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Low Alcohol Consumption: Maternal Functioning and offspring Development

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LOW ALCOHOL CONSUMPTION: MATERNAL FUNCTIONING AND OFFSPRING DEVELOPMENT

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ABSTRACT

While chronic alcoholism is a growing concern for human prenatal care, adverse effects may occur at lower levels of alcohol consumption more common in the general population. Alcohol research has not systematically employed low levels of maternal alcohol consumption. Therefore, the present experiment examined the extent to which low levels of maternal alcohol consumption, before, during, and following pregnancy effect maternal care and offspring revelopment. Three treatment groups were employed: two alcohol consumption groups and a non-alcohol control group. The alcohol dams received a 8% ethanol solution v/v with tap water. One alcohol group received alcohol before, during, and following pregnancy. The other alcohol group received alcohol only before and following pregnancy. Every other experimental litter was cross-fostered with a control litter and maternal observations were conducted on Post-partum Days 2, 5, and 8. The relatively low intake of ethanol had an adverse effect on normal maternal functioning and offspring maturation. Chronic intake of low levels of alcohol significantly reduced birth and post-natal weights. The effects of partial alcohol consumption were not as dramatic as those for the chronic a condition, however the trend was similar.

Introduction

The developmental deficits noted in the children of chronic alcoholic women known collectively as the fetal alcohol syndrome (FAS), (Jones & Smith, 1973), have received considerable attention in the psychological literature. The FAS includes intrauterine and postnatal growth retardation, microcephaly, central nervous system dysfunctions, and craniofacial dysmorphology (Streissguth, Landesman Dwyer, Martin, Smith, 1980).

Facial malformations are characterized by: narrow forehead; flat midface; narrow palpebral fissures; short nose; and diminished or absent infranasal border (Streissguth, 1978; Ouellette, Rosett, & Weiner, 1977; Streissguth, et al., 1980). Eye abnormalities include ptosis (drooping eyes) and strabismus (crossed eyes). The facial characteristics of FAS are as specific as those of Down's syndrome and have been recognized in FAS children of all races (Streissguth, et al., 1980).

The growth retardation typical of FAS has its onset during the prenatal period and postnatal growth catch-up generally does not occur. Children diagnosed as possessing FAS are generally below the third percentile in height, weight, and head circumference (Jones, et al., 1973; Streissguth, 1977). Joint anomalies and minor genital abnormalities have also been recognized in FAS children (Streissguth, et al., 1980). In addition to the various physical malformations, significant intellectual dysfunctions are the most frequent problem observed in surviving FAS children. Mental deficiencies ranging from borderline to severe retardation have been noted in these children with an average IQ of 65 (Jones, Smith, Streissguth, & Myrianthopoulous, 1974; Streissguth, 1977, 1978). In a longitudinal study conducted by Jones et, al. (1974), mental impairments were more severe at age 7 than at age 4. The degree of mental retardation was directly related to the severity of physical malformation. However, mental deficiencies have also been noted in the children of heavy drinkers in the absence of visible physical deformity (Streissguth, 1977).

Behaviorally, infants diagnosed as FAS are often classified as hyperactive. These infants tend to be tremulous, jittery, and irritable. While some researchers have reported these symptoms to be the direct result of alcohol withdrawal, the persistance of these symptoms suggests it to be a characteristic of the syndrome resulting from central nervous system damage (Streissguth, 1978). Hyperactivity in FAS has been associated with attentional deficits, distractibility, impulsiveness, excitability, learning disabilities and displinary problems in later development (Abel, 1981).

Additional behavioral deficits of FAS children include atypical sleeping head orientation (Landesman-Dwyer, Keller, & Streissguth, 1978), weak suckling ability (Martin, Martin, Streissguth, & Lund, 1979), decreased alertness (Landesman-Dwyer, et al., 1978), poor habituation (Streissguth, Barr, & Martin, 1983), increased hand to mouth stimulation (Streissguth, et al., 1983), low arousal and motor incoordination (Streissguth, 1980). Sleep disorders are frequently reported in FAS children. Heavy maternal alcohol consumption has been associated with a disturbance of sleep/awake state distribution. Infants of heavy drinkers tend to sleep less than infants of non-drinkers and also exhibit greater general body movements while sleeping (Rosett, Snyder, Lee, Cook, Weiner & Gould, 1979). Abnormal EEG patterns have been reported in infants of heavy drinkers with the effects lasting for as long as six weeks following birth (Landesman-Dwyer, et al., 1978).

Chronic alcoholism has been associated with several other factors that increase reproductive risks, such as spontaneous abortion, which makes assessment of the direct effects of alcohol consumption difficult in humans. Another contributing factor is malnutrition. Most alcoholics obtain the majority of their calories from alcohol which provides no other nurtritional value. Therefore, the developing fetus lacks the nutritants needed for prenatal growth. In addtion, increased cigarette smoking is associated with heavy drinking. Maternal smoking and drinking have been related to reduced birth weights and increased incidence of spontaneous abortions (Harlap & Shiono, 1980). Maternal smoking has also been found to decrease the amount of oxygen avaliable to the developing fetus which may result in reduced head circumference and possible brain abnormalities. Minor physical malformations such as cleft palate and lip have also been associated with maternal smoking (Stechler & Halton, 1982). Alcohol and nicotine consumption during pregnancy have also been associated with impaired neonatal performance. This interaction, however, was not predictable from the consumption of alcohol or nicotine separately (Martin, Martin, Lund, & Streissguth, 1977).

<u>Animal Models</u>

The major body of evidence implicating alcohol as a teratogen comes from experiments with laboratory animals. Animal models provide important information concerning maternal alcohol consumption by allowing for the control of confounding variables such as nicotine. Many of the deficits associated with FAS are thought to be a direct result of exposure to high levels of alcohol in utero. Consistent with this explanation is the observation that in laboratory mice, intrauterine exposure alone can produce the facial malformations typical of FAS at birth (Sulik, Johnson, & Webb, 1981; Randall, Taylor, & Walker, 1977). Impaired brain growth and malformation has also been found in animal studies (Diaz & Samson, 1980; Bauer-Moffett & Altman, 1976). In addition, intrauterine exposure to large and moderate dosages of alcohol has been associated with fetal reabsorption, reduced litter-size and birth rate (Baer & Crumpacker, 1977; Tze & Lee, 1975; Pilstrom & Keissling, 1967; Martin, Martin, Sigman, & Radow, 1977).

Moderate alcohol intake by pregnant rats may not produce gross physical malformations, but such doses have been reported to produce several behavioral deficits. These include increased offspring emotionality, reduced response inhibition, impaired shock-avoidance performance and hyperactivity (Abel, 1975; Riely, Lochry & Shapiro, 1979; Bond & DiGiusto, 1977; Martin, et. al., 1977). These findings are consistent with many of the behavioral deficits noted in the children of heavy drinkers who do not manifest the physical characteristics of FAS (Streissguth, et. al., 1980).

