attitudes, which was achieved for 62 out of 89 school classes that were eligible for model specification. Second, the parameters that are separately estimated for each school class are aggregated in a meta-analysis according to Snijders and Baerveldt 2003; Ripley, Snijders, Preciado, et al. 2011. Given that objective functions reveal how attractive specific tie configurations and behavioral- or attitudinal changes are for any given actor, parameters can be interpreted in a way that is similar to those obtained by logistic regression. Full model results are presented in the Appendix.

## RESULTS

The following section reports findings of models that have been specified to reveal preferences for tie expression, network structure, segregation or fragmentation of networks based on socio-demographic traits, values or modes of identity formation, as well as outcomes such as academic achievement and life satisfaction or well-being for each level of friendship strength. The results are summarized in different panels of Figures 5, 6, 7 and 8, each containing a subset of effects that are used to test hypotheses, as indicated by panel headers. Effects are shown on x-axes for each level of tie strength, as indicated on y-axes, starting with preferences for tie expression and network structure in Figures 5 & 6, preferences for the segregation or fragmentation of networks based on socio-demographic traits in Figure 7 and preferences for specific tie strengths associated with value priorities and modes of identity formation or academic achievement and life satisfaction outcomes in Figure 8. All meta-analyses including a complete list of effects along with the results of the goodness-of-fit tests corresponding to the models are shown in tables 1-16 of the Online Supplemental Information.

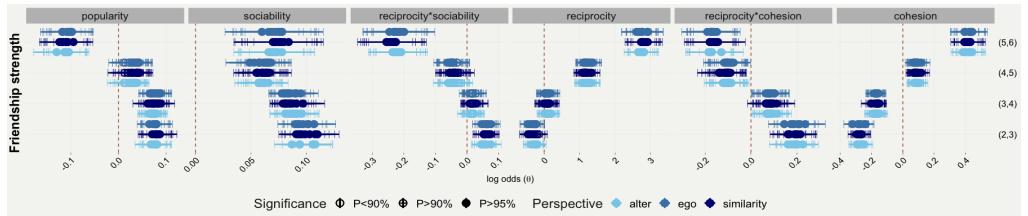
### *The strength-dependent nature of friendship ties*

The results provide consistent support for hypothesis H1. Meaningful tie expressions in the form of advice- or trust ties are associated with a certain minimum friendship tie strength of around 4. While moderate- or strong friendship ties generally foster the development of both kinds of tie expressions in 60 or 80 out of 100 occasions respectively, the odds for strong friendship ties to co-occur with ties expressing a trust nature are 1.51 to 1.65 times higher than the odds for them to co-occur with ties expressing an advice nature ( $1.732 < \log OR < 1.852$  vs.  $1.218 < \log OR < 1.365$ ,  $\bar{SE} = 0.233$  vs.  $\bar{SE} = 0.171$  for friendship → trust vs. friendship → advice;  $0.937 < \log OR < 1.161$  vs.  $0.474 < \log OR < 0.794$ ,  $\bar{SE} = 0.237$  vs.  $\bar{SE} = 0.190$  for trust → friendship vs. advice → friendship). However, this preference for trust- over advice ties disappears almost entirely at the level of moderate- ( $0.368 < \log OR < 0.597$  vs.  $0.286 < \log OR < 0.426$ ,  $\bar{SE} = 0.151$  vs.  $\bar{SE} = 0.169$  for



*Figure 5: Estimates  $\theta$  for entrainment effects capturing the extent to which friendship ties are promoting the formation of advice- and trust ties and vice versa, along with 90% and 95% confidence intervals are shown for models investigating teenagers' preferences for the expression of friendship ties: advice (steelblue) and trust (navyblue). Models are cast in facets according to the direction of entrainment (friendship to tie expression vs. tie expression to friendship), and control for endogenous processes of network formation. Full results are reported in Tables 6-18 of the SI Appendix.*

