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Social interaction and partner familiarity differentially alter voluntary ethanol intake in adolescent male and female rats

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Abstract

Alcohol readily facilitates social interactions and this effect plays an important role in adolescent drinking behaviors. The ability of social interaction to alter behaviors in response to alcohol in adolescent animals has been assessed using the demonstrator–observer paradigm. The demonstrator is exposed to ethanol and the observer is tested for changes in behaviors in response to ethanol after social interaction between the dyad. The present experiment expanded on previous work to investigate the effects of different types of social interaction on subsequent voluntary ethanol consumption in adolescent male and female rats. Specifically, voluntary ethanol intake was assessed in adolescent observers after social interaction with an alcohol-free or -intoxicated same-sex familiar cage-mate or an age-matched unfamiliar conspecific. Demonstrators were intragastrically administered water or 1.5 g/kg ethanol and allowed to socially interact with observers for 30 min after a 1-h social isolation period. Subsequently, observers were allowed voluntary access to ethanol using a two-bottle choice paradigm overnight for 13 h. Male and female observers that interacted with an alcohol-intoxicated familiar cagemate consumed significantly more ethanol relative to their alcohol-free counterparts. However, adolescent male observers that socially interacted with an alcohol-intoxicated, age-matched unfamiliar conspecific consumed significantly less ethanol than controls. The opposite effect was observed in adolescent female observers. The present results are consistent and extend previous work in support of the idea that exposure to the demonstrator–observer paradigm alters voluntary ethanol intake in a sex- and familiarity-dependent manner. Partner familiarity can induce elevated or reduced ethanol consumption in males. However, females appear to be more sensitive to the elevating effects of social interaction on voluntary ethanol consumption, regardless of familiarity of the partner.

Keywords: Adolescence; Voluntary alcohol intake; Social interaction; Demonstrator–observer paradigm

Introduction

Underage drinking is a serious health problem in the United States. According to the 2005 Monitoring the Future study, 17% of 8th graders, 33% of 10th graders, and 47% of 12th graders consumed at least one alcoholic beverage in the past 30 days. Additionally, 28.2% of young people aged 12–20 years reported alcohol use in the past month (SAMHSA, 2005). These statistics indicate that adolescents are reporting current use of alcohol, even though it is illegal to use this substance during the adolescent period. These statistics are of concern because previous research suggests that early use of alcohol may be a predictor of continued use into adulthood (e.g., Grant et al., 2001; Hasin & Glick, 1992). One of the major factors mediating alcohol use in adolescents is the impact it can have on facilitation of social interactions.

Social influences, including passive social influences, such as social modeling, contribute to future alcohol use in adolescent humans (Graham et al., 1991). Previous studies have shown the ability of alcohol to facilitate social interaction as an important factor in adolescent drinking behaviors (Beck et al., 1993; Beck & Treiman, 1996; Smith et al., 1995; Thombs et al., 1994). According to social learning theory, familiar peers may have a greater influence on behavior compared with unfamiliar peers (Bandura, 1977). Therefore, familiar or valued peers may be more able to influence alcohol-drinking behavior in adolescents (Borsari & Carey, 2006; Miller & Prentice, 1996), but this effect is different for males and females (Martino et al., 2006). Perceptions of the overestimation of an adolescent's friend's use of alcohol also contribute to the onset of alcohol use, and this effect is reportedly different for boys and girls (Graham et al., 1991). Therefore, sex differences in

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social influences may alter the onset of alcohol use in males and females. In general, adolescents use alcohol in a social context to enhance socialization and may be more likely to abuse alcohol within this context. Similarly, the ability of alcohol to alter social behaviors has been observed in animal models during adolescence.

