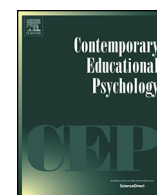




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Trajectories of psychological need satisfaction from early to late adolescence as a predictor of adjustment in school

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ABSTRACT

The present longitudinal study described developmental patterns of perceived psychological need satisfaction (PNS) from the end of elementary school to the end of high school and their contribution to school adjustment at the end of high school. The first goal thus consisted in estimating whether developmental trajectories of perceived PNS were homogeneous (i.e., all students reported similar developmental patterns) or heterogeneous (i.e., there were several distinct developmental trajectories). The second goal involved comparing trajectory groups on dimensions of school adjustment (social, academic, and emotional–personal). A stratified sample of 609 students (277 boys, 332 girls) was surveyed annually on a 6-year period, from the end of elementary school until the end of high school. Results of group-based trajectory modeling (Nagin, 1999, 2005) revealed that developmental trajectories of PNS were heterogeneous for autonomy, competence, and relatedness. For each need, four distinct developmental patterns were identified. These trajectories varied in shape, composition, and magnitude such that some students reported increasing PNS over time while others reported stable or decreasing PNS. Results from multivariate analyses revealed that students in upper trajectories (e.g., reporting higher levels of PNS, either stable or increasing) generally reported higher levels of academic, social, and personal–emotional adjustment at the end of high school. Results are discussed with respect to their implications for research and interventions.

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1. Introduction

Secondary education has several goals: instruct, socialize and qualify (Quebec Ministry of Education, Leisure and Sports, 2006). Qualification is operationalized as the earning of a high school diploma, issued once students successfully performed standardized tests and succeed core disciplines. Reaching this milestone implies that students have acquired knowledge and developed skills across the high school years, and that they have adjusted to the different academic demands and challenges. Because of the demands and stress placed upon students at the end of high school, their capacities to adjust are particularly put to the test.

While most students can be expected to adjust well to school demands and challenges, some of them experience difficulties that

can be exacerbated in periods of instability, such as at the end of high school where qualification examinations take place and significant decisions regarding their future need to be made (e.g., going to college, entering the job market). In order to better meet the needs of more vulnerable students and prevent the crystallization of their difficulties, it becomes important to better identify the protective factors on which we can intervene in the school context. A factor likely to shield students' adjustment capacity is the extent to which their psychological needs are being met within school. The present study therefore sought to understand how patterns of perceived psychological need satisfaction throughout the high school years can predict students' adjustment at the end of high school, using a self-determination perspective.

1.1. Psychological need satisfaction

Self-determination theory (Deci & Ryan, 2000; Deci & Vansteenkiste, 2004) is a macro-theory which postulates that all individuals have innate psychological needs whose satisfaction is essential for development, functioning, and well-being. First is the *need for autonomy* according to which individuals strive to be at the origin of their actions, to be volitional and intentional in their doings (deCharms, 1968; Deci & Ryan, 1991). In the school context, this

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need will be satisfied if, for instance, student feels volitional in their decision to engage in academic activities. Second is the *need for competence*, which involves being effective in producing changes on one's environment (White, 1959). When students perceive themselves as able to complete a class assignment, this need is being satisfied. Lastly is the *need for relatedness* and it refers to the need to establish significant and satisfying relationships with other individuals (Baumeister & Leary, 1995). This need will be satisfied when, for example, students perceive themselves as emotionally close to their fellow classmates.

These needs were shown to be innate, universal, and fundamental in the development of an individual's full potential (Deci & Ryan, 2000). The satisfaction of the basic psychological needs constitutes the nutriment on the basis of which individuals can integrate and actualize themselves as well as regulate their behaviors and emotions (Deci & Vansteenkiste, 2004; Ryan, 1995, 1998). Hence, to the extent that individuals perceive their psychological needs as being satisfied, they will experience benefits such as physical and psychological well-being, autonomous motivation, and effective coping strategies (Ntoumanis, Edmunds, & Duda, 2009; also see Deci & Ryan, 2000; Deci & Vansteenkiste, 2004; Ryan, 1995, 1998). Alternatively, perceived need thwarting predicts a host of negative outcomes characteristic of ill-being.

1.2. Psychological need satisfaction and adjustment in school

In education, research has documented the importance for students to perceive their psychological need as being satisfied, which has been associated with various dimensions of adjustment. Among studies that examined psychological need satisfaction (PNS) globally (i.e., averaging all needs in a single score), two general conclusions emerge: First, these studies showed that perceived PNS predicted higher scores of emotional adjustment, operationalized as high levels of subjective well-being and low levels of ill-being (Milyavskaya et al., 2009; Véronneau, Koestner, & Abela, 2004). Second, these studies showed that perceived PNS predicted higher scores of academic adjustment, operationalized as high levels of autonomous motivations, adaptive learning strategies, classroom engagement, low levels of dropout intentions, and high achievement (Betoret & Artiga, 2011; Doménech-Betoret & Gómez-Artiga, 2014; Jang, Kim, & Reeve, 2012; Milyavskaya et al., 2009; Sheldon & Krieger, 2007). The studies that examined the contribution of each need separately reported similar findings. Specifically, emotional and academic adjustment was predicted by the satisfaction of all three needs (Ciani, Sheldon, Hilpert, & Easter, 2011; Cox, Smith, & Williams, 2008; Gillison, Standage, & Skevington, 2008; Sheldon & Krieger, 2007; Véronneau et al., 2004).

In light of these findings, we expected that students' adjustment in school would be higher for students who perceive their psychological needs as being satisfied. We relied on the conceptualization of Baker and Stryk (1984, 1989), which distinguishes between academic, social, and personal–emotional adjustment. *Academic adjustment* pertains to the way students deal with the demands associated with their academic work. It includes elements such as their attitudes, efforts, and so on. *Social adjustment* refers to how students deal with the demands of the academic community and includes elements such as responsiveness to social activities and their appreciation of their social environment in school. Finally, *emotional–personal adjustment* involves the way students come to terms with an environment characterized by pressure and stress. It involves psychological as well as physical functioning. While there are no studies, to our knowledge, that related this conceptualization of adjustment to perceived PNS, we expect the satisfaction of students' needs for autonomy to predict all forms of adjustment based on the studies reviewed above.

1.3. Examining psychological need satisfaction longitudinally

According to the stage–environment fit hypothesis (Eccles, 2004; Eccles et al., 1993), one explanation for middle and high students' academic decline is the diminished opportunities where they can express their needs for autonomy and so on (Eccles, Lord, & Midgley, 1991; Eccles & Roeser, 2009). Indeed, during the transition to adolescence, students experience a variety of changes; their bodies and cognitive capacities change, their perception of themselves and their social relationships evolve (Brown & Larson, 2009; Harter, 1986; Harter, Stocker, & Robinson, 1996; Inhelder & Piaget, 1958; Kuhn, 2009; Laursen & Collins, 2009; Lerner & Steinberg, 2009). Unfortunately, academic environments do not necessarily support the satisfaction of adolescents' needs or, if they do, these efforts might not be perceived as such by students. In the present research, the focus will be on how students perceive their psychological needs to be satisfied.

In addition to person–environment mismatching, other reasons such as variations in class composition and teachers across school subjects can lead to fluctuations in PNS over time. Hence, across high school, we might expect students in the high school years to report fluctuation in the satisfaction of the psychological needs. Whether these fluctuations apply to all students remains to be investigated, and will largely depend on the way change is modeled, which is the topic of the next section. We first review research on changes in PNS.

Typically, studies on perceived PNS have used cross-sectional (i.e., one data wave) or short-term prospective (i.e., two data waves) designs and, in the education domain, only a few studies examined perceived PNS and even fewer surveyed a long period of time (1 year or beyond). There is thus a strong need for developmental research on students' perceived PNS that uses a truly longitudinal design (i.e., three data waves or more). Studying these processes over longer periods of time will inform us on the specific moments where PNS is more salient, and for whom. Such vital knowledge will in turn guide future interventions within the school setting.

