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The Altered Course of Learning: How Alcohol Outcome Expectancies Are Shaped by First Drinking Experiences

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Abstract
According to expectancy theory, outcome expectancies are first formed vicariously (through observing other people) and then through direct experience. This cohort-sequential longitudinal study explored these expectancy origins in 1,023 youths (52% female, ages 10.5–15.5 years at recruitment, M = 12.47 years, SD = 0.95). Discontinuous multilevel growth models described patterns of change in expectancies before and after the first experience of distinct drinking milestones (i.e., first sip, first full drink, first heavy-drinking situation). Youths' expectations for positive and negative drinking outcomes generally increased and decreased over adolescence, respectively, reflecting general developmental trends. Drinking experiences altered learning trajectories, however, reifying positive expectancies and invalidating negative expectancies at each milestone and altering the course of expectancy change thereafter. For positive outcome expectancies, the influence of direct experience on learning was stronger when drinking milestones were met at an earlier age. Conversely, invalidation of negative expectancies was stronger when the first-drink milestone was met at a later age.

Keywords
alcohol outcome expectancies, multilevel growth modeling, developmental discontinuity, expectancy theory, preregistered

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According to expectancy theory, diverse influences on learning are summarized in the construct of the "outcome expectancy," or the anticipated biopsychosocial outcomes of a behavior (Goldman, Del Boca, & Darkes, 1999; Kirsch, 1999). By this definition, alcohol outcome expectancies represent a culmination of alcohol-related learning that is a final common pathway leading to drinking behavior (Campbell & Oei, 2010; Goldman, Darkes, & Del Boca, 1999; Sher, Grekin, & Williams, 2005; Windle et al., 2009). Alcohol-related learning starts with acquiring awareness of what alcohol is, who drinks it, and why they do so, as well as eventually developing a personal understanding of alcohol's effects through direct experiences (Zucker, Donovan, Masten, Mattson, & Moss, 2009). In the present work, we aimed to move decades of research prompted by expectancy theory forward by disentangling the complex interplay of expectancy and behavior through mapping the shape of alcohol-outcome-expectancy trajectories with age and first drinking experiences.

Expectancy development begins in childhood through social modeling (Bandura, 1986). Preschoolers (Kuntsche, 2017) and school-age children (Mares, Stone, Lichtwarck-Aschoff, & Engels, 2015; Pieters, van der Vorst, Engels, & Wiers, 2010) understand that alcohol has positive and negative effects (Lang & Stritzke, 1993; Voogt et al., 2017). Their expectancies generally begin as negative but shift to be more positive during the transition to early adolescence (Treloar, Pedersen, &

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McCarthy, 2016). Positive expectancies continue to increase over adolescence (Jester et al., 2015; Young-Wolff et al., 2015), a period for which research on negative expectancy change is mixed, perhaps reflecting experiences of both positive and negative drinking outcomes (Donovan, Molina, & Kelly, 2009; Janssen, Treloar Padovano, Merrill, & Jackson, 2018; Montes, Witkiewitz, Pearson, & Leventhal, 2019; Noel & Thomson, 2012). Given that behavioral patterns evolve with age, understanding how outcome expectancies are influenced by behavior requires disambiguating changes in expectancies due to increasing age from changes due to direct experience (Johnston et al., 2018; Windle et al., 2009).

Several longitudinal studies have examined reciprocal associations of positive alcohol expectancies and drinking experiences (Dal Cin et al., 2009; Epstein, Griffin, & Botvin, 2008; Goldberg, Halpern-Felsher, & Millstein, 2002; Jester et al., 2015; Mitchell, Beals, & The Pathways of Choice Team, 2006; Ouellette, Gerrard, Gibbons, & Reis-Bergan, 1999; Settles, Zapolski, & Smith, 2014; Smith, Goldman, Greenbaum, & Christiansen, 1995; Ting, Chen, Liu, Lin, & Chen, 2015; Wills, Sargent, Gibbons, Gerrard, & Stoolmiller, 2009); less longitudinal research has also focused on negative expectancies or perceived risks of drinking (Goldberg et al., 2002; Settles et al., 2014). Overall, tests of expectancy theory suggest a positive feedback loop whereby experience reinforces the expectancies that initially promoted the behavior. That is, alcohol consumption predicts increases in positive alcohol expectancies and decreases in negative alcohol expectancies, which in turn predicts increased alcohol consumption. Of the body of prospective work, however, the majority of studies have focused primarily on positive expectancies and relied on few time points across short time frames (Smit, Voogt, Hiemstra, Kleinjan, & Otten, 2018).

Statement of Relevance

We hold expectancies about virtually everything we do. That is, on the basis of observations of other people's behavior, we expect that if we do *X*, then *Y* will happen. Expectancies are important because they influence the lessons that we take from our own direct experiences. In this research, we examined how expectancies about alcohol consumption are shaped by drinking experiences. We followed a large sample of adolescents from middle school through high school and conducted regular surveys of their experience with alcohol. For many, this period covered the first direct experience they ever had with drinking, from a mere sip through to the first heavy-drinking situation. Prior to any experience, youths expected the likely outcomes of drinking would be negative. But with time and drinking experience, their expectations became more nuanced: Their negative expectations decreased (although they still held them), but their positive expectations increased. These changes are important because expectancies serve as a final common pathway to a range of responses and behaviors, including drinking behaviors.

The Present Investigation

In the present investigation, we leveraged a large data set from a cohort-sequential study to provide evidence for expectancy theory as it applies to changes in learning with age and novel experiences. The assessment period spanned the early adolescent transition through the adolescent years, thereby capitalizing on the time of greatest escalation in drinking behaviors (Johnston et al., 2018; Windle et al., 2009). Developmental discontinuities and altered trajectories of expectancy growth were explored before, at, and after three distinct and novel behavioral events: (a) first sip of alcohol, (b) first full drink of alcohol, and (c) first heavy-drinking experience. Tenets of expectancy theory were tested by comparing specific forms of expectancy change. Statistical methods and equations for comparing alternative forms of change are expertly described by Singer and Willett (2003) and illustrated conceptually in Figure 1. Figure 1a shows an example in which onset of the behavioral milestone does not alter the trajectory of expectancy development. Figure 1b shows an example in which the overall level, or elevation, of expectancies increases at the time of the milestone, and then the trajectory of change over time continues in the same general form as prior to onset. Figure 1c shows an example in which the slope, or direction, of expectancy change is altered at the time of the milestone, but there is no overall shift in elevation at the time of onset. Figure 1d shows an example that combines a shift in elevation at the behavioral milestone, followed by an altered trajectory of expectancy change over time thereafter.