friendship→trust vs. friendship→advice) or casual friendship ties ( $-0.381 < \log OR < -0.288$  vs.  $-0.561 < \log OR < -0.438$ ,  $\bar{SE} = 0.133$  vs.  $\bar{SE} = 0.283$  for friendship→trust vs. friendship→advice;  $-0.540 < \log OR < -0.429$  vs.  $-0.533 < \log OR < -0.412$ ,  $\bar{SE} = 0.121$  vs.  $\bar{SE} = 0.134$  for trust→friendship vs. advice→friendship). While the development of trust- and advice tie expressions is generally not associated with casual- or weak friendship ties in 60 or 70 out of 100 occasions, the odds for weak friendship ties to co-occur with ties expressing an advice nature are 1.46 times higher than the odds for them to co-occur with ties expressing a trust nature ( $-0.561 < \log OR < -0.801$  vs.  $-0.806 < \log OR < -1.308$ ,  $\bar{SE} = 0.261$  vs.  $\bar{SE} = 0.462$  for advice→friendship vs. trust→friendship).

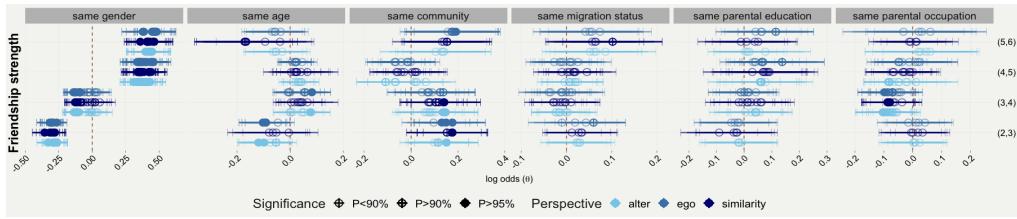


*Figure 6: Estimates  $\theta$  for structural effects: reciprocity, cohesion, activity and popularity, as well as interactions reciprocity\*cohesion and reciprocity\*activity, along with 90% and 95% confidence intervals are shown for models investigating teenagers' preferences for specific tie structures in strong- (5,6), moderate- (4,5), casual- (3,4) and weak-tied (2,3) friendship networks from different perspectives: alter (skyblue), similarity (navyblue) and ego (steelblue). Models are cast in facets according to structural effects. Full results are reported in Tables 6-18 of the SI Appendix.*

### The strength-dependent structure of friendship networks

Our findings also provide substantial support for hypothesis H2. On the local level, teenagers' preference for reciprocity and cohesion in friendship ties increases with each level of strength. Our findings show that in strong- and moderate-tied friendship networks, when given 100 opportunities to do so, teenagers will reciprocate friendship nominations 93 to 95 times ( $2.606 < \log OR < 2.930$ ,  $\bar{SE} = 0.209$ ) and 75 to 80 times ( $1.071 < \log OR < 1.328$ ,  $\bar{SE} = 0.120$ ) respectively, as well as close transitive triadic friendship relationships 60 to 61 times ( $0.384 < \log OR < 0.442$ ,  $\bar{SE} = 0.045$ ) and 52 to 53 times ( $0.063 < \log OR < 0.116$ ,  $\bar{SE} = 0.024$ ) respectively, as opposed to keeping dyadic