While intrauterine exposure to large and moderate dosages of alcohol has been associated with physical malformation and increased mortality, the negative impact of alcohol continues after birth. During the post-partum period, fewer pups survive and the body weight gain of the pups is retarded (Martin, et. al., 1977). However, if alcohol born pups are paired with control (water-consuming) mothers, they survive and gain weight at levels similar to those of control pups (Pilstrom & Keissling, 1967). Therefore, the lowered survival rate and retarded growth of the pups born to alcoholic mothers appears to be due to the direct effects of alcohol on the mothers during the post-partum period.

These studies suggest that post-partum factors may play a critical role in the growth and survival of alcohol exposed young. One reason for the increased mortality of pups during the post-partum period might be malnutrition. High alcohol consumption depresses the milk-ejection reflex thru inhibition of oxytocin (Fuchs, 1979), and reduces the milk available to the pups. Another possible factor is impaired parental care. Of all the exogenous factors controlling development in altrical young, parental behavior is the most critical (Rosenblatt & Lehrman, 1963). If alcohol affects parental behavior, there may be developmental consequences which would add to the deficits caused directly by alcohol exposure.

There is laboratory evidence suggesting that maternal-young interactions are affected by alcohol treatment and that maternal care may be an important mediating factor. In rats, maternal alcohol consumption alters care-giving behaviors. There is increased cannablism (Baer & Crumpacker, 1977), increased nest time (Bond, 1979), decreased nest building, increased retrival latencies (DaSilva, Riberio, Masur, 1979), and decreased contact with the young (Bond, 1981). In addition, a recent study showed a significant correlation between retreival behavior and pup survival. Pups that were not retreived on the first maternal observation did not survive past post-partum Day 7 (Weizenbaum, Herrman, Goff, Hartigan, 1983). Since pup physiology and behavior are quite reactive to maternal stimuli (Rosenblatt, et al., 1963), these findings suggest a maternal care role in the postnatal expression of developmental deficits found in alcohol exposed young.

While chronic alcoholism is a growing concern for human prenatal care, adverse effects may occur at levels of alcohol consumption more common in the general population than the high levels associated with FAS. In humans, chronic exposure to low levels of alcohol (approximately two ounces of alcohol per day) has been associated with reduced birth weights (Streissguth, 1977). Mothers are able to metabolize this dosage quickly (Riely, et al., 1979) and it is below the level needed for intoxication. The fetus (who receives alcohol freely across the placenta), however, is deficient in the alcohol dehydrogenase needed to remove alcohol (Ho et al., 1972) and is therefore at risk with alcohol levels that have little or no effect on the mother.

Recent research suggests that low levels of alcohol, below the legal intoxication limits, can disrupt the chromosomes of an unfertilized mouse egg (Kaufman, 1983) so that preconception alcohol exposure might affect the offspring. Consistent with this report is the observation that acute exposure to low levels of alcohol prior to mating has persistent effects upon litter size and maternal care (Herrman, 1982). Earlier studies found that acute alcohol exposure, by intraperitoneal injections, following parturition also impaired maternal care (Weizenbaum, et al., 1983). Futher, more recent research has demonstrated that maternal care is sensitive to preconception injections of alcohol with greater disruptions occuring when additional ethanol is injected during lactation (Herrman, 1983).

Alcohol research has not systematically employed low levels of maternal alcohol consumption and the effects of pre-conception alcohol consumption have received little attention. Therefore, the present experiment investigated the extent to which low levels of alcohol consumption, before, during, and following pregnancy affect maternal care and offspring growth and survival. While maternal exposure to large dosages of alcohol directly disrupts the developing embryo, smaller dosages produce no physical deficits. Therefore, sensitive measures of maternal behavior and pup development are required to test the effects of low levels of alcohol consumption. The primary dependent measures are an assessment of the mother's ability to care for the young and the subsequent maturation and development of the young.

Method

Subjects

The subjects were 36 nulliparious, Holtzman rats, approximately 70 days old at the start of the experiment. A room temperature of 75 F and a 14/10 hour reversed light/dark cycle was maintained for the duration of the experiment.

Procedure

Three treatment groups were employed: Two alcohol consumption groups and a non-alcohol control group. All experimental dams received a 8% ethanol solution (8% by volume with tap water) as the only source of fluid. This solution produces no signs of motor impairment in mature females (Herrman, 1983) and is roughly comparable metabollically to that of people considered moderate or 'social' drinkers (taking into account that the rat metabolizes alcohol 1-2 times quicker than humans (Martin, et al., 1977)). A two week adaptation period to the drinking solution was permitted prior to mating. Following confirmed mating, one experimental group terminated alcohol consumption until parturition at which time alcohol consumption resumed until post-partum Day 14. This experimental group is modeled after human females who discontinued drinking on discovery of their pregnancy and then resumed drinking after birth. The remaining group of alcohol dams received alcohol throughout the gestation and lactation period in order to examine the effects of chronic exposure to low levels of alcohol during pregnancy and throughout nursing. Fluid consumption was measured daily.

<u>Breeding</u>. Begining on Day 17, vaginal smears were taken

daily. On the evening of functional proestrus, each female was individually paired with a proven male. Cages were checked daily for the presence of sperm plugs. The presence of either sperm in the vaginal tract or a a sperm plug marked Day 1 of pregnancy. On Day 16 of pregnancy, each female was placed in a individual maternity tub (9 X 18 X 8) with a screen lid which was provided with wood shavings as bedding material.

On post-partum Day 1 (defined as 24 hours following parturition) each litter was culled to 6 pups and every other experimental litter was cross-fostered with a control litter. This cross fostering technique was employed to isolate the post partum contribution of the maternal alcohol consumption from the contribution of the prenatal alcohol exposure of the pups. In addition, this procedure allowed one separate measurement of the effects of the alcohol treatment on both the mothers and the pups. The overall design resulted in seven groups as shown in Table 1. Mother and young were weighed daily until post-partum Day 14. Measures of pup development included day of ear flap uncurling and eye opening.

Maternal Observations. There were three sets of observations of maternal behavior. The first test was conducted on post-partum Day 2, the second on post-partum Day 5, and the third on post-partum Day 8. Observations were recorded mid-way during the daily light phase since the mean time spent with the young is at its peak during this time (Grota & Ader, 1974). Each maternal test lasted for a 15 minute period.

On the day of the maternal test, the dam was removed from the home cage and placed in a holding cage for a 5 minute period. The pups were then removed from the nest and scattered in the corner diagonally opposite the orginal nest site. The former nest site was then leveled and a low intensity heat lamp was placed over the pups. One minute before the dam was returned to the home cage, one pup was hidden under the nest material.

