

Childhood Predictors and Mid-Adolescent Correlates of Developmental Trajectories of Alcohol Use among Male and Female Youth

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Abstract The identification of salient risk factors for alcohol consumption among male and female adolescents is an important topic not only for etiology research but also for designing effective gender-specific alcohol prevention programs for young people. This study examined the extent to which problematic alcohol use trajectories from ages 14 to 18 among male and female youth were related to childhood predictors assessed at age 9 (i.e., impulsivity, academic self-confidence, social problems with peers), socio-demographic variables, and mid-adolescent correlates [i.e., parental use, body mass index (BMI), risky peer context, conduct problems at school, parent–child relationship, somatic complaints]. Data analysis was based on a representative German longitudinal study (1986–1995, $n = 1,619$, 55 % female). Using growth mixture modeling methodology, associations of childhood predictors and mid-adolescent correlates to distinctive trajectories of alcohol use were examined for males and females separately. For males, a problematic consumption trajectory was associated with poor relationships to parents in adolescence and small community size. For females, low impulsivity during childhood, high BMI, and contact with

deviant peers during adolescence predicted problematic as compared to normative alcohol use trajectories. Additionally, high parental alcohol use, low parental educational background, and conduct problems at school during adolescence were common predictors of a problematic alcohol use trajectory in both genders. The results provide insights regarding differences in the gender-typical development of adolescent alcohol use as well as stress the need of gender-specific intervention components along with universal prevention strategies against problematic consumption trajectories.

Keywords Alcohol use · Growth mixture modeling · Longitudinal · Adolescence · Germany

Introduction

The classification of youths' drinking patterns based on their developmental course has been of high interest in recent years and resulted in a rapidly growing body of empirical studies using latent growth mixture modeling techniques to identify distinctive trajectories of alcohol use among adolescents and young adults. Some of these studies have examined gender differences in the number and shape of alcohol use trajectories. However, gender differences may occur not only in the number of trajectories or their shape, but also with regard to the early predictors and correlates of distinctive alcohol use trajectories during adolescence. This issue has received considerably less attention in prior research. Thus, the purpose of this prospective study was to examine associations of childhood predictors, socio-economic variables and mid-adolescent correlates to distinctive alcohol use trajectories for adolescent males and females separately.

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Contributions from Theory

Proponents of developmental taxonomies have posited that distinctive substance use trajectories in adolescence (i.e., characterized by differences in onset, increase, duration, and decline over time) are associated with trajectory-specific childhood predictors, adolescent correlates, and prognosis for adaptation in adulthood (e.g., Moffitt 1993; Tarter et al. 1999; Tarter 2002; Zucker 1994). These pathways include, for instance, antisocial alcoholism, with early onset, chronic course, co-morbid antisocial behaviors, and a history of family alcoholism. Moreover, a developmentally limited alcoholism pathway has been identified, among others, with episodic use during adolescence mainly among peers. Similarly, Moffitt (1993) posited in her developmental taxonomy (focusing on various forms of antisocial behaviors, including engagement in substance use) the existence of two different trajectories. The first trajectory, life-course persistent problem behaviors, is characterized by high levels of early childhood risk factors (e.g., impulsivity, aggression, attention deficits, low self-esteem, and adaptation problems in normative developmental contexts), and correlates with various adaptation problems during adolescence and adulthood (e.g., in family, school, and peer context). The second trajectory, adolescent limited problem behaviors, refers to antisocial behavior and externalizing problems (including substance use) that are limited to the period of adolescence. This trajectory is posited to be influenced by changes in the social milieu (i.e., higher peer influence and lower social control by the family), and problem behavior represents a pseudo-mature behavior used to bridge the gap between biological and social maturation. According to the taxonomy, the problematic developmental pathways may be already identified by certain predictors in childhood, and there is a lower likelihood for recovery in early adulthood, as compared to the group of adolescent-limited problem behavior.

Importantly, the vast majority of the developmental taxonomies of adolescent alcohol use (and other forms of externalizing problem behaviors) are gender-unspecific, although prior research suggests that several risk factors may act in a gender-specific manner (Petraitis et al. 1995; Schulte et al. 2009; Zucker et al. 2008). In contrast, Silverthorn and Frick (1999) argued that a distinct pathway of longer-term adaptation problems for females may be more appropriate to describe their developmental pathway to externalizing problem behavior in adolescence than a childhood-onset pathway which may be more typical for males. This gender-typical trajectory was called “delayed-onset” trajectory. Due to socialization pressures and associated contextual influences, females may suppress overt externalizing behavior during childhood and rather tend to show internalizing problems (see also Belsky et al. 1991).

However, along with growing physical maturation during puberty when new options for explorations and socialization with deviant peer groups arise, externalizing problems such as substance use or deviant behaviors are initiated and even increase over time among females as well. In sum, etiological models support the notion of distinctive developmental trajectories of alcohol use in youths, and associated risk factors in childhood and adolescence, which, at least in part, might be gender-specific.

Gender Differences in Number and Shape of Alcohol Consumption Trajectories

The empirical literature aiming at the identification of alcohol consumption trajectories during adolescence has frequently revealed four prototypical alcohol consumption trajectories, namely, chronic high use, low or non-using, declining use, and increasing use (Sher et al. 2011). They appear to be fairly robust to various methodological features such as measurement of alcohol involvement, length of observation, and age of the sample at baseline (Jackson and Sher 2005, 2006, 2008), but findings are mixed with regard to gender differences in drinking trajectories. Some studies uncovered rather similar alcohol use trajectories in both genders (e.g., Chassin et al. 2002; White et al. 2000), whereas others revealed differences in the proportion of males and females belonging to trajectories of similar shape (Schulenberg et al. 1996), differences in the shape of a subset of trajectories among males and females (Wiesner et al. 2007), and differences in the number of trajectories identified for males and females (Windle et al. 2005). In sum, gender seems to have mixed associations with the number of trajectories, their shapes, and the proportion of the sample belonging to each trajectory group, and further clarification of this issue is needed.

Gender Differences in Predictors of Youth Alcohol Use Trajectories

The empirical literature on gender differences in childhood predictors and correlates of distinctive alcohol use trajectories in adolescence is relatively sparse. Most of the risk factors that have been used in these studies to predict problematic consumption trajectories were measured during adolescence. Very few studies have included childhood predictors of adolescent alcohol use trajectories. Thus, the following section also includes findings from prospective studies examining risk factors for higher *levels* (besides risk factors for problematic trajectories) of alcohol use among adolescents in order to gain a more comprehensive understanding of potential gender-specificity in associations of childhood risks and adolescent correlates to more problematic drinking trajectories.

Childhood Predictors

There is a large body of empirical research documenting the importance of childhood risk factors in the personal and environmental domain for the prediction of levels of adolescent alcohol use (for overviews, see Schulte et al. 2009; Zucker et al. 2008). As summarized by these scholars, child dysregulation, antisocial and risk taking behavior, effortful control problems, learning difficulties, low social skills, and internalizing problems were related to early and high alcohol use in adolescence. Moreover, a family history of alcohol use problems, antisocial parents, and poor parent–child relationships are well-established childhood risk factors of levels of adolescent alcohol use.

Regarding gender differences in the salience of impulsivity and early conduct problems as risk factors for high levels of alcohol use among male and female adolescents, studies revealed mixed results (for reviews, see Nolen-Hoeksema and Hilt 2006; Schulte et al. 2009). While some investigators reported that high impulsivity in early childhood relates to later alcohol use problems only in males but not females (e.g., Caspi et al. 1996), others found that high behavioral under-control and low negative affectivity in childhood predicted later alcohol use in both males and females (Martin et al. 2000). Parental problem behavior and substance use (including problematic drinking patterns) were identified to impact levels of drinking in both males and females (Walden et al. 2007).

While no study so far has investigated the association between childhood personality and alcohol consumption trajectories during adolescence, a few alcohol trajectory studies have included examinations of the role of childhood predictors from the environmental domain. Chassin et al. (2004) reported that gender did not moderate the predictive effects of parent alcoholism and other parent psychopathology on trajectories of early and high use. Casswell et al. (2002) showed that family influences (i.e., frequency of mother's drinking) were common predictors of problematic consumption trajectories in male and female adolescents. In sum, childhood personality (i.e., impulsivity) appears to be a predictor of problematic alcohol consumption especially among males, whereas early risk factors in the environmental domain seem to operate in a gender-unspecific way.

Adolescent Correlates

Peer influences on drinking pattern are particularly high during early adolescence (Duan et al. 2009). The affiliation with deviant peers, in turn, is related to low interest in and bonding to school, as well as conduct problems, which also increase the risk for high alcohol use in adolescence (see for review Masten et al. 2008). In line with these findings,

longitudinal research suggests that adolescents with early onset of use and high consumption of substances such as alcohol show more dysfunctional levels on risk factors (difficulties with school performance, self-esteem, and family relationships, low resistance to peer pressure, sensation seeking, and conduct problems) compared to those with late onset or low consumption patterns (Flory et al. 2004).