or triadic friendship relationships unbalanced. However, while the norm of reciprocity does not matter for teenagers in casual-tied friendship networks, when given 100 opportunities to do so in weak-tied friendship networks, teenagers are found to be 54 to 61 times more likely to keep dyadic friendship relationships unbalanced as opposed to reciprocating friendship nominations ( $-0.216 < \log OR < -0.460$ ,  $\bar{SE} = 0.121$ ). Moreover, when given the opportunity to do so 100 times respectively, teenagers in casual- and weak-tied friendship networks will keep triadic friendship relationships unbalanced 54 to 55 times ( $-0.150 < \log OR < -0.191$ ,  $\bar{SE} = 0.025$ ) and 56 to 58 times ( $-0.239 < \log OR < -0.322$ ,  $\bar{SE} = 0.027$ ), as opposed to closing transitive triadic friendship relationships. On the global level, teenagers' sociability and popularity in terms of the number of friendship nominations they issued and received so far, decreases with each level of friendship strength. While teenagers with a large number of existing outgoing ties in strong- and moderate-tied friendship networks will create additional outgoing ties approximately 51 and 52 out of 100 times ( $0.060 < \log OR < 0.084$ ,  $\bar{SE} = 0.017$ ;  $0.049 < \log OR < 0.068$ ,  $\bar{SE} = 0.009$  respectively), teenagers with a large number of existing incoming ties will attract additional incoming ties 52 to 53 times ( $0.107 < \log OR < 0.130$ ,  $\bar{SE} = 0.022$ ) and 50 to 51 times ( $0.025 < \log OR < 0.045$ ,  $\bar{SE} = 0.014$ ). Moreover, while teenagers with many existing outgoing ties in casual- or weak-tied friendship networks will create additional outgoing ties approximately 52 and 53 out of 100 times ( $0.078 < \log OR < 0.097$ ,  $\bar{SE} = 0.007$ ;  $0.087 < \log OR < 0.110$ ,  $\bar{SE} = 0.008$  respectively), additional ties to teenagers with a large number of existing incoming ties will be created approximately 51 and 52 times ( $0.062 < \log OR < 0.089$ ,  $\bar{SE} = 0.011$ ;  $0.065 < \log OR < 0.087$ ,  $\bar{SE} = 0.015$  respectively).



*Figure 7: Estimates  $\theta$  for homophily effects capturing the extent to which friendship ties to peers that are similar on demographic traits are sought or avoided, along with 90% and 95% confidence intervals are shown for models investigating teenagers' preferences for homophily from different perspectives: alter (skyblue), similarity (navyblue) and ego (steelblue). Models are cast in facets according to demographics (gender, age, residential community, migration status, parental education and -occupation), and control for endogenous processes of network formation. Full results are reported in Tables 6-18 of the SI Appendix.*

### The strength-dependent segregation of friendship networks

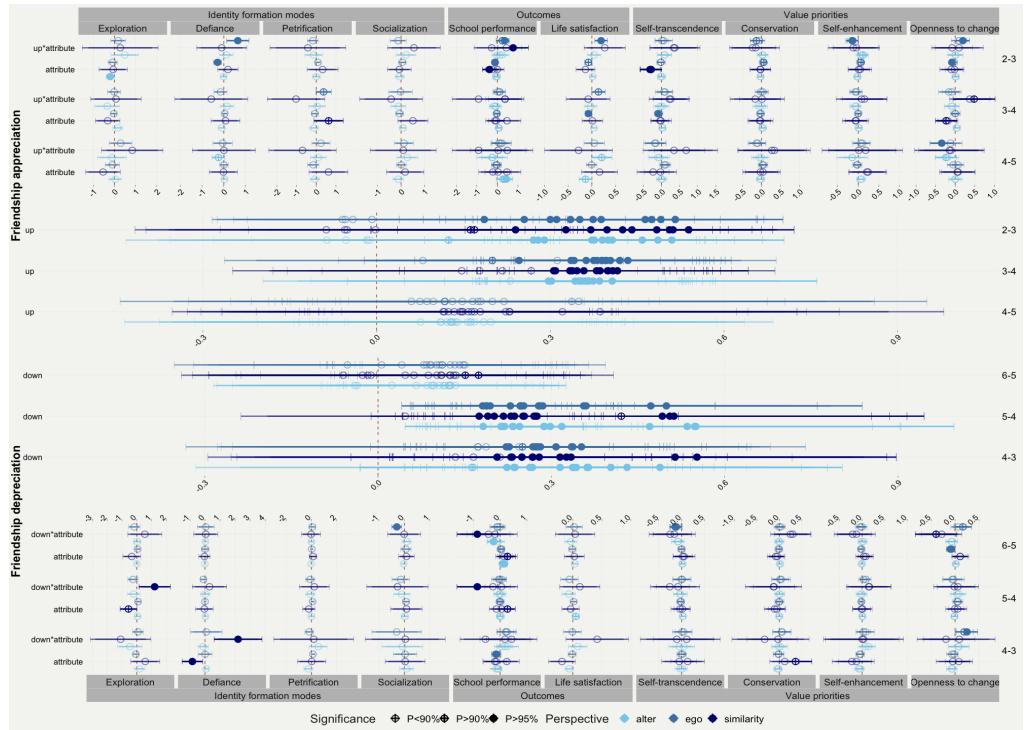
Hypothesis H3 is also consistently supported by our findings. In terms of the tendency to seek or avoid friendship relationships with peers that have similar traits as a function of the corresponding levels of strength, functions for demographics can be classified into three different forms. First, linear forms are about demographics, based on which teenagers in weak-tied friendship networks avoid contact with similar peers, but seek contact with similar peers in strong-tied friendship networks. Our findings show that gender homophily is an increasing function of the strength of friendship ties, whereby teenagers in weak-, casual-, moderate-, and strong-tied friendship networks will create ties to similar peers 41 to 43 times ( $0.358 < \log OR < 0.480$ ,  $\bar{SE} = 0.073$ ), 47 to 49 times ( $0.310 < \log OR < 0.456$ ,  $\bar{SE} = 0.059$ ), 58 to 61 times ( $-0.083 < \log OR < -0.140$ ,  $\bar{SE} = 0.045$ ), and 59 to 62 times ( $-0.264 < \log OR < -0.355$ ,