The latency to retrieve the first pup, the last pup, and the hidden pup was recorded. In addition, the frequency and duration of the following behaviors were recorded: a) dam in nest; b) active or passive nursing of pups; c) licking pups; d) contact with pups (other than licking or nursing); e) self-regulatory behaviors such as eating, drinking, and grooming and g) maternal inactivity. A microcomputer, programmed to time and record a number of different events keyed in by the experimenter was used to record maternal activity.

Results

Design and Analysis

The effect of alcohol was assessed by physical measures of dams, pup development, and maternal behavior. Mean values for all measures across days are given in Appendix A. Physical measures of the dams were analyzed using one-way ANOVAs. Data for the control (C) group were compared separately to the alcohol-all (AA) group and alcohol-partial (AP) group as shown in Table 1. Two sets of 2 (alcohol) X 2 (cross-fostering) analysis of variance were performed, one for the alcohol-all comparison and the other for the alcohol-partial comparison, with repeated measures (Post-partum day) on the maternal data. Similarly, 2 (alcohol) X 2 (cross-fostering) ANOVAs, without repeated measures, were performed on the pup development variables. Analysis of offspring data were performed using litter means.

Physical Measures

Ethanol Consumption. The mean daily intake of ethanol ingested during the two week adaptation period was 1.26 g/kg/day, 1.33 g/kg/day during gestation, and 2.54 g/kg/day thoughout the nursing period. Control dams ingested more fluid than subjects receiving alcohol thoughout the experiment. A depression in fluid intake by alcohol consuming animals is expected because of a reduction in food intake due to the caloric content of ethanol (ref).

Length of Gestation. A one-way analysis of variance on the length of gestation did not indicate a significant difference (F <1) among groups. The means for the groups were: AA=22.8, AP=23.1, and C=22.5.

Maternal Weight Gain. Maternal weight gain was slightly, but not significantly ($F < 1$), lower for alcohol-all females (M =81.8 g) than for alcohol-partial females (M =89.7 g) and for control females (M =88.7 g).

Litter Size at Birth. The one-way analysis of variance on the number of live offspring born per litter did not indicate a significant difference among groups ($F < 1$). The mean number of live pups born from alcohol-all dams was 12.7, from the alcohol-partial dams 12.7, and 12.9 from control females.

Birth Weights. At birth, the alcohol-all offspring (M =43.6) weighed less than those of control offspring (M =48.3), F (1,21)=10.01, p <.05. The control group (M =48.3) was not significantly different from the alcohol-partial group (M =46.8), F (1,17)=1.53 p >.20, and C (M =48.8).

Developmental Measures

Postnatal Weight Gain. There was a significant difference between alcohol-all born offspring and control born offspring across post-partum Days 2, 5, and 8 (F (1,21)=8.10, p <.05). Alcohol-all born litters continued to weigh less than control-born litters even when cross-fostered with control dams. Mean litter weights are presented in Figure 1.

In the alcohol-partial/control comparison there was a significant interaction (F (1,17)=6.57, p <.05) for alcohol-partial born litters. Alcohol-partial offspring crossfostered with control dams weighed significantly more (M =145.26) than alcohol-partial pups with alcohol-partial dams (M

=113 as shown in Figure 2). There were no differences between control born litters, regardless of crossfostering.

Ear-flap Uncurling. Approximately 87% of the control offspring and 66% of the alcohol-all offspring had uncurled pinnae by post-partum Day 2. The 2 X 2 analysis of variance for the alcohol-all comparison produced a significant interaction between groups for time of ear-flap uncurling AA(M =3.0), C(M =2.1), $F_{(1,21)}=4.12$, $p < .05$. An examination of the means suggests that the interaction was due to the post-partum alcohol intake of the dam and the prenatal alcohol exposure of the pup, resulting in a marked delay in ear uncurling for that group. This interaction did not occur in the alcohol-partial analysis (=2.2) $F_{(1,17)}$, $p > .05$.

Eye Opening. Eyes in the rat normally open between post-partum days 14-17 (Farris, 1949). Open eye was defined as a full aperture rather than merely a slit. There was a significant interaction between groups for time of eye opening. ($F_{(1,21)}=5.44$, $p < .05$, AA/AA(M =15.0),C/C(M =14.4), C/AA(M =14.83), AA/C(M =14.16)). The cell means suggest that the delay in eye opening resulted from the combination of mother′s alcohol level and the prenatal alcohol exposure of the offspring. An interesting result is that cross-fostering resulted in earlier eye opening for alcohol-all offspring reared by control dams (C/AA(M =14.8)). There was also a significant interaction in eye opening for alcohol-parital/control comparison: AP pups reared by control dams (M =13.7, $F_{(1,17)}=5,29$, $p < .05$) had earlier eye opening compared to other groups.

Maternal Behavior

Pup Retrieval. Alcohol consumption during lactation increased the latency to discover the hidden pup as shown in Table 2. Alcohol-all dams took longer than controls to find the hidden pup on all days of maternal observation (F (1,21)=38.58, p <.001). There was also a significant interaction between maternal treatment and pup condition such that AA dams paired with control pups took the longest to find the hidden pup (F (1,21)=6.84, p <.05). This pattern was also significant for the alcohol-partial dams F (1,17)=29.40 p <.05.

The mean times for total retrieval are reported in Table 3. The total time needed to retreive all pups was again retarded for the alcohol-all dams (F (1,21)=15.99 p <.05) and for the alcohol-partial dams (F (1,17)=17.11 p <.05) as compared to the control group.

In support of the retreival data, the alcohol-all dams had significantly fewer pups in the nest during the 15 minute maternal observation (M =3.4) than did control dams (M =5.4), F (1,21)=12.51, p <.05. as well as 15 minutes following the maternal observation (F (1,21)=18.58, p <.05, AA(M =4.9) and C(M =5.9)). Alcohol-partial dams also had significantly fewer pups in the nest during (M =4.3) and following (M =5) the maternal observation than did the controls F (1,17)=8.90, p <.05 and F (2,34)=10.19, p <.05 (M =5.5 and 6) respectively).

Additional Measures. A pattern of what was defined as ′disorganized′ retrieval was observed in the alcohol consuming dams. The retrieval was disorganized in the sense that the pups were either suddenly dropped by the dam or returned to the orginal location. The pups were rarely all retieved to the same location. 'Disorganized' retrieval was observed in 857% of the alcohol dams and only 26.3% of the control dams. ($\underline{x}$ =16.33, $\underline{p}$ < .05). Table 4 shows the mean values for the measures of maternal behavior.

The number of visits to the nest was significantly reduced for the alcohol-all and alcohol-partial dams. In addition, The mean and total time spent in the nest was significantly reduced in both maternal alcohol groups $\underline{F}$ (1,21)=6.17, $\underline{p}$ <.05 (alcohol-all) and $\underline{F}$ (1,17)=11.85, $\underline{p}$ <.05 (alcohol-partial).

