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Substance familiarity in middle childhood and adolescent substance use

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ABSTRACT

Background: Childhood familiarity with (knowledge of) substances is a potentially important, currently understudied adolescent substance use risk factor. We aimed to describe changes in childhood familiarity with substances and to test whether baseline familiarity predicts early adolescent substance use.

Methods: Utilizing the Substance Use Module of the longitudinal cohort study, Adolescent Brain Cognitive Development (ABCD; US youth aged 9–10 years followed for 10 years) through Data Release 4 (n=7896; individuals who completed all six assessments in the first three years), we conducted longitudinal mixed models and survival analyses to describe changes in familiarity and to determine the adjusted odds of substance use by age 13 based on number of familiar substances at baseline.

Results: The sample consisted of 3754 females and 4142 males, aged 9–10 at baseline, with majority White individuals (68.9%). Unconditional time models indicated age significantly predicted familiarity (B=0.08, $p<0.001$; $R^2=0.288$) with ~3.59 familiar substances at 9 years increasing to ~7.43 substances at 13 years. Family history, home use, peer use, and neighborhood availability predicted familiarity, accounting for 1% of additional variance ($R^2=0.299$; $\Delta R^2=0.011$). For each additional familiar substance at baseline, adjusted odds of future use increased 1.28 times (95% CI 1.22, 1.34).

Conclusions: This is the first study to characterize substance familiarity in this age range as a predictor of future substance use. Familiarity increases with age (age being the most predictive indicator). Familiarity at age 9–10 predicts early adolescent substance use. As such, childhood familiarity may represent an easily implemented screening tool for at-risk youth.

1. Introduction

Adolescence is a critical period for experimentation with substance use and development of substance use disorders (Schramm-Sapyta et al., 2009). Adolescent substance use can have substantial adverse outcomes, including increased risk for morbidity and mortality, mental health concerns problems, and legal implications (Squeglia and Gray, 2016; Volkow et al., 2014). Many risk factors for adolescent substance use have been explored, existing at the individual, interpersonal, community, and societal levels (Substance Abuse and Mental Health Services Administration, 2017), as well as across developmental stages (prenatal, infancy, toddlerhood, early-/mid-childhood) (Eiden et al., 2016). As such, the risk profile for adolescent substance use is complex and varied; consideration of new predictors is important, especially given the significant potential adverse outcomes. One understudied area of risk is the realm of childhood familiarity with substances. Familiarity is broadly defined as the knowledge of something (American Psychological Association, 2022), arising from knowledge of a stimulus (Wang et al., 2018), experience with a stimulus (Klein, 2008; Liao et al., 2011), or unconscious priming to a stimulus (Kahneman, 2003; Corrigan and Nieweglowski, 2019). In the context of this study, familiarity is operationalized as a continuous measure of the knowledge created by summing endorsement of having heard of specific substances. Familiarity with substances may be a risk factor for substance use as it may lower perceived risk (Smith et al., 2011), indicate social norms regarding substance use (Sechrist and Stangor, 2001), or signify a measure of exposure to substances via family members, peers, media or advertising (Strasburger et al., 2010; Srivastava et al., 2021; Schuler et al., 2019). Given these potential mechanisms, this study aims to describe predictors of substance familiarity, changes in familiarity from middle childhood through early adolescence, and ascertain whether early familiarity is related to earlier use.

The concept of familiarity producing altered patterns of behavior has been discussed and studied in social theory models, including the "mere

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exposure effect" (repeated stimuli produce higher subjective value, largely because they are considered safe) (D'souza and Rao, 1995; Ha et al., 2011; Cao et al., 2021; Song et al., 2021), social learning theory (children learn by observing or imitating what is seen on television or media, especially if observed behaviors are rewarded) (Strasburger et al., 2010), or "superpeer" theory (media represents a powerful best friend for children, giving guidance for how to behave in unfamiliar situations) (Strasburger, 2009). Zajonc et al. (1973) posited that individuals prefer familiar stimuli because they are considered safe, effectively describing a familiarity-safety association (Cao et al., 2021; Zajonc et al., 1973; Song and Schwarz, 2009). Other studies exploring perceived risks of new technologies (Cao et al., 2021) or investment opportunities (Weber et al., 2005) also showed a direct relationship between familiarity and perceived safety. With prior studies indicating risk perception is negatively correlated with substance use (Grevenstein et al., 2015), those who are familiar with substances may be more likely to use substances due to lowered risk perception. Thus, through mere exposure effects, lowered risk perception, or "superpeer" effects, familiarity with substances in childhood may confer its own risk for future substance use.