$\overline{SE}=0.041$ ) respectively, if given 100 opportunities to do so. Second, u-shaped forms are about demographics, based on which teenagers tend to seek contact to similar peers in both strong- and weak-tied friendship networks, but rather try to avoid contact to similar peers in moderate- or casual-tied friendship networks. The results demonstrate that homophily based on residential community, migration status and parental occupation is positive in strong- ( $0.153 < \log OR < 0.191$ ,  $\overline{SE}=0.097$  for residential community and  $\log OR=0.102$ ,  $\overline{SE}=0.056$  for migration status), negative in moderate- ( $\log OR=-0.109$ ,  $\overline{SE}=0.063$  for residential community and  $-0.080 < \log OR < -0.084$ ,  $\overline{SE}=0.045$  for parental occupation) or casual- ( $0.105 < \log OR < 0.147$ ,  $\overline{SE}=0.070$  for residential community and  $-0.069 < \log OR < -0.103$ ,  $\overline{SE}=0.044$  for parental occupation) and positive in weak-tied friendship networks ( $0.117 < \log OR < 0.176$ ,  $\overline{SE}=0.071$  for residential community and  $\log OR=0.060$ ,  $\overline{SE}=0.036$  for migration status). Third, inverse u-shaped forms are about demographics, based on which teenagers tend to seek contact to similar peers in moderate- or casual-tied friendship networks, but rather try to avoid contact to similar peers in both strong- and weak-tied friendship networks. Our findings indicate that homophily based on age, and parental education is negative in strong- ( $-0.166 < \log OR < -0.171$ ,  $\overline{SE}=0.096$  for age), positive in moderate- ( $0.062 < \log OR < 0.138$ ,  $\overline{SE}=0.050$  for parental education) and casual- ( $0.055 < \log OR < 0.082$ ,  $\overline{SE}=0.035$  for age) and negative in weak-tied friendship networks ( $-0.053 < \log OR < -0.119$ ,  $\overline{SE}=0.040$  for age).