Similar to childhood predictors, the salience of risk factors for alcohol use in adolescence (such as internalizing and externalizing symptoms), in part, varies by gender. Specifically, internalizing symptoms (e.g., depressive symptoms) appear to be more important predictors of high levels of alcohol use among female adolescents (e.g., Poulain et al. 2005), whereas externalizing behaviors (e.g., low behavioral control) is a stronger risk factor among male than female adolescents (Caspi et al. 1996). In addition, high BMI in females (Pasch et al. 2012) and early timing of pubertal development in males and females (e.g., Biehl et al. 2007; Wichstrom 2001) lead to alienation from normative peers and more contacts with deviant ones, and, by taking over their behavioral styles, to early and high alcohol use. Contact with older peers who already drink seems to be much more influential for alcohol consumption among young females as compared to males (Danielsson et al. 2011), which may be due in part to the fact that females are more likely than males to mimic the drinking patterns of their peers or partners (Nolen-Hoeksema and Hilt 2006). In contrast, family characteristics such as parenting styles during adolescence predict level of alcohol use especially in adolescent males relative to females (Schulte et al. 2009).

A small number of studies focusing on the prediction of drinking trajectories across adolescence investigated possible gender differences in the importance of various adolescent correlates from the personal and environmental domain. Regarding risk factors in the personal domain, Chassin et al. (2004) reported that gender did not moderate the predictive effects adolescent impulsivity, adolescent negative emotionality, and young adult personality characteristics on drinking trajectories. In addition, Colder et al. (2002) reported that the predictive effects of risk-taking and emotional distress on a drinking trajectory group were not moderated by gender. In contrast, externalizing problems were more salient risk factors for early and high alcohol use trajectories in males, and depressive symptoms for females, as compared to the other gender (Chassin et al. 2002). In addition, academic problems and low task orientation are more important risk factors for problematic consumption trajectories of high alcohol use among males than females (Windle et al. 2005). With regard to risk factors in the environmental domain, White et al. (2000) examined the predictive effects of parental drinking levels,

parental warmth, and parental hostility on male and female alcohol use trajectories, respectively, and found more commonality than gender-specificity in predictive effects. In the same vein, in the study by Chassin et al. (2002), family effects on alcohol use trajectories were detected for both males and females; however, when deviant peer environment was added as a predictor of trajectory membership, these effects were greatly diminished. Finally, socioeconomic status was investigated as a risk factor for high levels of alcohol use in adolescence. While some studies identified socioeconomic status to impact levels of drinking of both males and females (Walden et al. 2007), others delivered mixed results, depending on the construct under investigation, such as income versus parental education (see Chuang et al. 2005). In sum, whereas some adolescent risk factors in the family and school domains seem to have equal importance for both genders to predict levels and/or early and high consumption in adolescence, some risks in the personal domain, such as high BMI or internalizing symptoms, and the affiliation with deviant peers increase the risk for problematic alcohol use during adolescence, especially among females.

In conclusion, the scant body of literature on this issue has revealed a mix of both commonality and gender-specificity in the effects of childhood predictors and correlates on alcohol use in adolescence. This is true for studies searching for risk factors predicting levels of alcohol use at one single point in adolescence and also for studies predicting membership in problematic trajectories of alcohol use across this life phase. The mixed findings might be a consequence of the fact that some of the trajectory studies included only a small subset of relevant predictor domains (by comparison with the theoretical assumptions about trajectories, as described above), and mainly included predictors measured in adolescence. In addition, the majority of studies were based on US samples. Thus, additional research with more comprehensive predictor sets in childhood and adolescence is warranted, especially for non-US samples. Finally, the investigation of gender-specificity in predictors and correlates of problematic developmental trajectories of alcohol use is especially important for designing effective interventions against early and high alcohol use among male and female youth.

Study Aims

The current prospective study examined the association of childhood predictors and mid-adolescent correlates to distinctive trajectories of alcohol use that were identified in a prior study with German adolescents (Wiesner et al. 2007) for each gender separately. More specifically, we compared groups of males and females with “problematic” alcohol use

trajectories (i.e., high level with increasing pattern over time) to same-gender individuals on other trajectories (i.e., normative or rare use) with regard to predictors dating back to childhood and mid-adolescent correlates. This strategy is particularly informative for gaining more knowledge about predictors of problematic patterns of alcohol use trajectories in males and females, which, in turn, may lead to more informed gender-specific etiological models and the development of effective prevention strategies aiming at a reduction of problematic alcohol use among young males and females.

The selection of study variables was guided by the above-described theoretical assumptions on trajectories of alcohol use during adolescence, and their predictors and correlates (e.g., Moffitt 1993; Tarter 2002). More specifically, we included impulsivity, social problems with peers, and academic self-confidence as childhood predictors. Based on the extant body of literature, we assumed that externalizing problems, inattentiveness, and restlessness (i.e., impulsivity) in childhood are more relevant to predict a problematic trajectory of high alcohol use in male compared to female adolescents (e.g., Caspi et al. 1996). In contrast, we hypothesized that internalizing problems in childhood as indicated, for instance, by low self-confidence in the academic domain are more typical risk factors for high alcohol use during adolescence among females (see Silverthorn and Frick 1999). Finally, problems within the peer context should be a risk factor for a problematic trajectory of alcohol use in both males and females.

As mid-adolescent correlates, we included parental alcohol use, body mass index (BMI), risky peer context, adaptation problems in various developmental contexts (conduct problems at school, poor relationship with parents), somatic complaints, and various socio-demographic variables in this study. We assumed that parental alcohol use, negative parent–adolescent relationship and conduct problems at school are associated with a trajectory of high alcohol consumption during adolescence in both males and females (e.g., Chassin et al. 2004). We also posited that high BMI and contact with deviant peers would be considerably more important correlates of high alcohol use among adolescent females as compared to males. Finally, internalizing symptoms as indicated by somatic complaints should be more important correlates of a trajectory of high alcohol consumption among adolescent females than they are for males (Chassin et al. 2002).

Methods

Sample

The data used in this prospective study were drawn from the Younger Cohort of the Leipzig Schüler-Intervall (LSI)

Study, a nine-wave panel study in the former East Germany. The LSI was initiated in 1986 by the Zentralinstitut für Jugendforschung (Central Institute for Youth Research) in Leipzig and focused on studying intellectual abilities (see Friedrich 1997; Friedrich et al. 1999). Using a multi-stage probability sampling procedure, four schools were randomly selected from the former seven municipal districts of the city of Leipzig, and data were gathered from all third graders who were enrolled in these schools according to records of the residents' registration office and present on the day of survey administration ($n = 1,474$). Although the specific participation rate was not recorded, Friedrich (1997) reported that participation rates were typically very high (about 98 %) in surveys conducted by the Zentralinstitut für Jugendforschung. According to Kuhnke (1997), the sample was representative of the city of Leipzig in terms of socioeconomic status and educational experiences, and in many respects comparable to other large cities in the former East Germany. Data collection occurred in annual intervals from 1986 to 1995 (except the year 1994). After German unification in 1990, the LSI was continued under the direction of the Deutsche Jugendinstitut (German Youth Institute) in Munich and the focus of the study was broadened, including the addition of assessments of the adolescents' problem behavior (see Bien et al. 1995). These study participants had to cope in their early adolescent years with particular challenges resulting from the macro-societal changes.

Retention rates were quite high (≥ 89 %) for the first four waves. Because data collection spanned a period of almost ten years, which included massive social, political, and economic changes as a consequence of German unification (e.g., Noack et al. 1995), there were fluctuations in participation rates in later waves.¹ Hence, in 1991 and 1992 supplemental random samples of $n = 536$ (1991) and $n = 278$ (1992) adolescents were recruited from rural areas around the city of Leipzig that were comparable to the original sample in terms of age and gender (see Kuhnke 1997). They also did not differ from the original sample in levels of alcohol consumption during adolescence.

This study used data from Waves 1, 6, 7, 8, and 9 (corresponding to assessment years 1986, 1991, 1992, 1993, and 1995) for $N = 1,619$ adolescents who were already used in a prior report (for details on selection criteria, see Wiesner et al. 2007). Students were included in the analyses if they had participated in two or more of the waves. A more lenient inclusion criterion would have

resulted in too large amounts of missing values (particularly in the covariance coverage matrix; see “Statistical Analysis”). Adolescents within the selected sample were more likely to be female ($\chi^2_{(1)} = 9.58, p < .01$) and to have better school grades ($t_{(552)} = -8.21, p < .001$, Cohen's $d = 0.52$) compared with those who were not included. They also showed lower levels of impulsivity ($t_{(1447)} = -5.84, p < .001$, Cohen's $d = 0.30$), higher levels of academic self-confidence ($t_{(1224)} = 3.10, p < .01$, Cohen's $d = 0.17$), and fewer problems in the peer context ($t_{(1274)} = -3.03, p < .01$, Cohen's $d = 0.17$) than did those who were not included. No selection effects were found for repeating a school year, occupational qualification and current work situation of the parents, family status, and number of children in the household.

