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Regulation of Milk Intake After Exposure to Alcohol in Mothers' Milk

Julie A. Mennella
Monell Chemical Senses Center, Philadelphia, Pennsylvania

Abstract

Objective—Contrary to the folklore which claims that drinking alcohol during lactation benefits both mother and infant, previous research in our laboratory revealed that breastfed infants consumed significantly less milk during the immediate hours after their mothers' consumption of an alcoholic beverage. Because breastfed infants are clearly capable of regulating milk intake, the present study tested the hypothesis that infants would compensate for the diminished milk intake if their mothers then refrained from drinking alcohol.

Methods—A within-subjects design that controlled for time of day was implemented because of the great individual and daily variation in both milk composition and intake. To this end, 12 exclusively breastfed infants and their mothers were tested on 2 days separated by 1 week. Each woman drank a 0.3 g/kg dose of alcohol in orange juice on one testing day and orange juice alone on the other; the order was counterbalanced. The infants' behaviors were monitored for the next 16 hr, the first 4 hr of monitoring on each test day occurred at the Monell Center. The infants fed on demand and immediately before and after each feeding, infants were weighed without a change in clothing.

Results—Consistent with previous findings, infants consumed significantly less milk during the 4 hr immediately after exposure to alcohol in mothers' milk compared with the control condition. Compensatory increases in intake were then observed during the 8 to 16 hr after exposure when mothers refrained from drinking alcohol.

Conclusions—These findings demonstrate that short-term exposure to small amounts of alcohol in mothers' milk produces distinctive changes in the infants' patterns of feeding.

Keywords

Alcohol; Lactation; Infant; Breastmilk; Nutrition

The lore of many cultures relates that drinking alcohol during lactation benefits both mother and infant (Krebs, 1953; Mennella, 1999). Women in Mexico are encouraged to drink as much as 2 liters daily of a low alcoholic beverage made of fermented fruit juice (pulque) during pregnancy and lactation (Flores-Huerta et al., 1992), Indochinese women in California drink wine steeped with herbs (Fishman et al., 1988), whereas the magic elixir in Germany is malt beer (Walter, 1975). One-quarter of the lactating women surveyed in Philadelphia reported that a health professional encouraged them to drink alcohol to improve the quality and quantity of their milk, facilitate milk let-down, or help their babies get a good night's sleep (Mennella, in press). This percentage is remarkably similar to that reported in the late 1970s (see Dowdell, 1981).

Reprint requests: Julie A. Mennella, PhD, Monell Chemical Senses Center, 3500 Market Street, Philadelphia, PA 19104-3308; Fax: 215-898-2084; mennella@monell.org.

The claim that alcohol is a galactagogue is not accompanied by any controlled scientific evidence. On the contrary, research has demonstrated that human infants consumed approximately 20% *less* breast milk during the immediate hours after their mothers' consumption of an acute dose of alcohol (Mennella and Beauchamp, 1991, 1993), a finding that is consistent with several animal model studies (Subramanian and Abel, 1988; Swiatek et al., 1986; Vilaró et al., 1987). The observed decrease in milk intake was not the result of infants feeding for shorter periods of time after maternal alcohol consumption (Mennella and Beauchamp, 1991, 1993). Nor was it due to infants rejecting the altered flavor in their mothers' milk, which also resulted from maternal alcohol consumption (Mennella, 1997). Rather, maternal alcohol consumption slightly, but significantly, reduced the amount of milk produced without altering its caloric content (Mennella, 1998).

Because breastfed infants are clearly capable of regulating milk intake (Dewey and Lönnerdal, 1986; Matheny et al., 1990), the present study tested the hypothesis that they would compensate for the diminished milk intake that occurs after exposure to alcohol in mothers' milk if their mothers then refrained from drinking alcohol. A within-subjects design that controlled for time of day was implemented because of the great individual and daily variation in both milk composition and intake (Dewey and Lönnerdal, 1986; Dewey et al., 1991; Matheny et al., 1990, Neville et al., 1998).

METHODS

Subjects

Twelve, nonsmoking, lactating women (10 Caucasian, 2 African American), who were exclusively breastfeeding healthy infants and had consumed at least one alcoholic beverage during lactation, were recruited from ads in local newspapers and from Women, Infant and Children Centers throughout Philadelphia. The mothers (58.3% multiparous) were 27.8 ± 1.2 years, and their infants (8 girls, 4 boys) ranged in age from 1.8 to 5.0 months of age (mean = 3.1 ± 0.3 months). The weights and lengths of each infant fell within the 10th and 95th percentiles of published infant growth standards (Hamill et al., 1979). Three additional mother-infant pairs began testing but did not complete the study. Informed consent was obtained from each woman before testing. All procedures used in this study were approved by the Office of Regulatory Affairs at the University of Pennsylvania.