Our investigation of expectancy change was founded on these models of change. First, we anticipated that youths' expectations for positive drinking outcomes would increase over adolescence, whereas expectations for negative drinking outcomes would decrease, reflecting general developmental trends. Following the predictions of expectancy theory, we anticipated developmental discontinuities at each drinking milestone (i.e., first sip, first full drink, first heavy-drinking experience), followed by altered subsequent trajectories of expectancy development, as illustrated in Figure 1d. Specifically, we anticipated that positive expectancies would be reinforced at each milestone, whereas

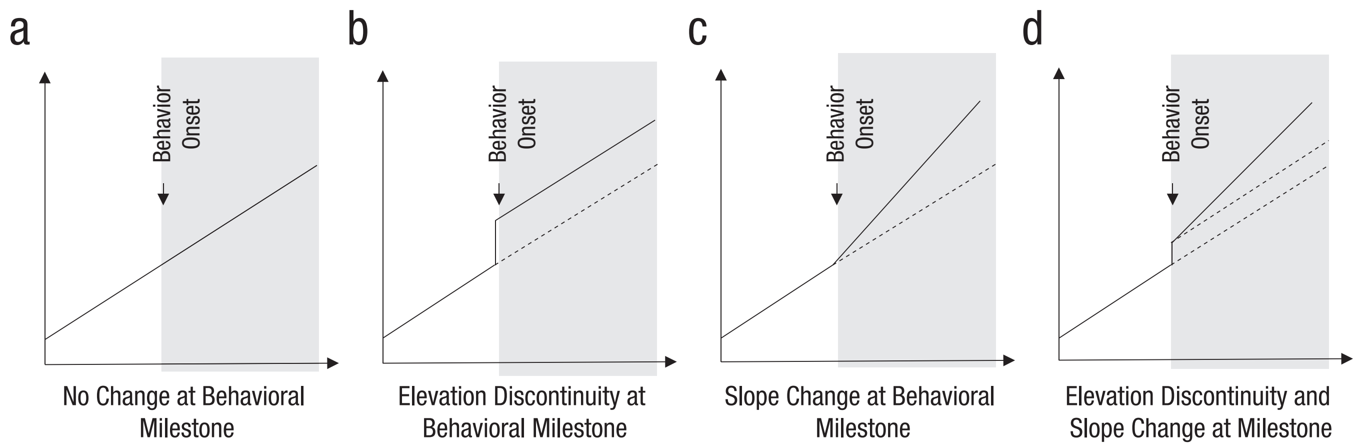

Fig. 1. Conceptual alternatives for change in expectancies at behavioral milestones (based on models described by Singer & Willett, 2003). The graphs show examples in which (a) no change occurs at the behavioral milestone; (b) the overall level of expectancy increases at the time of the milestone and then continues in the same general form as before; (c) there is no overall shift in elevation at the time of onset, but the direction of expectancy change is altered; and (d) there is both a shift in elevation at the behavioral milestone and an altered trajectory of expectancy change thereafter.

negative expectancies would be invalidated by drinking experiences. Next, we anticipated that drinking milestones would alter the subsequent trajectory of expectancy development, hastening increases in positive expectancies and decreases in negative expectancies.

In addition, we tested whether the influence of drinking onset on expectancy change depended on the age at which that milestone was reached. We speculated that, over time, expectancies may become less malleable. Moreover, we expected that first-drink and heavy-drinking milestones would be more normative at older, rather than younger, ages. Thus, meeting a drinking milestone might be particularly influential at a younger age. Prior to analysis, the following specific age-related hypotheses were preregistered on OSF (https://osf.io/k4dmb): (a) The effect of first sip will not vary with age, (b) first drink will be associated with the greatest increases in positive alcohol expectancies when this milestone is met at a younger age, (c) first drink will be associated with the greatest decreases in negative alcohol expectancies when this milestone is met at a younger age, (d) first heavy-drinking experience will be associated with the greatest increases in positive alcohol expectancies when this milestone is met at a younger age, and (e) first heavy-drink experience will be associated with the greatest decreases in negative alcohol expectancies when this milestone is met at a younger age.

Method

Participants and procedure

Biannual longitudinal surveys were collected from early to mid-adolescence for 1,023 youths. Participants were recruited from middle schools in Rhode Island. Six schools that reflected a mix of urbanicity—one in an urban school district, three in suburban school districts, and two in rural school districts—and that received approval from school administration to participate in the research study were selected as recruitment sites. Adolescents in sixth, seventh, or eighth grades (33%, 32%, and 35% of the sample, respectively) were recruited every 6 months in five sequential cohorts from 2009 to 2011 (Jackson, Barnett, Colby, & Rogers, 2015; Jackson et al., 2014). The average age at enrollment was 12.5 years (*SD* = 0.95); other demographics were as follows: 52.2% female, 12.1% Hispanic or Latino, and 24% non-White. The sample was more racially diverse and less socioeconomically disadvantaged than the school populations from which it was drawn but was representative with respect to gender and grade.

Study information was mailed to participants and distributed through schools. Interested participants whose parents provided consent completed a 2-hr in-person session that included a Web-based baseline survey. A series of follow-up assessments was conducted using Web-based surveys. Surveys for the first five waves were administered every 6 months, and Wave 6 was administered 1 year later (Phase 1). The research design was then altered at the point of refunding (Phase 2), and quarterly assessments were subsequently administered every 3 months following Wave 6 at varying intervals (range = 0–1.5 years, *M* = 0.41, *SD* = 0.41, depending on school cohort and grade at enrollment). Quarterly surveys continued through the end of high school. Response rates ranged from 84% (Wave 6) to 92% (Wave 1) in Phase 1. Of the 848 (82%) participants who agreed to participate in Phase 2, response rates on quarterly surveys ranged from 79% (Quarter 14) to 91% (Quarter 5). Study procedures were approved by the Brown University Institutional Review Board.

Measures

Positive and negative alcohol outcome expectancies. Expectancy items covered a wide range of potential positive and negative alcohol outcomes. A 23-item measure evaluated by Schell, Martino, Ellickson, Collins, and McCaffrey (2005) was used in the present analyses. After we removed one ill-fitting item assessing positive expectancies ("Look cool"), these items displayed good fit to a two-factor structure, with nine items assessing positive expectancies and 13 items assessing negative expectancies (Schell et al., 2005). In the present sample, internal consistency of mean scores on positive- and negative-expectancy subscales were high (positive expectancies: α = .871–.966, negative expectancies: α = .955–.988, when averaged across assessments). Items were preceded by the following question: "How likely is it that the following things would happen to people your age if they had one or more drinks of alcohol?" Response options ranged from 1, *very unlikely*, to 4, *very likely*. Example positive-expectancy items were "Have fun" and "Feel more friendly," and example negative-expectancy items were "Have trouble thinking" and "Act stupid." Expectancies were assessed every 6 months over the course of data collection, with data from some cohorts missing by design between the two funding cycles.

Drinking milestones. We considered three drinking milestones: first sip, first full drink, and first heavy-drinking experience. First sip and first full drink were based on the following items, "Have you ever had a sip of alcohol?" and "Have you ever had a full drink of alcohol?" respectively. In Phase 1, first heavy-drinking experience was based on responses to the item, "Have you ever had three or more drinks of alcohol on one occasion in your lifetime?" In Phase 2, this question was recast as, "What is the maximum number of drinks you have had in one sitting in your lifetime?" Responses indicating three or more drinks were classified as meeting the heavy-drinking milestone. Prior research evaluating estimated blood alcohol concentrations suggested that this lower cutoff is appropriate for identifying heavy or binge drinking for boys and girls in early adolescence, the age range of our sample at enrollment (Donovan, 2009). Drinking milestones were assessed sequentially, with participants prompted about consumption of a full drink after a sip was reported and heavy drinking after consumption of a full drink was reported.