Adolescent rats engage in distinctive forms of social behavior, including play behavior, social investigation, and social contact (Panksepp, 1981; Pellis et al., 1997; Pellis & Pellis, 1997; Varlinskaya et al., 2001; Varlinskaya & Spear, 2002). Play behaviors peak during adolescence, and social isolation increases play behavior in adolescent rats (Panksepp, 1981). Both male and female rats engage in the same forms of social behaviors, however, sex differences in the frequency of social play behavior have been observed (Pellis et al., 1997; Thor & Holloway, 1982). Adolescent animals seek out environmental cues paired with social interaction (Calcagnetti & Schechter, 1992) and social interaction is enhanced by ethanol. Low doses of ethanol (0.5 and 0.75 g/kg) produce social facilitation, whereas higher doses (2.0, 3.0, and 4.0 g/kg) induce social inhibition in adolescents (Varlinskaya et al., 2001). These findings support the idea that adolescents actively engage in social interaction and ethanol is able to enhance this effect. This may likely be one aspect that mediates sex differences in ethanol's ability to induce social facilitation. The demonstrator–observer paradigm is a model to assess changes in responsivity to social interaction in adolescent rodents.

The demonstrator–observer paradigm was designed to examine the effects of social interaction on learning in the absence of extrinsic reinforcement (Strupp & Levitsky, 1984). The paradigm is based on the interaction between two animals; one serving as a demonstrator and the other serving as an observer. In that study, the demonstrator was exposed to a potent smelling novel diet, such as cocoa or cinnamon. The observer interacted with the demonstrator and was later tested for preference of the novel diet. Strupp and Levitsky (2004) confirmed that the observer's preference for the novel diet was increased after social interaction with a demonstrator administered the same diet; an effect that occurred in as few as 24 h. Galef and colleagues (Galef & Stein, 1985; Galef et al., 1985) investigated the underlying behavioral processes of the demonstrator–observer model. Results indicated that interactions with an anesthetized rat dusted with the novel diet, either cinnamon or cocoa, were enough to create a preference for that diet in the observer, but this effect was not observed when a cotton surrogate was substituted as the demonstrator (Galef et al., 1985). Periadolescent rats (21-, 28-, 38-, or 45-days old) showed a preference for the novel diet when exposed to the anesthetized demonstrator rolled in either the cocoa or cinnamon diet. However, the 21 day olds also demonstrated an increase in diet preference when exposed to the cotton surrogate demonstrator rolled in either a cocoa or cinnamon diet (Galef & Kennett, 1987). These results indicated that older adolescent rats (postnatal day [PND] 28, PND 38, and PND 45) rats were more sensitive to the social context in which the olfactory stimuli were experienced (Galef, 1989). Specifically, only when the older adolescent rats interacted with the demonstrator exposed to the diet, but not the cotton surrogate, there was an increase in diet preference. The social context in which exposure to a demonstrator takes place is an integral aspect of the observer-demonstrator paradigm.

The demonstrator–observer model has been applied to assess preference for alcohol in adolescent animals after social interaction with a familiar alcohol-intoxicated peer (e.g., Fernandez-Vidal & Molina, 2004; Hunt et al., 2001). In one study, observers were either exposed to an alcohol-intoxicated or alcohol-free demonstrator, and animals that socially interacted with an alcohol-intoxicated peer spent more time investigating the alcohol odor relative to animals that interacted with an alcohol-free peer (Fernandez-Vidal & Molina, 2004). However, unlike the Galef and colleagues' experiments (Galef & Kennett, 1987; Galef et al., 1985), a change in preference for the alcohol odor was observed only after both members of the dyad were actively involved in social interaction, and this effect was not present when the adolescent observer was allowed to socially interact with an anesthetized demonstrator (Fernandez-Vidal & Molina, 2004). This study demonstrates the importance of active involvement in social interaction in adolescent rats and its ability to increase place preference for alcohol. Given that social interaction peaks during the adolescent period, this is a critical developmental time period to assess how social interaction modifies responsivity to ethanol.

Sex differences in voluntary ethanol intake have been observed and begin during the adolescent developmental period (Lancaster et al., 1996). Females have been reported to consume more ethanol than males when ethanol intake was equated for differences in body weight (Juárez & Barrios de Tomasi, 1999; Lancaster & Spiegel, 1992). Male observers were reported to consume more ethanol than females after social interaction with a same-sex sibling demonstrator, regardless of whether the demonstrator was administered ethanol, coffee, or water (Hunt et al., 2001). Previous studies used the demonstrator–observer paradigm with familiar cagemates as the dyad to investigate changes in alcohol-related behaviors (Fernandez-Vidal & Molina, 2004; Hunt et al., 2001). However, to our knowledge, changes in ethanol consumption have not been assessed in adolescent male and female rats using the demonstrator–observer paradigm with unfamiliar age-matched demonstrators. In human adolescents, familiar peers are more influential in changing alcohol-drinking behaviors compared with unfamiliar peers (Borsari & Carey, 2006; Miller & Prentice, 1996), and this effect is different for males and females (Martino et al., 2006). Therefore, familiarity of the demonstrator may have an important influence on ethanol consumption in the demonstrator–observer paradigm during adolescence.

