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Energy Drinks and Alcohol Related Risk among Young Adults

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Abstract

Background—Energy drink consumption, with or without concurrent alcohol use, is common among young adults. This study sought to clarify risk for negative alcohol outcomes related to the timing of energy drink use.

Methods—We interviewed a community sample of 481 young adults, aged 18–25, who drank alcohol use in the last month. Past 30 day energy drink use was operationalized as no-use, use without concurrent alcohol, and concurrent use of energy drinks with alcohol ("within a couple of hours"). Negative alcohol outcomes included past 30 day binge-drinking, past 30 day alcohol use disorder, and drinking-related consequences.

Results—Just over half (50.5%) reported no use of energy drinks,18.3% reported using energy drinks without concurrent alcohol use, and 31.2% reported concurrent use of energy drinks and alcohol. Relative to those who reported concurrent use of energy drinks with alcohol, and controlling for background characteristics and frequency of alcohol consumption, those who didn't use energy drinks and those who used without concurrent alcohol use had significantly lower binge-drinking, negative consequences, and rates of alcohol use disorder ($p < .05$ for all outcomes). There were no significant differences between the no-use and energy drink without concurrent alcohol groups on any alcohol-related measure ($p > .10$ for all outcomes).

Conclusions—Concurrent energy drink and alcohol use is associated with increased risk for negative alcohol consequences in young adults. Clinicians providing care to young adults could consider asking patients about concurrent energy drink and alcohol use as a way to begin a conversation about risky alcohol consumption while addressing two substances commonly used by this population.

Keywords

Energy drink; alcohol; young adults; caffeine; risk

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MS: edited extensively and is PI of the grant that collected the data

Introduction

Energy drinks (EDs), beverages marketed to increase energy that include caffeine and other ingredients (i.e. Taurine, Niacin, Ginseng) and caffeine content, anywhere from 50mg to over 500mg per can or bottle[1], are increasingly popular among emerging adults. Across a diverse group of samples, at least monthly ED use has been estimated between 23–53% in young adults, 18–25 years old[2–4]. ED sales worldwide are expected to surpass $52 billion by 2016[5].

Young adults report diverse motivations for ED use including staying awake for school, work, or driving, academic performance enhancement, and partying[4,6,7]. ED users are more likely to be male[2,8,9] while race and ethnicity findings have been mixed[2,10–12]. ED use has potential deleterious health effects, such as neurological and cardiac effects leading to emergency department visits[8], especially among certain vulnerable individuals, for example those with underlying cardiac conditions, or those with situational stressors such as sleep deprivation or elevated stress or anxiety. In addition, energy drink use is associated with behaviors such as unsafe driving[2,10], illicit substance use[2,13,14], and sexual risk taking[15]. To date, most research on ED use and alcohol use has evaluated alcohol used concurrently with energy drinks (AmED)[3,16–18], or has not distinguished between ED use generally and AmED specifically when evaluating negative alcohol use, such as alcohol dependence, hazardous drinking, or alcohol quantity and negative consequences[2,10,19].

Alcohol is often used concurrently with energy drinks (AmED), the two literally mixed together or used in tandem with one another, within two hours as defined by the Substance Abuse and Mental Health Services Administration[20], and results in risky alcohol consumption and deleterious outcomes. It has been hypothesized that AmED reduces the feeling of impairment from alcohol, likely due to increased feelings of stimulation[21,22] and may increase desire for alcohol[23]. A reduced perception of impairment is associated with more risk behavior and increased harms[21,24]. These results suggest neurochemical and pharmacological interactions, likely through the neurotransmitters adenosine and dopamine, when alcohol is mixed with energy drinks[25]. Other researchers suggest that any increased risk of harm from AmED may be due to a link between caffeine (with or without simultaneous alcohol use) and sensation-seeking[13,26]. Regardless of the mechanism of action, the regular, concurrent use of EDs and alcohol may produce greater alcohol-related consequences than use of alcohol alone[16,25,27], although there is disagreement in the literature as to the role of individual risk-taking characteristics when measuring negative consequences from alcohol and AmED consumption[28].