As compared to control dams, alcohol-partial dams spent significantly less time in general contact with their young ($\underline{F}$ (1,17)=18.79, $\underline{p}$ <.05) and the mean time in contact was also significantly less ($\underline{F}$ (1,17)=28.78, $\underline{p}$ <.05). Only the total time in contact with the young was significantly reduced in the alcohol-all dams ($\underline{F}$ (1,21)=24.92, $\underline{p}$ <.05). Licking pups was significantly reduced for the alcohol-all dams on all three measures (frequency, mean duration and total time) when compared to control dams $\underline{F}$ (1,21)=19.35, $\underline{p}$ <.05, $\underline{F}$ (1,21)=16.91, $\underline{p}$ <.05, and $\underline{F}$ (1,21)=11.89, $\underline{p}$ <.05 respectively.

Duration of time spent nest building was significantly reduced in the alcohol-all dams ($\underline{F}$ (1,21)=9.34, $\underline{p}$ <.05) but not for the alcohol-partial dams.

The reduced level of maternal behavior observed in the alcohol dams did not appear to be solely due to alcohol having a general depressant effect on motivated behaviors. Alcohol dams were as likely to perform non-maternal, self-directed activity as control dams (All means for general behaviors are presented in Table 5). In fact, both groups of alcohol females spent significantly more time in exploratory behavior than control females $\underline{F}$ $(1,21)=4.59$, $\underline{p} < .05$ (alcohol-all dams) and $\underline{F}$ $(1,17)=5.03$, $\underline{p} < .05$ (alcohol-partial dams). Alcohol dams spent significantly more time in self-directed behaviors such as grooming than controls $\underline{F}$ $(2,42)=5.29$, $\underline{p} < .05$ for alcohol-all dams and $\underline{F}$ $(1,17)=4.47$, $\underline{p} < .05$ for alcohol-partial dams.

Discussion

The findings of the present study clearly demonstrate that a relatively low intake of ethanol has a disruptive effect on normal maternal functioning and offspring development. A disorganized pattern of maternal care was observed in all dams receiving ethanol during the laction period. This disorganized pattern of maternal care was evidenced by adequate latencies to begin maternal care, but followed by a failure to complete these maternal tasks. Futhermore, chronic intake of low amounts of alcohol (before, during, and following pregnancy) significantly reduced birth and post-natal pup weights. The alcohol-partial group which recieved alcohol prior to and following pregnancy, also show impaired pup growth. Although the effects for the alcohol-partial (AP) group were not as dramatic as those of the alcohol-all (AA) condition, the trend was similar. Thus, even in the absence of intrauterine alcohol exposure, being cared for by a alcohol consuming mother significantly impaired offspring development.

The disorganized pattern of maternal behaviors was most clearly seen in the pup retrieval data. Alcohol consuming dams did not take significantly longer than controls to retrieve the first pup, which suggests that pup stimuli were sufficient to initate retrieval behaviors. However, the alcohol dams took significantly longer to locate the hidden offspring and consequently longer to retrieve the entire litter. These findings suggest that the alcohol dams were initally capable of retrieval behaviors, but were either incapable or readily distracted from completing the task.

A persistent pattern of incomplete behaviors was also indicated by the nest building data. The time spent in nest building activities was greatly reduced in the alcohol groups. This finding is consistent with an earlier study using a higher level of ingested alcohol. In that study, ethanol treated dams spent significantly less time in nest-building behaviors and retrieved fewer pups than controls (Da Silva, et al., 1979). In the present study, the number of pups retrieved was also reduced for alcohol consuming dams as indicated by fewer pups in the nest during the maternal observation and within 15 minutes following the observation. Thus, even within a 30 minute period the alcohol dams were incapable of completing the set of behaviors.

The deficits observed in maternal care appear to be due to the direct effect of ethanol on the dams. The cross-fostering technique was employed to isolate the post-partum contribution of maternal alcohol consumption from the contribution of the prenatal alcohol exposure of the pups. Even when control pups were paired with alcohol dams, maternal care was depressed. However, the most serious deficits in maternal care were observed in the AA mother/AA pup condition.

The deficits in maternal care do not appear to be a function of incompetent motor functioning. All pups survived until weaning which indicates that the alcohol dams were providing at least minimally adequate care. In addition, during the maternal observations all alcohol dams spent significantly more time in exploratory and self-directed behaviors than controls. The time spent in these behaviors exceeded the time spent in pup oriented behaviors for the alcohol dams. The observed pattern of disorganized maternal care in alcohol dams does not appear to be mediated by a lack of pup induced stimuli. This conclusion is drawn from the finding that maternal care was not depressed in any of the control conditions regardless of the prenatal condition of the pup. In contrast, maternal care was depressed in alcohol dams even when paired with control offspring.

The results of this experiment indicate that maternal behavior may be a critical factor in postnatal developmental deficits associated with alcohol consumption. Both the AA and AP groups show that maternal care is affected by post-partum alcohol consumption. These results agree with a previous study in which maternal care was depressed by acute exposure to i.p. injections of ethanol prior to and following pregnancy (Herrman, 1983). In addition, a recent study reported minimal effects when low dosages of ethanol were administered postnatally to rat pups. There were no reported differences in behavioral or neuroendocrine respones between pups that recieved ethanol (1.2/kg) directly and controls (Sonderegger, Calmes, Corbitt, & Zimmermann, 1982). These findings are in agreement with the present study which suggests that impaired maternal care is a critical factor in the postnatal developmental deficits associated with even low levels of alcohol consumption.

Disorganized maternal care seemed to affect pup development, especially in the AA mother/AA pup condtion. The ear flap uncurling data, in which the AA mother/ AA pup were more retarded than alcohol cross-fostered or alcohol-partial offspring suggests that ethanol may have a combinational effect on both the mother and young. This conclusion is based on the observation that AA offfspring cross-fostered with control dams did not show a delayed ear flap uncurling. A similar trend was observed in the eye opening data. AA mother/AA pup group showed a significant delay in eye opening compared to all other conditions. An interesting result, however, was that AP born pups paired with control dams had opened eyes at an earlier date than the other groups.

That gross malnutrition did not result from alcohol consumption was indicated by the following: pregnant rats that received ethanol exhibited weight gain during gestation similar to control females; gestation lengths did not differ significantly across groups which indicates that the alcohol dosage employed was low enough not to produce prolonged gestations; and no significant differences were found in the number of live offspring born across groups. Finally, no gross physical malformations were observed in any of the alcohol-born offspring. In combination, these results indicate that the alcohol dosaged employed was low enough not to produce any overt signs of impairment.

Post-natal weight gain was also reduced for the AA born offspring. AA pups paired with AA dams continued to weigh less than control born offspring and weighed slightly less than AA pups paired with control dams. This retarded weight gain could account for the delay in ear flap uncurling and eye opening in the AA mother/AA pup condtion. In contrast, AP pups paired with control dams weighed significantly more than AP pups paired with AP dams on post-partum day 8. These smaller pups might have nursed more strongly or otherwise served as a more powerful stimuli for the control dams. This weight gain might account for the earlier eye opening in this group.