Mothers were interviewed and completed a series of questionnaires that elicited such information as the type of advice, if any, given to them about alcohol use during lactation. Using a time line follow-back questionnaire (Sokol et al., 1981), they also estimated the number, types and frequency of alcoholic beverages consumed during pregnancy and lactation. All mothers reported drinking very little during pregnancy (range = 0–4 alcoholic beverages per month; mean = 1.2 ± 0.3 drinks per month), and significantly increasing alcohol intake during lactation to, on average, 7.2 ± 1.9 alcoholic beverages per month [range = <1–20 drinks per month; paired $t(11df) = -3.39$; $p = 0.006$]. Approximately 41.7% of the mothers reported that they were advised to drink alcohol during lactation by a health professional (i.e., doctor, lactation consultant, midwife, nurse) to facilitate lactation and/or to help their babies sleep better, 16.6% were discouraged from drinking, whereas the remaining were not given any advice at all about drinking (41.7%).

Procedures

A within-subject design study that controlled for the time of day was implemented (Mennella and Beauchamp, 1991, 1993). Each mother-infant pair was tested at the Monell Chemical Senses Center on 2 days separated by 1 week. Mothers were instructed to refrain from drinking any alcoholic beverages during the 3 days preceding and the 2 days after each test day. The

mother and infant arrived at the Monell Center at approximately 9:30 AM, having last fed her infant at approximately the same time on each testing day [paired $t(11df) = -1.19$; $p = 0.26$]. After acclimatization to the room and personnel, each mother drank, in counterbalanced order, ethanol in orange juice (0.3 g/kg of body weight) on one test day and orange juice alone on the other (Mennella and Beauchamp, 1991, 1993). The beverage was consumed within 15 min as a 15% solution (vol/vol) in orange juice or an equal volume of orange juice alone. No effect of order was observed for any of the variables investigated.

For the next 4 hr, each infant was videotaped as they breastfed at the frequency customary for each mother-infant pair (Mennella and Beauchamp, 1991, 1993). The babies fed on demand and the mother chose which breast the baby suckled from first. The feeding terminated when the infant refused the breast on three consecutive occasions, using the criterion that the infant exhibited such behaviors as turning his or her head away from the breast, crying, becoming playful, or falling asleep. Immediately before and after each feeding, the baby was weighed, without a change in clothing, on an Acme Medical Pediatric Scale (San Leandro, CA), accurate to 1.0 g. The volume of milk consumed by the infant in milliliters was then estimated by dividing the weight of the milk consumed by 1.031, the specific gravity of mature human milk. Immediately after each feeding, the mothers asked whether they noticed any difference in their infants' behaviors, whether they thought their infants got enough milk, and whether they experienced a let-down. Mothers were not informed of the type of beverage consumed or how much milk their infants consumed during each test session.

Each mother-infant pair then immediately returned home and for at least the next 16 hr, the mother weighed her infant before and after each breastfeed on a pediatric scale identical to the one used at the test sessions at the Monell Center. Mothers were trained in these procedures several days prior to the start of the study when an investigator delivered a pediatric scale to the mothers' homes. This scale remained in the home until the end of the study. Each mother was taught how to use the scale and completed the exercise several times at home and then again at the Monell Center until it was consistently performed properly. Mothers were instructed to record the weight of the baby before and after each of the feeds, the time that the feeding occurred, and from which breast the infant fed. Phone contact was made with the mother to ensure compliance.

Statistical Analyses

Repeated Measures Analyses of Variance (ANOVA) were conducted to determine whether there were significant differences in the amount of milk consumed as a function of time since exposure in 4-hr blocks (0–4, 4–8, 8–12, and 12–16 hr post exposure) and experimental condition (control, alcohol). Significant effects in the ANOVA were probed by paired *t* tests. χ^2 analyses were performed to determine whether there were significant differences in the mothers' perception of their lactation performance or infants' behaviors on the two test days. All summary statistics reported in this article are expressed as means ± SEM, and all *p* values represent two-tailed tests, and the Yates' correction for continuity was applied to all chi square analyses.