The average age of the selected adolescents was 9.01 years at Wave 1, 14.05 years ($SD = .29$) at Wave 6, and 17.79 years ($SD = .47$) at Wave 9. About 55 % ($n = 892$) of the adolescents were female and 45 % ($n = 727$) male. At the last measurement occasion, 55 % of the adolescents were still in school (i.e., college-bound), 39 % had an apprenticeship (i.e., non-college bound), with the rest (6 %) mostly engaging in some other form of vocational training. Seventy-two percent of the sample came from areas with more than 100,000 residents (the city of Leipzig), 8 % from areas with 10,000–100,000 residents, and 20 % from areas with fewer than 10,000 residents (surrounding smaller towns and villages). Forty-one percent of the fathers had a maximum of 3 years or less of post-secondary education (i.e., “Facharbeiterabschluss”), 30 % 4 years of post-secondary education (i.e., “Meister-” or “Fachschulabschluss”), and 29 % 5 years of post-secondary education (i.e., “Hochschul-” or “Universitätsabschluss”). Seventy-eight percent of the fathers and 63 % of the mothers were employed full-time, 8 % of the fathers and 15 % of the mothers were employed part-time, and 13 % of the fathers and 18 % of the mothers were in short-time work (“Kurzarbeit”), in a waiting position for a job, or unemployed. The median per capita household income was 625 DM per month (ranging from 104 to 1,938 DM).² Seventy-three percent of the adolescents were living with both biological parents, 15 % lived with one biological and one step-parent, and 12 % came from a single-parent household.

Procedures

Data were collected from the adolescents and also, at some waves, from their teachers and parents. Questionnaires, as

¹ Participant loss primarily occurred for two reasons (both a consequence of German unification). First, families moved away from the city of Leipzig from 1990 onward, usually to West Germany (see also Sahner 1996; Statistisches Landesamt des Freistaates Sachsen 2002). Second, the East German school system was restructured in 1990–1991 (Kuhnke 1997).

² As of July 1991, the equivalent amounts in USD currency were: the median per capita household income was \$344.92 per month (ranging from \$57.40 to \$1069.54).

well as some cognitive tests, were administered to the adolescents in the classrooms in the presence of study personnel only. If adolescents had completed their school education during the study period, then questionnaires were sent to them by regular mail. Parents and teachers also filled out questionnaires. Any personal identification information was eliminated from study materials and datasets. Adolescents were not compensated for their participation.

Measures

Amount of Pure Alcohol (Ethanol) Consumption

Adolescents reported at Waves 6 through 9 (14–18 years of age) how many glasses of beer, wine, and hard liquor they had consumed in the last 4 weeks. In general, the validity of self-reports of alcohol use has been supported in numerous studies with adolescents (e.g., Lintonen et al. 2004; Winters et al. 1991), but questions remain about the degree to which response accuracy is jointly influenced by social context factors, participant characteristics, and task attributes, and whether different drinking patterns are linked to different response biases (e.g., Del Boca and Darkes 2003). For example, there is limited evidence from German research that consumption levels for hard liquor may be considerably more under-reported in self-report surveys relative to sales data than are consumption levels for wine and beer (Bühringer et al. 2000). However, underreporting problems often result from the exclusion of subpopulations, such as the homeless and institutionalized, from sampling frames (Gmel and Rehm 2004). The bias caused by underreporting should be rather small in contexts such as Germany where respondents tend to interpret drinking as “usual” or “customary.” Moreover, the self-reports analyzed in the current study were collected across a longer recall period (4 weeks vs. a single drinking occasion) by using beverage-specific instruments, which were not intended to establish clinical cut-off points, and were gathered from a normative sample of adolescents. Together, these characteristics support the assumption that our estimated consumption quantities came acceptably close to the true mean amounts (cf. Gmel and Rehm 2004). Nevertheless, findings of this study need to be evaluated in light of these potential measurement limitations.

Definitions of the amount of pure alcohol (ethanol) per standard drink vary between countries (International Center for Alcohol Policies 1998). In this study, German standard formulas were employed (see Simon et al. 1999; accordingly, one standard glass of beer contains 11.6 g pure alcohol, one standard glass of wine 21.6 g pure alcohol, and one standard glass of hard liquor 6 g pure alcohol) to compute the consumed amount of pure alcohol

(in grams) for each substance. Then a total score was formed by summing up the amounts across the three substances. Comparisons showed that the amounts of pure alcohol consumed by youth in the LSI were highly similar to findings in nationally representative studies with German adolescents (e.g., Simon et al. 1999). Prior to use in the LGMM (latent growth mixture modeling) analyses, log-transformations (a constant was added because the distributions contained values below one) were applied to normalize the distribution of the total scores.

Identification of Distinctive Developmental Trajectories of Alcohol Use

This study examined childhood predictors and mid-adolescent correlates of several alcohol use trajectory groups that were already identified and described in an earlier report. Using LGMM (Muthén and Muthén 2000; Muthén and Shedden 1999), Wiesner et al. (2007) identified homogeneous subgroups with distinct developmental trajectories of alcohol use from ages 14 to 18 years. This was done using the measure of amount of pure alcohol consumption described above. A detailed account of the method, analysis strategy, model selection criteria, and model fit statistics is given in their study. Briefly summarizing the results from Wiesner et al. (2007), gender-specific statistical analysis suggested that a four-class model with a quadratic growth function (the intercept factor mean was centered on age 15.5 years) fitted the data best for males and females each. The male trajectory groups included 58 (8.0 %) *rare users*, 81 (11.1 %) *late escalators*, 33 (4.6 %) *early peakers*, and 555 (76.3 %) *regular users*. The female trajectory groups included 80 (9.0 %) *rare users*, 231 (25.9 %) *increasers*, 73 (8.2 %) *decreasers*, and 508 (56.9 %) *regular users*. Figure 1 shows the alcohol consumption trajectory for each identified group. Classification quality was good for males and females each (i.e., average posterior class membership probabilities ranged from .84 to .98 for males and from .86 to .89 for females; median posterior class membership probabilities were 1.00 for all male trajectory classes and ranged from .85 to 1.00 for female trajectory classes; entropy was .93 for males and .81 for females). For males and females, the group of “regular users” with high and even increasing alcohol consumption from age 14 to 18 can be interpreted as trajectories with a problematic alcohol use pattern.

Socio-Demographic Variables

Socio-demographic information included adolescents’ age and gender as well as paternal education and community size.

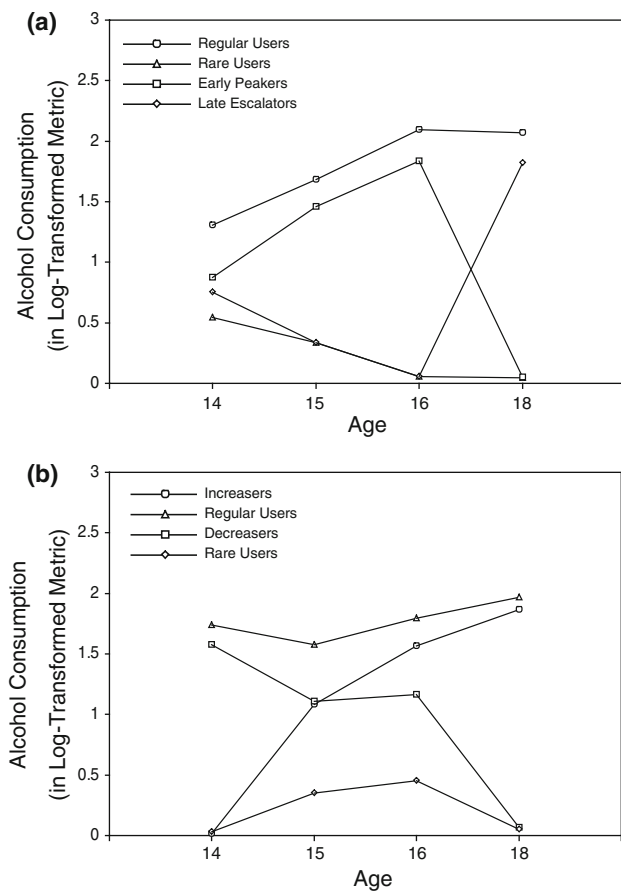


Fig. 1 **a** Empirical growth curves for final latent growth mixture model with four alcohol use trajectory classes for 727 males. **b** Empirical growth curves for final latent growth mixture model with four alcohol use trajectory classes for 892 females. The male trajectory groups included 58 (8.0 %) *rare users*, 81 (11.1 %) *late escalators*, 33 (4.6 %) *early peakers*, and 555 (76.3 %) *regular users*. The female trajectory groups included 80 (9.0 %) *rare users*, 231 (25.9 %) *increasers*, 73 (8.2 %) *decreasers*, and 508 (56.9 %) *regular users*. Reprinted from Wiesner et al. (2007), with permission from APA

Participants further reported the monthly net income of the household on a nine-point response scale from 1 (*below 500 DM*) to 9 (*5,000 DM or more*). Categories were replaced by their category means and divided by the number of household members to create a measure of *per capita family income*. To gain a more stable measure, ratings of per capita family income were averaged across the years 1991 and 1992 [$M(\text{females}) = 610.41$, $SD(\text{females}) = 284.38$; $M(\text{males}) = 726.33$, $SD(\text{males}) = 309.00$].