Analytic strategy

We took two broad approaches to examining expectancy development, which were implemented in SAS PROC MIXED: discontinuous, piecewise growth models and interactive growth models. First, we used an empirical approach to identifying the best-fitting multiple-discontinuity piecewise growth model—in which time epochs were based on age at first report of first sip, first drink, and first heavy-drinking event—to test whether average expectancy-growth trends deviated from their usual patterns when youths met these drinking milestones and thereafter. A time variable reflected age to the closest half year. Data missing because of missed assessments (either planned or nonresponse) were accounted for through full-information maximum likelihood (there were no excluded observations beyond missed assessments). Second, an alternate form of the discontinuity model tested hypotheses about how the timing of milestones (i.e., age at which the milestone was reached) influenced the effect of the milestone on expectancy change through the inclusion of interactive terms of time and dichotomous variables indicating milestone achievement (0 until milestone achieved, 1 thereafter).

Discontinuous, piecewise growth models. In initial unconditional growth models, a single parameter, time (i.e., age to the nearest half year), modeled normative changes in expectancies over time. For youths who did not have a drink event, time was centered at the first time point. For youths who had a drink event, time was person-centered at the age of the first drink event (i.e., sip). Next, discontinuity (0 until milestone achieved, 1 thereafter) and slope-change (postmilestone time variable, which was 0 until milestone was met and clocked in same metric as time thereafter) parameters were added sequentially. Figure 1 illustrates possible forms of change for one milestone, although the three were tested simultaneously in a multiple-discontinuity model. The following effects were explored: time (normative trends, i.e., slope, over time), sip discontinuity (shift in expectancies at first sip), sip slope (change in slope after first sip), drink discontinuity (shift in expectancies at first drink), drink slope (change in slope after first drink), heavy discontinuity (shift in expectancies at first heavy-drinking event), and heavy slope (change in slope after first heavy-drinking event). Specific data for each of these time parameters for a hypothetical participant who reported a sip at age 11.5 years, a drink at age 15.5 years, and a heavy drink at age 18 years are provided in Table S1 in the Supplemental Material available online. A conceptual model including parameters for the intercept, time, sip discontinuity, and sip slope is shown in Figure 2. This is only a partial model depicting parameters for one milestone; the full model included discontinuity and slope parameters for the first-sip, first-drink, and heavy-drinking milestones, as described in the Results section and depicted in Figure 3.

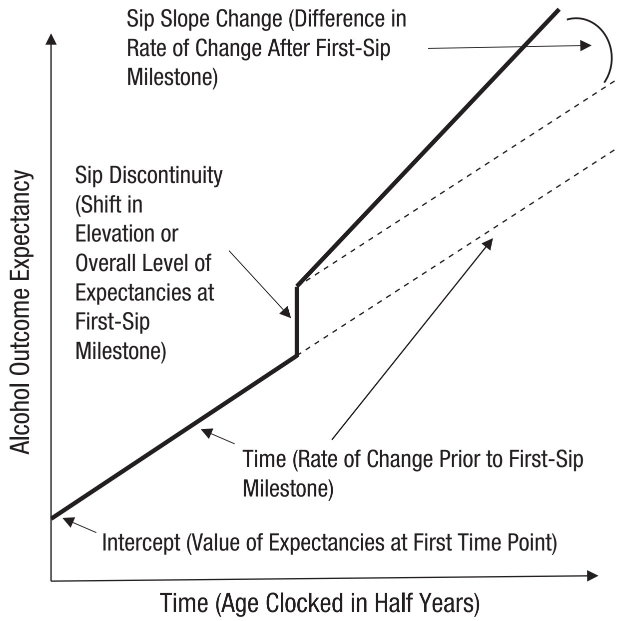

Fig. 2. Conceptual model illustrating the interaction of alcohol outcome expectancy and time on intercept, time slope, sip discontinuity, and sip slope, tested sequentially in model comparisons (based on models described by Singer & Willett, 2003). The solid line depicts overall fixed effects averaged across all participants. Random effects (not shown) tested the degree to which the overall estimates varied between participants.

A taxonomy of models was examined. Model-deviance tests (i.e., −2 log-likelihood change) provided formal statistical evaluation of the incremental improvement in fit based on the addition of fixed effects as well as random effects for each drink event (i.e., sip discontinuity, sip slope, drink discontinuity, drink slope, heavy discontinuity, heavy slope) and the incremental decrement in fit after removing the random effects for each parameter. All models also used the between–within method of calculating degrees of freedom and an unstructured variance–covariance matrix, which does not impose restrictions on the interrelations of variance components. Fixed effects described the overall trajectories for the sample. Random effects allowed the magnitude of fixed effects to vary between participants. Thus, model-deviance comparisons tested whether each fixed-effects parameter (i.e., time, sip discontinuity, sip slope, drink discontinuity, drink slope, heavy discontinuity, and heavy slope) improved the model. In other words, does the overall level of expectancies shift at the time of the first-drink milestone in a more immediate way (Fig. 1b, discontinuity), is the influence of drinking milestones reflected in an altered rate of change in expectancies over time (Fig. 1c, slope change), or both (Fig. 1d, discontinuity and slope change)? Subsequent inspection of the influence of random effects on model fit tested whether these overall changes were similar for all participants in the sample or whether the changes caused by milestone attainment varied between participants, having more of an effect for some and less of an effect for others.

Interactive growth models. An alternative approach to modeling discontinuous change tested whether the effects of sipping, drinking, and heavy drinking varied with age, as described by Singer and Willett (2003) and implemented in prior work (Jester et al., 2015; Young-Wolff et al., 2015). These models were fitted separately for each milestone, with only youths who met the milestone included and time-centered at the milestone event. Interactive effects of time with discontinuity parameters tested whether the magnitude of change at the drinking milestone was dependent on the age at which that milestone occurred. Interactive models were unique from the prior models in that they allowed the shift in expectancies at each milestone to vary over time. In contrast with the prior models, the effects of sipping, drinking, and heavy-drinking discontinuities were of less interpretive value. Instead, the interactive effects were the meaningful parameters, reflecting the degree to which endorsing a drinking milestone earlier rather than later influenced the magnitude of expectancy shift at that milestone.