Adolescent risky behavior arising from exposure via media/advertising has been studied previously, providing rationale for familiarity with substances as a potential substance use risk factor. Generally, more frequent advertising exposure is associated with evaluation of presented information as more trustworthy and reliable (Rindfleisch and Inman, 1998; D'Souza and Rao, 1995). For instance, exposure to junk food advertising impacts children's food beliefs and obesity risk (Brownell et al., 2009). Exposure to fashion magazines in early adolescence is associated with body image distortion in later adolescence (Hogan and Strasburger, 2008). Further, childhood violence exposure is a demonstrated risk factor for adolescent violent or aggressive behavior (Wilson et al., 2002; Boxer et al., 2009) and early media exposure to risky sexual behaviors predicts risky sexual behaviors in adolescence and young adulthood (Lin et al., 2020). Thus, with disordered feeding/eating, aggression, and sexual behaviors, evidence suggests that early exposure predicts future behaviors. Familiarity predicting substance use has been less well studied, however. Prospective studies in Australia found that children who approved of cigarette advertising were twice as likely to smoke tobacco (Alexander et al., 1983). Similarly, longitudinal studies show that exposure to smoking in movies/TV in grades 5–8 predicts smoking initiation 1–8 years later (Dalton et al., 2003). As such, existing evidence supports the theory that exposure may predict risky behaviors and that exposure to specific substances predicts specific substance use (i.e., exposure to tobacco advertisements predicts future tobacco use). What is not yet known is whether familiarity itself predicts *any* early adolescent substance use (regardless of substance category) and whether being familiar with more substances at an earlier age represents a risk factor for future substance use in this age range.

In addition to early media exposure, the role of family members (parental monitoring and family members' substance use, separate from genetic susceptibility) and neighborhood may influence adolescent use (Srivastava et al., 2021; Yu, 2003). Particularly, in mid-childhood, familiarity with substances may originate from immediate family use or attitudes towards use (Schuler et al., 2019; Yu, 2003; Pettigrew et al., 2018; Van Ryzin et al., 2012). For instance, the more time children spend with an alcohol-using parent, the more likely they are to engage in underage drinking (Yu, 2003), and particularly, if parental substance misuse occurs, risk for adolescent substance use increases (Keeley et al., 2015). Similarly, perceived older sibling use is associated with cannabis use in the younger sibling, particularly in grades 6 and 7 (Schuler et al., 2019). Further, studies indicate that parental monitoring is negatively associated with adolescent substance use and poorly monitored youth are more likely to use substances (Steinberg et al., 1994). As youth transition to adolescence, peer groups gain more influence on substance use behavior: exposure to friends who smoke is one of the strongest predictors of smoking initiation by adolescents (de Vries et al., 2003). Thus, an important source of substance exposure in childhood is likely a combination of family members and peers. Additionally, a recent study examining characteristics of youth curious about substances in this age range (also using ABCD data) suggested that neighborhood availability is a predictor of curiosity regarding that substance (Martz et al., 2022). Our study aims to expand on this knowledge by exploring familiarity with substances as a risk factor in and of itself, while also evaluating the roles of family history, adult home use, parental monitoring, perceived peer use and neighborhood availability in substance familiarity to understand aggregate exposure's risk for future substance use.

With existing literature supporting the hypothesis that early familiarity with risky behaviors predicts future risky behaviors, familiarity with substances may represent a currently understudied modifiable risk factor for adolescent substance use. As is the case for many risk factors for substance use, familiarity may exist as a risk factor in and of itself while also being a proxy for other potential risk factors for substance use (such as perceived peer use). To our knowledge, no other study has specifically examined familiarity over time in this age range (9–13 years) or as a risk factor for adolescent substance use. The primary aims of this study are 1) to characterize familiarity with substances across early adolescence (i.e., to understand how number of familiar substances changes over time from ages 9–10 to 12–13 years old), 2) to test the hypothesis that several potential risk factors (i.e., family history, neighborhood availability, density of home use, and perceived peer use) predict increased baseline familiarity; and 3) to examine familiarity as a predictor of subsequent substance use, after adjusting for significant predictors of baseline familiarity.

2. Methods

2.1. ABCD study overview

ABCD is a 10-year, multisite longitudinal cohort study of participants aged 9–10 years at baseline (N=11,875). Participants were recruited from 21 sites across the United States. Detailed accounts of full study protocol have been published previously (Garavan et al., 2018; Volkow et al., 2018; Uban et al., 2018), as have detailed overviews of measures & data collection strategy specific to substance use (Lisdahl et al., 2018). While the ABCD sought to recruit a sample that approximate the US population's diverse socio-demographics, importantly, it is not a US-nationally representative sample (Compton et al., 2019). Rather, it is a population-based, demographically diverse sample that has been described in previous reports (Garavan et al., 2018; Compton et al., 2019).