#### *Determinants and outcomes associated with different tie strengths*

Our findings provide partial support for Hypothesis H4. First, teenagers emphasizing socially oriented self-transcendence values seem to have a preference for maintaining strong ties rather than creating moderate- ( $-0.141 < \log OR < -0.117$ ,  $\overline{SE}=0.064$ ) or casual ties ( $\log OR=-0.099$ ,  $\overline{SE}=0.050$ ). The latter are only preferred if teenagers emphasizing self-transcendence are in a social environment of similar peers ( $0.290 < \log OR < 0.320$ ,  $\overline{SE}=0.146$ ). Second, teenagers prioritizing personally oriented openness to change values seem to have a preference for moderate ties. While casual-, moderate- or strong ties are unlikely to be created unconditionally ( $\log OR=-0.084$ ,  $\overline{SE}=0.042$  for casual ties,  $\log OR=-0.233$ ,  $\overline{SE}=0.135$  for moderate ties and  $\log OR=-0.344$ ,  $\overline{SE}=0.077$  for strong ties), existing weak ties are likely to be upgraded to casual ties ( $\log OR=0.197$ ,  $\overline{SE}=0.094$ ), whereby the latter are more likely to be further upgraded to moderate ties ( $\log OR=0.483$ ,  $\overline{SE}=0.269$ ) rather than created to downgrade from moderate ties ( $0.190 < \log OR < 0.249$ ,  $\overline{SE}=0.106$ ). Third, while teenagers emphasizing personally oriented self-enhancement values seem to have a preference for casual- or weak ties, contrary to our expectations, a similar picture also emerges for teenagers with socially oriented conservation values. While casual ties are likely to be created unconditionally ( $\log OR=0.057$ ,  $\overline{SE}=0.033$  for conservation values,  $\log OR=0.066$ ,  $\overline{SE}=0.032$  for self-enhancement values), existing weak ties are not likely to be upgraded to casual ties ( $\log OR=-0.135$ ,  $\overline{SE}=0.078$  for conservation values,  $-0.145 < \log OR < -0.136$ ,  $\overline{SE}=0.070$  for self-enhancement values).

The results also provide partial support for Hypothesis H5. Higher life satisfaction seems to be associated with strong ties. On the one hand, teenagers with higher life satisfaction are not likely to create weak- ( $\log OR=-0.074$ ,  $\overline{SE}=0.038$ ) or casual ties unconditionally ( $\log OR=-0.073$ ,  $\overline{SE}=0.035$ ), but rather prefer to upgrade weak to casual- ( $\log OR=0.194$ ,  $\overline{SE}=0.068$ ) and casual- to moderate ties ( $\log OR=0.138$ ,  $\overline{SE}=0.073$ ). On the other hand, while their peers appear indifferent about creating moderate ties to them ( $-0.135 < \log OR < 0.051$ ,  $\overline{SE}=0.031$ ), moderate ties are likely to be upgraded to strong ties, should they already exist ( $\log OR=0.207$ ,  $\overline{SE}=0.111$ ).



**Figure 8: Estimates  $\theta$  for entrainment effects capturing the extent to which weak friendship ties (2,3) are promoting the emergence of casual- (3,4), moderate- (4,5) or strong friendship ties (5,6) (up: 2-3, 3-4, 4-5) and vice versa (down: 6-5, 5-4, 4-3), selection effects based on attributes from different perspectives: alter (skyblue), similarity (navyblue) and ego (steelblue) as well as interactions attribute\*up or attribute\*down along with 90% and 95% confidence intervals are shown for models investigating teenagers' preferences for creating or maintaining friendship ties at a specific level (2,3 vs. 3,4 vs. 4,5 vs. 5,6), as well as the appreciation- (up: 2-3, 3-4, 4-5) or depreciation (down: 6-5, 5-4, 4-3) of friendship ties to a more preferred level. Models are cast in facets according to attributes (modes of identity formation, higher order values as well as school performance- and life satisfaction outcomes), and control for endogeneous processes of network formation. Full results are reported in Tables 6-18 of the SI Appendix.**

However, contrary to our expectations, higher academic achievement is also associated with strong- rather than weak friendship ties. On the one hand, while teenagers with higher academic achievement are not likely to create weak- ( $-0.117 < \log OR < -0.120$ ,  $\bar{SE} = 0.056$ ) or casual ties unconditionally ( $-0.137 < \log OR < -0.153$ ,  $\bar{SE} = 0.074$ ), they rather prefer to upgrade weak- to casual ties ( $0.247 < \log OR < 0.355$ ,  $\bar{SE} = 0.131$ ), particularly if they are in an environment with similar peers ( $\log OR = -0.391$ ,  $\bar{SE} = 0.167$  for creating weak ties unconditionally and  $\log OR = 0.764$ ,  $\bar{SE} = 0.408$  for upgrading weak- to casual ties). On the other hand, their peers are not only likely to unconditionally create both strong- ( $0.089 < \log OR < 0.162$ ,  $\bar{SE} = 0.059$ ) and moderate ties ( $0.281 < \log OR < 0.430$ ,  $\bar{SE} = 0.175$ ) to them, they show a clear preference for strong ties ( $-0.234 < \log OR < -0.244$ ,  $\bar{SE} = 0.129$  for downgrading strong- to moderate ties). Moreover, in an environment with similar peers, teenagers with higher academic achievement exhibit a similar tendency themselves ( $\log OR = 0.276$ ,  $\bar{SE} = 0.149$  for creating strong ties unconditionally and  $\log OR = -0.849$ ,  $\bar{SE} = 0.358$  for downgrading strong- to moderate ties).