A possible explanation for the reduction in weight gain of alcohol-born pups is that offspring exposed to higher doses of ethanol prenatally take longer than controls to attach to the nipple (Riley, Bunis, & Greenfeld, 1983). Although the alcohol dosage in the present study was low enough not to cause any signs of physical impairment, it may be that even small amounts of ethanol predispose the offspring to weak suckling. Pups exposed to alcohol prenatally, therefore, might nurse inadequately or spend less time in actual nursing resulting in reduced pup weight. These findings are in agreement with clinical observations of poorer suckling behavior in human neonates exposed to alcohol (Stressiguth, et al., 1981).

While the present study did not investigate the effects of alcohol exposure on offspring emotionality and cognitive growth, it is possible that impaired maternal care could lead to behavioral anomilies later in development.

Maternal care differs in detail between rats and humans, but not in its importance to the normal physical, emotional and intellectual development of the young. Given the relatively greater role of maternal-infant interactions in primates (Harlow, 1971), factors that impair maternal care in the rat would be expected to have an even greater impact in humans. In light of the present results, it would be reasonable to assume that moderate alcohol consumption by humans might also impair maternal-infant interactions. In humans, the effects of moderate alcohol consumption might reduce the normally high rate of infant related behaviors such as touching, talking to, and possibly feeding the child on a regular schedule. Another possiblity is that alcohol consumption might make the mother more distractable and less responsive to the infant's emotional and biological needs. Given the importance of early mother-infant experiences, even a slight deficit in mother-infant interactions could result in a disportionately large emotional and intellectual handicaps later in childhood.

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Table 1

Number of Litters
For Each Condition

Pup Condition	Dam Condition: Control	Dam Condition: Alcohol-All
Control	N = 10	N = 6
Alcohol-All	N = 6	N = 3

Pup Condition	Control	Alcohol-Partial
Control	N = 10	N = 3
Alcohol-Partial	N = 3	N = 5

Figure 1

Mean Litter Weights For
Alcohol-All and Control Conditions.

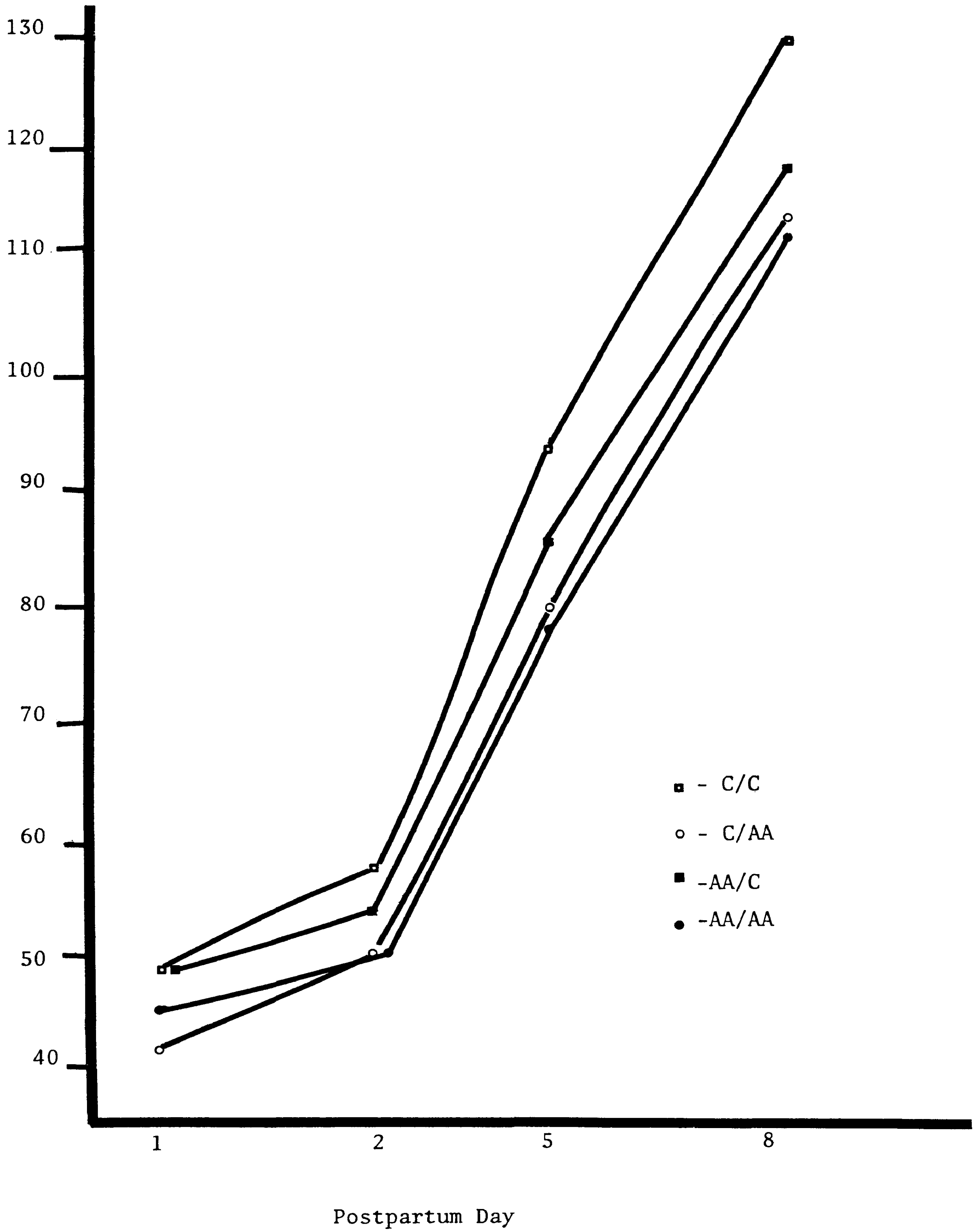

Table 2

Mean Time (In Seconds) to Locate Hidden Pup

Post-Partum Condition	Post-Partum Day		
	Day 2	Day 5	Day 8
AA/AA	504.03	728.80	248.20
AA/ C	590.52	810.03	742.93
C /AA	311.08	292.02	290.02
C / C	230.44	266.76	204.85
C /AP	522.10	399.47	98.93
AP/ C	807.33	780.50	601.57
AP/AP	669.08	531.64	511.42

Table 3

Total Time (In Seconds) to Retrieve Litter

Post-Partum Condition	Post-Partum Day Day 2	Day 5	Day 8
AA/AA	845.23	826.13	564.10
AA/ C	756.82	811.95	799.65
C /AA	575.13	603.35	701.43
C / C	474.88	512.36	375.90
C /AP	542.87	603.87	170.73
AP/ C	805.27	900.00	804.27
AP/AP	787.96	686.10	680.32