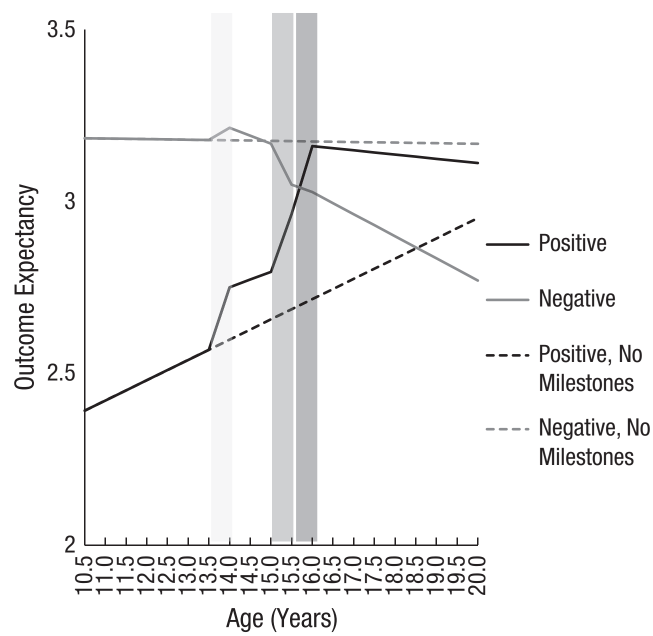

Fig. 3. Average empirical Bayes (model-based) trajectories of positive and negative expectancy growth based on fixed-effects parameter values (see Table 2). Vertical bars denote the first-sip (light gray), first-drink (medium gray), and heavy-drinking (dark gray) milestones. Average trajectories for participants who did not report any drinking across the assessment window are denoted by dashed lines. Outcomes expectancy was rated on a scale from 1 to 5.

Table 1. Sample Characteristics at First and Last Available Assessments

Characteristic	First assessment	Last assessment
Age (years)	*M* = 12.47, *SD* = 0.95	*M* = 17.01, *SD* = 1.51
Ever sipped	*n* = 428 (41.8%)	*n* = 804 (78.6%)
Ever had full drink	*n* = 79 (7.7%)	*n* = 542 (53.0%)
Ever drank heavily (3+ drinks)	*n* = 28 (2.7%)	*n* = 379 (37.0%)
Positive expectancies	*M* = 2.38, *SD* = 0.75	*M* = 2.85, *SD* = 0.74
Negative expectancies	*M* = 3.21, *SD* = 0.81	*M* = 3.02, *SD* = 0.76

Sample-size justification. Sample size was based on power analyses for a planned longitudinal analysis designed to address the primary aims of the parent grant supporting this work. Those aims were to explore characteristics of the early drinking career, including sequencing of, attainment of, and progression through drinking-related milestones. The current study involved secondary analysis of the data resulting from that parent grant. The power analyses were conducted using the Power in Two-Level Designs (PINT) program (Snijders & Bosker, 1993) to estimate power for multilevel models predicting alcohol use from two within-person (random) variables and two fixed variables. Given moderate effect sizes for intercorrelations of random effects and intercorrelations between fixed effects, a residual Level 1 variance of 0.5, and α equal to .05, the analysis indicated that power was .95 or greater to detect small effects (Cohen's $d = 0.20$) with 10 observations and 250 participants (Level 1 predictor) and 400 participants (Level 2 predictor and cross-level interaction). Data for the present analyses exceeded these parameters. Recruitment was stopped when the planned enrollment target (N = 1,000) was achieved, and data collection was stopped at a prespecified ending point (when participants graduated from high school).

Results

Sample characteristics

Table 1 describes the sample at the first and last assessments available for each participant. Drinking escalated during this period; whereas less than 3% of participants reported heavy drinking at the first assessment, more than one third (37.0%) reported heavy drinking by the last assessment. For participants who experienced drinking milestones, the average age of first sip was 13.76 years (SD = 1.73; minimum = 10.5, maximum = 18.5). The first full drink occurred, on average, about 1.5 years later at age 15.39 years (SD = 1.58; minimum = 10.5, maximum = 19.0), and the first heavy-drinking experience followed within half a year at age 15.93 years (SD = 1.37; minimum = 12.0, maximum = 19.5). The average positive-expectancy score at the last assessment was half a point higher than at the first assessment (on a 4-point scale), whereas the average negative-expectancy score was about a fifth of a point lower at the last assessment, relative to the first. For participants who experienced drinking milestones, the average positive- and negative-expectancy scores at the first-sip milestone were 2.64 (SD = 0.74) and 3.25 (SD = 0.69), respectively. Averages at the first-drink milestone were 2.93 (SD = 0.68) and 3.11 (SD = 0.66) and at the heavy-drinking milestone were 3.00 (SD = 0.67) and 3.03 (SD = 0.67).

Normative trends in expectancy development: unconditional growth models

Fully unconditional models (without any predictors) identified variability in positive and negative expectancies over time, which was similar in magnitude for both expectancy dimensions; intraclass correlation coefficients were .35 and .39, respectively. Unconditional growth models with time as the sole predictor evaluated changes in youths' positive and negative expectations for drinking outcomes over assessments (model A, Table S2 in the Supplemental Material). Model-deviance tests indicated significant improvement in model fit after the inclusion of fixed and random growth slopes for positive and negative expectancies, $\chi^2(3) = 904.9$, $p < .001$, and $\chi^2(3) = 400.5$, $p < .001$, respectively. Removal of random slopes resulted in significant decrement in model fit as well, $\chi^2(2) = 340.1$, $p < .001$, and $\chi^2(2) = 329.9$, $p < .001$, respectively. The resulting fixed slope estimates reflected prototypical developmental trends in expectancies over adolescence, with positive expectancies increasing with age ($b = 0.10$, $SE = 0.005$, $p < .001$) and negative expectancies decreasing with age ($b = -0.04$, $SE = 0.006$, $p < .001$). Random slopes for these models indicated significant variability around average trends (ps < .001).

Drinking-milestone influences: discontinuous, piecewise growth models

Results of incremental deviance tests are shown in Table S2. The best-fitting model for both positive and negative expectancies included fixed effects of sip,

Table 2. Fixed Effects and Variance Components From the Best-Fitting Multiple-Phase Growth Model Including Discontinuities in Elevation and Slope at First Sip, First Drink, and First Heavy-Drinking Experience

	Positive expectancies			Negative expectancies		
Variable	Estimate	95% CI	*p*	Estimate	95% CI	*p*
			Fixed effects (γ)			
Intercept	2.39	[2.34, 2.44]	< .001	3.18	[3.13, 3.24]	< .001
Time	0.06	[0.05, 0.07]	< .001	−0.00	[−0.02, 0.01]	.804
Sip discontinuity	0.15	[0.10, 0.21]	< .001	0.04	[−0.02, 0.09]	.212
Sip slope change	−0.01	[−0.04, 0.01]	.197	−0.04	[−0.07, −0.02]	< .001
Drink discontinuity	0.14	[0.08, 0.21]	< .001	−0.10	[−0.16, −0.03]	.003
Drink slope change				−0.01	[−0.05, 0.03]	.501
Heavy discontinuity	0.18	[0.10, 0.25]	< .001	0.01	[−0.06, 0.08]	.825
Heavy slope change	−0.06	[−0.09, −0.02]	.002	−0.00	[−0.06, 0.05]	.857
			Variances (σ^2)			
Intercept	0.34	[0.29, 0.39]	< .001	0.38	[0.32, 0.44]	< .001
Time	0.01	[0.004, 0.01]	< .001	0.01	[0.01, 0.01]	< .001
Sip discontinuity	0.00			0.04	[−0.04, 0.11]	.160
Sip slope change	0.00					
Drink discontinuity	0.00			0.01	[−0.07, 0.08]	.451
Heavy discontinuity	0.05	[−0.03, 0.13]	.093	0.00		
Heavy slope change				0.04	[0.01, 0.06]	.002
Residual	0.34	[0.33, 0.36]	< .001	0.36	[0.35, 0.37]	< .001