Participants and measures included in the study were from ABCD Data Release 4.0 except for "household substance use", which was only available in ABCD Data Release 3.0, and thus, data from that release are used for that variable. Our analyses included only participants who completed all six assessments over the first three years of the project (three in-person assessments and three remote interviews). Thus, though the total number of available participants was 11,870, our sample yielded 7896 participants. Of the 3974 participants not included, 3400 did not meet inclusion criteria because they had not yet completed the final remote assessment due to timing of the data release.

2.2. Measures

2.2.1. Substance familiarity and use

The substance familiarity measure indexed the total number of substances/substance classes participants either endorsed having "heard of" or specifically mentioned following a free-response question querying familiarity with any additional substances. Participants were explicitly asked whether they had heard of 1) alcohol, 2) cannabis, 3) synthetic cannabis, 4) caffeine, 5) nicotine, 6) misuse of prescribed substances, or 7) inhalants. Each substance named in the free response question was recorded as belonging to one of the following categories: 1)

stimulants, 2) cathinones, 3) methamphetamine, 4) ecstasy/MDMA, 5) ketamine, 6) GHB, 7) heroin, 8) hallucinogens (general), 9) hallucinogens (psilocybin), 10) hallucinogens (salvia), or 11) steroids. Thus, familiarity scores could range from 0 to 18. Once familiarity was endorsed, it was not queried again in subsequent assessments; thus, familiarity values increased monotonically. Full familiarity assessments were conducted annually (i.e., baseline, one-year, two-year follow-ups). Truncated familiarity assessments were conducted by phone interview between yearly assessments (i.e., 6-month, 18-month follow-ups). To preserve adolescents' privacy during phone interviews, these interim assessments included the "heard of" questions for all aforementioned substance classes except synthetic cannabis, but did not capture the aforementioned free responses, allowing adolescents to respond with only "yes"/"no" answers. Following the 30-month follow-up assessment, familiarity was no longer queried.

Following positive confirmations of familiarity, youth were asked whether they had used the substance in question. Beginning with 30-month assessments, youth were queried regarding use of all seven substance classes, and subsequently asked a free-response question assessing use of additional substances. Any magnitude of substance consumption (e.g., "puff" of cannabis) was considered positive use, excepting alcohol, for which use was considered positive following consumption of a full drink.

2.2.2. Perceived peer substance use

Perceived peer substance use was derived from a larger peer deviance survey that was completed by youth participants assessing the number of friends an adolescent currently has who engage in substance use related activities (i.e., use of different substances, sell or give drugs to others, have problems with alcohol or other drugs). A binary peer use variable was derived from this measure where the indication of any number of friends using any substance was coded as "peer use positive" while those with zero friends using any substances were coded as "peer use negative.".

2.2.3. Availability of substances

Neighborhood substance availability was queried using the Availability of Substances questionnaire (Johnston et al., 2017). Caregivers indicated how easy obtaining various classes of substances would be for their child, using a 0–3 scale (0=very hard; 3=very easy). Substance classes included alcohol, cigarettes, electronic nicotine products, cannabis, illicit drugs, inhalants, and three classes of medications (anxiolytics; opioids; stimulants) obtained without a prescription. Thus, scores could range from 0 to 27.

2.2.4. Parental history of substance use problems

ABCD utilizes a family history inventory that assesses lifetime occurrences of a range of psychological problems in first- and second-degree biological relatives of the child. For parental substance use problems, a parental substance use history value from 0 to 4 was derived for each participant, with 0 indicating no substance use problems in either biological parent and 4 indicating both alcohol and drug use problems in both parents, as reported by the guardian completing the parent-interview.

2.2.5. Household substance use

Household use reflected the number of adults using substances inside the home and breadth of substances used. Caregivers indicated the number of adults using each of a variety of substance classes (e.g., alcohol; stimulants; opioids; inhalants) in the household. Only non-prescription use was included in this measure. A single household use value was derived by summing across the number of adults using each class of substances in the primary and (where relevant) secondary residences of the adolescent. Of note, due to these data not being available in ABCD Data Release 4.0, all models incorporated data from ABCD Data Release 3.0.

2.2.6. Parental substance use rules

Parental substance use rules assess whether the adult allows the adolescent to use alcohol, nicotine, or marijuana, and, if so, under what constraints. Rules around substances could consist of no use under any circumstance, use under specific circumstances (e.g., parental supervision or when the child asks to use a substance), or no enforced rules regarding use of each substance. Additionally, it is queried whether these same rules apply to all or some of the members of the household (children vs. teens vs. adults) and if there are any consequences for breaking family rules. Though there could be several permutations of parental rules for particular substances, for our purposes, parental rules were categorized into three categories, "no use allowed" (including explicit restriction of all substances), "incomplete rules set" (including any combination of restriction for some substances and lack of rule establishment for others), and "some use allowed", including permissiveness for any substance, regardless of whether other substances are restricted or rules have not yet established.