Table 4

Mean Values of
Maternal Behaviors

Dependent Measure		Dam Condition						
	Pup Condition	AA AA	AA C	C AA	C C	C AP	AP C	AP AP
In Nest								
Frequency		0.11	0.00	1.33	1.80	2.11	3.33	0.07
Mean Duration		4.79	0.00	36.74	57.88	85.14	5.15	5.00
Total Duration		4.79	0.00	80.65	114.73	193.94	4.36	5.00
Contact								
Mean Duration		2.79	6.20	4.50	5.80	4.80	2.85	2.81
Total Duration		70.61	68.85	148.44	171.92	127.30	72.78	80.53
Licking Pups								
Frequency		0.55	0.39	5.89	4.60	4.44	1.44	1.47
Mean Duration		2.20	2.84	14.17	13.31	8.63	4.44	6.59
Total Duration		6.70	3.75	89.72	87.20	60.24	12.90	12.48
Nest Building								
Mean Duration		10.24	8.00	16.94	20.54	16.14	12.92	11.79

Table 5

Mean Values of
Additional Measures

Dependent Measure	Dam Condition / Pup Condition	AA AA	AA C	C AA	C C	C AP	AP C	AP AP
Exploratory Behavior Total Time		589.95	547.16	464.74	468.74	413.13	504.85	578.51
Self-Directed Behaviors Total Time		128.18	200.58	102.46	58.47	108.93	172.69	122.64

APPENDIX A

Means and Standard Deviations
for Control/Control Condition

	Day 2	Day 5	Day 8
Pup Weight	57.09 (6.00)	94.84 (6.04)	129.85 (11.39)
npupb	5.9 (0.31)	6.0 (0.00)	6.0 (0.00)
npupd	5.50 (1.70)	5.80 (0.42)	5.90 (0.32)
npupa	6.00 (0.00)	6.00 (0.00)	6.00 (0.00)
fnest	1.90 (1.66)	1.90 (2.28)	1.60 (2.22)
dnest	60.42 (46.69)	51.87 (56.93)	61.35 (141.63)
tnest	140.44 (131.39)	105.11 (108.70)	98.63 (149.27)
fpnur	0.00 (0.00)	0.10 (0.30)	0.00 (0.00)
dpnur	0.00 (0.00)	0.04 (1.26)	0.00 (0.00)
tpnur	0.00 (0.00)	0.04 (0.00)	0.00 (0.00)
fanur	0.30 (0.70)	0.70 (0.94)	0.70 (1.25)
danur	29.80 (45.58)	3.41 (10.78)	65.55 (157.98)
tanur	42.04 (78.11)	10.24 (32.38)	95.10 (189.46)
fcont	31.20 (6.21)	30.50 (6.50)	29.50 (13.03)
dcont	5.51 (1.47)	5.41 (0.99)	6.49 (2.36)
tcont	165.58	166.58	183.83

	(34.73)	(51.36)	(83.82)
flick	7.60 (3.89)	3.20 (3.79)	3.00 (3.82)
dlick	20.08 (12.51)	11.65 (10.35)	8.20 (7.75)
tlick	155.56 (99.65)	58.70 (104.12)	47.34 (79.45)
fexpl	15.00 (5.44)	14.30 (5.40)	12.30 (4.60)
dexpl	30.27 (15.67)	42.81 (21.53)	52.69 (47.56)
texpl	399.30 (110.28)	525.11 (159.59)	481.31 (119.56)
fsdir	5.20 (4.36)	5.10 (3.07)	3.40 (1.90)
dsdir	10.59 (10.52)	15.15 (13.21)	15.89 (9.61)
tsdir	56.72 (46.89)	64.56 (50.15)	54.14 (36.43)
fbuild	11.50 (7.23)	11.20 (6.14)	9.90 (5.42)
dbuild	19.63 (10.93)	19.76 (12.57)	22.22 (11.57)
tbuild	218.56 (144.17)	194.69 (108.40)	208.51 (146.07)
finact	0.30 (0.48)	0.10 (0.32)	0.00 (0.00)
dinact	0.14 (0.23)	2.07 (6.54)	0.00 (0.00)
tinact	0.14 (0.23)	2.07 (6.54)	0.00 (0.00)
lret	167.22 (286.76)	45.56 (37.89)	73.23 (69.19)
lhid	230.44 (189.71)	266.76 (180.80)	204.86 (128.46)

tret	474.88 (332.51)	512.36 (233.92)	375.90 (276.32)
npupsb	12.00 (2.53)		
eyes open	14.40 (0.51)		
e uncurled	2.10 (0.31)		
wtgest	330.82 (19.23)		
wtlact	326.85 (19.99)		
wtadapt	250.12 (10.68)		
fladapt	73.11 (13.25)		
flgest	92.51 (11.81)		
fllact	102.69 (11.92)		
gestlength	22.5 (1.02)		
gestgain	84.02 (14.47)		
birthwt	48.25 (3.75)		

Means and Standard Deviations
for Control/Alcohol-All Condition

	Day 2	Day 5	Day 8
Pup Weight	57.09 (4.91)	80.01 (10.71)	114.11 (13.41)
npupb	5.5 (1.22)	6.0 (0.00)	6.0 (0.00)
npupd	6.00 (0.00)	5.33 (1.21)	3.33 (2.80)
npupa	6.00 (0.00)	6.00 (0.00)	5.50 (0.83)
fnest	2.17 (1.94)	0.83 (0.98)	1.00 (2.00)
dnest	41.70 (50.09)	34.48 (65.73)	34.05 (54.82)
tnest	87.60 (80.61)	67.93 (132.07)	86.43 (158.29)
fpnur	0.00 (0.00)	0.16 (0.40)	0.00 (0.00)
dpnur	0.00 (0.00)	0.06 (0.16)	0.00 (0.00)
tpnur	0.00 (0.00)	0.06 (0.16)	0.00 (0.00)
fanur	0.16 (0.40)	0.50 (0.83)	0.33 (0.82)
danur	0.16 (0.41)	67.20 (113.45)	1.05 (2.57)
tanur	0.17 (0.40)	88.91 (137.80)	2.10 (5.14)
fcont	34.33 (12.67)	30.83 (4.44)	30.67 (11.97)
dcont	4.60 (1.27)	4.56 (0.93)	4.93 (2.58)
tcont	153.02 (53.48)	144.67 (42.76)	147.65 (69.09)