Childhood Predictors

In this study, measures of impulsivity, academic self-confidence, and problems in the peer context were included as childhood predictors. All measures were gathered at wave 1 of the study (i.e., at age 9).

Impulsivity For impulsivity, a composite indicator was built based on parent report (“Did your child show nervous restlessness, problems in concentration or low tenacity?”); one point was given if parents answered with “yes”, teacher report (assessments of concentration, tenacity, and striving for goal accomplishment; one point was given if the individual value was more than +1 SD above the sample mean), and individual test results of the child in two cognitive tests. One test measured cognitive information processing speed (Zahlenverbindungstest, ZVT; Oswald and Roth 1978) and the other concentration abilities (Testreihe zur Prüfung der Konzentrationsfähigkeit, TPK; Kurth 1984); one point was given if at least one of the test results was more than –1 SD below the sample mean. According to this composite index, 19 % of the females and 28 % of the males showed high impulsivity.³

Academic Self-confidence The measure of academic self-confidence focused on the academic context and was based on self-reports (5 items, e.g., “I am anxious if I have to write on the blackboard”; “I easily give up learning as soon as I don’t understand something”). The response scale for these items ranged from 1 = *very often* to 4 = *never* in this study (Cronbach’s Alpha = .64 for females and .63 for males). The total score was formed by averaging across the items, with higher values indicating higher levels of academic self-confidence in the academic context [$M(\text{females}) = 3.37$, $SD(\text{females}) = 0.49$; $M(\text{males}) = 3.50$, $SD(\text{males}) = 0.44$].

Problems in the Peer Context Finally, problems in the peer context were measured based on self-reports (3 items, e.g. “Do other children in the classroom tease you?”, *yes/no*). Affirmative responses were summed to form the total score, with higher values on this measure indicating a higher load of peer problems [$M(\text{females}) = 0.36$, $SD(\text{females}) = 0.60$; $M(\text{males}) = 0.43$, $SD(\text{males}) = 0.63$].

Mid-Adolescent Correlates

The following mid-adolescent correlates were included in this study: measures of the adolescents’ BMI, risky peer

³ According to Pulkkinen (1996), impulsivity is characterized by acting without appropriate reflection, distorted information processing, or inability to maintain attention. In the present study, both cognitive (i.e., cognitive test results) and behavioral (i.e., parent and teacher reports) aspects of impulsivity were assessed (White et al. 1994). All indicators sought to capture features of temperament that are related to problematic use of alcohol among adolescents (see Tarter 2002). Our measure of impulsivity was validated by concurrent parent reports which revealed meaningful associations between high impulsivity on the one hand and perinatal complications and problematic, harsh parenting practices on the other hand (see Weichold 2002, for more information).

context, parent–child relationship, somatic complaints, parental alcohol use, and adolescents' conduct problems at school. Data were gathered at wave 6 or 7 (i.e., at age 14 or 15).

BMI The adolescent's BMI was calculated based on their self-reported height and weight. Both were highly correlated ($r = .40, p < .001$ for females, $r = .55, p < .001$ for males). The individual BMI was calculated according to the protocol of Graber et al. (1994) [$M(\text{females}) = 20.10, SD(\text{females}) = 2.53; M(\text{males}) = 20.48, SD(\text{males}) = 2.29$].

Risky Peer Context Risky peer context was assessed by self-reports (3 items, i.e., whether the youth belongs to a group that is engaged in some illegal activities, whether the youth has a steady male/female friend, and whether the youth is a member of a clique (*yes/no*). Affirmative responses were summed to form the composite index, with higher values indicating higher risk within peer relationships. According to this index, 12 % of the females and 11 % of the males had a risky peer context in adolescence.

Negative Parent–Adolescent Relationship Negative parent–adolescent relationship as averaged across parents was also measured by self-reports (4 items, e.g., “I have a good relationship with my mother/father”, one item each for mother and father, two items referring to the relationship quality to both parents; Cronbach's Alpha = .70 for females and .70 for males). Because of varying response scales, items were z-transformed before they were averaged to form the total score. Higher values on the total score indicated negative parent–adolescent relationships [$M(\text{females}) = 0.00, SD(\text{females}) = 0.73; M(\text{males}) = 0.00, SD(\text{males}) = 0.73$].

Somatic Complaints Information on somatic complaints was also gathered from the adolescents (11 items, e.g., headache). For this study, the response options were reverse-coded so that they ranged from 1 = *never* to 4 = *often* (Cronbach's Alpha = .75 for females and .76 for males). The total score was formed by averaging across the items, with higher values on the total score indicating more frequent somatic complaints [$M(\text{females}) = 1.10, SD(\text{females}) = 0.52; M(\text{males}) = 0.77, SD(\text{males}) = 0.48$].

Parental Alcohol Use Further, we used a measure of parental alcohol use as reported by the adolescent for their mother and father separately (response options were reverse-coded in this study so that they ranged from 0 = *not at all* to 5 = *almost daily*). Because reports on mothers' and fathers' alcohol use were highly correlated ($r = .59, p < .001$ for females, $r = .62, p < .001$ for

males), they were averaged. Higher values on this measure indicated more frequent parental alcohol use [$M(\text{females}) = 2.72, SD(\text{females}) = 1.24; M(\text{males}) = 2.78, SD(\text{males}) = 1.28$].

Conduct Problems at School Finally, conduct problems at school were measured based on teacher reports for each student (9 items, e.g., rule violations, disruptions, verbal abuse of other students). In this study, the response options were reverse coded so that they ranged from 0 = *never* to 4 = *frequently* (Cronbach's alpha = .88 for females and .85 for males). The total score was formed by averaging across the items, with higher values indicating more frequent conduct problems at school [$M(\text{females}) = 0.18, SD(\text{females}) = 0.61; M(\text{males}) = 0.82, SD(\text{males}) = 1.24$].

Statistical Analysis

The effects of childhood predictors, socio-demographic controls, and mid-adolescent correlates on alcohol use trajectory group membership were examined by estimating conditional latent growth mixture models for males and females separately. Latent growth mixture modeling (LGMM) (Muthén and Muthén 2000; Muthén and Shedden 1999) can be viewed as a more general form of conventional growth curve modeling. In the latter, a growth curve is estimated for the sample and individual differences in developmental trajectories are captured by allowing for continuous variability of the growth factors (i.e., estimation of growth factor variation). The LGMM approach, in contrast, assumes that the sample is composed of a mixture of distinct subgroups, each defined by a prototypical growth curve. Because this method allows for cross-group differences in the shape of trajectories, it is especially suited for identifying and modeling heterogeneity in developmental trajectories within a given sample (Nagin and Tremblay 1999).

The conditional LGMM models were estimated with the software package Mplus 3.0 (Muthén and Muthén 1998–2004). Mplus allows for missing data in all parts of LGMM models except observed background variables. Missing values are accommodated by full information maximum likelihood (FIML) estimation. To assess the extent of missing data in the dataset, Mplus provides a covariance “coverage” matrix that gives the proportion of available observations for each indicator and pairs of variables, respectively. The default minimum coverage necessary for models to converge is .10, though each element in the coverage matrix should preferably have a convergence greater than .50 (see Muthén and Muthén 1998–2004; Schafer 1997). In this study, coverage ranged from .51 to .85 for males and from .51 to .89 for females, more than adequate for acceptable estimation.

There were some missing values on the background variables. Specifically, rates of missing values ranged from 9.8 to 55.9 % for males (11 out of 14 variables had rates of missing values below 36 %) and ranged from 7.6 to 59.4 % for females (11 out of 14 variables had rates of missing values below 40 %). Missing values on background variables are not accommodated by Mplus. Many traditional missing value strategies, including listwise deletion, pairwise deletion, or mean substitution, would have resulted in loss of statistical power and somewhat biased parameter estimates (Graham and Hofer 2000; Little and Rubin 1987; Schafer and Olsen 1998). To avoid these problems, missing values on background variables were estimated with multiple imputation using the software package NORM 2.03 (Schafer 1999). Even if the missing at random assumption is not fully met this procedure produces less biased parameter estimates than listwise deletion or mean substitution methods (Graham and Hofer 2000; Schafer and Olsen 1998). Ten data sets were imputed in NORM for males and females each. This number was sufficient in relation to the percentage of missing data in this study (see Graham et al. 2007). The imputation data set included the self-reported amount of pure alcohol consumption at each assessment wave and all childhood predictors, socio-demographic variables, and mid-adolescent correlates used in this study. All conditional LGMM models were estimated for the ten imputed data sets and results aggregated using the Mplus RUNALL utility.