However the existing literature does not provide enough evidence on whether alcohol consequences are associated with *any* ED use among young adults who drink regardless of the timing of consumption, or specifically with *concurrent* use of EDs with alcohol. Patrick et al.,[29] linked ED use to same day, event level alcohol consequences, but did not distinguish between ED and AmED use. Other studies that analyzed alcohol outcomes by ED and AmED use had conflicting results on the impact of ED use alone[9,30]. Flotta et al.,[30] evaluated the association of a number of risk behaviors with ED, AmED and alcohol only use, including alcohol-related behaviors in a sample of adolescents, finding differential risk

behaviors associated with different consumption types. Velazquez et al.,[9] found increasing alcohol and AmED use for each additional past month ED use day in a survey of college students.

The current study examines the association of negative alcohol consequences with ED use and AmED use when these two consumption types are analyzed separately. The study objective is to determine whether adverse alcohol outcomes are differentially related to AmED use, ED use regardless of timing, and no-use of energy drinks in a group of young adult drinkers. Although the risks of AmED have been documented, the risk of ED use alone as it relates to alcohol outcomes has not been well documented. We hypothesized that those who used AmED would have worse alcohol-related outcomes than those who did not use ED or who used ED alone. It is important to understand the distinction as to help effectively steer intervention efforts for at-risk young adults. If those who use AmED are most likely to experience deleterious outcomes, prevention efforts should be targeted at those most at-risk for concurrent use. If any ED use is with alcohol problems, education is needed for all young adult consumers who drink

Methods

Study Design and Participants

Study participants were recruited between January 2012 and March 2015 for a parent "health behaviors study" among emerging adults. Recruitment was completed using several outlets, including targeting the Southern New England geographical area online through Southern New England Craig's List and Facebook advertising, and through advertisements placed in local college newspapers, on public transportation, and on commercial radio. Interested individuals called the study number or emailed the study address to receive a call back and were given a 10-minute anonymous phone screen. The screen included questions about basic demographics, substance use, sexual activity, mental health, and general health. As previously described[31,32], eligible individuals were invited for an in-person interview at the research site and offered compensation ($40) and free Sexually Transmitted Infection testing.

Eligibility criteria for the parent study included being 18–25 years old, using alcohol or marijuana in the last month, being heterosexually active in the last six months, not having suicidal ideation in the past two weeks, and living within 30 minutes of the research site. Of the 2,645 individuals screened by phone, 1,252 were ineligible. The remaining 1,393 eligible persons were invited for an interview and 799 were either not interested (n=102 actively refused; n=188 passively refused, i.e. said they would call back to schedule an appointment, but never did), or did not keep a scheduled appointment (n=509).

Five hundred ninety four provided written informed consent (the study was approved by the Institutional Review Board of the authors' research institution) and completed a baseline interview after which 24 persons were found to be ineligible (their baseline assessment data did not meet study eligibility criteria) and 4 withdrew their participation. The final sample consisted of five hundred sixty-six persons. This analysis was limited to those who were current (past 30 day) alcohol users and included 481 persons.

Measures

Demographics—Participants were asked to provide demographic information, including age, race/ethnicity, and school status. Participants gave their date of birth which was used to determine participant age. Race and ethnicity were assessed using two separate questions, the first querying ethnicity (Latino/Hispanic yes/no), and the second racial background. School status was collected with the question "Are you currently in school?" Response options were "Full time, part time, not in school."

Energy Drink Use—The use of energy drinks was measured with two questions. The first asked participants to indicate, "During the past 30 days, on how many days did you use energy drinks (such as Red Bull, Amp, Rockstar, Full Throttle)?" Response options were on a 0–30 day scale. The second question asked participants to indicate, "In the last 30 days have you consumed energy drinks and alcohol within a couple of hours of each other?" Response choices were on a 0 "Never" to 3 "Daily or Almost Daily" scale. We constructed a 3-category indicator coded no ED use, ED use but not concurrent with alcohol, and any reported AmED use in the past 30 days. Participants were coded no ED use if they answered the first question "0 days", ED only if they answered the first question >0 days and the second question "never", and AmED if the first question was >0 day and the second question was > never.