Note: Time and age variables are equivalent, reflect age ranging from 10.5 to 20.5 years, and are centered at the age of the respective drinking milestone. Although model fit comparisons, shown in Table S2 in the Supplemental Material available online, identified which random effects contributed significantly to model fit, the variances of some random effects were estimated to be 0. Removing these nonsignificant variances had minimal influence on the fixed-effects estimates and did not alter the significance of fixed effects. CI = confidence interval.

drink, and heavy discontinuity as well as fixed effects of sip and heavy slope change. Only the model for negative expectancies included a fixed effect for drink slope change. As a summary of the findings reported in the table, an empirical approach to identifying the best-fitting, discontinuous, piecewise growth model with multiple time epochs based on reported age at first sip, first drink, and first heavy-drinking experience suggested that average growth trends deviated from their usual patterns when youths met these drinking milestones. Further, after each milestone, the average growth trend generally deviated from the prior trajectory.

The magnitude and significance of fixed- and random-effects estimates are provided in Table 2. Empirical Bayes trajectories based on fixed-effects parameter values are shown in Figure 3. The linear increase in positive expectancies over time was disrupted by first sip ($\gamma = 0.15$, $SE = 0.03$, $p < .001$), first drink ($\gamma = 0.14$, $SE = 0.03$, $p < .001$), and first heavy-drinking experience ($\gamma = 0.18$, $SE = 0.04$, $p < .001$); expectancies shifted to be more positive at each drinking milestone. Youths who met the heavy-drinking milestone experienced attenuated increases in positive expectancies thereafter ($\gamma = -0.06$, $SE = 0.02$, $p = .002$).

Negative expectancies did not shift at the first-sip or heavy-drinking milestones (*p*s = .212 and .825, respectively; Table 2). However, the linear decrease (sip slope change) in negative expectancies was hastened after meeting the first-sip milestone ($\gamma = -0.04$, $SE = 0.01$, $p < .001$). This decreasing trajectory was further altered by the first-drink milestone, with the expectancies shifting to be less negative for participants who went on to have a full drink of alcohol ($\gamma = -0.10$, $SE = 0.03$, $p = .003$). The rate of linear decrease was not changed thereafter (*p*s = .501 and .857 for drink slope change and heavy slope change, respectively).

Both positive- and negative-expectancy models included random intercepts and random time, discontinuity, and slope-change parameters as reported in the bottom portion of Table 2. Individual empirical Bayes trajectories for 10 randomly chosen participants are shown in Figure 4. These trajectories illustrate how the overall average trajectories described by fixed effects (Fig. 3) are not sufficient to model change for any given individual. Random effects allow the timing of each milestone, shift at attainment of the milestone, and change thereafter to vary across participants.

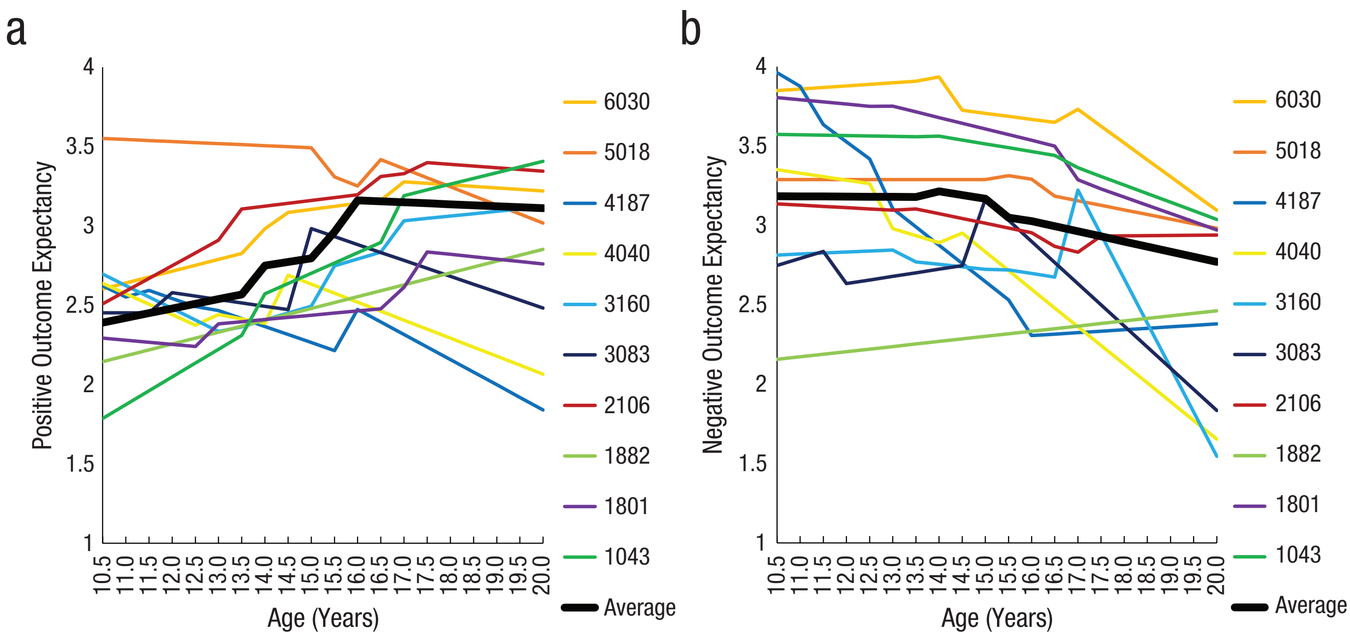

Fig. 4. Individual empirical Bayes (model-based) trajectories of (a) positive- and (b) negative-expectancy growth for 10 randomly chosen participants. Individual lines are labeled with participant numbers for randomly chosen participants. Individual trajectories use random-effects parameters for each participant to model growth. Thus, these trajectories incorporate fixed-effects parameter values (illustrated in Fig. 3) with individual deviations from average trajectories. Average trajectories are shown with black, bold lines. Outcome expectancies were rated on a scale from 1 to 5.

Sensitivity analyses explored the similarity or difference in effects when age was not centered and when milestones were modeled separately. Alternative discontinuous change trajectories are compared in Tables S3a and S3b in the Supplemental Material for positive and negative expectancies, respectively. Results of best-fitting models are shown in Table S4 in the Supplemental Material. All significant fixed effects reported in Table 2 remained significant. For negative expectancies, postmilestone slope changes were significant in separate models for first drink and heavy drinking, whereas these were not significant in the combined model. Inclusion of the drink-discontinuity effect for positive expectancies was supported by model comparisons and significant in the individual model, whereas this was not included in the combined model. Differences between models were likely due to the timing of the first-drink and heavy-drinking milestones. It is plausible that slope changes associated with the first drink were subsumed by heavy-drinking effects in cases in which the two occurred at the same or adjacent time points.