Results

Descriptives

Table 1 contains descriptive information for socio-demographic variables, childhood predictors, and mid-adolescent correlates for each gender (cell sizes varied because of some missing values). A more stringent alpha-level of $p < .01$ was used to control for Type I error inflation due to the number of tests. Overall, the male alcohol use trajectory groups did not show any significant group differences on childhood predictors, socio-demographic variables, and mid-adolescent correlates. Female alcohol use trajectory groups differed significantly in terms of per capita household income ($p < .01$; regular users, interpreted as most problematic alcohol use trajectory, resided in households with a significantly higher income compared to increasers), parents' alcohol use ($p < .001$; parents of regular users consumed significantly more alcohol than did those of increasers and rare users), and risky peer context ($p < .001$; increasers, decreasers, and regular users were exposed to a significantly more risky peer context compared to rare users). Finally, inspection of intercorrelations among the

childhood predictors, socio-demographic variables, and mid-adolescent correlates (not shown) revealed correlation coefficients of small-to-moderate size for males and females (all correlation coefficients were below $|\lambda|0$). The variables shown in Table 1 were used as predictors in the conditional alcohol use trajectory models.

Prediction of Alcohol Use Trajectories for Males

The model specification with predictive effects of childhood predictors, socio-demographic variables, and mid-adolescent correlates on alcohol use trajectory class membership (*Conditional Model 1*) for males resulted in a log likelihood statistic of $-2,261$ with 66 degrees of freedom ($BIC = 4,957$, *sample-size adjusted BIC* = 4,747, $AIC = 4,654$, *Entropy* = .94). Next, within-class effects of childhood predictors, socio-demographic variables, and mid-adolescent correlates on latent growth factors were added in a stepwise manner (i.e., for each variable separately) to determine whether the additional specification of within-class effects provided a significantly better fit to the data.⁴ This series of model tests revealed that the additional specification of within-class effects on latent growth factors was indicated for just one variable, namely risky peer context [$\Delta\chi^2 (12, N = 727) = 36, p < .001$]. Thus, the model with within-class effects for risky peer context (*Conditional Model 2*) was chosen as the final model for males ($-LL = 2,243$, $df = 78$, $BIC = 5,000$, *sample-size adjusted BIC* = 4,752, $AIC = 4,642$, *Entropy* = .94). Inspection revealed that the within-class effects of risky peer context were only significant for the regular user class. Higher levels of risky peer context were positively related to the intercept factor ($b = .25, SE = .05, p < .001$) and negatively linked to the linear factor ($b = -.11, SE = .04, p < .01$), whereas the association with the quadratic factor was not significant ($b = .02, SE = .03, p > .10$). This means that regular users with a more risky peer context consumed more alcohol at age 15.5 years and showed smaller increases in amounts of consumed alcohol across time than did regular users with a less risky peer context. Moreover, there was very little evidence that the addition of predictors and correlates altered the trajectory class solution that was identified in prior work (e.g., class proportions in *Conditional Model 2* were almost identical to

⁴ As shown in several studies (e.g., Lane et al. 2013; Stoolmiller et al. 2005), predictors may be related to trajectory class membership and/or developmental course over time within a given trajectory group. Both components of prediction have important implications for prevention and intervention efforts. Because the main focus of the current study was on the prediction of trajectory class membership, we applied the described stepwise testing strategy in order to empirically identify the most salient predictors of within-class developmental course and thus minimize model complexity.

Table 1 Study variable descriptives by alcohol use trajectory classes

	Four-class trajectory model for 727 males				Overall test statistic
	Regular users	Rare users	Early peakers	Late escalators	
<i>Childhood predictors</i>					
High impulsivity (<i>M</i>)	0.83	0.94	0.58	0.79	$F_{(3, 353)} = 0.75$
Academic self-confidence (<i>M</i>)	3.51	3.50	3.49	3.41	$F_{(3, 317)} = 0.59$
Problems in peer context (<i>M</i>)	0.45	0.42	0.53	0.29	$F_{(3, 49.82)} = 1.37^a$
<i>Socio-demographic variables</i>					
Age (<i>M</i>)	14.07	14.14	14.00	14.04	$F_{(3, 489)} = 1.03$
Paternal education (%)					
Facharbeiter or less (low)	41.8	51.9	54.5	28.4	$\chi^2_{(6)} = 8.83$
Meister/Fachschulabschluss	27.6	23.1	22.7	34.3	
Uni-/Hochschulabschluss (high)	30.7	25.0	22.7	37.3	
Community size (%)					
Up to 10,000	18.8	8.2	14.8	10.8	$\chi^2_{(6)} = 7.43$
10,000–100,000	7.9	10.2	3.7	7.7	
More than 100,000	73.3	81.6	81.5	81.5	
Per capita household income (<i>M</i>)	737.59	660.91	679.83	708.36	$F_{(3, 652)} = 1.27$
<i>Mid-adolescent correlates</i>					
Parents' alcohol use (<i>M</i>)	2.82	2.61	2.85	2.65	$F_{(3, 463)} = 0.52$
Body mass index (<i>M</i>)	20.59	20.07	20.60	19.92	$F_{(3, 597)} = 2.21$
Risky peer context (<i>M</i>)	0.70	0.73	0.53	0.50	$F_{(3, 493)} = 1.08$
Conduct problems at school (<i>M</i>)	0.88	0.49	0.88	0.66	$F_{(3, 55.60)} = 2.07^a$
Negative parent–adolescent relationship (<i>M</i>)	0.31	−0.19	−0.00	−0.10	$F_{(3, 602)} = 1.77$
Somatic symptoms (<i>M</i>)	0.79	0.68	0.84	0.68	$F_{(3, 464)} = 1.34$
	Four-class trajectory model for 892 females				Overall test statistic
	Increasesers	Regular users	Decreasers	Rare users	
<i>Childhood predictors</i>					
High impulsivity (<i>M</i>)	0.67	0.54	0.56	0.71	$F_{(3, 388)} = 0.98$
Academic self-confidence (<i>M</i>)	3.29	3.40	3.39	3.28	$F_{(3, 358)} = 1.41$
Problems in peer context (<i>M</i>)	0.35	0.38	0.24	0.38	$F_{(3, 364)} = 0.45$
<i>Socio-demographic variables</i>					
Age (<i>M</i>)	14.05	14.01	14.11	14.05	$F_{(3, 561)} = 2.69^*$
Paternal education (%)					
Facharbeiter or less (low)	39.4	41.6	47.3	35.6	$\chi^2_{(6)} = 6.27$
Meister/Fachschulabschluss	28.6	33.3	32.7	30.5	
Uni-/Hochschulabschluss (high)	32.0	25.1	20.0	33.9	
Community size (%)					
Up to 10,000	25.3	22.3	24.1	14.7	$\chi^2_{(6)} = 5.65$
10,000–100,000	10.6	7.4	6.9	8.8	
More than 100,000	64.1	70.3	69.0	76.5	
Per capita household income (<i>M</i>)	558.63 _A	634.79 _B	635.02	541.85	$F_{(3, 794)} = 4.62^{**}$
<i>Mid-adolescent correlates</i>					
Parents' alcohol use (<i>M</i>)	2.47 _A	2.90 _B	2.54	2.31 _A	$F_{(3, 537)} = 6.10^{***}$
Body mass index (<i>M</i>)	19.89	20.17	19.88	20.32	$F_{(3, 756)} = 0.82$
Risky peer context (<i>M</i>)	0.74 _A	0.90 _A	1.13 _A	0.43 _B	$F_{(3, 119.61)} = 10.30^{a-***}$
Conduct problems at school (<i>M</i>)	0.13	0.22	0.22	0.00	$F_{(3, 552)} = 2.05$
Negative parent–adolescent relationship (<i>M</i>)	−0.11	0.03	0.05	0.56	$F_{(3, 145.72)} = 1.88^a$
Somatic symptoms (<i>M</i>)	1.08	1.11	1.11	1.13	$F_{(3, 547)} = 0.17$

Means with different subscripts differed significantly ($p < .05$) by Bonferroni (Tamhane 2 in the presence of unequal variances) post hoc tests. The male trajectory groups included 58 (8.0 %) *rare users*, 81 (11.1 %) *late escalators*, 33 (4.6 %) *early peakers*, and 555 (76.3 %) *regular users*. The female trajectory groups included 80 (9.0 %) *rare users*, 231 (25.9 %) *increasers*, 73 (8.2 %) *decreasers*, and 508 (56.9 %) *regular users*

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

^a Robust test statistic (Welch statistic)

those in the unconditional trajectory model). As described in the introduction, the parameter estimates for Conditional Model 2 are shown using the regular users (reflecting a problematic consumption trajectory) as baseline group (Table 2).⁵

None of the variables was significantly related to membership in the early peaker group in contrast to regular users. Three variables significantly predicted membership in the late escalator group compared to regular users. Males with more highly educated parents ($p < .05$) and from larger communities ($p < .05$) were more likely to be in the late escalator group, and males with higher levels of parents' alcohol use ($p < .01$) were less likely to be in the late escalator group relative to the baseline group of regular users. Three variables were significantly linked to membership in the rare user group as compared to regular users. Males from larger communities were more likely to be in the rare user group ($p < .05$), and males with more conduct problems at school ($p < .05$) and poorer relationships with their parents ($p < .01$) were less likely to be in the rare user group compared to the baseline group of regular users.