Alcohol Measures—Participants were asked to recall the 90 days prior to the interview using the Timeline FollowBack method[33], which is widely used for a variety of intervals and is reliable and valid[34,35]. Participants indicated days in which they used alcohol and the quantity of alcohol used on drinking days. We defined binge alcohol use as 4 or more drinks for women, 5 or more for men, in a two-hour period. Summary measures based on the Timeline FollowBack are expressed as rates of drinking days / 30 days. We analyzed only the past 30 days of use to parallel the energy drink measure. Alcohol-related consequences were measured using the Short Inventory of Problems (SIP)[36], a fifteen-item measure of alcohol-related negative consequences in the previous three months consisting of six subscales, physical, interpersonal, intrapersonal, interpersonal, impulse control, and social responsibility. The sum of each subscale is totaled to give a SIP total score. Response options were on a 0 "Never" to 3 "Daily or Almost Daily" scale for items 1–6 and 0 "Not at all" to 3 "Very Much" scale for items 7–16. Sample items from the SIP include "I have been unhappy because of my drinking", "My drinking has damaged my social life, popularity, or reputation", and "My drinking has gotten in the way of my growth as a person". Internal consistency coefficient alpha for SIP scale was .90. Current (past 90 days) alcohol use disorder (AUD) was assessed using the Structured Clinical Interview for DSM-IV[37] and participants were classified as none, mild, moderate, or severe AUD according to DSM-V criteria[38]. Age of initiation of alcohol use was assessed by asking "How old were you when you had your first drink of alcohol (other than a few sips)?"

Analytical Methods

We report descriptive statistics to summarize the background characteristics of the full sample and by ED use. We used F-tests for differences in means and χ^2-tests for differences on categorical outcomes to evaluate bivariate outcomes. The Holm-Bonferroni method[39] was

used to control family-wise error rates when performing pairwise comparisons. Alcohol disorder severity was analyzed as an ordered categorical outcome and p-values for the pairwise comparisons were estimated with ordered logistic regression.

Adjusted associations between patterns of ED use and alcohol outcomes were analyzed in a generalized linear model framework. Frequency of binge drinking was analyzed as a proportion using the fractional logit model[40] with robust standard errors. The SIP was analyzed as a continuous outcome using OLS regression with robust standard errors. DSM-V alcohol use disorder severity was an ordered categorical outcome and analyzed using ordered logit regression with robust standard errors. All models included age, gender, race/ethnicity, school status, age of alcohol initiation, and proportion of days using alcohol as covariates. Early age of alcohol initiation has been associated with risky alcohol use[41] and thus was included as a covariate. Frequency of alcohol use was included as a covariate as higher frequency of alcohol use is associated with greater alcohol related consequences and AUD.

Results

Participants averaged 21.3 (± 2.1) years of age, 48.0% were male, 65.9% were non-Latino White, 10.4% were African-American, 11.9% were Latino, and 11.9% were of other ethnic or racial origins (Table 1). Subsequent analyses compared non-Latino Whites to all ethnic and racial minorities. Two hundred thirty-six (49.1%) were full-time students, 12.1% were part-time students, and 38.9% were not enrolled in school. The mean age at which participants initiated alcohol use was 15.6 (± 2.32, the mean rate (days / 30) of alcohol use prior to baseline was 7.9 (± 5.5) days, and participants binged on an average of 3.8 (± 4.2) days. The mean score on the SIP was 6.3 (± 6.3). Two hundred eighty (58.2%) did not meet DSM-V criteria for alcohol use disorder, 105 (21.8%), 68 (14.1%), and 28 (5.8%) met criteria for mild, moderate, and severe AUD, respectively. Two hundred forty-three (50.5%) reported no use of ED, 88 (18.3%) reported using ED but not concurrently with alcohol use, and 150 (31.2%) reported AmED.

Statistically significant bivariate associations were observed between ED use and age, gender, ethnicity, age of initiation alcohol use, frequency of alcohol use, frequency of binge drinking, mean SIP scores, and AUD severity (Table 1). Based on the Holm-Bonferroni corrected p-value, persons who reported no ED use were significantly older, less likely to be male, and less likely to be non-Latino White than those who used AmED. Persons who used AmED initiated alcohol use at a significantly younger age than persons who reported no ED use. Compared to those who did not use energy drinks or who used them alone, persons who used AmED had significantly higher mean rates of alcohol use, mean rates of binge drinking, mean SIP scores, and more severe AUD. Differences between non-ED users and those who used ED alone were not statistically significant and substantively small (Table 1).