To our knowledge, only one study examined students' perceived PNS using a truly longitudinal design (Wandeler & Bundick, 2011). This large-scale longitudinal study surveyed 414 university students over a 3-year period where they completed measures of PNS in their training program. Their findings suggest that competence and relatedness satisfaction were more stable over a 3-year training period whereas stability coefficients for autonomy satisfaction were lower. We might consequently expect more fluctuations, or distinct developmental patterns, for autonomy satisfaction, although the sample of this study included young adults. We also found one prospective study that examined students' perceived PNS over a 7-month period. Data come from a large-scale longitudinal study that surveyed 1004 elementary school students from Grades 3 to 6 over a 4-year period (Marchand & Skinner, 2007). Findings revealed high stability for all three needs (r s ranged from .55 to .67), with some grade-level effects. These two studies are difficult to compare or aggregate, given their differences in design and sample. We can nevertheless expect some stability on developmental patterns of perceived PNS.

In the related domain of physical education class, a first, prospective study used data from a longitudinal study surveying 455 students from grade 6 until the end of middle school (Cox et al., 2008). Here, 356 students provided measures of perceived PNS toward physical education, 1 year apart. Findings revealed a statistically significant decrease in the satisfaction of competence but not of other needs. The second study used an event-sampling design where 178 students from grades 6 to 9 completed measures of perceived PNS in physical education class 3 months in a row (Taylor, Ntoumanis, Standage, & Spray, 2010). While precise change statistics were omitted, means and standard deviations were reported,

allowing the calculation of confidence intervals. These posterior analyses suggested a significant increase in autonomy satisfaction from Time 1 to Time 3.

1.3.1. Studies that examined one or two needs

Some studies indirectly examined the satisfaction of one or more psychological needs in the education domain through perceptions of autonomy, competence, or relatedness. While these studies were generally not anchored in a need-based approach or only focused on one need, they can be informative for predicting patterns of change in perceived PNS across adolescence. We identified two studies that examined *autonomy* using a truly longitudinal design. In a first study, 41 middle school students completed measures of perceived autonomy three times over the course of a year (Isakson & Jarvis, 1999). Perceived autonomy was stable over this period, suggesting that autonomy satisfaction remained the same over a 1-year period. The second study surveyed 81 adolescents enrolled in a soccer academy, where they completed a measure of autonomy three times over an 8-month period (Laurin & Nicolas, 2009). Their findings revealed a decrease in perceived autonomy. The results from these two studies are difficult to integrate due to their difference in subject (i.e., focusing on school in general vs. soccer) or to the fact that change might not be homogeneous (i.e., distinct profiles might exist). The next section is devoted to this issue.

With respect to *competence*, research on the akin concepts of ability self-concept and competence beliefs has documented a decreasing trend across the high school years in specific domains like math, reading and sports (Durik, Vida, & Eccles, 2006; Eccles, 1987; Fredricks & Eccles, 2002; Eccles et al., 1989; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Linnenbrink-Garcia & Fredricks, 2008; Wigfield, Byrnes, & Eccles, 2006; Wigfield & Eccles, 1994; Wigfield, Eccles, Mac Iver, Reuman, & Midgley, 1991), as well as toward one's training program in general (Perez, Cromley, & Kaplan, 2014). These findings are unequivocal in documenting a decrease in high school students' perceptions of competence across high school years, suggesting that this need received decreasing satisfaction in the high school context as adolescents grow.

Finally, longitudinal studies on *relatedness* examined several relational sources such as peers, teachers, and parents, the latter of which will not be considered in the present study given that our focus is on PNS within schools. We can expect fluctuations for teacher relatedness as students change school levels, as well as for peers as their role increase during adolescence (Juvonen, 2006). Prospective studies with elementary students over periods of 6 months to a year (e.g., Davidson, Gest, & Welsh, 2010; Gest, Welsh, & Domitrovich, 2005; Kuperminc, Blatt, Shahar, Henrich, & Leadbeater, 2004) revealed decreasing relatedness. In opposite, university students reported increases in relatedness over a 3-year longitudinal study (Pan & Gauvain, 2004). This contrast in findings might be explained by the fact that these studies surveyed students at very different developmental periods and using different designs, but it might also reflect the existence of distinct developmental trends.

This review of the literature yields two major conclusions. First, from the studies that examined changes in perceived PNS within the school, stability coefficients suggest that students' perceptions do not dramatically change over the surveyed periods, which ranged from 3 months to 3 years. Mean differences, however, suggest that competence and relatedness satisfaction might decrease over time for adolescents, which are the targeted population in our study. Opposing trajectories were found for autonomy satisfaction, suggesting that there might be more than one developmental pattern for the satisfaction of this need. Second, previous studies related changes in the satisfaction of one or several needs to student variables such as hope (Wandeler & Bundick, 2011), academic help-seeking (Marchand & Skinner, 2007), leisure sport participation and satisfaction (Cox et al., 2008; Laurin & Nicolas, 2009; Taylor et al.,

2010), as well as to academic and emotional adjustment (Davidson et al., 2010; Gest et al., 2005; Kuperminc et al., 2004). We will try to replicate these last findings using a truly longitudinal design spanning across adolescence, using a multidimensional conceptualization of student adjustment, and using an alternate method for modeling change. We now turn to the issue of how change can be estimated.

1.4. Assessing developmental patterns

Developmental patterns can be assumed to be homogeneous or heterogeneous. That is, we can expect all students to experience similar trends of perceived need satisfaction or we can expect distinct subgroups to report different patterns where, for instance, a group of students might report initially high competence that decreases in time while another group would report low and stable levels of competence. The first case, homogeneous development, is usually assessed through mean-level fluctuations with analytical techniques such as hierarchical linear modeling (Raudenbush & Bryk, 2002) and latent growth curve modeling (McArdle, 1986; Meredith & Tisak, 1990), which model population variability but do not allow identifying distinct developmental trajectories that can be opposed in slopes (see Nagin & Odgers, 2010). The second case, heterogeneous development, can be assessed with group-based trajectory modeling (GBTM; Nagin, 2005), a mixture-modeling technique designed to identify subgroups of participants who display distinct levels of a variable (e.g., competence, autonomy, relatedness) and describe the observed pattern of change for each. The present study will test whether there are distinct patterns of perceived need satisfaction from the end of elementary school to the end of high school using GBTM, therefore allowing us to estimate whether students' trajectories of PNS in school differ across subgroups of students (i.e., are heterogeneous) as well as the number and shape of the obtained developmental trajectories.

1.5. The present study

The first goal of this study was thus to identify developmental patterns of PNS from the end of elementary school to the end of high school, using a person-centered approach, i.e. GBTM. This will allow the identification of distinct developmental patterns in PNS instead of assuming that changes occur in a uniform fashion for all students. Developmental patterns will be examined distinctively for autonomy, competence, and relatedness respectively. Because of the exploratory nature of this goal, no hypothesis was formulated as to the specific number and shape of trajectories for each need. In light of previous research, we can nevertheless expect that: 1) there will be more than one trajectory for autonomy satisfaction, which was found to be less stable over time (Wandeler & Bundick, 2011), 2) one of the trajectories of competence satisfaction will be decreasing (Durik et al., 2006; Eccles et al., 1989; Fredricks & Eccles, 2002; Jacobs et al., 2002; Linnenbrink-Garcia & Fredricks, 2008; Wigfield, Byrnes, & Eccles, 2006; Wigfield et al., 1991; Wigfield & Eccles, 1994), and 3) one of the trajectories of relatedness satisfaction will be decreasing (Davidson et al., 2010; Gest et al., 2005; Kuperminc et al., 2004).