## DISCUSSION

This study contributes a comprehensive typology based on network selection effects and how they differ in strong-, moderate-, casual- and weak-tied friendship networks. Using the effects included in this typology, we investigate differences in the way ties are expressed, as well as the way preferences for specific structures, segregations or fragmentations evolve in the corresponding networks, and can thus identify different forms of social capital, as well as outcomes that are associated with decisions to change the strength of these ties. The empirical setting of this study is a longitudinal panel of 3'936 students clustered in the social environments of 171 school classes in Switzerland and Poland.

### *Forms of social capital revealed by the expression of friendship ties*

First, bonding- and bridging forms of social capital may be differentiated through the relative extent to which friendship ties co-occur with trust- or advice ties at specific levels of strength. Our findings suggest that strong- and weak friendship ties have a fundamentally different nature. On the one hand, strong friendship ties are a foundation that fosters the development of many meaningful tie expressions, for as many as 6-8 out of 10 co-occur with both trust- and advice ties. Moreover, the co-occurrence with trust ties is around 1.58 times more prevalent than the co-occurrence with advice ties, which suggests that strong friendship ties are rather associated with bonding social capital and the exchange of emotional- and appraisal support. On the other hand, weak friendship ties are generally not associated with meaningful tie expressions, as only 3-4 out of 10 co-occur with trust- or advice ties. However, if they are associated with meaningful tie expressions, the co-occurrence with advice ties is around 1.46 times more prevalent than the co-occurrence with trust ties, which indicates that weak friendship ties are rather associated with bridging social capital and the exchange of instrumental- and informational social support. Moreover, the linear relationship between the strength- and expression of ties also indicates that between the two extremes, there are hybrid forms, which exhibit more balanced combinations of trust- and advice expressions, and thereby give access to more balanced combinations of bonding- and bridging forms of social capital.

### *Forms of social capital revealed by the structure of friendship networks*

Second, the image that the expression of ties revealed, can also be seen in the structure of ties that is conducive for the accessibility of the corresponding forms of social capital in friendship networks on any given level of strength – either local structures such as the norm of reciprocity and cohesion Kawachi et al. 1997 or global structures such as the sociability or popularity within networks. Once again, our findings suggest that strong- and weak friendship ties have a fundamentally different nature. On the one hand, teenagers in strong-tied friendship networks, where dyadic- or triadic friendship ties are balanced around 93-95 or 60-61 out of 100 times respectively, primarily have access to bonding social capital. Strong-tied friendship networks create a sense of communalities such that even unbalanced ties can survive if they are embedded within cohesive communities, and thus facilitate action - either to support collective decision-making or to enforce social norms. On the other hand, teenagers in weak-tied friendship networks, where unbalanced dyadic- or triadic friendship ties are maintained around 54-61 and 56-58 out of 100 times respectively, primarily have access to bridging social capital. Weak-tied friendship networks create a sense of individuality, whereby unbalanced ties can only survive outside cohesive communities, and tend to