⁵ We also predicted trajectory group membership using groups with "normative" consumption trajectories (i.e., "late escalators" for males and "increases" for females) as baseline groups. Result tables for these analyses can be obtained from the first author upon request. Briefly summarizing, the key findings for these prediction models were as follows: for *males*, just one variable was significantly linked to membership in the early peaker group. Older males were more likely to belong to the early peaker group than to the baseline group of late escalators ($p < .05$). Three variables were significant predictors of membership in the regular user group. Males from larger communities ($p < .05$) and with highly educated parents ($p < .05$) were less likely to belong to the regular user group, and males with higher levels of parents' alcohol use were more likely to belong to the regular user group ($p < .01$) relative to the baseline group of late escalators. Finally, two variables were significantly associated with membership in the rare user group. Older males were more likely to be in the rare user group ($p < .05$), and males with more highly educated parents were less likely to belong to the rare user group ($p < .05$) compared to the baseline group of late escalators. For *females*, two variables significantly predicted membership in the rare user group. Females with higher impulsivity ($p < .05$) and from larger communities ($p < .05$) were more likely to be in the rare user group than in the baseline group of increasers. Two variables were significantly linked to membership in the decreaser group. Females with higher body mass index ($p < .05$) and with a more risky peer context ($p < .01$) were more likely to belong to the decreasers compared to the baseline group of increasers. Finally, five variables were significant predictors of regular user group membership. Females with higher levels of impulsivity ($p < .05$) and higher paternal education ($p < .05$) were less likely to belong to the regular users than to the baseline group of increasers. Females with higher levels of parents' alcohol use ($p < .01$), higher body mass index ($p < .01$), and a more risky peer context ($p < .01$) were more likely to be in the regular user group compared to the baseline group of increasers.

Prediction of Alcohol Use Trajectories for Females

For females, the model specification with effects of childhood predictors, socio-demographic variables, and mid-adolescent correlates on alcohol use trajectory class membership (*Conditional Model 1*) resulted in a log likelihood statistic of $-2,698$ with 65 degrees of freedom ($BIC = 5,838$, *sample-size adjusted BIC* = 5,632, $AIC = 5,527$, $Entropy = .84$). Next, within-class effects of childhood predictors, socio-demographic variables, and mid-adolescent correlates on latent growth factors were added in a stepwise manner (i.e., for each variable separately) to determine whether the additional specification of within-class effects provided a significantly better fit to the data. This series of model tests revealed that the additional specification of within-class effects on latent growth factors was indicated for three variables, namely academic self-confidence, paternal education, and somatic symptoms [$\Delta\chi^2(48, N = 892) = 116, p < .001$]. Therefore, the model with within-class effects for paternal education, academic self-confidence, and somatic symptoms (*Conditional Model 2*) was chosen as the final model for females ($-LL = 2,640$, $df = 113$, $BIC = 6,049$, *sample-size adjusted BIC* = 5,690, $AIC = 5,507$, $Entropy = .84$). The within-class effects of paternal education were significant for the decreaser and increaser classes. For both trajectory classes, higher paternal education was positively related to the linear factor ($b = .27, SE = .11, p < .05$ for decreasers; $b = .12, SE = .05, p < .05$ for increasers), whereas associations with the intercept and quadratic factors were not significant. Specifically, a paternal "Hochschul-/Universitätsabschluss" degree was linked to a steeper decrease in alcohol consumption among decreasers, and a paternal "Meister/Fachschulabschluss" degree was related to a steeper increase in alcohol consumption among increasers relative to the reference category (low education).

The within-class effects of academic self-confidence were significant for the rare user, regular user, and increaser classes. For rare users, higher academic self-confidence was negatively associated with the intercept factor ($b = -.28, SE = .13, p < .05$) and positively with the quadratic factor ($b = .35, SE = .13, p < .01$), whereas the association with the linear factor was not significant ($b = .00, SE = .03, p > .10$). This means that rare users with higher academic self-confidence consumed less alcohol at age 15.5 years and showed a more pronounced curvilinear trend compared to those with lower academic self-confidence. For both regular users and increasers, higher academic self-confidence was positively related to the intercept factor ($b = .19, SE = .07, p < .01$ for regular users; $b = .30, SE = .12, p < .05$ for increasers) and not significantly linked to the linear factor ($b = -.06, SE = .03, p > .10$ for regular users; $b = .02, SE = .05, p > .10$ for increasers). In addition, higher

Table 2 Parameter estimates for conditional model 2 for male alcohol use trajectory groups with baseline group regular users ($N = 727$)

	Early peakers ($N = 33, 4.6\%$)		Late escalators ($N = 81, 11.1\%$)		Rare users ($N = 58, 8.0\%$)	
	Logit	SE	Logit	SE	Logit	SE
Constant	-9.47		4.31		-9.73	
<i>Childhood predictors</i>						
High impulsivity	-0.69	0.48	-0.07	0.16	0.03	0.22
Academic self-confidence	-0.80	0.50	0.15	0.35	-0.04	0.39
Problems in peer context	0.33	0.38	-0.01	0.23	-0.01	0.30
<i>Socio-demographic variables</i>						
Age	0.62	0.39	-0.33	0.27	0.59	0.31
Paternal education						
Meister/Fachschulabschluss	-0.54	0.73	0.63	0.35	-0.36	0.37
Hochschul-/Universitätsabschluss	-0.42	0.64	0.82*	0.37	-0.54	0.41
Per capita family income	0.00	0.00	-0.00	0.00	-0.00	0.00
Community size	0.33	0.28	0.65*	0.29	0.70*	0.28
<i>Mid-adolescent correlates</i>						
Parents' alcohol use	-0.06	0.17	-0.33**	0.11	-0.11	0.13
Body mass index (BMI)	-0.01	0.09	-0.09	0.07	-0.08	0.08
Risky peer context	-0.66	0.48	-0.18	0.19	-0.13	0.24
Conduct problems at school	0.06	0.16	-0.07	0.12	-0.40*	0.20
Negative parent-adolescent relationship	-0.08	0.35	-0.25	0.20	-0.82**	0.26
Somatic symptoms	0.27	0.51	-0.60	0.33	-0.41	0.44

Logit coefficients are unstandardized. Baseline group is regular users. Within-class effects for risky peer context are not shown. All parameters are based on the robust maximum likelihood (MLR) estimator which corrects for non-normality

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

academic self-confidence was negatively related to the quadratic factor for increasers ($b = -.21, SE = .11, p < .05$), whereas the association was not significant among the regular users ($b = -.04, SE = .06, p > .10$). In other words, regular users and increasers with higher academic self-confidence drank more alcohol at age 15.5 years, and increasers with higher academic self-confidence also showed a less pronounced curvilinear trend than those with lower academic self-confidence.

The within-class effects of somatic symptoms were significant for the decreaser and regular user classes. For both trajectory classes, higher levels of somatic symptoms were positively linked to the intercept factor ($b = .46, SE = .21, p < .05$ for decreasers; $b = .35, SE = .09, p < .001$ for regular users) and negatively linked to the quadratic factor ($b = -.43, SE = .19, p < .05$ for decreasers; $b = -.13, SE = .06, p < .05$ for regular users), whereas the association with the linear factor was not significant ($b = -.11, SE = .08, p > .10$ for decreasers; $b = .04, SE = .04, p > .10$ for regular users). This means that both decreasers and regular users with more somatic symptoms consumed more alcohol at age 15.5 years and showed a less pronounced curvilinear trend compared to those with fewer somatic symptoms.

Finally, there was very little evidence that the addition of predictors and correlates altered the trajectory class solution that was identified in prior work (e.g., class proportions in Conditional Model 2 were almost identical to those in the unconditional trajectory model). As mentioned in the introduction, the parameter estimates for Conditional Model 2 are shown using the regular users (representing a problematic consumption trajectory) as baseline group (Table 3).