The second goal was to predict school adjustment at the end of high school from developmental trajectory membership. This will be done via multivariate comparisons performed on dimensions of academic, social, and emotional adjustment. These analyses will control for gender, academic achievement, and symptoms of anxiety, in light of previous research that repeatedly found 1) girls to report lower levels of emotional and social adjustment and higher levels of academic adjustment (e.g., Duchesne, Ratelle, Larose, & Guay, 2007; Duchesne et al., 2007), 2) academic achievement to be positively associated with academic, emotional, and social adjustment

(e.g., Duchesne et al., 2007; Roeser & Eccles, 1998), and 3) self-reported anxiety symptoms to be associated with academic, emotional, and social adjustment (e.g., Duchesne, Ratelle, & Roy, 2012; Duchesne, Vitaro, Larose, & Tremblay, 2008; Wood, 2006). Based on previous motivational research and theory (Milyavskaya et al., 2009; Ratelle, Larose, Guay, & Senecal, 2005; Sheldon & Krieger, 2007; Véronneau et al., 2004), we would expect trajectories characterized by high PNS to predict higher levels of academic, social, and emotional adjustment. More specifically, and as mentioned in the review above, we expected students in trajectories characterized by high levels of autonomy satisfaction to report the highest levels of academic, social, and personal–emotional adjustment. Based on the domains of the two other needs and of the adjustment dimensions, we expected students in trajectories characterized by high levels of relatedness satisfaction to report the highest levels of social adjustment and student in trajectories characterized by high levels of competence satisfaction to report the highest levels of academic adjustment.

2. Method

2.1. Participants and procedure

Data come from a longitudinal study on school adjustment and persistence that spanned from the end of elementary to the end of high school. It took place in the province of Quebec, Canada, from the academic years 2005–2006 to 2010–2011. This study began when students were in their last year of elementary school (Grade 6) and the total sample included 762 students (45% boys, 55% girls) with an average age of 11.80 years ($SD = .44$) at Time 1. A total of 609 students (79.92%) participated in two or more waves, allowing imputation of the data on GBTM (Nagin, 1999, 2005). The majority of the students were born in the province of Quebec (93%), spoke French at home (97%), and grew up in intact families (71%). Children came from middle-class families, as indicated by the average family income (\$50,000 to \$59,000 CAN, as reported by mothers), which compared to the average household income in the province of Quebec at the time of the first data wave (\$59,734 CAN; Statistics Canada, 2009).

Participants in this longitudinal study were randomly selected by the Quebec Ministry of Education among students who were enrolled in Grade 6 during the 2005–2006 academic year and attended a French-speaking, public school. The sample was stratified on the basis of gender, geographic representation (rural or urban), and socioeconomic status. Upon receiving parental consent, students were given a consent form and a questionnaire either in paper or electronic format (via a secured server). Participants were surveyed each year in the spring: 2006 (Time 1; T1), 2007 (Time 2; T2), 2008 (Time 3; T3), 2009 (Time 4; T4), 2010 (Time 5; T5), and 2011 (Time 6; T6). In the present study, we are using the student data from T1 to T6.

2.2. Measures

2.2.1. Psychological need satisfaction

The perceived satisfaction of students' psychological needs was assessed yearly using three scales. The *satisfaction of the need for autonomy* as assessed with the Academic subscale of the Perceived Self-Determination in Life Domains Scale (Blais & Vallerand, 1991), the *satisfaction of the need for competence* was assessed with the Academic subscale of the Perceived Competence in Life Domains Scale (Losier, Vallerand, & Blais, 1993), and the *satisfaction of the need for relatedness* was assessed with the Intimacy subscale of the Need for Relatedness Scale (Richer & Vallerand, 1998). Participants had to indicate the extent to which they agreed with each item using a 7-point scale (1 = do not agree at all, 7 = strongly agree). Examples of items include "I go to school out of personal choice"

Table 1
Descriptive statistics for variables of the study.

Wave	Level	Variables	Mean	SD	α
Time 1	Grade 6 (n = 618)	Autonomy ^a	5.09	1.47	.62
		Competence ^a	5.65	1.12	.67
		Relatedness ^a	4.96	1.41	.83
Time 2	Secondary 1 (n = 450)	Autonomy ^a	5.07	1.47	.69
		Competence ^a	5.46	1.09	.75
		Relatedness ^a	4.91	1.43	.86
Time 3	Secondary 2 (n = 471)	Autonomy ^a	5.03	1.48	.70
		Competence ^a	5.43	1.16	.81
		Relatedness ^a	5.16	1.35	.89
Time 4	Secondary 3 (n = 433)	Autonomy ^a	5.18	1.45	.74
		Competence ^a	5.38	1.12	.76
		Relatedness ^a	5.14	1.36	.89
Time 5	Secondary 4 (n = 345)	Autonomy ^a	5.21	1.48	.76
		Competence ^a	5.40	1.13	.79
		Relatedness ^a	5.10	1.39	.90
Time 6	Secondary 5 (n = 374)	Autonomy ^a	5.40	1.36	.74
		Competence ^a	5.45	1.12	.78
		Relatedness ^a	5.10	1.40	.89
		Social adjustment ^b	4.28	.66	.67
		Academic adjustment ^b	3.42	.64	.73
		Personal–emotional adjustment ^b	3.82	.84	.83
		Anxiety ^c	16.71	3.65	.86
		French achievement ^d	75.36	10.23	–
		Math achievement ^d	73.73	13.29	–

Note:

^a Used a 7-point scale.

^b Used a 5-point scale.

^c Sums varied from 12 to 24.

^d Used a 1–100 scale.

(autonomy; three items), "In general, I have difficulty doing my school work well" (competence; three items), and "In my relationships with my classmates, I feel close to them" (relatedness; three items). Previous research supported the psychometric qualities of these three scales (see Losier et al., 1993; Richer & Vallerand, 1998; Vallerand, 1997). In the present research, Cronbach's alphas were all above .70 except for T1 autonomy and competence (.62 and .67, respectively) and T2 autonomy (.69; see Table 1). The fact that scale reliabilities increased each year is consistent with previous work that showed how students' perceptions become increasingly differentiated with age, especially using scales with only a few items (see Guay et al., 2010).

2.2.2. School adjustment

To assess the extent to which students perceived they adjust well to the school setting during their last year of high school (i.e., at T6), we used a French version (Larose, Soucy, Bernier, & Roy, 1996) of the Student Adaptation to College Questionnaire (SACQ; Baker & Siryk, 1989). While this questionnaire was designed for college populations, many of the items were also found to apply to high school students (e.g., Duchesne et al., 2007). Of the original 69 items, 21 were used to assess three dimensions of adjustment: *academic adjustment*, which refers to students' perceptions of being able to adjust to the several demands in terms of homework, class work, and exams; *social adjustment*, which refers to students' perceptions of their socializing with peers and school professionals; and *personal–emotional adjustment* which focuses on students' perceived general affective status (e.g., anxiety, distress) and physical status (e.g., somatic symptoms). Participants had to indicate the extent to which each item applied to them, using a 5-point scale ranging from 1 (does not apply to me at all) to 5 (applies to me very well). Sample items include "I have been keeping up to date with my academic work" (academic; 10 items), "I have friendly relationships with several people at school" (social; four items), and "I have been feeling in good health" (personal–emotional; seven items).

Empirical support for the psychometric qualities of the SACQ has been obtained for both the English (e.g., Palladino Schultheiss & Blustein, 1994) and French versions (Duchesne et al., 2007; Larose et al., 1996). In the present study, Cronbach's alphas were .73, .67, and .83 for academic, social, and personal–emotional subscales respectively.