Timing of milestones and expectancy development: interactive growth models

The final set of models tested whether the discontinuity in expectancy development associated with each drinking milestone varied depending on milestone timing. Separate models were fitted for the first-sip, first-drink, and heavy-drinking milestones (see Table 3). A Time × Milestone (0 until milestone achieved, 1 thereafter) interaction tested whether the timing of the milestone altered the shift in expectancies for that milestone. The interactive effect was significant and negative in all but one model (Table 3). Of note, the interpretation of a negative interactive effect depended on the component main effects for time and milestone and, thus, differed for positive and negative expectancies. Specifically, the increases in positive expectancies at the first-drink and heavy-drinking milestones were attenuated when the milestone was met later (Time × First Drink: $\gamma = -0.03$, 95% confidence interval, or CI = [−0.06, −0.006], $p = .015$; Time × Heavy Drinking: $\gamma = -0.06$, 95% CI = [−0.09, −0.02], $p = .001$), supporting Hypotheses 2 and 4. The interactive effect of time and sip was not significant for positive expectancies ($p = .436$), consistent with Hypothesis 1. Although the null hypothesis cannot be proven, the lack of a significant interactive effect is consistent with our anticipated results. Last, the decreases in negative expectancies at the first-sip, first-drink, and heavy-drinking milestones were enhanced when that milestone was met later (Time × First Sip: $\gamma = -0.06$, 95% CI = [−0.08, −0.04], $p < .001$; Time × First Drink: $\gamma = -0.05$, 95% CI = [−0.07, −0.02], $p < .001$; Time × Heavy Drinking: $\gamma = -0.05$, 95% CI = [−0.09, −0.02], $p = .002$), inconsistent with Hypotheses 3 and 5. In sum,

Table 3. Moderating Effects of Time (Age in Years) on Positive and Negative Expectancy Change at Drinking Milestones

	First sip			First drink			Heavy drinking		
Variable	Estimate	*SE*	*p*	Estimate	*SE*	*p*	Estimate	*SE*	*p*
Positive alcohol outcome expectancies									
Intercept	2.36	0.03	< .001	2.45	0.02	< .001	2.43	0.02	< .001
Time	0.06	0.01	< .001	0.05	0.01	< .001	0.06	0.005	< .001
Milestone	0.23	0.03	< .001	0.35	0.03	< .001	0.43	0.03	< .001
Time × Milestone	0.01	0.01	.436	−0.03	0.01	.015	−0.06	0.02	.001
Negative alcohol outcome expectancies									
Intercept	3.19	0.03	< .001	3.19	0.02	< .001	3.18	0.03	< .001
Time	−0.003	0.01	.663	−0.02	0.005	.002	−0.01	0.005	.002
Milestone	0.02	0.03	.481	−0.11	0.03	< .001	−0.11	0.03	< .001
Time × Milestone	−0.06	0.01	< .001	−0.05	0.01	< .001	−0.06	0.02	.002

Note: Time and age variables are equivalent, reflect age ranging from 10.5 to 20.5 years, and are centered at the age of the respective drinking milestone.

enhancement of positive expectancies at drinking milestones diminished when the milestone was met later, whereas the attenuation of negative expectancies at drinking milestones was exacerbated when the milestone was met later.

Discussion

Outcome expectancies are important because they predict behavior (Smit et al., 2018). A general learning model of a situation prompting behavior involves four ordered events: indirect cue, direct stimulus, internal response, and outcome (Vogel-Sprott & Fillmore, 1999a). The link between each event reflects three expectancies, summarized simply as anticipation, response, and outcome (Kirsch, 1999). Prior to direct experience and an associated internal response and outcome, these expectancies are purely based on vicarious learning through observations of other people. Direct experience is key to altering learning. Further, repeated pairing of a stimulus with a response and a response with an outcome contributes to learning about these associations and strengthens expectancies. The present work offers an application of expectancy theory, capitalizing on the first direct experiences that an individual ever has with alcohol, from the first-sip stimulus to the first drink to the first heavy-drinking situation and beyond. In a cohort-sequential design, youths were followed through their early adolescent years, allowing for new insight into how the shape of learning changes over time and is influenced by direct behavioral experiences.

In the case of alcohol outcome expectancies and drinking behavior, learning begins early (Voogt et al., 2017). What youths expect to happen if they drink becomes more favorable with age (Colder et al., 2014) and with drinking experience (Settles et al., 2014). The widespread action of alcohol allows it to affect a variety of internal responses and outcomes (Vogel-Sprott & Fillmore, 1999b). Conceptual models illustrate potential alternative learning trajectories (Figs. 1 and 2). As anticipated, our data supported a model of expectancy change in which the first drinking experiences resulted in immediate changes in expectancies, followed by an altered course thereafter (Fig. 3). Prior to direct experience, expectancies for the likely outcomes of drinking began as more negative and less positive. Positive expectancies increased over time, and negative expectancies tended to remain stable or decrease slightly, all a product of vicarious learning. Our data also distinguished general trends from those influenced by behavioral milestones (illustrated by dotted lines in Fig. 3). These data suggest that distinguishing learning via vicarious experience from learning after direct experience may help to understand discrepant findings and validate expectancy theory. Our findings suggest that expectancy change is greatest at the time of specific drink-onset events and, moreover, that first-sip, first-drink, and first-heavy-drinking experiences each add to alcohol-related learning. Further, the changes in learning trajectories that follow immediate shifts in expectancies associated with each milestone may point to a bidirectional feedback loop whereby behavior and expectancies mutually influence each other (Settles et al., 2014; Smith et al., 1995).

Responses to and outcomes of a behavior can be positive or negative. Overall, negative expectancies appeared more stable over time, relative to positive expectancies. Yet negative expectancies showed a great deal of change for individuals who met first-drink or heavy-drinking milestones and a high degree of individual variability (Fig. 4). In the substance-use-expectancy literature, findings for negative expectancy change over adolescence and, moreover, the relation of negative expectancies to drinking have been mixed (Treloar et al., 2016). It is theorized that positive and negative expectancies will converge or cross over at some point, so that expectancies will be more positive and less negative (Colder et al., 2014; Hipwell et al., 2005). In our data, this crossover occurred, on average, between the first drinking experience and first heavy-drinking experience and, on average, between 15 and 16 years of age. It is important to note that the crossover appeared to occur, on average, only for individuals who initiated drinking in this time frame, and the shift from negative to positive expectancies may occur much later, if at all, for individuals who do not engage in drinking behavior. Last, although Figure 3 shows average trajectories, the crossover of positive and negative expectancies is highly variable for each individual adolescent. As illustrated by Figure 4, a one-size-fits-all approach may fit no one in particular.