2.3. Data analyses

2.3.1. Aim 1 analysis

Characterization of how familiarity changes across time (ages ranging from 9 to 13 years old) was accomplished by assessing change in the cumulative number of familiar substances as well as familiarity by substance class (i.e., alcohol, marijuana, etc.) at each timepoint.

2.3.2. Aim 2 analysis

Predictors of familiarity were examined using longitudinal mixed models. Three models of increasing complexity were constructed. All models included participants, participant families, and assessment sites, as random effects. Participant family was included to account for multiple youth participants coming from the same family. The initial conditional model included only mean-centered participant age as a fixed effect. Building upon this, the second model included additional fixed effects, namely potential predictors of familiarity, including family history of substance use, ease of obtaining substances, density of adult use in the home, perceived peer substance use, parental monitoring score, and youth substance use allowed. The full model further added covariates of interest to the second conditional model including sex, race, ethnicity, family income, and family education. A summary of these models and how they relate to one another can be found in Table 1. Descriptive analyses of familiarity were conducted for each assessment period. However, due to heterogeneity in opportunities for change between the yearly and 6-month familiarity assessments, only yearly assessments were included in the statistical models.

2.3.3. Aim 3 analysis

Given the discrete-time nature of available substance use data, survival analysis examining substance use was conducted using logistic regression. Data were organized in person-period structure (Willett and Singer, 1993). The logistic model included familiarity at baseline as the primary predictor and included all covariates in the final mixed model described above. Though familiarity was assessed at multiple timepoints, for substance use analyses, only baseline familiarity was used as a predictor. Although analyses were conducted using familiarity as a continuous measure, visual depictions of hazard/survival used three categorizations, including *low* (0–3 substances), *medium* (4–6 substances), and *high* (7+ substances) familiarity. R scripts used for data processing and analyses are included as supplementary materials.

3. Results

3.1. Participants

The sample yielded 7896 adolescents, including 3754 females and 4142 males. The sample was predominantly White (n=5438) but

Table 1
Predicting Familiarity - Results from each of three longitudinal mixed models. The unconditional time model (simple model) included only time as a fixed factor. The model including predictors of interested added fixed terms for family history, ease of obtaining substances, density of adult use in the home, peer substance use, parental monitoring score and youth substance use allowed (predictor model). The model including covariates included both predictors from the second model and added terms for sex, race, ethnicity, family income, and family education (covariates).

	Unconditional Time		Predictors		Covariate-adjusted	
Predictors	*Estimates*	*p*	*Estimates*	*p*	*Estimates*	*p*
Intercept	5.51	**<0.001**	5.44	**<0.001**	4.68	**<0.001**
Time (age in months)	0.08	**<0.001**	0.08	**<0.001**	0.08	**<0.001**
Family History			0.11	**<0.001**	0.13	**<0.001**
Ease of Obtaining			0.03	**0.001**	0.03	**<0.001**
Adult Home Use Density			0.05	**<0.001**	0.04	**<0.001**
Peer Substance Use			0.34	**<0.001**	0.35	**<0.001**
Parental Monitoring Score			0.00	0.157	0.00	0.225
Youth Substance Use Allowed			-0.02	**0.040**	-0.02	**0.010**
Observations	23,652		23,652		23,652	
Marginal R^2 / Conditional R^2	0.288 / 0.795		0.299 / 0.794		0.317 / 0.795	

included representation by American Indian/Alaskan Native or Native Hawaiian/Pacific Islander (n=46), Black (n= 888), and Asian (n=192) individuals, with 926 individuals identifying as mixed identity. 1487 individuals identified as being of Hispanic ethnicity. The remaining 341 participants indicated 'other' or declined to answer. Participants' families reported household incomes of <$50k/year (n=1816), $50-$100k/year (n=2183), and the largest group reporting $100k/year (n=3347), with 550 participants declining to answer. "Post-graduate degree" was the most represented group of parental education (n=2957; 37.4%), while 2193 reported a parent having a bachelor's degree (27.8%), 1883 reported having "some college" (23.8%), 557 reported having a high school diploma or GED (7.1%), and 293 reporting "less than high school diploma" (3.7%) being the highest level of education achieved. Participant demographic factors at baseline can be found in Supplementary Table 1.

3.2. Familiarity over time

Measures of central tendency and distributional qualities of the data are visualized by assessment period (Fig. 1). Mean number of familiar substances at baseline was 4.23 (SD=1.47), increasing to 6.26 (SD=1.67) at the last assessment period. Means and ranges of all proposed predictors of familiarity can be found in Supplementary Table 2. Fig. 2 shows growth in familiarity stratified by substance class across participant age.