Four variables were significantly related to membership in the rare user group as compared to regular users. Females with higher levels of impulsivity ($p < .001$) were more likely to be in the rare user group, and females with higher levels of parents' alcohol use ($p < .01$), a more risky peer context ($p < .001$), and more conduct problems at school ($p < .05$) were less likely to be in the rare user group relative to the baseline group of regular users. Two variables significantly predicted decreaser group membership. Females with higher levels of impulsivity ($p < .05$) were more likely to be in the decreaser group, and females with higher levels of parents' alcohol use ($p < .05$) were less likely to be in the decreaser group relative to the baseline group of regular users. Finally, five predictors were significantly associated with membership in the

Table 3 Parameter estimates for conditional model 2 for female alcohol use trajectory groups with baseline group regular users ($N = 892$)

	Rare users ($N = 80, 9.0\%$)		Decreasers ($N = 73, 8.2\%$)		Increasesers ($N = 231, 25.9\%$)	
	Logit	SE	Logit	SE	Logit	SE
Constant	-9.29		-8.73*		4.60	
<i>Childhood predictors</i>						
High impulsivity	0.83***	0.21	0.46*	0.23	0.38*	0.15
Academic self-confidence	0.44	0.31	0.15	0.30	-0.19	0.26
Problems in peer context	-0.17	0.30	-0.22	0.33	0.09	0.22
<i>Socio-demographic variables</i>						
Age	0.50	0.31	0.40	0.26	-0.02	0.20
Paternal education						
Meister/Fachschulabschluss	0.04	0.34	-0.38	0.35	-0.18	0.26
Hochschul-/Universitätsabschluss	0.62	0.41	-0.08	0.44	0.69*	0.28
Per capita family income	-0.00	0.00	0.00	0.00	-0.00	0.00
Community size	0.32	0.19	-0.02	0.19	-0.19	0.13
<i>Mid-adolescent correlates</i>						
Parents' alcohol use	-0.41**	0.13	-0.27*	0.11	-0.31***	0.08
Body mass index (BMI)	-0.03	0.06	0.02	0.06	-0.12**	0.05
Risky peer context	-0.65***	0.18	0.22	0.20	-0.43**	0.15
Conduct problems at school	-1.36*	0.67	-0.09	0.27	-0.24	0.22
Negative parent-adolescent relationship	0.22	0.19	-0.06	0.25	-0.03	0.16
Somatic symptoms	-0.51	0.30	-0.01	0.32	-0.29	0.22

Logit coefficients are unstandardized. Baseline group is regular users. Within-class effects for academic self-confidence, paternal education, and somatic symptoms are not shown. All parameters are based on the robust maximum likelihood (MLR) estimator which corrects for non-normality
* $p < .05$; ** $p < .01$; *** $p < .001$

increaser group. Females with higher levels of impulsivity ($p < .05$) and higher paternal education ($p < .05$) were more likely to belong to the increasers, and females with higher levels of parents' alcohol use ($p < .001$), higher BMI ($p < .01$), and a more risky peer context ($p < .01$) were less likely to belong to the increasers than to the baseline group of regular users.

Discussion

The identification of salient risk factors for alcohol consumption trajectories in males and females during adolescence is an important topic not only for etiology research but also for designing effective gender-specific alcohol prevention tools. Based on a large representative sample of German youth we examined childhood predictors and mid-adolescent correlates of four distinctive drinking trajectories for male and female adolescents, separately. The selection of predictors and correlates included in the analyses was guided by developmental taxonomies of alcohol use (e.g., Moffitt 1993; Silverthorn and Frick 1999; Tarter et al. 1999; Zucker 1994) and the extant empirical literature on gender differences in risk factors of levels and/or trajectories of adolescent alcohol use. As described in

prior work (Wiesner et al. 2007), the four drinking trajectories differed in their shapes between males and females, but in both sub-samples we found a group of "regular users" who started at age 14 already with a high level, which they maintained until age 18. This pattern was interpreted as reflecting problematic usage over time. In contrast, other groups (labeled "late escalators" for the males and "increasers" for the females) showed a rather normative consumption pattern from ages 14 to 18 with late initiation of alcohol use, or generally low consumption during adolescence ("rare users").

Before discussing the main findings of the study, we summarize and discuss the within-class effects of childhood predictors, socio-demographic variables, and mid-adolescent correlates on latent growth factors. For males, regular users with high involvement in risky peer contacts drank more alcohol at age 15.5 years but showed a smaller increase across time than those with a less risky peer context. In females of the regular users group and also the decreaseers group, internalizing symptoms (i.e., somatic complaints) related to high alcohol consumption at age 15.5 but to a less pronounced increase over time. Thus, involvement with deviant peers for males and internalizing symptoms for females seems to be linked with high alcohol use during early adolescence within some trajectory

groups. This suggests that in times of rapid developmental changes and new contextual influences, gender-typical coping strategies and expectations for consuming alcohol (i.e., alcohol use to solve emotional problems in females; Nolen-Hoeksema and Hilt 2006, and alcohol use as an attempt to gain high peer status, or a normative initiation ritual in males; Kuntsche et al. 2006) are of particular importance. Finally, for females, both, high paternal education and academic self-confidence differentially facilitated or reduced alcohol consumption within classes, which has to be further investigated in the future.

In the present study, the groups with problematic alcohol usage across adolescence were of particular interest because their prediction by childhood factors and mid-adolescent correlates can be informative for prevention efforts. Consequently, these groups were contrasted with adolescents of normative or very rare alcohol consumption during adolescence, separately by gender. Several important findings emerged indicating both commonality and gender-specificity in associations of childhood predictors and mid-adolescent correlates to problematic drinking trajectories for adolescent males and females.

More specifically, we found for males that adaptation problems in two developmental contexts during adolescence (i.e., in school and family) were significantly related to trajectory membership. Males with problematic alcohol use during adolescence reported a higher rate of conduct problems at school and more negative relationships to parents during adolescence compared to adolescents with very rare alcohol consumption. Thus, a trajectory of rather stable high usage of alcohol was associated with low adjustment in school and family among male adolescents. Both contexts provide youth with normative values, social control (Jessor et al. 1998), and major developmental assets (e.g., Lerner 2000). These multiple adaptation issues may increase the likelihood that problem behaviors among the male regular users continue beyond the adolescent years.

In contrast and against expectations, none of the childhood predictors were significantly related to the trajectories of alcohol use in adolescence for males. Neither social problems with peers, nor academic self-confidence or impulsivity had a predictive effect on trajectory membership among males. This finding stands against key theoretical assumptions about developmental pathways of problematic substance use, which stress the importance of early characteristics, such as restless or inattentive behaviors as risk factors for early and high substance use during adolescence (e.g., Tarter 2002; Zucker 1994). However, it is important to consider that our study findings were based on data from a normative sample showing moderate levels of alcohol use even in the male regular user group (see Wiesner et al. 2007). Thus, problem drinking in males (e.g., as indexed by diagnostic criteria or binge drinking

status) was not under investigation in the current study. It is possible that childhood risk factors might be more important predictors of trajectories of alcohol misuse or abuse during adolescence, especially for males. In Western societies, high alcohol use during adolescence among males is accepted and belongs to normative gender-stereotypical behaviors shared by peers (Nolen-Hoeksema and Hilt 2006), rather than representing the outcome of a problematic developmental trajectory from early childhood onwards. This may be particularly true for males living in smaller communities or villages with a strong drinking culture while also experiencing the effects of macro-social change after German unification (for instance, families being affected by unemployment or new options for consumption-oriented leisure activities; Baier et al. 2009; Crockett and Silbereisen 2000; Weichold 2002). In contrast, for females high substance use during adolescence may be much more indicative of problem behavior, predicted and accompanied by greater severity of problems in psychosocial adjustment, than it is for males (Tarter et al. 2011).

For females, several childhood predictors and mid-adolescent correlates were associated with trajectory group membership. Results showed that females with low impulsivity during childhood were more likely to belong to the trajectory with problematic usage. In addition, this trajectory was linked to high BMI, conduct problems at school, and a risky, deviant peer context during adolescence. Thus, a trajectory of high alcohol usage during adolescence, which reflects a more problematic behavior for females than it does for males, given the social sanctions they experience (Nolen-Hoeksema and Hilt 2006), was preceded by gender-specific risks in childhood and accompanied by a particular pattern of adjustment in adolescence. The findings highlighted the importance of low impulsivity (i.e., low restlessness, high levels of concentration and tenacity) as a specific risk factor for females during childhood. In females, mastery experiences are heavily influenced by the quality of interpersonal relationships and popularity among peers (Miller 1986); thus, if their personality is more controlled and quiet rather than impulsive and acting out, and if they experience exclusion from their peers in school at the same time, they might be likely to react with internalization. Such a coping style is typical for females and predicts alcohol use later on (Chaplin et al. 2009). Affective problems have also been identified as the most common comorbid problem behavior in adolescent females with an alcohol use disorder (Tarter et al. 1997). Unfortunately, we could not test this interpretation because depressive symptoms were not assessed in the data set and other measures used (i.e., academic self-confidence and somatic complaints which did not exert a predictive effect on trajectory classes for females) may not optimally capture this aspect of adjustment. Thus, this issue

needs further investigation in future research. However, the results reveal similarities to the hypothesized delayed-onset pathway for females (i.e., externalizing problems in childhood are unlikely to be predictors of problem behavior in adolescence according to Silverthorn and Frick 1999) and to models based on an evolutionary framework suggesting that depressive symptoms along with other risk factors are predictors of problematic developmental pathways characterized by high involvement in deviant peer activities, and various adaptation problems in females (Belsky et al. 1991).