Because this is a within-subject design study, relative scores based on data from individuals are more informative than group mean data (refer to Table 1). For each infant, we calculated a percent difference score by dividing the difference in each infant's response (i.e., milk intake, number of breastfeeds) after alcohol exposure when compared with the control session by his or her response on the control day: (alcohol-control)/(control)*100.

RESULTS

There was a significant interaction between the experimental condition (control, alcohol) and time since exposure for the amount of breast milk consumed by the infants [$F(3,33df) = 2.82$; $p = 0.05$]. Consistent with previous findings (Mennella and Beauchamp, 1991, 1993), infants consumed approximately 20% less breast milk (paired t ($11df$) = 2.35; $p = 0.04$; see Table 1) but breastfed similar number of times [paired $t(11df) = -0.00$; $p = 1.00$] during the first 4 hr after exposure to alcohol in mothers' milk when compared with the control condition. As shown in Table 1, they then compensated for this diminished intake during the 8 to 12 hr after exposure [paired $t(11df) = -2.13$; $p = 0.05$]. This compensation appears to be due, in part, to the increased number of breastfeedings that occurred during the 8- to 12-hr postexposure period [paired t ($11df$) = −2.24; $p = 0.04$].

There was no significant difference in the mothers' perceptions of various aspects of their infants' behaviors or their lactational performance under the two testing conditions. During the vast majority of the feeds on both testing days, mothers reported that they experienced a letdown during nursing ($\chi^2 = 0.21$, 1 df, p not significant), did not notice any difference in their infants' behaviors ($\chi^2 = 0.07$, 1 df, p not significant), and believed their infants had consumed enough milk ($\chi^2 = 0.06$, 1 df, p not significant).

As a preliminary step in determining whether maternal beliefs impacted upon the infants' responses to alcohol exposure, an ANOVA was conducted to determine whether there were differences between infants whose mothers were encouraged to drink alcohol during lactation by a health professional ($n = 5$) versus those whose mothers received no advice at all ($n = 5$). There were no significant effects between these two groups on the infants' responses to alcohol for any of the measures studied [milk intake: $F(1,8df) = 0.24$; $p = 0.64$; number of feeds: F ($1,8df$) = 0.02; $p = 0.88$], nor were there any significant interaction effects between these two groups and experimental conditions or time since exposure (all ps >0.10).

DISCUSSION

The present study confirmed previous findings (Mennella and Beauchamp, 1991, 1993) that milk intake is diminished in the short term after exposure to alcohol in mothers' milk. This reduction in milk intake was not due to infants feeding less because there was no significant difference in the number of breastfeeds that occurred during the 4 hr after alcohol exposure when compared with the control condition. The study also demonstrated, however, that infants then compensated for this reduction in milk intake when their mothers refrained from drinking any additional alcohol. This compensation appears to be due, in part, to the increased number of breastfeedings that occurred during the 8 to 12 hr post exposure. The findings were remarkably similar to those observed for the deficits in active sleep that also occur during the immediate hours after exposure to alcohol in mothers' milk (Mennella and Garcia, unpublished; Mennella and Gerrish, 1998). That is, previous research demonstrated that infants exhibited a 25% decrease in the amount of time spent in active sleep during the 3.5 hr after exposure (Mennella and Gerrish, 1998). If mothers then refrained from drinking, the infants experienced an active sleep rebound during the next 20.5 hr (Mennella and Garcia, unpublished). Recall that the mothers in the present study also refrained from drinking alcohol during this time period. Whether similar findings would be observed if mothers continued to drink is unknown.

Infant feeding behaviors can be influenced by a variety of environmental and physiologic factors affecting both members of the mother-infant dyad. The present study aimed to experimentally control for a variety of such factors. For example, each of the test sessions occurred at the same time of day and testing occurred in a private, quiet room. The infants fed

on demand and determined when the feed terminated. Moreover, mothers did not notice any difference in their infants' behaviors or their experience of the let-down reflex. Although possible, it seems unlikely that the change in the patterning of breastfeeding was due to changes in the infants' interaction with their mother. Rather, it appears that alcohol consumption by lactating mothers had an effect, albeit subtle, on the amount of milk consumed by their infants, which was due, in part, to a reduction in the amount of milk available to the infants (Mennella, 1998).