Multivariate analysis yielded generally consistent results. Controlling for background characteristics and frequency of alcohol consumption, binge drinking was significantly lower for persons reporting no ED consumption ($b = -0.49$, $z = -4.23$, $p < 0.001$) and for those reporting ED consumption without concurrent alcohol ($b = -0.40$, $z = -2.51$, $p =$

0.012) than for persons reporting AmED (Table 2). Those using ED without concurrent alcohol use did not differ significantly from those reporting no ED consumption with respect to frequency of binge drinking.

Significant differences were also observed with respect to the SIP. Persons reporting ED use without concurrent alcohol (b = −2.49, z = −3.25, p = 0.001) had significantly lower adjusted mean SIP scores than those reporting AmED (Table 2). Persons who reported no ED use tended to have lower adjusted mean SIP scores (b = −1.35, z = −1.93, p = .054) than those who used AmED. Adjusted mean SIP scores for persons reporting no use of ED and use of ED without concurrent alcohol use did not differ significantly.

A consistent pattern was observed when examining the association between ED use and DSM-V alcohol use disorder severity (Table 2). Persons reporting no ED use (OR = 0.54, z = −2.64, p = 0.008) and persons reporting ED without concurrent alcohol use (OR = 0.45, z = −2.91, p = 0.004) had significantly lower alcohol use disorder severity than those reporting AmED. Differences between those not using ED and those using ED without concurrent use of alcohol were not statistically significant.

Discussion

Young adults commonly use energy drinks, and of those who use EDs, many use them concurrently with alcohol. In the current study, those who use energy drinks and alcohol concurrently (AmED) had a greater constellation of alcohol problems, including alcohol related problems, AUD, and binge drinking, than either persons who use energy drinks without concurrent alcohol, or non-ED users. We found no significant differences between ED users and non-ED users on any alcohol-related measures.

Although the extant literature[9,13,42] describes negative alcohol consequences related to both EDs and AmEDs, the current study found significant differences between these groups on all negative alcohol outcomes. This is notably different than other studies, where any use of EDs, regardless of its concurrent use with alcohol, was related to worse alcohol-related consequences[2,29,43]. Our analysis revealed no substantive differences in alcohol-related consequences between the EDs without concurrent alcohol and the no-use groups. Prior AmED studies have linked AmED and negative alcohol outcomes[44], but many do not include a group of ED users who do not engage in AmED, making it difficult to parse out the risks associated with ED use in relation to the timing of alcohol use. Our findings are supported by a study of adolescent drinkers that found negative alcohol outcomes in ED users were largely mediated by AmED use[45]. Event level data, specifically detailing the timing of ED and alcohol consumption is an important next step. Patrick et al[29], began this work linking ED use and event level alcohol consequences, but the current study shows the timing of ED and alcohol use remains an important factor.

It has been reported that consuming energy drinks concurrently with alcohol increases feelings of stimulation and increases a desire for alcohol[21,23] but does not reduce the impairing effects of alcohol[46], although the evidence of AmED's impact on intoxication and perception of intoxication is still mixed[47,48]. However, other studies have found no "masking

effect" of alcohol intoxication by EDs[49,50], calling into question the motivation for using EDs while drinking. It is possible the reasons for ED use among those who use alcohol and energy drinks concurrently and those who use energy drinks at different times from alcohol are distinct. It seems likely that the intention with AmED is to be able to drink more or longer without feeling impaired, which may increase alcohol-related risk. Alternatively, there is emerging evidence that energy drinks and alcohol interact in unique ways in the brain so as to increase craving for alcohol[23]. Those who use EDs without concurrent alcohol use may be drinking for the taste, to stay awake, or for other non-impairing reasons.

It is possible that the risks of ED usage, as they relate to alcohol outcomes, are a result of the facilitation of risky drinking, thereby leading to worse drinking-related outcomes. This has important implications for ED regulation and intervention as all ED use may be associated with negative alcohol consequences. Physicians and mental health providers may wish to question patients about their engagement in the riskier AmED use as opposed to asking about ED use in general, especially as it relates to alcohol use. Alternatively, it may be important to query about risk-taking behavior or sensation-seeking as it relates to caffeine consumption to determine those most at risk[13,26] for alcohol-related negative consequences. Young adult patients may find a question asking whether they have ever mixed alcohol and energy drinks to be a less threatening way to begin a conversation about hazardous drinking and negative drinking consequences than a direct assessment of alcohol use; querying about ED use more generally may not afford the same opportunities to assess risk.