flick	6.67 (6.53)	7.67 (3.50)	3.33 (4.08)
dlick	14.48 (10.51)	17.65 (6.28)	10.38 (9.90)
tlick	78.23 (79.86)	130.75 (76.08)	60.18 (86.55)
fexpl	16.50 (4.28)	15.17 (3.76)	15.67 (4.27)
dexpl	29.56 (9.03)	34.63 (12.12)	39.13 (28.32)
texpl	472.46 (125.97)	506.15 (185.41)	415.62 (152.71)
fsdir	3.00 (1.54)	4.33 (2.25)	10.83 (8.49)
dsdir	21.71 (20.45)	11.70 (7.54)	15.82 (6.34)
tsdir	59.30 (61.24)	61.88 (68.06)	186.20 (160.75)
fbuild	12.83 (5.98)	8.83 (5.82)	7.17 (8.01)
dbuild	18.20 (11.20)	21.43 (21.20)	11.20 (6.28)
tbuild	257.32 (186.68)	130.00 (126.52)	111.08 (172.44)
finact	0.00 (0.00)	0.17 (0.41)	0.00 (0.00)
dinact	0.00 (0.00)	10.13 (24.82)	0.00 (0.00)
tinact	0.00 (0.00)	10.13 (24.82)	0.00 (0.00)
lret	73.20 (61.52)	106.67 (80.01)	363.15 (421.06)
lhid	311.08 (180.94)	292.62 (264.80)	290.02 (308.17)
tret	575.13 (249.31)	603.34 (211.22)	701.43 (288.67)

npupsb	12.00 (2.53)
eyes open	14.83 (0.75)
uncurled	2.50 (0.54)
wtgest	330.82 (19.23)
wtlact	326.85 (19.99)
wtadapt	250.12 (10.68)
fladapt	73.11 (13.25)
flgest	92.51 (11.81)
fllact	102.69 (11.92)
gestlength	22.5 (1.02)
gestgain	84.02 (14.47)
birthwt	48.25 (3.75)

Means and Standard Deviations
for Alcohol-All/Control Condition

	Day 2	Day 5	Day 8
Pup Weight	54.71 (5.57)	86.63 (7.54)	118.50 (13.20)
npupb	5.7 (0.82)	5.7 (0.82)	5.5 (0.83)
npupd	3.67 (2.42)	1.66 (2.65)	2.83 (2.71)
npupa	4.50 (1.52)	4.67 (1.50)	4.83 (1.33)
fnest	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
dnest	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
tnest	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
fpnur	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
dpnur	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
tpnur	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
fanur	0.00 (0.00)	0.17 (0.05)	0.00 (0.00)
danur	0.00 (0.00)	1.13 (0.37)	0.00 (0.00)
tanur	0.00 (0.00)	1.13 (0.37)	0.00 (0.00)
fcont	29.50 (6.53)	20.00 (7.15)	25.00 (18.58)
dcont	2.03 (0.63)	13.26 (24.24)	3.30 (0.30)
tcont	63.23 (25.61)	61.56 (31.49)	81.75 (58.49)

flick	0.50 (0.54)	0.33 (0.82)	0.33 (0.52)
dlick	4.22 (8.32)	2.75 (6.37)	1.55 (3.60)
tlick	4.23 (8.32)	5.50 (13.47)	1.55 (3.60)
fexpl	16.50 (6.41)	15.00 (4.09)	15.83 (6.73)
dexpl	44.58 (19.45)	31.88 (10.53)	36.17 (18.35)
texpl	648.47 (97.49)	464.78 (159.47)	528.25 (157.97)
fsdir	5.50 (1.76)	10.17 (6.73)	8.50 (5.04)
dsdir	26.63 (16.37)	25.83 (19.96)	25.11 (28.12)
tsdir	127.60 (75.85)	246.25 (273.63)	227.90 (262.49)
fbuild	9.67 (5.20)	6.17 (6.40)	8.00 (9.23)
dbuild	7.85 (3.70)	7.58 (6.44)	8.57 (8.01)
tbuild	71.43 (49.52)	80.12 (113.38)	87.98 (91.85)
finact	1.33 (1.63)	2.00 (2.09)	0.50 (1.22)
dinact	8.73 (10.28)	22.20 (27.74)	9.08 (22.20)
tinact	22.55 (27.09)	86.53 (151.60)	27.21 (66.66)
lret	399.87 (369.96)	378.02 (406.23)	503.07 (347.42)
lhid	590.52 (280.19)	810.03 (215.99)	742.93 (295.19)
tret	756.82 (181.81)	811.95 (215.68)	799.64 (223.17)

npupsb	12.00 (1.00)
eyes open	14.16 (0.40)
uncurled	2.00 (0.00)
wtgest	333.83 (18.29)
wtlact	334.28 (19.18)
wtadapt	256.18 (10.53)
fladapt	52.97 (9.99)
flgest	77.13 (14.11)
fllact	88.33 (7.63)
gestlength	22.8 (0.35)
gestgain	81.08 (13.62)
birthwt	42.03 (3.78)

Means and Standard Deviations
for Alcohol-All/Alcohol-All Condition

	Day 2	Day 5	Day 8
Pup Weight	50.83 (4.19)	77.90 (12.50)	113.90 (8.15)
npupb	5.3 (1.15)	6.0 (0.00)	6.0 (0.00)
npupd	4.00 (1.00)	4.67 (1.52)	4.00 (3.46)
npupa	5.67 (0.58)	5.00 (1.73)	5.00 (1.73)
fnest	0.00 (0.00)	0.00 (0.00)	0.33 (0.58)
dnest	0.00 (0.00)	0.00 (0.00)	14.36 (24.88)
tnest	0.00 (0.00)	0.00 (0.00)	14.36 (24.88)
fpnur	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
dpnur	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
tpnur	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
fanur	0.00 (0.00)	0.00 (0.00)	0.67 (0.58)
danur	0.00 (0.00)	0.00 (0.00)	32.80 (28.82)
tanur	0.00 (0.00)	0.00 (0.00)	32.80 (28.82)
fcont	34.00 (10.53)	21.67 (7.37)	20.00 (7.54)
dcont	2.77 (1.15)	3.90 (1.57)	1.70 (0.30)
tcont	89.93 (34.13)	89.23 (52.30)	32.67 (7.16)

flick	0.33 (0.58)	0.00 (0.00)	1.33 (2.30)
dlick	2.10 (3.63)	0.00 (0.00)	4.50 (7.79)
tlick	2.10 (3.64)	0.00 (0.00)	18.00 (31.18)
fexpl	10.00 (7.81)	44.33 (40.85)	24.33 (3.05)
dexpl	375.33 (575.65)	373.60 (601.42)	2360.73 (4056.43)
texpl	671.73 (140.00)	612.07 (185.05)	486.95 (65.97)
fsdir	4.00 (1.73)	4.00 (1.00)	39.67 (26.63)
dsdir	17.47 (3.44)	12.13 (8.58)	17.00 (23.15)
tsdir	68.20 (30.10)	49.57 (35.46)	266.77 (131.17)
fbuild	12.00 (3.60)	15.33 (9.45)	13.33 (10.78)
dbuild	8.53 (4.46)	13.90 (5.24)	8.30 (2.52)
tbuild	112.70 (81.73)	217.53 (135.30)	123.17 (114.00)
finact	1.00 (1.00)	0.00 (0.00)	0.00 (0.00)
dinact	9.90 (16.89)	0.00 (0.00)	0.00 (0.00)
tinact	19.73 (33.91)	0.00 (0.00)	0.00 (0.00)
lret	100.80 (10.02)	202.83 (174.61)	365.10 (463.43)
lhid	504.03 (190.90)	728.80 (296.53)	248.10 (137.15)
tret	845.23 (94.85)	826.13 (127.94)	564.10 (292.00)

npupsb	12.00 (1.00)
eyes open	15.00 (1.00)
uncurled	3.00 (0.00)
wtgest	333.83 (18.29)
wtlact	334.28 (19.18)
wtadapt	256.18 (10.53)
fladapt	52.97 (9.99)
flgest	77.13 (14.11)
fllact	88.33 (7.63)
gestlength	22.8 (0.35)
gestgain	81.08 (13.62)
birthwt	45.13 (0.70)