The present study assessed the effects of social interaction on voluntary ethanol intake using a two-bottle choice paradigm with a choice between an alcohol solution and water. The purpose was to determine whether social interaction with a same-sex familiar cage-mate or an age-matched unfamiliar conspecific altered subsequent voluntary ethanol intake in adolescent male (experiment 1) or adolescent female (experiment 2) rats. Based on previous work conducted in animals, adolescent observers were expected to show greater voluntary ethanol intake after social interaction with an alcohol-intoxicated familiar cage-mate. Because familiarity of peers influences drinking behaviors differently in males and females and the demonstrator–observer paradigm has not been used with unfamiliar conspecifics to assess changes in alcohol-related behaviors, it was hypothesized that adolescent male and female rats would differ in voluntary ethanol intake after social interaction with an unfamiliar conspecific.

Methods and materials

Subjects

Ninety-four male (experiment 1; 47 observers and 47 demonstrators) and 78 female (experiment 2; 39 observers and 39 demonstrators) Sprague–Dawley rats (Harlan Laboratories, Indianapolis, IN) derived from established breeding pairs at the University of South Florida, Tampa were used as subjects for the present set of experiments. Litters were sexed and culled to 10 pups per litter on PND 1, with the date of birth designated as PND 0. Each litter comprised 6–8 males and 2–4 females. Extra pups were used in other ongoing experiments. Pups remained with their respective dams until PND 21, when pups were weaned and group-housed with same-sex littermates. Animals were maintained on a 12:12 hour light:dark cycle, with lights on from 0700 to 1900 hours, in a temperature- and humidity-controlled vivarium. Animals were allowed ad libitum access to food and water in their home cage. No more than one male or one female pup per litter was used in any given condition. Animals were randomly assigned as demonstrator or observer following the model established by Strupp and Levitsky (1984). All observers were adolescents, PND 28–30. Demonstrators were adolescent familiar cagemates, PND 28–30, or adolescent unfamiliar conspecifics, PND 28–30. In all respects, maintenance and treatment of the animals were within the guidelines for animal care by the National Institutes of Health.

Apparatus

All procedures took place in polycarbonate cages maintained on a 12:12 hour light:dark cycle. Demonstrators were intragastrically administered water or 12.6% vol/vol ethanol mixed in water using 12-cm lengths of polyethylene tubing (PE-50) attached to a 21.5-gauge blunted needle tip and a 5-ml disposable syringe. Assessment for voluntary intake of ethanol and water by observers was performed with 500-ml glass bottles with double ball-bearing tips. Previous work has indicated voluntary ethanol intake is higher in adolescent rats when using double ball-bearing tips as compared with standard open-ended tips (Doremus et al., 2005).

Procedure

All procedures were similar for experiments 1 and 2.

Handling

The present experiment occurred over three days. On days one and two, animals were handled for 5 min each after which rats were randomly assigned the role of either demonstrator or observer. Handling occurred at the same time every day (between 1730 and 1900 hours).

Demonstrator–observer paradigm

On day 3, animals were weighed and socially isolated for 30 min beginning at 1730 hours. The demonstrator was removed from the home cage and placed in a holding cage, whereas the observer remained in the home cage. After the initial 30 min of social isolation, the demonstrator was removed from the holding cage and intragastrically administered 1.5 g/kg EtOH (12.6% vol/vol ethanol mixed in water) or an isovolumetric administration of water. The 1.5 g/kg dose of ethanol was chosen because it has been shown to produce the most effective olfactory cues necessary for learning in adolescent animals (e.g., Hunt et al., 2001). The demonstrator was immediately returned to the holding cage for an additional 30 min. After the 1 h of social isolation, the demonstrator was placed into the observer cage where the two animals were allowed to socially interact for 30 min. After the social interaction session, the observer was placed in a holding cage where access to ethanol and water occurred. The demonstrator was placed back into the home cage and immediately returned to the colony.