This study had some limitations. First, our convenience sample included only young adults, and our results may not generalize to adolescents and older adults. Second, a significant proportion of those screened were either ineligible or did not complete a baseline interview with rates similar to what we have found in others studies of this age group[51]. Third, AUD in our sample was high, however moderate and severe prevalence rates were similar to those reported in a previous study which found 11–26% alcohol dependence among ED users[42]. DSM-IV dependence criteria and moderate and severe levels of DSM-V AUD are highly concordant[52]. Fourth, we did not have event level data, and therefore could not link AmED and alcohol-related consequences directly. Fifth, our definition of concurrent use ("within a couple of hours of each other") does not necessarily equate to combining ED and alcohol at the same sitting, but is the standard definition of AmED[20]. Sixth, we did not assess ED or AmED use motives, which would have been informative. Seventh, we only assessed recent ED and AmED use (past 30 days). Future studies should explore differences in past year vs recent users. Eighth, we did not have a measure of the frequency with which persons consumed AmED, which would have been illustrative. Finally, while ED use without concurrent alcohol use was not associated with negative alcohol consequences, caffeine-related consequences were not assessed, so we have not established that drinking ED alone is not problematic.

This study also had important strengths. We enrolled an ethnically diverse community sample of young adults. We also enrolled a sample with a range of current educational engagement, and found that school status was not associated with ED use or with alcohol outcomes. Most research in this age group has been done exclusively among college samples. Finally, participants reported ED and AmED use separately, allowing an evaluation

of the risk of problematic alcohol outcomes associated with each, an important addition to the literature that we believe is important for clinical discussion with young adults.

Although the extant research has been equivocal as to whether negative alcohol outcomes are related to energy drink use in general, regardless of the timing of use or more specifically related to the concurrent use of energy drinks and alcohol, the current study found significantly greater alcohol-related risk associated with AmED. This important distinction suggests that health care providers, community health centers, and general health screening tools might target concurrent ED and alcohol use in an effort to identify and intervene on a risk behavior with deleterious consequences to young adults. The elevated risk of AmED also has important implications for caffeinated alcohol mixtures, which are no longer sold pre-formulated but are popular among young adults, and easily obtained at local bars and social gatherings.

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Table 1

Background Characteristics and Alcohol Use Outcomes by Use of Energy Drink Use Typology. Reported Cell Values are Means (±SD) or n (%).

		ENERGY DRINK USE			
	Sample (n = 481)	**None (n = 243)**	**Not w Alcohol (n = 88)**	**With Alcohol (n = 150)**	**F- or χ^2 (p =)**
Years Age	21.3 (± 2.07)	21.5 (± 2.10)[a]	21.1 (± 2.17)	20.9 (± 1.91)	5.04 (.010)
Gender (Male)	231 (48.0%)	99 (40.7%)[a]	48 (54.6%)	84 (56.0%)	10.49 (.005)
Non-Latino White	317 (65.9%)	144 (59.3%)[a]	62 (70.5%)	111 (74.0%)	9.96 (.007)
School Status					
Full-Time	236 (49.1%)	106 (43.6%)	51 (58.0%)	79 (52.7%)	6.51 (.164)
Part-Time	58 (12.1%)	33 (13.6%)	9 (10.2%)	16 (10.7%)	
Not In School	187 (38.9%)	104 (42.8%)	28 (31.8%)	55 (36.7%)	
Age First Used Alcohol	15.6 (± 2.32)	16.0 (± 2.28)[a]	15.6 (± 2.39)	15.0 (± 2.20)	8.78 (<.001)
Days Alcohol Use / 30	7.88 (± 5.49)	7.51 (± 5.56)[a]	6.51 (± 5.32)[b]	9.27 (± 5.21)	8.30 (<.001)
Days Binged / 30	3.79 (± 4.15)	3.00 (± 3.74)[a]	3.11 (± 3.84)[b]	5.47 (± 4.48)	17.22 (<.001)
SIP	6.30 (± 6.26)	5.81 (± 5.98)[a]	4.49 (± 4.38)[b]	8.15 (± 7.16)	11.42 (<.001)
DSM-V AUD Severity[c]					
No Disorder	280 (58.2%)	157 (64.6%)[a]	60 (68.2%)[b]	63 (42.0%)	31.09 (<.001)
Mild Disorder	105 (21.8%)	45 (18.5%)	19 (21.6%)	41 (27.3%)	
Moderate Disorder	68 (14.1%)	25 (10.3%)	9 (10.2%)	34 (22.7%)	
Severe Disorder	28 (5.8%)	16 (6.6%)	0 (0.0%)	12 (8.0%)	