3.3. Predictors of familiarity

The assessment of familiarity was accomplished with three models of increasing complexity (first, the unconditional time model; second the model adding predictors of interest, or the "predictor model"; and third, the model adding both predictors of interest and socio-demographic variables, or the "covariate model"). The unconditional time model (Table 1) indicated significant effect of participant age on familiarity (B= 0.08, p<0.001; R^2= 0.288). This model indicated an intercept of familiarity with 5.51 substances at mean age of ~11 years (131 months), with a change of ~0.08 substances/month. Thus, familiarity was estimated at ~3.59 substances at 9 years and ~7.43 substances at 13 years. The potential for multicollinearity was explored between all the covariates; no correlations higher than 0.20 were observed. Significant effects for six of the seven predictors of interest were observed, including participant age (B= 0.08, p<0.001), family history (B= 0.11, p<0.001), substance availability (B= 0.03, p<0.001), household use (B= 0.05, p<0.001), perceived peer substance use (B= 0.34, p < 0.001), and youth substance use allowed (B= −0.02, p=0.040) with parental monitoring (B= 0.00, p = 0.157) showing a non-significant effect. However, these

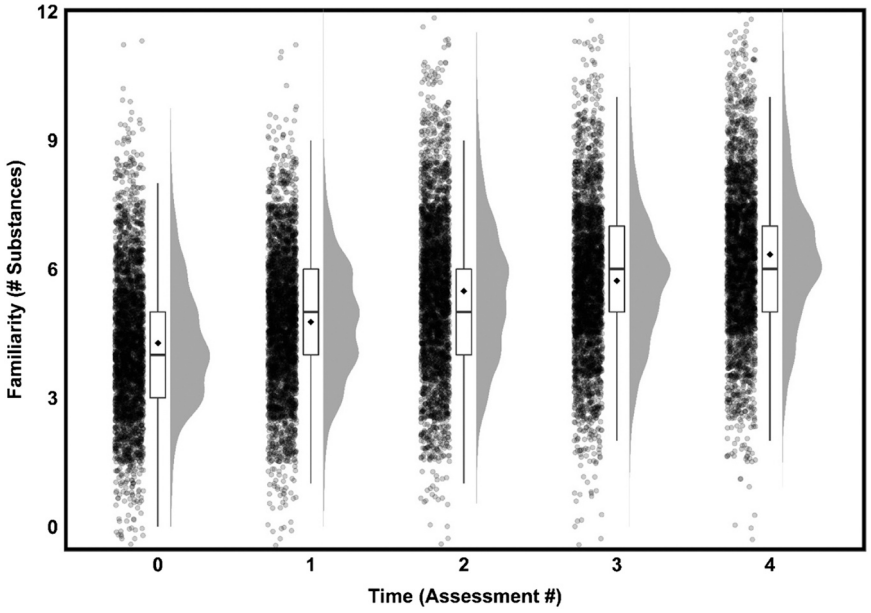

Fig. 1. Number of familiar substances by time assessment period. Data for each assessment period were presented using three visualization methods, including raw data (jittered; left column); box plots (central column) with superimposed means (diamonds); and raincloud plots (right column).

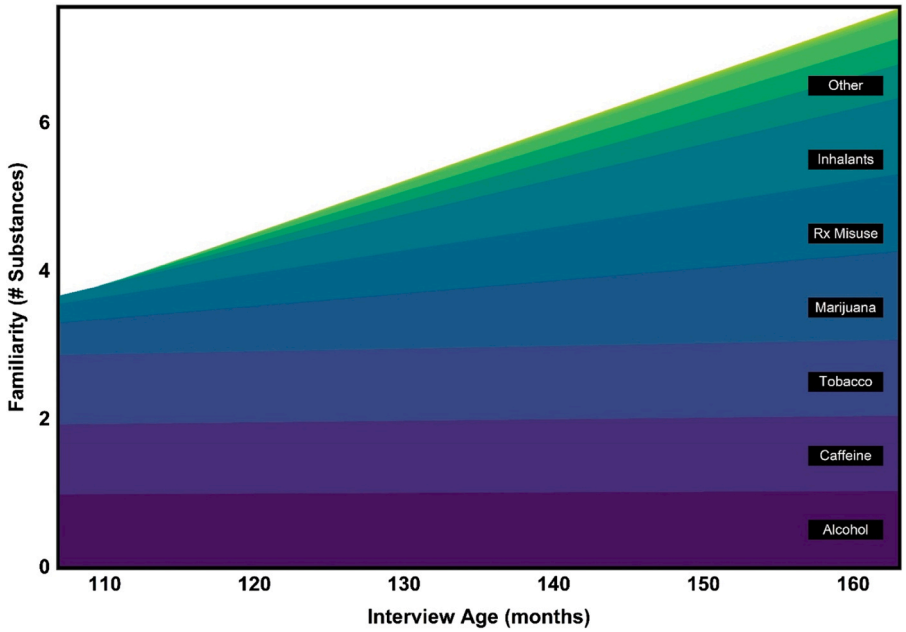

Fig. 2. Linear trends in substance familiarity by substance class. Linear growth plot visualizing linear trends for each substance class. Ordered from bottom to top by proportion of total sample familiar at baseline.