be dissolved or balanced inside-, which yields a segregation or fragmentation that facilitates access to- and exchange of non-redundant information as well as opportunities. This image is further validated on the global level. On the one hand, aversion against the norm of reciprocity or cohesion favours the emergence of structural holes or bridging ties connecting different communities within the network, which is reflected in a positive preference for popularity in weak-tied friendship networks, where teenagers with a large number of existing incoming ties are likely to attract additional ties. On the other hand, aversion against popularity is a reflection of an absence of structural holes or bridging ties, which can be observed in strong-tied friendship networks, where teenagers' preferences for the norm of reciprocity and cohesion are unlikely to make a large number of existing incoming ties attractive for additional ties. Moreover, between these pure forms of bonding- and bridging social capital that are predominantly accessible via strong- and weak-tied networks respectively, our findings on structural main effects - particularly teenagers' ambivalence regarding their preferences for the norm of reciprocity or cohesion combined with an ambivalence regarding the preference for popularity based on the number of existing friendship ties - indicate a presence of hybrid forms of social capital that can be accessed via moderate- and casual-tied networks.

#### *Forms of social capital revealed by the segregation or fragmentation of friendship networks*

Third, different forms of social capital can also be revealed based on how the corresponding networks are segregated or fragmented depending on the extent to which adolescents emphasize similarity – both in ascribed properties such as their gender and age as well as inherited characteristics such as their migration status, residential area, as well as their parents' occupations or levels of education. McPherson, Smith-Lovin, and Cook 2001. While our findings reveal linearly increasing functions of preferences for similarity based on gender with increasing levels of friendship strength, u-shaped functions are shown for similarity based on age and parental education, and inverse u-shaped functions are revealed for similarity based on residential area, migration status and parental occupation.

On the one hand, the homogeneity regarding gender, residential area, parental education and migration status observed in strong-tied networks suggests that the social capital provided for the corresponding members mainly takes the form of bonding social capital. Arguably, the exchange of emotional- or appraisal support is more effective and efficient among adolescents identifying with the same gender or growing up in families with the same parental education, migration status or living in the same residential area, as they are in a similar situation and are likely to have experienced similar challenges. On the other hand, weak-tied networks are more likely to facilitate access to bridging social capital through the heterogeneity based on gender and age, as well as the indifference regarding similarity based on parental education and -occupation observed in these networks. Social networks that are heterogeneous in terms of gender and age, as well as composed of adolescents growing up in families with different socio-economic status include a diversity of perspectives, which is conducive for the exchange of instrumental- or informational support.

But what about moderate- and casual-tied networks? While strong- and weak-tied networks are diametrically opposed to each other in the way their respective systemic utility functions produce homophily or heterophily regarding gender, the preferences for similarity regarding age, residential area, migration status as well as parental education and occupation are more or less aligned in both strong- and weak-tied networks, and more or less opposed to the corresponding preferences in moderate- and casual-tied networks. However, the access to hybrid forms of social

capital, which one could assume to be provided by moderate- and casual-tied networks due to their ambivalent tie expressions and network structures, is nevertheless reflected in ambivalent preferences for similarity regarding gender, age, residential area as well as parental education and -occupation.

#### *Drivers and outcomes associated with changes in tie strength and matching forms of social capital*

Meta-analyses investigating drivers for changing the strength of friendship ties along with the outcomes associated with such changes indicate that teenagers' motivations for changing the strength of friendship ties should be classified based on the perspective that distinguishes between motivations that are associated with self-protective vs. self-expansive values Schwartz et al. 2012.

Adolescents emphasizing self-protective motivations such as conservation and self-enhancement values appear to prefer casual- or weak ties. Thus, while the resources of adolescents such as these are largely preoccupied in the pursuit of their own goals, weak ties appear to be the preferred medium for the allocation of available resources, serving both personally- and socially oriented motivations - such as the control over resources- and the preservation of harmony in their social networks. However, for adolescents emphasizing self-expansive motivations such as self-transcendence- and openness to change values, resources are largely available to be committed to the creation and maintenance of relationships. On the one hand, adolescents emphasizing self-transcendence values seem to prefer strong ties. While their self-expansive motivation indicates that they have a high capacity to commit resources to the creation and maintenance of relationships, their social orientation indicates a willingness to commit as many resources as are necessary to provide the kind of support their relationship partners need. On the other hand, for adolescents emphasizing openness to change values, moderate ties seem to be the medium of choice for the exchange of social support, given their capacity to commit resources and their motivation to spread available resources on as many relationships as can be sustained based on a moderate commitment, as well as their peers' interests in committing resources to creating and maintaining corresponding relationships with them.