We found, in line with our hypotheses, that high BMI, conduct problems at school, and risky peer interactions during adolescence were associated with the trajectory of regular use of alcohol among adolescent females. As argued by Silverthorn and Frick (1999), during puberty and under the influence of deviant peers, females' externalizing adaptation problems become overt. Thereby, high BMI might play a role to promote alienation from "normative" same-aged peers and higher contact to deviant peers. Within a deviant peer context, young females take over the behavioral norms and styles of older youths, including early and high alcohol consumption, while interactions with age-mates in school become more problematic. This finding is also consistent with research by Danielsson et al. (2011), which identified drinking peers as the most influential risk factor for heavy episodic drinking in early adolescence for females, but not for males. It could be argued that a high BMI in females also reflects early pubertal maturation, but findings on associations between BMI and pubertal timing are mixed. For instance, Tremblay and Frigon (2005) found that females with both early and late pubertal timing have a higher risk for being overweight during adolescence, and that in particular the combination of obesity and early pubertal timing relates to negative developmental outcomes. The BMI, however, is a marker for physical attractiveness in young females. Overt appearance and unattractiveness (e.g., obesity), in turn, is known to influence the likelihood of substance use during adolescence, because youth seeks to comply with group and social norms; and unattractiveness leads to stress, and, consequently, to marginalization in the normative peer group (Tarter 2002). In line with this, Pasch et al. (2012) found that the amount of body fat (BMI) is related to substance use in female adolescents, controlled for pubertal status. Because the current study did not directly assess pubertal timing, we were unable to include such data in the analysis. Consequently, we have to interpret the finding as a standalone effect of BMI on high alcohol consumption. Future research, however, has to disentangle the influence of BMI and early pubertal timing on females' problematic alcohol consumption trajectories and associated risk mechanisms during adolescence.

Regarding socio-economic correlates and their association with alcohol use trajectories in adolescent males and females, this study identified two gender-unspecific risk factors. Females and males with parents from low educational background (but not from low-income families) and high parental alcohol usage were more likely to belong to problematic alcohol trajectories during adolescence. Thus, living in a family milieu characterized by low educational background and high levels of parental alcohol consumption, both genders will drink earlier and at higher levels during adolescence. This effect may be transmitted in various ways, including behavioral modeling of consumption behavior, high availability of alcoholic drinks, positive attitudes towards drinking, or low social sanctions of youth alcohol use. This finding is consistent with earlier studies stressing the importance of family transmission in the development of adolescent substance use (for a summary, see White et al. 2000).

Overall, the findings of this study suggest that some of the risk factors related to problematic courses of alcohol use during adolescence apply to both male and female adolescents (i.e., high alcohol use of parents, conduct problems at school, low paternal education). Other risk factors were only related to problematic consumption trajectories in males (i.e., residing in smaller communities, poor relationships to parents) or in females (i.e., low impulsivity in childhood, high BMI, and involvement in risky peer contexts during adolescence). These results provide insightful information not only regarding qualitative differences in the gender-typical development of adolescent alcohol use but also for the designing of effective gender-appropriate interventions against problematic consumption trajectories. For females, involvement in deviant groups, high BMI, and low childhood impulsivity represent risk factors associated with a problematic alcohol consumption trajectory in adolescence. Thus, for females especially, it seems to be important to strengthen interpersonal relationships and integration with normative peers, to avoid alienation from same-aged peers, and to promote positive behaviors in schools. These issues should be addressed even before adolescence, for instance via comprehensive school-based intervention programs based on the Life-Skills approach. Weichold et al. (2012) showed for a German sample that a Life-Skills program against early alcohol consumption can be especially beneficial for females by strengthening their self-assurance, assertiveness, and interpersonal skills, along with integration and activity within a supportive classroom setting. In addition to such universal programs, gender-specific additional program components might be offered to females (see Blake et al. 2001). Furthermore, our results highlight that it is important to also target gender-unspecific risk factors (i.e., negative parental role models regarding substance use) associated with problematic alcohol

consumption during adolescence via additional parent-focused prevention components to ensure positive effects on substance use behaviors among males and females during adolescence and beyond (e.g., Spoth et al. 2012). Such intervention attempts seem to be particularly needed for adolescents from low educational backgrounds, and males from rural areas. Finally, both, males and females should be involved in school-focused intervention components aiming at the improvement of within-school behavior and school bonding in order to increase options for integration in same-aged peer groups, for schools to provide youth with normative values and social control, and thus for preventing problematic substance use across adolescence (e.g., Wenzel et al. 2009).

The current study certainly has some limitations. First, the data of this study were collected from a regionally representative sample in East Germany among adolescents predominantly residing in urban areas and showing rather normative substance use behavior. Therefore, the generalizability of findings to high-risk youths or clinical populations of adolescents living in other cultural contexts may be limited. Second, our sample was investigated during a time of manifold macro-societal changes in Germany, which added other stressors to the participants' lives. For instance, East German adolescents had to cope with transformations of the educational system as a direct result of German unification (study participants attended grade 5 at time of unification), and many were indirectly affected by social change via unemployment of their parents (Crockett and Silbereisen 2000). Consequently, it may well be that these macro-societal stressors affected the participants' developmental trajectory to a larger extent in this particular sample than did childhood risk factors. Third, a secondary data analysis was conducted for a study which originally aimed at the investigation of cognitive development. Thus, some of the constructs of interest according to developmental taxonomies of alcohol use were not measured (e.g., depressive symptoms). In addition, some of the measures used could have been assessed more comprehensively. For example, the availability of diagnostic data would have strengthened the operationalization of some constructs (e.g., impulsivity). Fourth, our analyses included mid-adolescent correlates at wave 6 or 7 (i.e., variables were not available for later waves). As a consequence, these variables were modeled as time-invariant, although the majority of them are expected to change across adolescence. Thus, future trajectory research needs to investigate their role as time-varying variables in predicting adolescent substance use over time. Fifth, it is not well understood how model complexity, sample size, and other study features (e.g., rates of missing values, class mixing percentages) jointly affect findings from LGMM studies. Although results from limited simulation studies to

date (e.g., Li and Hser 2011; Nylund et al. 2007; Tofighi and Enders 2008) indicate that sample sizes in this study likely were reasonably large for identifying the correct number of trajectory classes (but see Peugh and Fan 2012), it is possible that some of our findings might have been contingent on the given predictor set, model complexity, sample sizes, and/or other study features such as the unequal class mixing percentages. Finally, we used (among others) Moffitt's developmental taxonomy as theoretical framework for selecting appropriate variables as possible risk factors for this study. For a clear distinction of adolescent-limited versus life-course-persistent problem behavior, however, a follow-up assessment would be necessary for capturing the transition to adulthood. This would help to evaluate how problematic the trajectory groups of male and female regular users really were and allow for an investigation into which trajectories experienced maturing-out processes in later years. Analyses optimally should be replicated on an additional sample for which data on alcohol use before age 14 and after age 18 are available in order to model and predict the onset and maturing-out of alcohol use among early adolescent males and females.

Nevertheless, this study also had several notable strengths, including the longitudinal analysis of data from a large non-US sample spanning nearly 10 years of the participants' lives and the focus on a relatively under-researched topic. In addition, multiple risk factors and correlates measured both in childhood and adolescence (gathered from multiple informants) were included, and advanced statistical approaches were used for data analysis.

Conclusion

This study identified gender-specific and -unspecific childhood risk factors and adolescent correlates for problematic alcohol use trajectories across adolescence, which delivers important information not only for understanding the etiology of problematic alcohol use in adolescence, as varying by gender, but also for designing effective prevention tools for male and female adolescents. We demonstrated that family background (i.e., alcohol use and education level of parents) and behavioral problems in school matter for predicting problematic consumption trajectories in both genders. In contrast, a problematic alcohol use trajectory in males was accompanied by adaptation problems in the family context, while for females personal characteristics (i.e., low impulsivity and high BMI) in association with a risky peer environment seem to be more salient risk factors for early and high alcohol use through adolescence. These findings have important applied implications insofar as they support both gender-unspecific prevention components (i.e., focusing on family and

school) and gender-specific alcohol prevention components (i.e., focusing on personal characteristics and peer context in females, and on family relationships in males). Thus, a combination of both gender-specific and -unspecific prevention components targeting the “right” risk factors in childhood and adolescence seems to be a promising new avenue to effectively prevent high alcohol consumption and its negative psychosocial consequences in adolescent males and females.

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