2.2.3. Anxiety

To assess students' symptoms of anxiety, we used the Worry/Oversensitivity subscale of the French–Canadian version (Turgeon & Chartrand, 2003) of the Revised Children's Manifest Anxiety Scale (RCMAS; Reynolds & Richmond, 1978). Participants had to indicate whether each of the 12 items described their feelings using a yes/no scale, where “Yes” means that the item describes their feelings. A sample item is “I worry most of the time”. Adequate psychometric qualities were observed for both English and French versions (Reynolds & Richmond, 1978; Turgeon & Chartrand, 2003). In the present study, the Cronbach alpha was .86.

2.2.4. Academic achievement

We used self-reported academic achievement in math and French at T6. These measures were scored on a 1–100 scale. Previous findings reported high correlations between self-reported and objective measures of achievement (r s up to .80; e.g., Kuncel, Credé, & Thomas, 2005).

2.3. Statistical analyses

2.3.1. Trajectory analyses

To estimate changes in students' PNS, we performed GBTM, using the TRAJ PROC module in SAS (for version 9; Jones, Nagin, & Roeder, 2001; Jones & Nagin, 2007). Trajectories were calculated separately for autonomy, competence, and relatedness using mean scores from T1 to T6. For each need, we identified the number of distinct developmental patterns, the number of students in each trajectory group, the shape of the trajectory, as well as the probability of belonging to the assigned trajectory. Models for one, two, three, and four groups were estimated with constant, linear, quadratic, and cubic parameter estimates. Optimal models were chosen on the basis of the Bayesian Information Criterion (BIC; see Jones et al., 2001; Nagin, 1999, 2005) and group membership probabilities. While no clear guidelines exist for interpreting the magnitude of the BIC, the optimal model is the one with the maximum BIC value. Since BIC values are always negative, the maximum value is the least negative one. Group membership probabilities refer to the probability of belonging to each group, based on observed longitudinal pattern (Nagin, 1999, 2005). The average probability for students belonging to a specific trajectory group should be high (maximum of 1) for the group to which they belong and low (minimum 0) for the other groups. A good fit would be indicated by probabilities around .70/.80 or higher (Nagin, 1999, 2005).

2.3.2. Missing data

Because longitudinal research inevitably entails missing data, we imputed the data to correct for loss of statistical power, as well as diminished precision of and biases in estimates that result from pairwise and listwise deletion (see Acock, 2005; Peugh & Enders, 2004; Schafer & Graham, 2002). To compare trajectory groups on measures of student adjustment, we used the PROC MI procedure in SAS (version 9.2), which performs multiple imputations. Multiple imputation is to be favored over simple imputation procedure such as mean substitution, median substitution, regression substitution, or maximum likelihood strategies (e.g., Expectation Maximization), which underestimate parameters' standard errors and provide possibly unstable parameter estimations (e.g., Newman, 2003). In the present study, we used the Markov chain Monte Carlo

(MCMC) method (Schafer, 1997), which assumes multivariate normality. Furthermore, the PROC TRAJ procedure used for trajectory modeling accommodates missing data; missing data was assumed to be missing at random.

3. Results

3.1. Preliminary analyses

Data were screened to ensure that they met basic statistical assumptions. We identified some univariate outliers on measures for competence (T1 to T6) as well as on social adjustment (T6). To reduce their deviation from the sample, and consequently, their influence on the mean, we brought them back closer to the mean by assigning them a value within a 3 standard deviation range (see Tabachnick & Fidell, 2007). We also identified two multivariate outliers, which were deleted from the sample. Descriptive statistics are presented in Table 1.

We also examined whether the proposed control variables (anxiety and achievement) were related to dimensions of adjustment, which was generally the case. Specifically, anxiety was negatively related to all three adjustment dimensions (r s = $-.28$, $-.11$, and $-.51$ for academic, social, and personal–emotional adjustment, respectively; p s < .03). Achievement in French and math were positively related to all dimensions of adjustment, with coefficients that ranged from .11 to .24 (p s < .04), except for the correlations between math achievement and social adjustment ($r = .08$, $p = .16$) and between French achievement and personal–emotional adjustment ($r = .04$, $p = .45$), which both failed to reach statistical significance and evidenced relations of small magnitude. In light of these findings, the contribution of anxiety and achievement to dimensions of school adjustment was controlled for in subsequent analyses. We also examined within-wave correlations among measures of PNS to determine whether we should use a composite score for all three needs. While correlations tended to increase in time, they were generally not high enough to require a composite score (T1 correlations ranged from .08 to .31; T2 correlations ranged from .12 to .36; T3 correlations ranged from .09 to .49; T4 correlations ranged from .15 to .51; T5 correlations ranged from .18 to .53; T6 correlations ranged from .16 to .48). As a result, we estimated developmental trajectories of PNS on each need separately.

3.2. Trajectory analyses

3.2.1. Autonomy

A four-group solution was found to be optimal (BIC = -4304.30 ; group membership probabilities ranged between .76 and .81). As presented in Fig. 1, a first group (10% of the sample) included students who reported initially low satisfaction of autonomy at school that increased in time (linear parameter statistically significant at $p = .008$). A second group (51% of the sample) included students whose need for autonomy was moderately satisfied at T1 and increased in time (linear parameter statistically significant at $p = .001$). A third group (12% of the sample) reported initially moderate levels of autonomy that decreased in time (linear and quadratic parameter statistically significant at p s < .001). Finally, a fourth group included students whose autonomy in Grade 6 was highly satisfied and increased across high school (linear parameter statistically significant at $p = .05$). For the sake of comparison, we included an overall trajectory for the entire sample (thick line in Fig. 1). It is important to note, however, that the fit indices for the four-group solution were superior to those for a one-group, homogeneous solution (BIC = -4630.13). We can see that while, as a group, these participants reported moderate to high levels of autonomy, examining changes in the satisfaction of autonomy from a group-based

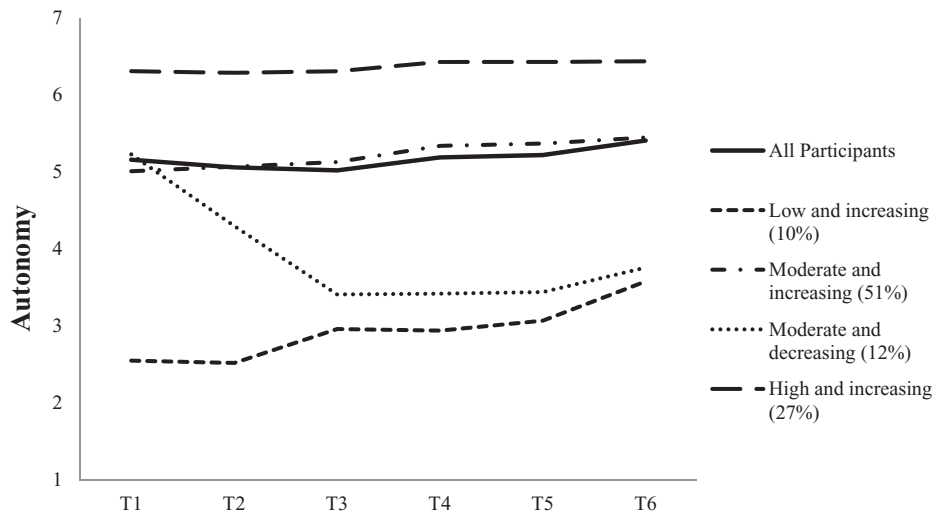


Fig. 1. Average autonomy levels at each measurement time for trajectory groups and the total sample ($n = 606$).

approach allowed the identification of distinct developmental patterns that contrast with the overall trend.