Voluntary ethanol intake

Two drinking bottles were introduced into the observer's cage; one containing a 5.6% vol/vol ethanol solution sweetened with 1% wt/vol sucrose and the other containing water. The former was chosen based on the results of a pilot experiment, in which adolescent animals did not voluntarily consume unsweetened ethanol (5.6% vol/vol ethanol) but did consume slightly sweetened (sucrose 1% wt/vol) ethanol (5.6% vol/vol) overnight. Observers were left over night for 13 h with free access to both bottles until 0800 hours. The next morning, 0800 hours, both bottles were removed from the observer's cage, and observers were returned to their home cage. Bottles were weighed to the nearest 0.1 g before introducing the bottles in the cage and after removal. Ethanol intake was expressed as grams of ethanol

consumed per kilogram of body weight (g/kg). Spillage was accounted for by placing the water and ethanol bottles in an empty holding cage overnight. The difference in weight was subtracted from each animal's intake score to account for spillage that may have occurred overnight.

Design and analyses

Data were analyzed separately for each experiment using a two-factor between-subjects design analysis of variance for Demonstrator (2; Cagemate, Conspecific) and Drug (2; water or 1.5 g/kg ethanol). The dependent variable was analyzed as the amount of ethanol ingested (g/kg). Subsequent comparisons (Fisher's protected least significant difference tests and simple effects) were used to isolate effects. The level for significance was set at 0.05.

Results

Experiment 1: males

Levels of voluntary ethanol intake varied as a function of demonstrator and drug as indicated by a significant Drug by Demonstrator interaction ($F[1, 43] = 6.61$, $P < .01$). As depicted in Fig. 1, observers that socially interacted with an alcohol-intoxicated familiar cagemate voluntarily consumed significantly higher levels of ethanol than those observers that socially interacted with an alcohol-free familiar cagemate. Observers that socially interacted with an intoxicated unfamiliar conspecific consumed significantly less ethanol than those observers that socially interacted with an alcohol-free unfamiliar conspecific. There were no significant differences in voluntary ethanol intake among any of the observers that socially interacted with an alcohol-free demonstrator.

Experiment 2: females

Levels of voluntary ethanol intake were increased in adolescent female observers that socially interacted with an alcohol-intoxicated demonstrator relative to those that socially interacted with an alcohol-free demonstrator, as indicated by a significant main effect of Drug ($F[1, 35] = 13.85$, $P < 0.001$). As shown in Fig. 2, female observers that socially interacted with an alcohol-intoxicated familiar cagemate or an unfamiliar conspecific consumed significantly more ethanol relative to their alcohol-free counterparts. There were no significant differences in voluntary ethanol intake between any of the observers that socially interacted with alcohol-free demonstrators. Additionally, there were no significant differences in voluntary ethanol intake between any of the observers that socially interacted with an alcohol-intoxicated demonstrator.

Discussion

The fact that familiar or valued peers may have a greater influence than unfamiliar or less-valued peers on alcohol-drinking behaviors has been suggested (Borsari & Carey, 2006; Bot et al., 2005; Martino et al., 2006; Miller & Prentice, 1996). The quality of peer relationships influences drinking behavior in both males and females (Bot et al., 2005; Urberg et al., 2003). However, quality of peer relationships appears to be driven by different factors in males and females, with