All findings must be interpreted in the context of the study's strengths and limitations. To disentangle expectancy and behavior, we leveraged data in this prospective study from a relatively large sample of youths predominantly naive to the focal drinking experiences at the study outset. Future studies including younger participants would have advantages for studying normative trends in expectancy development exclusively shaped by vicarious, rather than direct, drinking experiences. This regional sample may not be representative of the U.S. adolescent population as a whole and may not generalize to diverse racial or ethnic groups. However, we would not necessarily expect this to diminish validity; our goal in this study was to generalize to processes, not populations. Additionally, our study examined explicit expectancies assessed only via participant self-report. A wealth of literature points to the importance of implicit alcohol expectancies, which operate outside of immediate awareness (Reich, Below, & Goldman, 2010; Thush & Wiers, 2007). Further, we cannot conclusively ascertain whether responses were altered by social desirability or recall bias. To minimize the potential for bias, we took steps to increase the privacy of responses and account for recanting. First, data were collected via a computerized survey platform that did not require participants to provide direct answers to research staff. Second, a certificate of confidentiality was obtained and explained during the orientation and assent process, and participants were explicitly told that parents and teachers would not see their responses. Finally, first reports of drinking milestones were carried forward to eliminate discrepancies in reporting.

Whereas this application of expectancy theory demonstrates an altered course of learning with direct behavioral experiences, significant residual variances in our models suggest that there are important predictors of expectancy change not accounted for by direct experience alone. Vicarious learning about alcohol before any direct drinking experience and, moreover, internal responses to alcohol with direct experience are likely influenced by characteristics of the person (e.g., personality factors, psychopathology, genetic diathesis) and also of the environment (e.g., parental modeling of drinking and parenting practices, peer drinking, media exposure to alcohol-related content; Smit et al., 2018; Treloar et al., 2016). Although evaluation of putative individual-difference or time-varying predictors is outside the scope of the present article, our research group is currently planning analyses to identify factors that further influence expectancy trajectories in this rich data set. Relatedly, individual variability in discontinuity and slope-change parameters may be, in and of themselves, important for understanding further changes in expectancy trajectories.

Transparency

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Author Contributions

K. M. Jackson conceptualized and designed the longitudinal study. All the authors designed the analyses and interpreted the results. H. Treloar Padovano conducted the analyses and drafted the manuscript. K. M. Jackson, T. Janssen, and A. Sokolovsky provided critical revisions to the manuscript. All the authors approved the final manuscript for submission.

Declaration of Conflicting Interests

The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

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Open Practices

Neither the data nor the materials have been made publicly available on a permanent third-party archive; requests for data or materials can be e-mailed to the corresponding author. The study was preregistered on OSF at https://osf

.io/k4dmb. Age-related hypotheses were preregistered after data collection but before analysis. Data visualization to explore the general functional form of expectancies over time was also conducted prior to preregistration. This article has received the badge for Preregistration. More information about the Open Practices badges can be found at http://www.psychologicalscience.org/publications/badges.

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Supplemental Material

Additional supporting information can be found at http://journals.sagepub.com/doi/suppl/10.1177/0956797620959006

References

Bandura, A. (1986). *Social foundations of thought & action: A social cognitive theory*. Upper Saddle River, NJ: Prentice Hall.

Campbell, J. M., & Oei, T. P. (2010). A cognitive model for the intergenerational transference of alcohol use behavior. *Addictive Behaviors*, *35*(2), 73–83. doi:10.1016/j.addbeh.2009.09.013

Colder, C. R., Connor, R. M. O., Read, J. P., Eiden, R. D., Lengua, L. J., . . . Wieczorek, W. F. (2014). Growth trajectories of alcohol information processing and associations with escalation of drinking in early adolescence. *Psychology of Addictive Behaviors*, *28*, 659–670. doi:10.1037/a0035271

Dal Cin, S., Worth, K. A., Gerrard, M., Stoolmiller, M., Sargent, J. D., Wills, T. A., & Gibbons, F. X. (2009). Watching and drinking: Expectancies, prototypes, and friends' alcohol use mediate the effect of exposure to alcohol use in movies on adolescent drinking. *Health Psychology*, *28*, 473–483. doi:10.1037/a0014777

Donovan, J. E. (2009). Estimated blood alcohol concentrations for child and adolescent drinking and their implications for screening instruments. *Pediatrics*, *123*, e975–e981. doi:10.1542/peds.2008-0027

Donovan, J. E., Molina, B. S. G., & Kelly, T. M. (2009). Alcohol outcome expectancies as socially shared and socialized beliefs. *Psychology of Addictive Behaviors*, *23*, 248–259. doi:10.1037/a0015061

Epstein, J. A., Griffin, K. W., & Botvin, G. J. (2008). A social influence model of alcohol use for inner-city adolescents: Family drinking, perceived drinking norms, and perceived social benefits of drinking. *Journal of Studies on Alcohol and Drugs*, *69*, 397–405.

Goldberg, J. H., Halpern-Felsher, B. L., & Millstein, S. G. (2002). Beyond invulnerability: The importance of benefits in adolescents' decision to drink alcohol. *Health Psychology*, *21*, 477–484. doi:10.1037//0278-6133.21.5.477

Goldman, M. S., Darkes, J., & Del Boca, F. K. (1999). Expectancy mediation of biopsychosocial risk for alcohol use and alcoholism. In I. Kirsch (Ed.), *How expectancies shape experience* (pp. 233–262). Washington, DC: American Psychological Association.

Goldman, M. S., Del Boca, F. K., & Darkes, J. (1999). Alcohol expectancy theory: The application of cognitive neuroscience. In K. E. Leonard & H. T. Blane (Eds.), *Psychological theories of drinking and alcoholism* (2nd ed., pp. 203–246). New York, NY: Guilford Press.

Hipwell, A. E., White, H. R., Loeber, R., Stouthamer-Loeber, M., Chung, T., & Sembower, M. A. (2005). Young girls' expectancies about the effects of alcohol, future intentions and patterns of use. *Journal of Studies on Alcohol*, *66*, 630–639.

Jackson, K. M., Barnett, N. P., Colby, S. M., & Rogers, M. L. (2015). The prospective association between sipping alcohol by the sixth grade and later substance use. *Journal of Studies on Alcohol and Drugs*, *76*, 212–221.

Jackson, K. M., Roberts, M. E., Colby, S. M., Barnett, N. P., Abar, C. C., & Merrill, J. E. (2014). Willingness to drink as a function of peer offers and peer norms in early adolescence. *Journal of Studies on Alcohol and Drugs*, *75*, 404–414.

Janssen, T., Treloar Padovano, H., Merrill, J. E., & Jackson, K. M. (2018). Developmental relations between alcohol expectancies and social norms in predicting alcohol onset. *Developmental Psychology*, *54*, 281–292.

Jester, J. M., Wong, M. M., Cranford, J. A., Buu, A., Fitzgerald, H. E., & Zucker, R. A. (2015). Alcohol expectancies in childhood: Change with the onset of drinking and ability to predict adolescent drunkenness and binge drinking. *Addiction*, *110*, 71–79. doi:10.1111/add.12704

Johnston, L. D., Miech, R. A., O'Malley, P. M., Bachman, J. G., Schulenberg, J. E., & Patrick, M. E. (2018). *Monitoring the future national survey results on drug use, 1975-2017: Overview, key findings on adolescent drug use*. Ann Arbor: Institute for Social Research, University of Michigan.