3.2.2. Competence

A four-group solution also best-fitted the data ($BIC = -3696.15$; group membership probabilities ranged from .66 to .86). A first group (20% of the sample) included students whose need for competence was initially moderately satisfied that decreased in time (linear and quadratic parameters statistically significant at $ps < .01$; see Fig. 2). A second group (6% of the sample) included students who initially reported moderate competence satisfaction that increased in time (linear and quadratic parameters statistically significant at $ps \leq .01$). A third group (48% of the sample) included students who reported initially high competence satisfaction that decreased over time (linear and quadratic parameters statistically significant at $ps < .001$). Finally, a fourth group (26% of the sample) included students who reported high and stable competence satisfaction across the 6 years of the study. The fit indices for the four-group solution were superior to those for a one-group, homogeneous solution ($BIC = -4016.74$). As the visual representation of the overall trend illustrates (thick line in Fig. 2), the homogeneous pattern of

change mimics the High and decreasing trajectory. But, using such an approach precludes the identification of the three other distinct patterns of change.

3.2.3. Relatedness

Again, a four-group solution was found to be optimal ($BIC = -4285.57$; group membership probabilities ranged between .74 and .86). A first trajectory (10% of the sample) was composed of students reporting low and stable satisfaction of the need for relatedness over time (see Fig. 3). A second group (37% of the sample) included students whose relatedness was moderate and stable across the 6-year period. A third group (48% of the sample) included students whose initial level of relatedness satisfaction was moderate and increased in time (linear parameter statistically significant at $p = .009$). Finally, a fourth group (5% of the sample) included students whose perceptions of relatedness were initially high and increased in time (linear parameter statistically significant at $p = .005$). The overall pattern of means, as represented by the thick trajectory in Fig. 3, suggests that in general, students' feelings of relatedness were moderately high and stable across the 6-year period surveyed by our study. It however neglects the presence of four

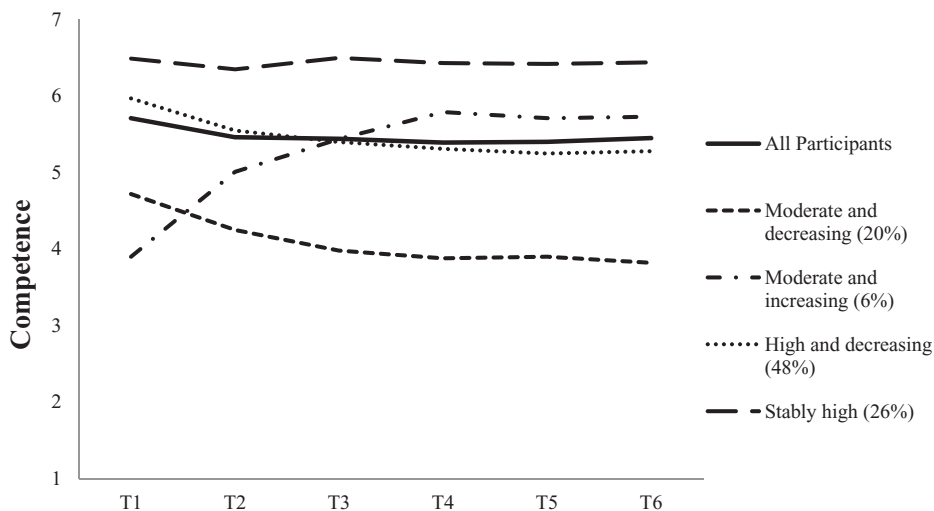


Fig. 2. Average competence levels at each measurement time for trajectory groups and the total sample ($n = 606$).

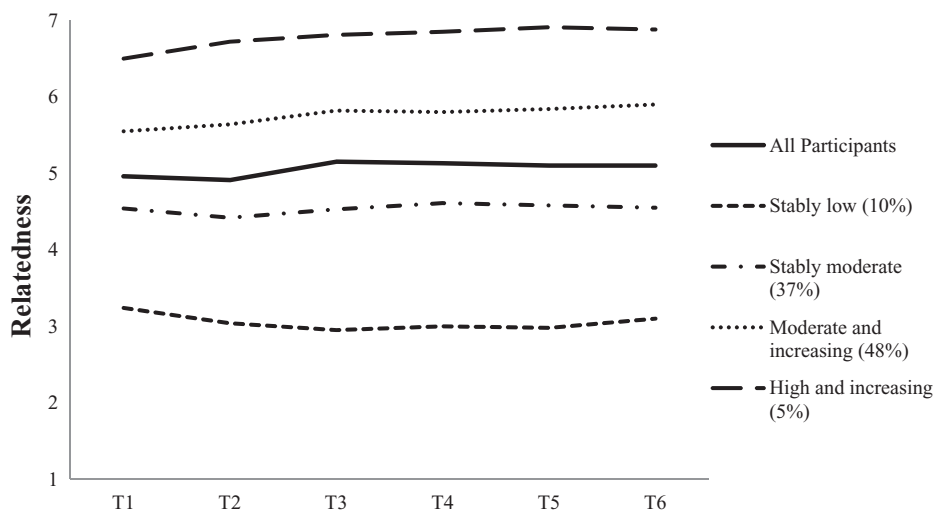


Fig. 3. Average relatedness levels at each measurement time for trajectory groups and the total sample ($n = 609$).

distinct and quite contrasting trajectories. Indeed, fit indices for the four-group solution were again superior to those for a one-group, homogeneous solution ($BIC = -4559.64$).

3.2.4. Gender differences

Once trajectories had been identified for each psychological need, we examined whether the proportion of boys and girls differed across trajectory groups. For autonomy, the distribution of boys and girls across trajectory groups was not equivalent, as evidenced by a statistically significant chi-square test ($\chi^2 [3] = 34.23, p < .01$): While there were more boys in the bottom trajectories (Low and increasing, Moderate and decreasing), girls were more frequently observed in the two top trajectories (Moderate and increasing, High and increasing). For competence, a statistically significant chi-square test ($\chi^2 [3] = 7.92, p = .048$) also revealed uneven gender distribution across the trajectory groups: While the proportion of boys and girls was roughly equivalent in the Moderate and increasing trajectory, we observed more girls in the two top trajectories (High and decreasing, Stably high) and more boys in the bottom trajectory (Moderate and decreasing). Finally, a statistically significant chi-square test ($\chi^2 [3] = 18.41, p < .01$) suggested that boys and girls were unequally distributed across trajectory groups of relatedness: There were more boys in the bottom trajectories (Stably low, Stably moderate) and more girls in the top two trajectories (Moderate and increasing, High and increasing). Overall, these results suggest that girls were generally found in the most positive trajectories (i.e., they reported higher satisfaction of needs for autonomy, competence, and relatedness across the high school years). Given the disparity of gender representation across trajectories, subsequent analyses controlled for this variable.

3.2.5. Associations between trajectory group memberships

We also examined the association among trajectory group membership for the three needs. The overall three-way contingency test revealed a statistically significant association (Mantel–Haenszel $\chi^2 [9] = 27.77, p = .001$), suggesting that trajectory group membership on relatedness is associated with trajectory group membership on competence, when adjusting for trajectory group membership on autonomy. One must be careful not to over-interpret the specific contingencies, especially since some of the combined row sample sizes were below the recommended 30. Nevertheless, inspection of frequency tables suggests that students in the problematic trajectories of autonomy (i.e., Low and increasing, Moderate and decreasing), were more likely to be found in problematic trajectories

of competence (i.e., Moderate and decreasing and High and decreasing) and relatedness (i.e., Stable and low, Stable and Moderate, Moderate and increasing). Alternatively, students in positive trajectories of autonomy (i.e., Moderate and increasing, High and increasing) were more likely to be found in High trajectories (Stable and decreasing) of competence, while for relatedness, results are less clear. Still, we find that the proportion of students in the High and increasing trajectory of relatedness was highest for students who were in the Stable and high trajectory of competence as well as in increasing trajectories (both Moderate and High) of autonomy. It is important to note, however, that membership in a positive trajectory on one need did not guarantee membership in a positive trajectory on the other needs, thereby supporting the need to examine trajectories separately.