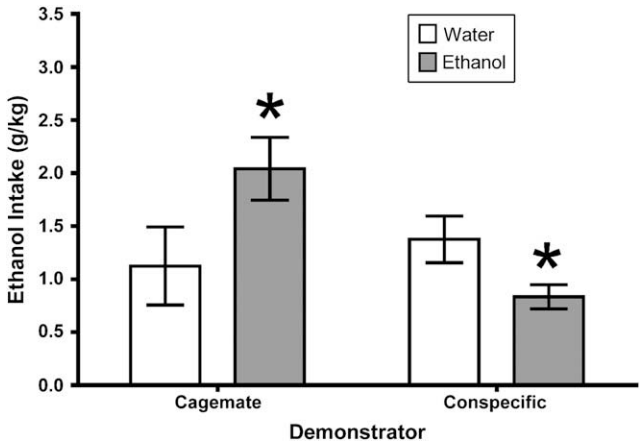

Fig. 1. Social interaction differentially alters voluntary ethanol intake in adolescent males. Data are presented as mean ± SEM. There were no significant differences in voluntary alcohol intake among water controls, regardless of demonstrator. Adolescent familiar cage-mate observers that socially interacted with an alcohol-intoxicated demonstrator voluntarily consumed significantly higher levels of alcohol relative to their alcohol-free counterparts. Adolescent observers that socially interacted with an alcohol-intoxicated unfamiliar conspecific demonstrator consumed significantly less alcohol than conspecific water controls. *Significantly differs from water control. Water-familiar cage-mate, $n = 13$; ethanol-familiar cage-mate, $n = 11$; water-unfamiliar conspecific, $n = 12$; ethanol-unfamiliar conspecific, $n = 11$.

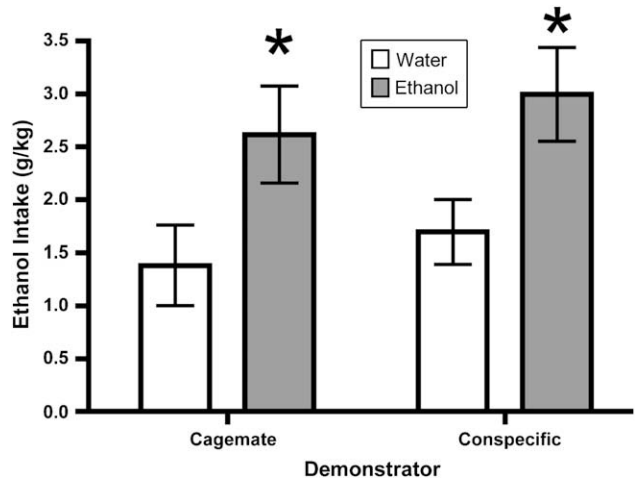

Fig. 2. Social interaction with an alcohol-intoxicated demonstrator increases voluntary ethanol intake in adolescent females. Data are presented as mean ± SEM. There were no significant differences in voluntary alcohol intake among water controls, regardless of demonstrator. Adolescent observers that socially interacted with an alcohol-intoxicated familiar cage-mate or an unfamiliar conspecific demonstrator consumed significantly more ethanol than water controls. *Significantly differs from water control. Water-familiar cage-mate, $n = 9$; ethanol-familiar cage-mate, $n = 11$; water-unfamiliar conspecific, $n = 10$; ethanol-unfamiliar conspecific, $n = 9$.

quality of peer relations appearing to be more closely tied to drinking behaviors in males (Borsari & Carey, 2006). However, quality of peer relations in females appear to be mediated by factors not closely tied to drinking behaviors (Borsari & Carey, 2006). Consistent with previous work in animals (Hunt et al., 2001), in the present set of experiments, adolescent males and females that socially interacted with an alcohol-intoxicated familiar cagemate demonstrated increased voluntary ethanol intake. Adolescent males and females that socially interacted with an alcohol-intoxicated unfamiliar conspecific displayed opposite patterns of voluntary ethanol intake. Therefore, the effects of sex differences in partner familiarity were clearly evident in the present set of experiments, with familiar cagemates increasing voluntary ethanol consumption in both adolescent male and female observers, and unfamiliar conspecifics increasing ethanol consumption only in adolescent female observers and decreasing ethanol intake in adolescent male observers.