Kirsch, I. (Ed.) (1999). *How expectancies shape experience*. Washington, DC: American Psychological Association. doi:10.1037/10332-000

Kuntsche, E. (2017). "Do grown-ups become happy when they drink?" Alcohol expectancies among preschoolers. *Experimental and Clinical Psychopharmacology*, *25*(1), 24–30.

Lang, A. R., & Stritzke, W. G. K. (1993). Children and alcohol. In M. Galanter (Ed.), *Recent developments in alcoholism* (pp. 73–85). Berlin, Germany: Springer. doi:10.1007/978-1-4899-1742-3_4

Mares, S. H. W., Stone, L. L., Lichtwarck-Aschoff, A., & Engels, R. C. M. E. (2015). Alcohol expectancies in young children and how this relates to parental alcohol use. *Addictive Behaviors*, *45*, 93–98. doi:10.1016/j.addbeh.2015.01.007

Mitchell, C. M., Beals, J. & The Pathways of Choice Team. (2006). The development of alcohol use and outcome expectancies among American Indian young adults: A growth mixture model. *Addictive Behaviors*, *31*, 1–14. doi:10.1016/j.addbeh.2005.04.006

Montes, K. S., Witkiewitz, K., Pearson, M. R., & Leventhal, A. M. (2019). Alcohol, tobacco, and marijuana expectancies as predictors of substance use initiation in adolescence: A longitudinal examination. *Psychology of Addictive Behaviors*, *33*(1), 26–34.

Noel, J. G., & Thomson, N. R. (2012). Children's alcohol cognitions prior to drinking onset: Discrepant patterns from implicit and explicit measures. *Psychology of Addictive Behaviors*, *26*, 451–459. doi:10.1037/a0025531

Ouellette, J. A., Gerrard, M., Gibbons, F. X., & Reis-Bergan, M. (1999). Parents, peers, and prototypes: Antecedents of adolescent alcohol expectancies, alcohol consumption, and alcohol-related life problems in rural youth. *Psychology of Addictive Behaviors*, *13*, 183–197.

Pieters, S., van der Vorst, H., Engels, R. C. M. E., & Wiers, R. W. (2010). Implicit and explicit cognitions related to alcohol use in children. *Addictive Behaviors*, *35*, 471–478. doi:10.1016/j.addbeh.2009.12.022

Reich, R. R., Below, M. C., & Goldman, M. S. (2010). Explicit and implicit measures of expectancy and related alcohol cognitions: A meta-analytic comparison. *Psychology of Addictive Behaviors*, *24*(1), 13–25. doi:10.1037/a0016556

Schell, T. L., Martino, S. C., Ellickson, P. L., Collins, R. L., & McCaffrey, D. (2005). Measuring developmental changes in alcohol expectancies. *Psychology of Addictive Behaviors*, *19*, 217–220. doi:10.1037/0893-164X.19.2.217

Settles, R. E., Zapolski, T. C. B., & Smith, G. T. (2014). Longitudinal test of a developmental model of the transition to early drinking. *Journal of Abnormal Psychology*, *123*(1), 141–151. doi:10.1037/a0035670

Sher, K. J., Grekin, E. R., & Williams, N. A. (2005). The development of alcohol use disorders. *Annual Review of Clinical Psychology*, *1*, 493–523. doi:10.1146/annurev.clinpsy.1.102803.144107

Singer, J. D., & Willett, J. B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence*. Oxford, England: Oxford University Press.

Smit, K., Voogt, C., Hiemstra, M., Kleinjan, M., & Otten, R. (2018). Development of alcohol expectancies and early alcohol use in children and adolescents: A systematic review. *Clinical Psychology Review*, *60*, 136–146. doi:10.1016/j.cpr.2018.02.002

Smith, G. T., Goldman, M. S., Greenbaum, P. E., & Christiansen, B. A. (1995). Expectancy for social facilitation from drinking: The divergent paths of high-expectancy and low-expectancy adolescents. *Journal of Abnormal Psychology*, *104*(1), 32–40. doi:10.1037/0021-843X.104.1.32

Snijders, T. A. B., & Bosker, R. J. (1993). Standard errors and sample sizes for two-level research. *Journal of Educational Statistics*, *18*, 237–259.

Thush, C., & Wiers, R. W. (2007). Explicit and implicit alcohol-related cognitions and the prediction of future drinking in adolescents. *Addictive Behaviors*, *32*, 1367–1383. doi:10.1016/j.addbeh.2006.09.011

Ting, T.-T., Chen, W. J., Liu, C.-Y., Lin, Y.-C., & Chen, C.-Y. (2015). Peer influences on alcohol expectancies in early adolescence: A study of concurrent and prospective predictors in Taiwan. *Addictive Behaviors*, *40*, 7–15. doi:10.1016/j.addbeh.2014.08.001

Treloar, H., Pedersen, S. L., & McCarthy, D. M. (2016). The role of expectancy in substance-use progression. In C. E. Kopetz & C. W. Lejuez (Eds.), *Addictions: A social psychological perspective* (pp. 120–147). Abingdon, England: Routledge.

Vogel-Sprott, M., & Fillmore, M. T. (1999a). Expectancy and behavioural effects of socially used drugs. In I. Kirsch (Ed.), *How expectancies shape experience* (pp. 215–232). Washington, DC: American Psychological Association.

Vogel-Sprott, M., & Fillmore, M. T. (1999b). Learning theory and research. In K. E. Leonard & H. T. Blane (Eds.), *Psychological theories of drinking and alcoholism* (2nd ed., pp. 292–327). New York, NY: Guilford Press.

Voogt, C., Beusink, M., Kleinjan, M., Otten, R., Engels, R., Smit, K., & Kuntsche, E. (2017). Alcohol-related cognitions in children (aged 2–10) and how they are shaped by parental alcohol use: A systematic review. *Drug and Alcohol Dependence*, *177*, 277–290. doi:10.1016/j.drugalcdep.2017.04.006

Wills, T. A., Sargent, J. D., Gibbons, F. X., Gerrard, M., & Stoolmiller, M. (2009). Movie exposure to alcohol cues and adolescent alcohol problems: A longitudinal analysis in a national sample. *Psychology of Addictive Behaviors*, *23*(1), 23–35. doi:10.1037/a0014137

Windle, M., Spear, L. P., Fuligni, A. J., Angold, A., Brown, J. D., Pine, D., . . . Dahl, R. E. (2009). Transitions into underage and problem drinking: Summary of developmental processes and mechanisms: Ages 10–15. *Alcohol Research & Health*, *32*, 30–40.

Young-Wolff, K. C., Wang, P., Tuvblad, C., Baker, L. A., Raine, A., & Prescott, C. A. (2015). Drinking experience uncovers genetic influences on alcohol expectancies across adolescence. *Addiction*, *110*, 610–618. doi:10.1111/add.12845

Zucker, R. A., Donovan, J. E., Masten, A. S., Mattson, M. E., & Moss, H. B. (2009). Developmental processes and mechanisms: Ages 0–10. *Alcohol Research & Health*, *32*, 16–29.