Because the mothers in the present study drank very little during both pregnancy and lactation, we do not know whether infants who are frequently exposed to alcohol in mothers' milk would experience growth deficits over the long term. However, the findings from two epidemiologic studies suggested that this might not be the case. One set of studies focused on nursing women living in central Mexico (Flores-Huerta et al., 1992; Villalpando et al., 1993). Folklore in this community relates that pulque, a low (3%) alcoholic beverage made from the fermented juice of *Agave atrovirens*, is a galactagogue and women are encouraged to drink as much as 2 liters of this beverage daily during lactation. Although pulque can theoretically provide an additional energy load of 400–800 kcal to the women, there was no significant difference in their infants' weight at 3 or 6 months when compared with the control infants of non-drinking, breastfeeding mothers.

The other study consisted of approximately 400 women who were members of a health maintenance organization in Seattle (Little et al., 1989). Although women who breast fed were less likely to smoke cigarettes or marijuana or use cocaine, their "regular" drinking patterns at 1 and 3 months postpartum were not significantly different from those who had never breastfed their infants, although they were less likely to report occasional binges of heavy drinking. Approximately 10% of this sample of lactating women reported drinking two or more alcoholic beverages daily. Of interest here was the report that the weights, heights, and body mass indices of their infants at 1 year were not significantly different from similarly aged infants whose lactating mothers drank less (Little et al., 1989, 1994). However, it is interesting to note that breastfeeding women who drank more heavily during lactation had higher nutrient intakes than those who did not (Little et al., 1994).

To be sure, we do not know whether mothers who drink alcohol are more likely to complement their infants' diets with solid foods at an earlier age. Nor do we know whether long-term alcohol consumption and perhaps alterations in nutrient intake (Little et al., 1994) affect the caloric content of the milk. Animal model studies demonstrated that *chronic* ethanol consumption during lactation resulted in significant reductions in milk yield (Vilaró et al., 1987) as well as an altered fatty acid profile of individual phospholipids when compared with control dams (Heil et al., 1999). Whether such effects were due to a direct consequence of prolonged drinking or malnutrition is not known. Nor do we know whether chronic alcohol consumption in humans has similar effects on the fatty acid profile of human milk.

Although the amount of alcohol ingested in breast milk is a minute fraction of that consumed by the mother (Mennella and Beauchamp, 1991, 1993), the present study provides additional support for the hypothesis that acute alcohol exposure impacts upon the infants' behaviors in the short term and raises serious doubts about the validity of the folklore that encourages women to drink during lactation. Perhaps one reason for the persistence of the folklore that occasional drinking by the nursing mother enhances breastfeeding (Falkner, 1987; Fishman et al., 1988; Flores-Huerta et al., 1992; Grossman, 1987; Krebs, 1953; Walter, 1975) is that the infants feed more later to compensate for the alcohol-induced deficits in their mothers' milk production (Mennella, 1998). The effects are subtle and remarkably similar to the changes in active sleep that follow exposure to alcohol in mothers' milk (Mennella and Garcia, unpublished; Mennella

and Gerrish, 1998). These findings highlight the infants' resiliency in modulating their behaviors in response to acute alcohol exposure and provide an obvious scope for future studies.

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Table 1

Infants' Feeding Behaviors during the Hours After Exposure to Alcohol in Mothers' Milk[a]

	Type of beverage consumed by lactating mothers		
Behavior: hours post exposure	**Orange juice alone (Control Condition)**	**Orange juice + ethanol (ROH Condition)**	**Percent difference[b] (ROH-Control)/Control★100)**
Milk intake (ml)			
0–4	200.6 ± 24.4	147.4 ± 17.7★	−21.1 ± 8.3
4–8	138.7 ± 18.1	120.2 ± 18.9	13.3 ± 28.3
8–12	117.8 ± 16.9	149.1 ± 17.4★	38.0 ± 16.1
12–16	70.8 ± 16.7	77.6 ± 13.3	24.7 ± 34.7
Total	527.8 ± 37.7	494.3 ± 46.9	−7.3 ± 6.4
Number of breastfeeds			
0–4	2.4 ± 0.2	2.4 ± 0.3	5.5 ± 14.9
4–8	2.3 ± 0.3	2.0 ± 0.2	6.9 ± 20.3
8–12	1.5 ± 0.2	2.1 ± 0.3★	45.8 ± 19.9
12–16	1.4 ± 0.3	1.3 ± 0.1	8.3 ± 17.3
Total	7.6 ± 0.6	7.8 ± 0.7	6.3 ± 10.3

[a] A within-subjects design study in which each of 12 infants was observed for 16 hr after exposure to alcohol in mothers' milk on one testing day and mothers' milk alone on another.

[b] Percent difference scores were calculated from each infant's individual data, not from the group means (see text).

★ $p < 0.05$ when compared with the control condition.