In humans, perceived overestimation of an adolescent's friend's use of alcohol can contribute to the onset of alcohol use (Graham et al., 1991), and is influenced by close friends but not by more distant friendships (Urberg et al., 1997). Adolescent males and females start using alcohol at about the same time and consume similar amounts of alcohol (Opland et al., 1995). However, others have reported that adolescent males consume more alcohol than adolescent females (Poelen et al., 2007); and also, gender differences have been observed in motivations for alcohol use (Graham et al., 1991). Females tend to use alcohol more to manage emotional distress and in response to peer pressure, whereas males tend to use alcohol more with social bonding and to facilitate social interaction (Opland et al., 1995; Simons-Morton et al., 2001; Thombs et al., 1993). In both males and females, the same-sex best friend's drug use behavior was the best predictor for drug use (Gaughan, 2006; Wang et al., 1995). Problem-drinking males were reportedly more likely to drink in all social contexts compared to problem-drinking females and non–problem-drinking males (Roche & Watt, 1999; Treiman & Beck, 1996). Females appear to be more sensitive to peer norms in influencing alcohol drinking (Dick et al., 2007; Yeh et al., 2006). Having age-matched friends who regularly used alcohol was strongly associated with the adolescents' own use (Poelen et al., 2007). The mechanism reportedly mediating this effect is that adolescents with age-matched friends spend more time with each other, and the more time spent together would produce more shared experiences between the adolescent friends (Poelen et al., 2007; Urberg et al., 2003). Alcohol drinking appears to be enhanced by the quality of peer relationships in males, but not in females. The issue regarding differentiating between peers and friends has been raised, as this likely mediates some of the results observed in human adolescent research (Dick et al., 2007). It seems that females are more likely to be influenced by peers and perhaps the quality of peer relationship does not have as strong an influence in changing alcohol-drinking behavior, compared to males, given that females use alcohol more for psychological and emotional distress relief and males use alcohol for social bonding and social facilitation. Therefore, the differences in ethanol consumption obtained in experiments 1 and 2 are mediated by sex differences in social influences.

Social interaction is an important aspect of the demonstrator–observer paradigm because adolescent animals engage in distinct forms of social interaction, including play behaviors and social investigation (Varlinskaya et al., 2001). Enhanced ethanol intake was observed only at the 1.5 g/kg dose in adolescent rats using the demonstrator–observer paradigm, and not at a higher or lower dose in a familiar situation (Hunt et al., 2001). However, a higher dose of ethanol may be necessary for facilitation in social interaction in an unfamiliar environment (Varlinskaya & Spear, 2002). Specifically, social investigation dose-dependently increased in the unfamiliar test situation, but play behavior decreased (Varlinskaya & Spear, 2002). If conspecific demonstrators did engage in more social investigation and less play and social contact behavior with the unfamiliar age-matched observer, then the unfamiliar test situation may have produced a less salient social interaction session as compared to social interaction among familiar cagemates. Therefore, adolescent observers may not have engaged in the same level of social interaction and, therefore, were less likely to consume ethanol.

Previous research using the demonstrator–observer paradigm in adolescent rats to assess changes in alcohol-related behaviors has been conducted in both male and female rats using familiar cage-mates (Fernandez-Vidal & Molina, 2004; Hunt et al., 2001). When rats were given two-choice access to an ethanol or coffee solution after social interaction in the demonstrator–observer paradigm, males were reported to consume more ethanol than females, (Hunt et al., 2001). However, when given free access (Doremus et al., 2005) or limited access (Bergstrom et al., 2006) to ethanol, adolescent female rats consumed more ethanol than adolescent males. In the present set of experiments, when animals were allowed to socially interact with a familiar cage-mate, males and females consumed approximately equivalent levels of ethanol. However, in adolescent males and females that were allowed to socially interact with an unfamiliar conspecific, females consumed more ethanol than males, particularly when females socially interacted with an alcohol-intoxicated unfamiliar conspecific. Similar sex-based differences were observed in the present set of experiments, an effect contingent on familiarity of the alcohol-intoxicated demonstrator.

In humans, being surrounded by a regular drinker increased the likelihood of the adolescent to drink similarly in both age-matched regular drinking adolescent siblings and age-matched regular drinking friends in both males and females (Scholte et al., 2008). It is important to note in the present set of experiments that siblings composed the dyad in the familiar cagemate conditions and unrelated

age-matched animals composed the unfamiliar conspecific conditions. However, similar results have been observed in previous work using related (Hunt et al., 2001) and unrelated (Fernandez-Vidal & Molina, 2004) familiar cagemates. Specifically, Hunt et al. (2001) used adolescent siblings as the dyad and observed enhanced ethanol intake after social interaction with an alcohol-intoxicated peer, as was observed in the present set of experiments in both males and females. Fernandez-Vidal and Molina (2004) used unrelated adolescents as the dyad and familiarized the animals from PND 28 to the beginning of the experiment and observed that more time was spent investigating an alcohol odor after social interaction with an alcohol-intoxicated peer. Therefore, the results obtained in the familiar cagemate conditions are generalizable and the results obtained in the unfamiliar cage-mate conditions are interesting and should be investigated in future work, given the dramatic sex-based differences observed in those groups.