variables accounted for 1% of additional variance in familiarity (model R^2=0.299; ΔR^2=0.011). Effects of six of the seven predictors of interest were found to be significant after accounting for covariates, including participant age (B= 0.08, p< 0.001), family history (B= 0.13, p< 0.001), neighborhood availability (B= 0.03, p< 0.001), household use (B= 0.04, p< 0.001), perceived peer substance use (B= 0.35, p< 0.001), and youth substance use allowed (B= −0.02, p= 0.010) with parental monitoring (B= 0.00, p= 0.225) not reaching significance. The covariate-adjusted model accounted for a nearly 2% increase in variance for familiarity (model R^2=0.317; ΔR^2=0.018). Results for all models are reported in Table 1. Though many predictors significantly deviated in Shapiro-Wilk's testing, it is commonly suggested that such violations be ignored in large datasets, such as the ABCD (Ghasemi and Zahediasl, 2012). To confirm that our results were not biased, we conducted log transformations of all predictor variables and reran the model with the transformed values. Results were exceptionally similar in their direction and significance, but more difficult to interpret meaningfully. Thus, we present here the raw/untransformed values in the primary analyses, with transformed analyses available in Supplementary Table 3. Although numerous covariates accounted for significant variance in familiarity, those results were not the focus of the primary analysis; full results including covariate findings can be found in Supplementary Table 4.

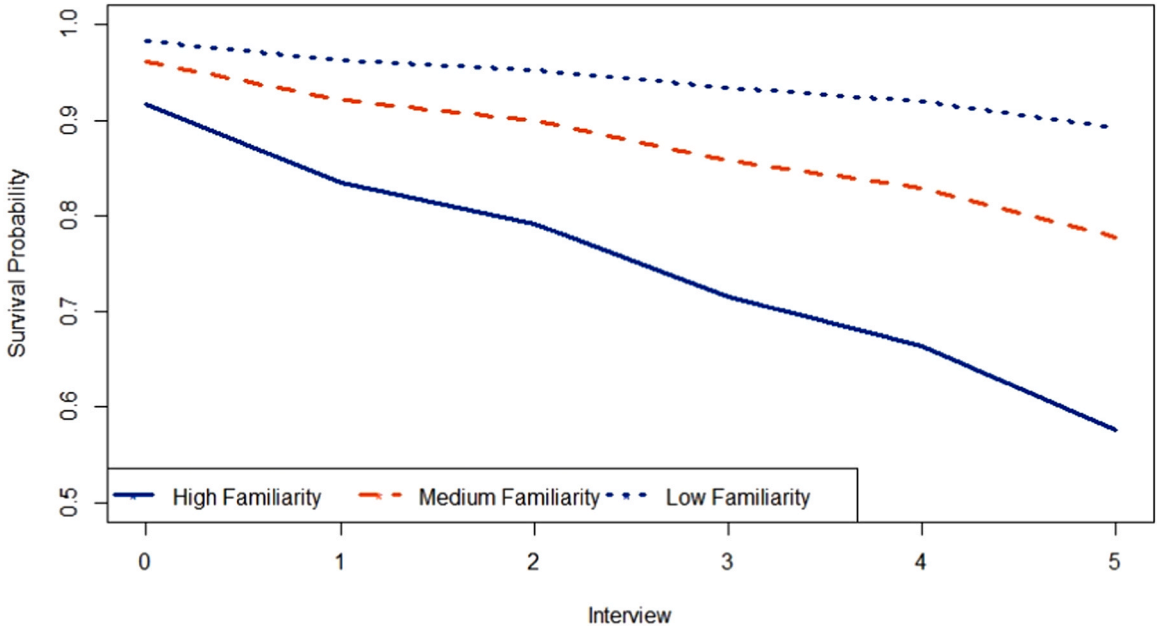

Fig. 3. Model-implied survival probability (substance use) by familiarity level. Plot of model-implied survival probability by familiarity level. For visualization purposes the survival model was reiterated with familiarity as a categorical variable (representing participants familiar with either ≤3 substances [Low], 4–6 substances [Medium], or ≥7 substances [High]).