3.3. Predicting adjustment in school

We next performed MANCOVAs to compare trajectory groups on dimensions of school adjustment (social, academic and emotional–personal) at the end of high school, while controlling for variables known to contribute to these dimensions, namely, gender, achievement, and anxiety. Statistically significant multivariate tests were followed by ANCOVAs, using the same controlled variables. These analyses were performed under multiple imputations with the MI procedure (SAS, version 9.3, 2014) on 20 imputed files, after which results were aggregated using the MIANALYZE procedure. Adjusted means and confidence intervals on dimensions of school adjustment for trajectories of autonomy, competence, and relatedness are presented in Figs. 4–6. In line with what Kline (2004, 2009) labeled the *statistics reform* (also see Wilkinson and the APA; Wilkinson & Task Force on Statistical Inference, 1999), the meaningfulness of group comparisons were estimated by inspections of descriptive statistics (mainly means inspections), confidence intervals, and effect size estimates for group differences.

3.3.1. Autonomy

MANCOVAs performed on the 20 imputed samples yielded statistically significant Wilks' λ (9, 859.26) that ranged from .87 to .90 (all $ps < .001$) and F values from 4.42 to 5.41. These findings suggest that trajectory groups of autonomy differed on several adjustment dimensions across the 20 imputed files. ANCOVAs were then performed on each adjustment dimension and yielded F values (3,355) that ranged from 6.72 to 8.48 (all $ps < .001$) for social adjustment, from 7.95 to 10.11 (all $ps < .001$) for academic adjustment, and from

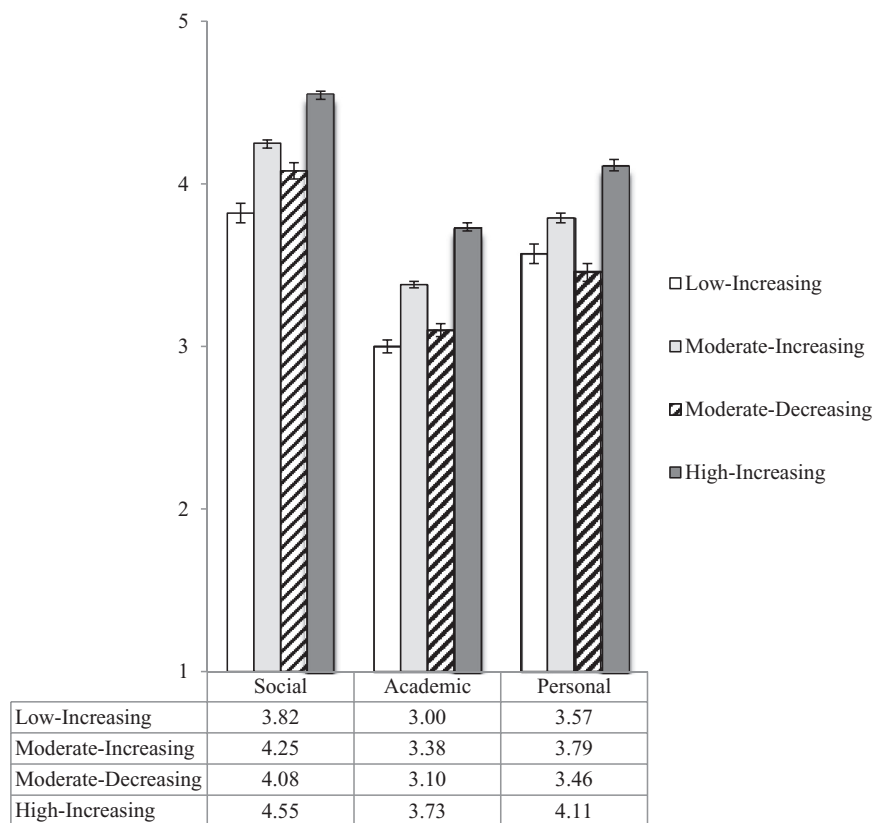


Fig. 4. Adjusted means and 95% confidence intervals for dimensions of adjustment in school for trajectory groups of autonomy ($n = 606$).

4.63 to 6.20 for personal–emotional adjustment (all $ps < .01$). Inspection of the adjusted means for each dimension of school adjustment allows several conclusions (see Fig. 4): 1) Students in the High and increasing trajectory reported the highest indices on all three dimensions of adjustment. 2) Students in the Moderate and increasing trajectory reported the second best indices of academic, social, and personal–emotional adjustment. 3) Students in the Low and Increasing trajectory, while reporting the lowest levels of social and academic adjustment, evidenced higher levels of personal–emotional adjustment than students in the Moderate and decreasing trajectory. Across imputed files, trajectory groups of autonomy explained 5–7% of the variance on social adjustment, 6–8% of the variance on academic adjustment, and 4–5% of the variance on personal–emotional adjustment.

3.3.2. Competence

All MANCOVAs for the 20 imputed files yielded statistically significant Wilks' λ s (9, 864.13) varying between .86 and .88 and F values ranging from 4.97 to 6.37, $ps < .001$. Hence, these multivariate effects suggest that trajectory groups of competence differed on several dimensions of adjustment across the 20 imputed files. ANCOVAs on adjustment dimensions yielded F values (3,355) that ranged from 7.07 to 9.44 (all $ps < .001$) for social adjustment, from 8.77 to 12.27 (all $ps < .001$) for academic adjustment, and from 2.53 to 4.01 for personal–emotional adjustment (all $ps < .05$). Inspection of adjusted means suggests that (see Fig. 5): 1) Students in the Stably high trajectory reported higher scores on social and personal–emotion adjustment. 2) Students in the Stably high and Moderate and increasing trajectories reported equivalent levels of academic adjustment. 3) Students in the Moderate and increasing trajectory reported higher levels of academic and personal–emotional adjustment than students in both High and decreasing and Moderate and

decreasing trajectories. 4) Students in the High and decreasing trajectory reported higher social adjustment scores than those in moderate trajectories (increasing and decreasing). Across imputed files, trajectory groups of competence explained 6–7% of the variance on social adjustment, 7–9% of the variance on academic adjustment, and 2–3% of the variance on personal–emotional adjustment.

3.3.3. Relatedness

MANCOVAs also yielded statistically significant results across the 20 imputed files, with Wilks' λ s (9, 859.26) that ranged from .86 to .88 and F values from 4.97 to 6.37 ($ps < .001$). Trajectories of relatedness therefore appeared to differ across several dimensions of adjustment across imputed files. ANCOVAs on adjustment dimensions yielded F values (3,355) that ranged from 21.62 to 24.26 (all $ps < .001$) for social adjustment, from 2.40 to 2.97 (all $ps < .07$) for academic adjustment, and from 0.62 to 0.70 for personal–emotional adjustment (all $ps > .05$). Mean inspections allowed a rather straightforward conclusion for all adjustment dimensions: The best adjustment scores were observed for students in the High and increasing trajectory, followed by Moderate and increasing trajectory, Stably moderate trajectory, and Stably low trajectory (see Fig. 6). Across imputed files, trajectory groups of relatedness explained 15–17% of the variance on social adjustment, 2% of the variance on academic adjustment, and 1% of the variance on personal–emotional adjustment.