Unfamiliar and familiar mature (PND 90) demonstrators were equally able to increase diet preference in periadolescent (PND 42) observers (Galef et al., 1984). However, in Mongolian gerbils, there was no increase in diet preference among observers that were unfamiliar and unrelated to the demonstrator fed with the novel diet (Valsecchi et al., 1996). When observer rats were given a choice between a coffee-flavored and a vinegar-flavored solution in liquid form or as solid mash, observers preferred the same liquid or solid mash given to the demonstrator (Galef et al., 1984). Galef et al. (1984) indicated that the change in preference was therefore similar for solid food or liquid solutions. The was demonstrator–observer paradigm did not, however, influence changes in behavior similarly in adolescent observers after social interaction with an anesthetized adult demonstrator, in which an increase in diet preference was observed in adolescent observers (Galef & Stein, 1985). However, no changes in preference for an alcohol odor were observed in adolescent observers after social interaction with an anesthetized-alcohol-intoxicated demonstrator (Fernandez-Vidal & Molina, 2004). Social interaction behaviors, specifically play behavior, were reportedly higher in males as compared to female juvenile animals (Meaney & Stewart, 1981; Poole & Fish, 1976). Acute ethanol increased social interaction in adolescent rats (Varlinskaya et al., 2001) and produced social inhibition in adult rats (Varlinskaya & Spear, 2006). Using the conditioned place preference paradigm in males, social interaction with a peer was able to decrease the aversion observed when animals were conditioned with ethanol alone; an effect that was not investigated in females (Gauvin et al., 1994). Given the ethanol induces changes in behaviors primarily through its pharmacological actions, the social interaction that occurs between the adolescent observer and the adolescent alcohol-intoxicated demonstrator is different from that of social interaction with an adolescent non-intoxicated demonstrator. Given the demonstrator–observer paradigm has not been used with age-matched adolescent unfamiliar conspecific demonstrator–observer dyads, it is not entirely clear as to the reason why decreased voluntary ethanol intake was observed in adolescent male observers that socially interacted with unfamiliar age-matched alcohol-intoxicated conspecifics.

In the present set of experiments, all animals were pair-housed before access to ethanol overnight. The overnight access to ethanol was the first time the rats had been single-housed and also allowed access to ethanol. Both of these were novel situations for the adolescent observer. It is well noted that novelty preference increases during adolescence (Stansfield & Kirstein, 2006). It is possible that the levels of consumption observed in the present set of experiments may have been altered due to the conditions of the testing situation. However, it has been reported that animals pair-housed before the isolated ethanol access period consumed less ethanol than those individually housed before the isolated ethanol access period (Doremus et al., 2005). Therefore, the results obtained in the present set of experiments were likely not altered by the isolate-housing conditions during the ethanol access period.

Overall, the present results suggest adolescent males and females are sensitive to environmental conditions when socially interacting with an alcohol-intoxicated demonstrator. Alcohol's ability to induce social facilitation has been one of the most important reasons reported for initiation of alcohol use in human adolescents (Beck & Treiman, 1996; Beck et al., 1993; Smith et al., 1995). Additionally, selection and socialization of substance using peers also has a dramatic influence on alcohol use (Borsari & Carey, 2006). The social impact of peers seems to have a greater influence on drinking behaviors in males than females (Borsari & Carey, 2006; Martino et al., 2006; Miller & Prentice, 1996). Therefore, these factors may be some of the underlying conditions for the observed sex difference and social influence factors on ethanol consumption. Attempts to understand the underlying conditions in the initiation of alcohol use may help to prevent the possibility of prolonged use into adulthood. Future work should investigate the familiarity- and sex-related differences of social interaction by investigating different types of social interaction (i.e., play behavior, social investigation, or social contact) that may mediate the present differences observed.

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