3.4. Baseline familiarity as a risk factor for substance use

Survival analysis revealed a positive association between baseline familiarity and substance use, with odds ratio of 1.27 (95% CI: 1.21–1.33; p<.001). Importantly, this reflects an estimated increase in odds of any substance use by age 13 years old for each additional familiar substance at baseline age of 9–10 years old. Family history also predicted use initiation, with an associated OR of 1.31 (95% CI: 1.19–1.43; p<.001). Further, less strict substance use rules (OR = 1.10, 95% CI: 1.01 – 1.21, p =.04), lower parental monitoring (OR = 0.93, 95% CI: 0.91 – 0.96, p<.001), and higher perceived peer use (OR = 6.01, 95% CI: 4.98 – 7.25, p<.001) exhibited significant associations with use initiation. Additionally, the association between substance availability and use was in the predicted direction (OR=1.07; 95% CI: 1.04–1.1, p = <.001). These results are depicted in Fig. 3, showing model-implied survival probability across three categories (low, medium, high) of familiarity. Additionally, the overall proportion of substance use initiation by number of familiar substances are depicted in Fig. 4.

4. Discussion

Substance familiarity increases with time from baseline (ages 9–10 years), with age being the single most significant predictor. Although family history, adult home use, peer substance use, and neighborhood availability were all identified as predictors, the strength of these relationships was modest relative to age, even after adjusting for additional demographic covariates. On average, individuals were familiar with 5.51 substances at the average age of 11 years old (extrapolated to 3.59 substances at earliest age of 9), increasing to an average of 7.43 substances by 13 years. 6.1% of the sample reported using a substance at some point following baseline. After adjusting for other predictors, the odds of reporting using a substance increased by 1.27 times for each additional familiar substance. To our knowledge, this is the first study to examine change in substance familiarity or to examine familiarity as a risk factor for substance use in this age group. The results of our study indicate that familiarity with substances represents an important risk factor for future early adolescent substance use.

Additionally, though not assessed directly in our sample, understanding how youth gain familiarity with substances is important in translating our results to clinical action. Given the developmental stage of children aged 9–11, a probable exposure to substances may be via family members' use or discussion of substances, or via youth's immediate environment or neighborhood. However, even after controlling for peer use, home use and neighborhood availability, familiarity still significantly predicted adolescent substance use in our analyses. This finding suggests that familiarity itself may be an inherent risk factor aside from these likely confounders. Thus, other theories, including that familiarity with risky stimuli decreases perceived risk perception (Zajonc et al., 1973; Song and Schwarz, 2009), thereby making future substance use more likely, may be more probable. Additionally, other confounders not assessed in our analyses or available to be tested in our sample may contribute to the relationship between familiarity and substance use. For instance, individuals who are familiar with more substances at an earlier age may be exposed via other means, such as peers or media. Further, our finding that substance use risk increases depending on baseline number of familiar substances suggests that there may be risk-stratified groups of children. Exploration of such risk stratification will be important in future studies on this matter.

Although the current analyses leverage data collected from the ABCD study, which includes unprecedented methodological strengths, their interpretation requires consideration of several important limitations. 1) While longitudinal analyses were well-matched to characterizing change in familiarity, the repeated nature of the data collection creates a potential confound: every six months, participants were asked if they were familiar with several substances (e.g., alcohol), thus it is likely that following baseline interviews subsequent familiarity may have been partially dependent on recognizing substance names from previous interviews. 2) Analyses included only three follow-up time points. Despite relevant data being collected at six-month intervals, differences in data collection methods between interview types (in-person versus phone interviews) challenged their combination in a single longitudinal model. When analyses included all six follow-up points of data, we found similar results (not shown). 3) Although familiarity was assessed across eighteen classes of substances, knowledge within each class was represented as binary. While not inappropriate, this approach may have missed important within-substance granularity (e.g., participants with extensive knowledge of particular cannabis strains and/or administration routes were not differentiated from those simply aware of cannabis as a psychoactive substance). 4) Potential sources of familiarity (e.g., peers; social media) were not queried. While not a direct limitation to