4. Discussion

Research has shown that the satisfaction of an individual's needs for competence, autonomy, and relatedness is important for development, actualization and adjustment (Deci & Ryan, 2000; Deci &

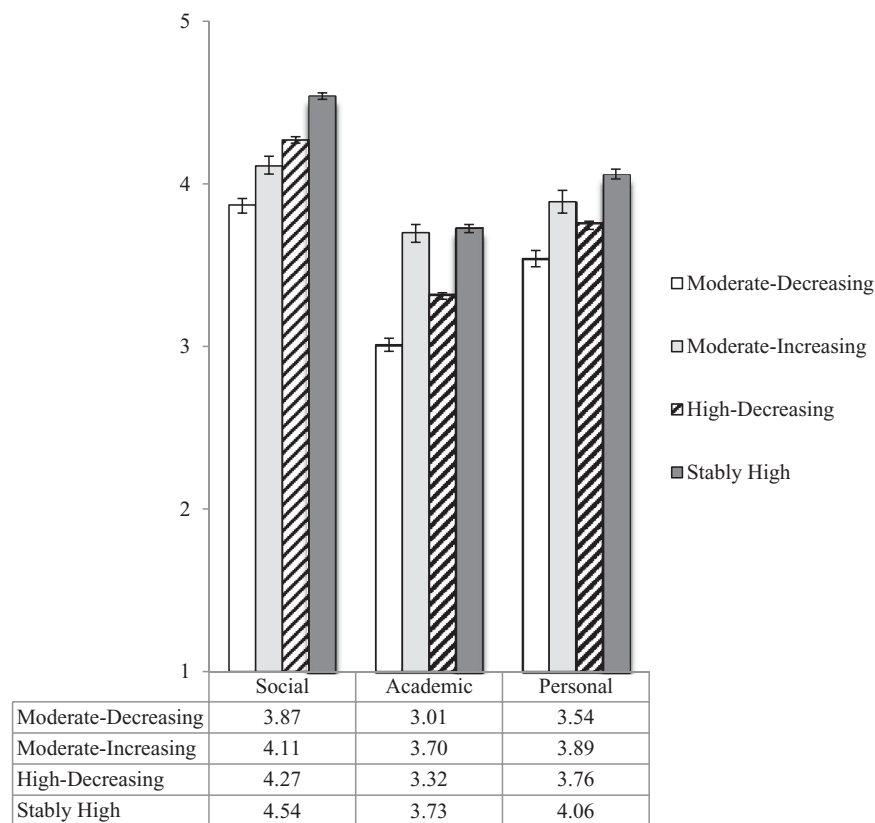


Fig. 5. Adjusted means and 95% confidence intervals for dimensions of adjustment in school for trajectory groups of competence ($n = 606$).

Vansteenkiste, 2004; Ryan, 1995). While the beneficial role of perceived PNS has been supported in the education sphere (Milyavskaya et al., 2009; Ratelle et al., 2005; Sheldon & Krieger, 2007; Véronneau et al., 2004), research with students was largely cross-sectional or prospective, except for research related to competence (e.g., Jacobs et al., 2002). The present study aimed to uncover the developmental trajectories of PNS in school from early to late adolescence and relate it to school adjustment. Based on a stratified sample of adolescents, our findings suggest that perceived PNS in school fluctuated in a heterogeneous fashion for all three psychological needs across adolescence. Furthermore, our results supported the importance, for all three needs, of distinguishing among trajectories of PNS for predicting social, academic, and emotional–personal adjustment. Key findings are presented, along with their implications for motivational and educational literature and interventions.

4.1. Distinct developmental patterns of PNS

As our findings revealed, the perceived satisfaction of students' needs for autonomy, competence, and relatedness within the school context fluctuated in a heterogeneous fashion from the end of elementary school to the end of high school. Specifically, developmental trajectories for each need demonstrated no uniform patterns of perceived PNS at school from early to late adolescence. Some students were for instance reporting initially low levels of autonomy that increased across adolescence to reach moderate levels while other students revealed completely different patterns (e.g., decreasing), and so forth for competence and relatedness. Hence, students do not experience the same changes in PNS across adolescence.

These findings are the first to document longitudinal trajectories of PNS in general and, more specifically, in education. Across

adolescence, students undergo subtle as well as marked changes in the school context (Eccles & Roeser, 2009). For one, they undergo a school transition from elementary to high school. Some might even experience more than one school transfer when, for instance, they move to another neighborhood or city. Students also experience changes in teachers they encounter, which are typically different for each school subject in high school. Another systematic change is in classroom composition where classmates might not be the same across school subjects, mostly because of differences in achievement (i.e., placing in core school subjects is determined by prior achievement) and interests (i.e., for elective classes, students choose among a series of options). These changes lay the basis for differential satisfaction of basic psychological needs, which might explain why groups of students reported different trajectories of perceived PNS.

The determinants of these distinct developmental patterns have yet to be identified, but previous research and theory in the self-determination literature suggest three social factors (see Connell & Wellborn, 1991; Deci & Ryan, 2000; Grolnick, 2009; Guay, Ratelle, & Chanal, 2008). First is *autonomy support*, which entails recognizing students as unique volitional beings by acknowledging their perspective, providing meaningful rationales for performing less interesting activities, and offering opportunities for making meaningful choices. Second is *involvement*, the allocation of physical and emotional resources. Finally, *structure* includes behaviors that contribute to making students' environment predictable and their behaviors easier to regulate (e.g., providing clear and consistent guidelines). These social factors were found to predict individuals' self-regulation and adjustment, via an increase in PNS (see Grolnick, 2009).

The fact that some students reported a constant, and actually high, satisfaction of their psychological needs while others reported declines or increases in perceived PNS also needs to be better

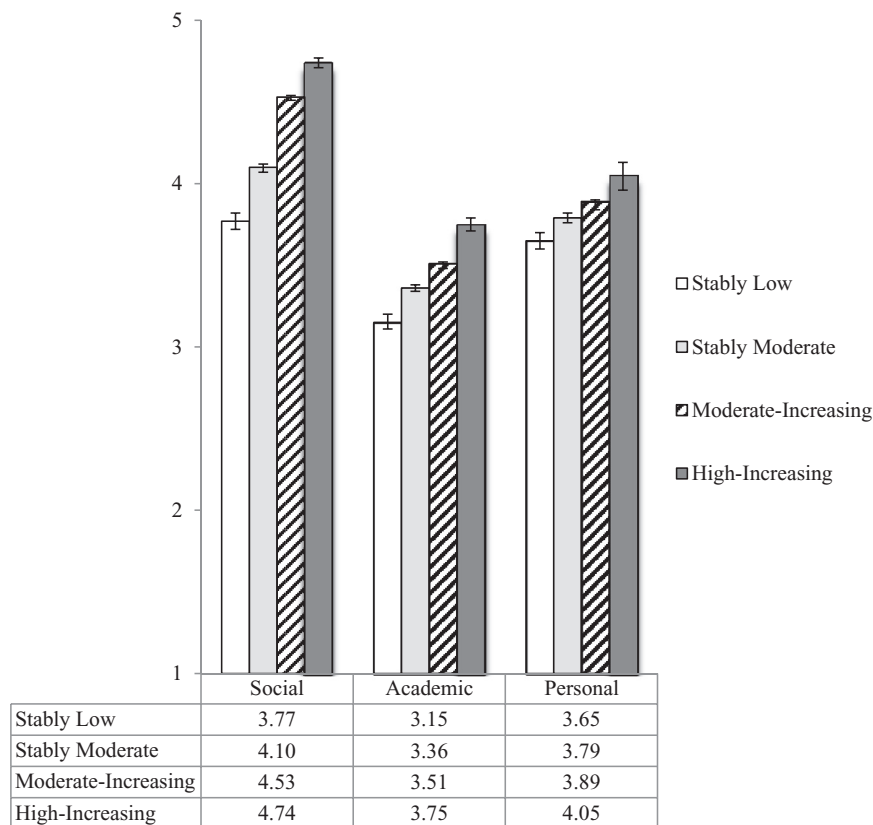


Fig. 6. Adjusted means and 95% confidence intervals for dimensions of adjustment in school for trajectory groups of relatedness ($n = 609$).

understood. Aside from the unlikely possibility that they do not experience the same academic changes and transitions, a variety of factors can be expected to intervene. For one, we can expect that more global, and stable, social factors exert an influence on students across adolescence. For instance, these students' parents might adopt highly autonomy supportive behaviors in a more stable fashion (see Grolnick, 2009). Another possibility is that students' dispositional factors such as causality orientation (Deci & Ryan, 2000) or global motivational orientation (e.g., being autonomously oriented in general; Vallerand & Ratelle, 2002) can serve as protective factors against academic changes and other need-thwarting factors. Hence, students reporting stable trajectories might have an autonomous global motivation, which means that they would typically behave out of pleasure and/or volition. This global orientation could explain contextual need satisfaction through a top-down effect (see Vallerand & Ratelle, 2002).