SIP = Short Inventory of Problems; AUD = Alcohol Use Disorder

[a] No energy drink use significantly ($p < .05$) different than concurrent energy drink use with alcohol, based on Holm-Bonferroni corrected p-value.

[b] Energy drink alone significantly ($p < .05$) different than concurrent energy drink use with alcohol, based on Holm-Bonferroni corrected p-value.

[c] P-values for pairwise between group comparisons on alcohol use disorder severity were estimated by ordered logistic regression.

Table 2

Generalized Linear Models Estimating the Adjusted Association Between Type of Energy Drink Use with Frequency of Binge Drinking, The Short Inventory of Problems, and DSM-V Alcohol Use Disorder Severity (n = 481).

	Binge Frequency[a] b (95% CI)	SIP[b] b (95%CI)	AUD Severity[c] OR (95%CI)
Years Age	−0.04 (−0.101; 0.021)	0.18 (−0.13; 0.49)	1.05 (0.95; 1.17)
Gender (Male)	0.26 * (0.05; 0.48)	−0.88 (−2.02; 0.25)	0.50 ** (0.34; 0.72)
Race/Ethnicity			
African-American	0.37 ** (0.09; 0.66)	0.98 (−1.41; 3.17)	1.66 (0.85; 3.24)
Latino	−0.03 (−0.42; 0.35)	−0.79 (−2.27; 0.69)	1.40 (0.77; 2.55)
Other	0.07 (−0.30; 0.44)	0.17 (−1.37; 1.70)	1.31 (0.74; 2.32)
White [REF]	[0.00]	[0.00]	[1.00]
School Status			
Full-Time	0.10 (−0.15; 0.34)	−0.06 (−1.34; 1.22)	0.89 (0.57; 1.38)
Part-Time	0.09 (−0.27; 0.45)	−0.27 (−2.37; 1.83)	0.59 (0.29; 1.19)
Not In School [REF]	[0.00]	[0.00]	[1.00]
Age First Used Alcohol	−0.02 (−0.07; 0.24)	−0.14 (−0.40; 0.12)	0.90 * (0.82; 0.99)
Frequency Alcohol Use	3.03 ** (2.26; 3.81)	2.45 (−1.13; 6.03)	6.08 ** (1.79; 20.59)
Frequency Binge Drinking	d	11.99 ** (6.71; 11.27)	25.09 (4.25; 148.0)
Energy Drink Use			
None	−0.49 ** (−0.72; −0.26)	−1.35 (−2.71; 0.02)	0.54 ** (0.34; 0.85)
Yes (Not with Alcohol)	−0.40 * (−0.71; −0.09)	−2.50 ** (−4.00; −0.98)	0.45 ** (0.27; 0.77)
Yes (With Alcohol) [REF]	[0.00]	[0.00]	[1.00]

* p < .05,

** p < .01

[a] Proportion of TLFB days persons reported consuming ≥ 4 (females) or ≥ 5 (males) drinks. Coefficients, confidence interval estimates, and tests of significance were estimated using the fractional logit model (38) with robust standard errors.

[b] Short Inventory of Problems related to alcohol. Coefficients, confidence interval estimates, and tests of significance were estimated using OLS regression with robust standard errors.

[c] DSM-V alcohol use disorder was coded 0, no disorder, 1, mild disorder, 2, moderate disorder, and 3, severe disorder. Coefficients, confidence interval estimates, and tests of significance were estimated using ordered logistic regression with robust standard errors.

[d] Not Applicable in the model predicting binge drinking.