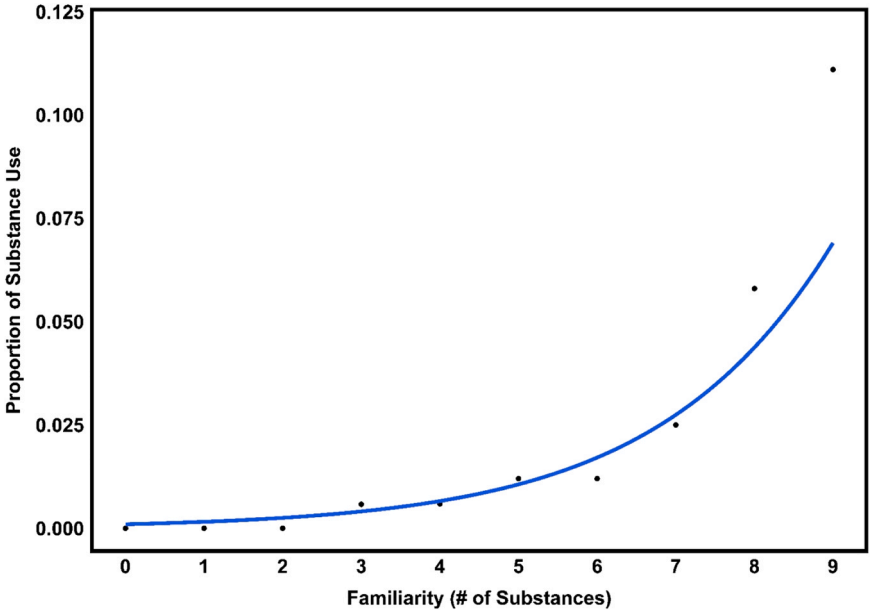

Fig. 4. Overall proportion of substance use initiation by number of familiar substances. Due to lower sample sizes, proportions of initiators were not visualized for individuals familiar with 10+ substances.

descriptive analyses, integrating familiarity sources could potentially strengthen future analyses of familiarity as a risk factor for use. 5) Both familiarity and substance use indices were based on self-report and were thus subject to both recall and acceptability bias. While solutions to these possibilities are limited, the observed difference in reported use as a function of interview type (phone vs. face-to-face) suggest the possibility that they may be more effectively minimized in future studies. 6) Substance use assessments were completed approximately every six months, thus somewhat limiting the granularity of their analysis. 7) Despite a substantive sample, given the relatively young age of participants, substance use remained rare. Thus, early use was not differentiated between substance classes (e.g., early drinking vs. early smoking), although this approach remains a potential avenue for future investigation as additional data becomes available. 8) Analyses characterized familiarity at baseline as a potential risk factor for subsequent use. While relevant, more complex models interrogating dynamic, time-varying relationships between use and familiarity might yield additional information. 9) Though there were several permutations of parental rules regarding substance use (including different rules for different substances), for purposes of this study, we collapsed the variable into three categories. As such, we may have missed some granularity of the relationships between specific parental rules and adolescent substance use that would be important to explore in future analyses. 10) While traditionally, in predicting risk for substance use in youth, parental problems with substances have been a highly studied and meaningful factor (Ohannessian et al., 2004; van der Zwaluw et al., 2008; Hoffmann and Cerbone, 2002; Anderson et al., 2023), the restriction to parental problems with substance use may give a slightly limited view into the scope of the influence of family use. 11) Though we have adjusted for several variables and potential confounders, it is possible that there exist some additional factors for which we were not able to or did not adjust for. Therefore, while familiarity appears to be a risk factor for substance use after adjusting for the included covariates and predictors, it is likely that familiarity alone does not explain all the risks associated with adolescent substance use initiation.

These limitations notwithstanding, our study has several exciting implications and a multitude of potential future directions. Understanding differences in substance use outcomes based on source of familiarity (e.g., witnessing others using versus attending a school-based anti-drug prevention talk) would be helpful in considering future prevention efforts. Characterizing familiarity further, exploring other facets of the relationship between familiarity and substance use outcomes, and potential interventions or screening tools based on familiarity with substances in mid-childhood are all possible future directions of research and implementation that could arise from our presented results.

5. Conclusions

The implications and future directions of this study are multifold. Early familiarity as a substance use risk factor may inform how substance use prevention efforts are framed. Current gold standards of screening or risk determination tools for substance use in adolescence, including Screening, Brief Intervention and Treatment (SBIRT) and Car, Relax, Alone, Forget, Friends, Trouble (CRAFFT) are used for youth ages 9–21 (Kulak and Griswold, 2019). However, screening and prevention tools encompassing a broad range of substances specifically aimed at school-aged youth (ages 9–11 years old) are less well studied or characterized (Kulak and Griswold, 2019). Identifying young individuals at risk for substance use with an easy-to-use screening instrument such as familiarity with substances may be an important tool for healthcare workers that would be easily implemented in a variety of healthcare settings. Additionally, results from the present study may provide a resource for parents and educators as well as guidance for public health messaging directed towards substance use education & prevention.

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CRediT authorship contribution statement

Devika Bhatia, M.D., Benjamin Lewis, Ph.D., and Sara Jo Nixon, Ph. D. conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript. Hugh N. Farrior, Jr., M.S. and Andrew Moore, B.S., carried out initial analyses, contributed to study design, and reviewed and revised the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Declaration of Competing Interest

No conflict declared.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.drugalcdep.2023.110892.

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