4.2. Heterogeneous trajectories of competence and previous homogeneous trends

Obtaining stable and increasing trajectories of perceived competence might stand in contrast with previous findings on competence-related construct such as academic self-concept (Durik et al., 2006; Eccles, 1987; Eccles et al., 1989; Fredricks & Eccles, 2002; Jacobs et al., 2002; Linnenbrink-Garcia & Fredricks, 2008; Wigfield et al., 1991, 2006). A rather consensual finding in the educational literature was that students experience decreasing levels of perceived competence in most school domains from elementary school to the end of high school (e.g., Jacobs et al., 2002). While our findings suggest otherwise, it is important to consider that previous research used an analytical approach that assumes change to be homogeneous (i.e., these studies did not attempt to isolate distinct

developmental patterns; see Nagin & Odgers, 2010). In the present study, two decreasing trajectories, starting at high and moderate levels, were identified, consistent with prior research. Furthermore, our overall developmental trend for all participants also decreased in time, but the decline was not as steep as those observed in these previous studies. What is important to consider, however, is that our findings showed this declining trend to be characteristic of a fragment of students. A central implication of our findings is thus to demonstrate, using a different analytical approach, the existence of other developmental trends of perceived competence satisfaction across adolescence. These findings therefore complement previous ones. They also call for additional research to understand why only a subset of students is at risk to perceive a decreased satisfaction of their need for competence.

4.3. Adjustment levels higher in upper trajectories

Across psychological needs, our results revealed that adjustment levels were higher for students in upper trajectories of PNS. Hence, students in High and increasing autonomy, Stably high competence, and High and increasing relatedness trajectories evidenced the highest levels of social, academic, and personal-emotional adjustment at the end of high school. These findings support self-determination theory (Deci & Ryan, 2000; Deci & Vansteenkiste, 2004) and, more precisely, the importance of supporting the satisfaction of students' psychological needs in the school domain. One exception was found for trajectories of competence, and more specifically for students in the Moderate and increasing trajectory. These students reported levels of academic adjustment that were equivalent to those of students in the Stably high trajectory as well as levels of personal-emotional adjustment that were superior to those of students in the High and decreasing trajectory. While the

positive relationship between the competence satisfaction and outcomes such as well-being and autonomous motivation has been documented (see Deci & Ryan, 2000; Deci & Vansteenkiste, 2004; Ryan, 1995), our findings demonstrate that students whose need for competence is initially less satisfied can experience high levels of academic adjustment years later if they perceived increasing satisfaction of this need throughout these years. This increase in the perceived satisfaction of the need for competence might promote students' academic adjustment by increasing students' autonomous motivations while decreasing controlled motivations and amotivation, a hypothesis that would be consistent with the hierarchical model of intrinsic and extrinsic motivation (Vallerand, 1997; Vallerand & Ratelle, 2002). While future research is needed to confirm the precise causal mechanisms at play, this finding is encouraging in showing that deficits in need satisfaction can be overcome in the long run. Intervention could therefore target the social factors identified earlier (i.e., autonomy support, involvement, and structure; Connell & Wellborn, 1991; Deci & Ryan, 2000; Grolnick, 2009; Niemiec & Ryan, 2009), known to promote the satisfaction of psychological needs to competence, as well as autonomy and relatedness.

As mentioned above, students in the Moderate and increasing trajectory of competence reported higher levels of academic and personal-emotional adjustment as well as lower levels of social adjustment than students in the High and decreasing trajectory. This suggests that improvement in perceived competence satisfaction from moderately low to high over this 6-year period was beneficial for students' adjustment to school demands as well as their affective and physical states, but not so much for their socialization within school, when compared to students in the High and decreasing trajectory. Possibly, perceived school competence is more important for meeting school demands and one's physical and emotional states, consistent with self-efficacy theory (Bandura, 1997). Perceived satisfaction of students needs for autonomy and relatedness might therefore be more important for social adjustment than perceived competence. Nevertheless, trajectory group membership explained considerable amounts of variance in each outcome, over and beyond the contribution of control variables. Hence, considering students' specific trajectory of perceived need satisfaction appears critical for better understanding their adjustment levels at the end of high school.

Overall, while some of the trajectories were more problematic, we generally found that students reporting low PNS, and associated poor adjustment, were in minority. It would be inaccurate to conclude that, across adolescence, all students are at risk in experiencing declining PNS, and consequently, poorer adjustment. Our findings rather demonstrate that only a subset of them should be considered as such. Future research should therefore focus on identifying determinants of problematic trajectories in order to help design intervention programs for supporting and increasing students' PNS in school. We also found that there were more girls in the most positive trajectories of perceived PNS. How much of this finding results from individual predispositions vs. environmental factors remains to be tested, but these findings are rather convincing in showing that boys are more at risk for low PNS within school than girls. They also concur with previous gender differences on motivational variables that follow from PNS (e.g., Guay & Vallerand, 1997). Replication studies are, nevertheless, required to support these gender differences.

4.4. Strength, limits, and future research

Despite the many strengths of this study (i.e., 6-year longitudinal design, stratified sample, imputation of missing data, etc.), there were inevitable limits that must be taken into account when interpreting these findings. First, measures were self-reported, which

makes them susceptible to desirability biases. Including a measure of social desirability as a control variable would be important in future replication studies. Another limit pertains to the descriptive nature of our design, which precludes formulating causal conclusions. Yet, while we recognize that having experimental control over our variables might allow for causal conclusions, it would be difficult to study such developmental trajectories with an experimental design. Finally, we must be careful in generalizing our findings because of the restricted diversity within the sample regarding ethnicity and socioeconomic status. Future replication studies should specifically aim to include students from more diverse strata of society.

Other suggestions for future research include replicating our findings with similar but also different types of sample (e.g., young children, college students), as well as using similar and different outcomes (e.g., achievement). It will also be important to identify the factors responsible for the heterogeneity of developmental patterns. For instance, it would be interesting to determine the role of social agents within (e.g., teachers, friends) and outside (e.g., parents) the school in explaining the unfolding of developmental trajectories of PNS by focusing on need-satisfying behaviors (i.e., autonomy support, involvement, and structure). The determining role of dispositional variable such as global motivational orientation and personality traits would also be important to study. Another potential area of investigation is the analysis of joint trajectories, which would provide a more complex analysis of interactions among developmental patterns of psychological need satisfaction. Finally, future research should examine the relationships between PNS and adjustment to school throughout high school.

5. Conclusion

From the end of elementary school to the end of high school, adolescents experience several changes and transitions in the school domain. We found that during this 6-year period, groups of students will report distinct developmental trajectories of PNS for autonomy, competence, and relatedness. No study to date identified and described such trajectories of PNS from early to late adolescence. We also found that these trajectories predicted different levels of adjustment at the end of high school. Interventions aiming to increase students' adjustment should therefore aim at increasing PNS earlier in the school track as well as throughout the high school years to change the trajectory of negative developmental patterns. While future research is needed to identify the specific mechanisms underlying these developmental patterns, research on self-determination theory suggests that promoting need satisfying behaviors such as autonomy support, involvement, and structure, from important social agents in students' lives (e.g., parents, teachers, friends) will be essential.

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