Moreover, in line with this perspective, strong ties are associated with higher school performance. On the one hand, adolescents outperforming their peers at school are attractive as targets of friendship nominations - preferably for strong- but also for casual friendships. On the other hand, while friendship nominations of the latter nature might create conflicts, as highly outperforming adolescents prefer not to engage in casual- or weak-tied relationships, their indifference regarding strong ties might favour the odds for observing ties of that nature in relationships involving adolescents with higher levels of school performance. Thus, the positive association between strong ties and school performance is mainly built on the popularity that adolescents with higher levels of school performance enjoy, rather than on their preferences.

Further supporting this perspective, strong ties are associated with higher life satisfaction. Initially, out of concern that they might set an unobtainable standard for social comparison, adolescents with a higher life satisfaction seem more attractive for weak-ties. In return, such weak-tied friendship nominations are likely to be accepted based on the prospect that weak-ties might be a good foundation to build on, as highly satisfied adolescents prefer to upgrade weak- to casual- and moderate ties. Moreover, such friendship fortifications might be reciprocated based on the prospect that once moderate ties to highly satisfied teenagers exist, peers are highly motivated to upgrade moderate- to strong ties. Thus, similar to school performance, the positive association between strong ties and life satisfaction is not so much built on the preferences of adolescents that are more satisfied with their lives, but rather on the popularity they enjoy.

## LIMITATIONS AND OUTLOOK

To capture the systemic nature and embeddedness of social relationships in networks, the structure in our data is hierarchical with classes nested in schools, and we assume identical utility functions for adolescents across classes. However, meta-analyses investigating structural- and relational properties have revealed considerable heterogeneity across school classes. Further research is needed to investigate the capacity of macro-level properties in social systems to explain such heterogeneity. In their function as potential key informants of their associated classes, teachers might be considered as important drivers for structural- and relational properties of organizational foci Algesheimer, Bagozzi, and Dholakia 2018. On the one hand, multi-level analyses investigating the impact of class-level properties such as the class size, the composition or diversity within classes as well as teacher attributes and classroom organizations could capture observed heterogeneity to a great extent Hallinan 1979. On the other hand, random coefficient analyses would allow parameters to vary across classes and thus capture unobserved heterogeneity.

Moreover, in this article, we argue that school classes are the center of adolescents' social universes, and thus capture most of their social activities. However, moving from early to late adolescence, adolescents' social activities are likely to transcend the boundaries of school classes to a great extent. Thus, investigating effects driving the selection of friends on specific levels of strength, and the structures of the corresponding networks within and across school classes would generate invaluable contributions regarding the corresponding impact of organizational foci such as school classes.

Finally, this articles' efforts are directed towards building a greater understanding for the evolution of structural properties as well as distinct forms of social capital embedded in strong-, moderate-, casual- and weak friendship ties, and their association with outcomes such as school performance and well being. However, while the corresponding insights provide a solid foundation, they are built on self-reported data on adolescents' strength of friendship ties. To increase their objectivity and reliability, the systemic logic that drives teenagers' decisions on the amount of time spent in the company of peers within and across school classes should be validated using network data based on wearable proximity sensors. Moreover, causal links between the access to- and mobilization of different forms of social capital and outcomes such as these, should be revealed through interventions focused on seating arrangements that are conducive for the emergence of corresponding structural- and relational properties in social networks.

## CONCLUSIONS

We conclude that future research should further investigate the heterogeneity in structural- and relational properties of friendship networks on different levels of strength across school classes. Furthermore, additional research is needed to investigate the extent to which distinct forms of social capital are accessible within or across social networks that are centered around school classes, ideally based on network data, as revealed by aggregating the companionship among participants over time. Finally, we call on future research to build on the knowledge generated in this article and design interventions that reveal causal links between the access to distinct forms of social capital provided by social networks based on specific tie strengths and outcomes such as educational achievement and well being.

## CONFLICTS OF INTEREST

All authors have nothing to disclose.

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