Means and Standard Deviations
for Control/Alcohol-Partial Condition

	Day 2	Day 5	Day 8
Pup Weight	55.00 (3.01)	94.00 (2.91)	145.27 (8.11)
npupb	5.3 (1.15)	6.0 (0.00)	6.0 (0.00)
npupd	5.00 (1.73)	5.33 (1.15)	6.00 (0.00)
npupa	6.00 (0.00)	6.00 (0.00)	6.00 (0.00)
fnest	1.00 (1.00)	2.33 (2.08)	3.00 (2.64)
dnest	152.70 (183.04)	58.30 (72.08)	44.43 (45.48)
tnest	186.87 (178.49)	186.90 (211.70)	208.07 (229.73)
fpnur	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
dpnur	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
tpnur	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
fanur	0.67 (1.15)	0.33 (0.57)	1.33 (2.31)
danur	5.83 (10.10)	69.57 (120.49)	21.23 (36.77)
tanur	11.63 (20.15)	69.57 (120.49)	84.67 (147.17)
fcont	28.00 (4.35)	26.00 (12.29)	25.67 (6.65)
dcont	4.43 (2.06)	5.43 (1.10)	4.53 (0.81)
tcont	118.60 (33.43)	147.40 (92.02)	115.90 (33.67)

flick	3.67 (2.51)	2.00 (2.00)	7.67 (6.65)
dlick	10.00 (9.05)	7.06 (10.72)	8.83 (7.72)
tlick	51.93 (55.33)	27.03 (43.74)	101.77 (90.12)
fexpl	21.00 (3.00)	14.67 (5.68)	19.33 (6.42)
dexpl	20.53 (5.80)	28.37 (10.52)	20.43 (5.40)
texpl	427.43 (116.07)	418.87 (195.91)	393.10 (177.40)
fsdir	7.67 (1.52)	5.67 (4.62)	16.67 (17.62)
dsdir	18.63 (18.82)	36.20 (43.84)	6.60 (4.17)
tsdir	148.57 (152.13)	97.93 (139.92)	80.30 (55.22)
fbuild	16.00 (0.00)	11.00 (1.73)	16.00 (7.55)
dbuild	14.03 (3.91)	21.37 (4.33)	13.03 (0.70)
tbuild	224.53 (63.14)	238.40 (77.68)	211.00 (108.37)
finact	0.67 (0.57)	0.00 (0.00)	0.00 (0.00)
dinact	0.43 (0.45)	0.00 (0.00)	0.00 (0.00)
tinact	0.43 (0.45)	0.00 (0.00)	0.00 (0.00)
lret	164.03 (140.20)	215.43 (326.30)	61.83 (57.67)
lhid	522.10 (374.15)	399.47 (285.10)	98.93 (99.21)
tret	542.87 (345.46)	603.87 (452.99)	170.73 (35.70)

npupsb	13.00 (1.00)
eyes open	13.66 (0.58)
uncurled	2.00 (0.00)
wtgest	330.82 (19.23)
wtlact	326.85 (19.99)
wtadapt	250.12 (10.68)
fladapt	73.11 (13.25)
flgest	92.51 (11.81)
fllact	102.69 (11.92)
gestlength	22.5 (1.02)
gestgain	84.02 (14.47)
birthwt	48.25 (3.75)

Means and Standard Deviations
for Alcohol-Partial/Control Condition

	Day 2	Day 5	Day 8
Pup Weight	55.53 (3.26)	87.53 (6.95)	126.73 (0.93)
npupb	5.6 (0.58)	6.0 (0.00)	5.3 (1.15)
npupd	4.67 (1.52)	4.33 (1.15)	4.67 (1.53)
npupa	5.53 (0.58)	6.00 (0.00)	2.66 (2.52)
fnest	0.00 (0.00)	10.00 (17.32)	0.00 (0.00)
dnest	0.00 (0.00)	15.47 (26.79)	0.00 (0.00)
tnest	0.00 (0.00)	13.07 (22.63)	0.00 (0.00)
fpnur	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
dpnur	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
tpnur	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
fanur	0.33 (0.58)	0.00 (0.00)	0.33 (0.58)
danur	0.13 (0.23)	0.00 (0.00)	33.23 (57.56)
tanur	0.13 (0.23)	0.00 (0.00)	33.23 (57.56)
fcont	33.00 (7.54)	27.00 (12.49)	23.00 (10.53)
dcont	2.43 (1.25)	3.53 (1.76)	2.60 (0.90)
tcont	73.10 (28.92)	82.20 (8.81)	63.03 (36.75)

flick	1.00 (1.00)	1.33 (1.52)	2.00 (2.64)
dlick	3.90 (4.35)	4.77 (4.16)	4.67 (7.73)
tlick	6.77 (9.16)	27.26 (41.64)	4.67 (7.73)
fexpl	15.33 (3.05)	21.67 (4.04)	22.33 (7.09)
dexpl	34.37 (13.59)	24.23 (6.11)	23.43 (6.43)
texpl	501.97 (97.14)	510.13 (55.10)	502.47 (110.20)
fsdir	5.00 (1.00)	7.00 (1.00)	17.00 (12.76)
dsdir	33.16 (26.42)	18.83 (3.21)	8.90 (2.00)
tsdir	153.70 (152.68)	131.60 (26.82)	232.77 (230.41)
fbuild	12.67 (2.30)	15.67 (2.52)	14.67 (9.02)
dbuild	16.93 (10.44)	11.30 (2.52)	10.53 (8.01)
tbuild	207.27 (131.50)	174.43 (34.24)	161.56 (125.38)
finact	0.67 (1.54)	2.66 (3.05)	1.33 (0.57)
dinact	4.83 (8.37)	6.17 (6.82)	9.00 (7.69)
tinact	2.37 (4.10)	7.83 (7.00)	11.33 (7.84)
lret	187.90 (204.82)	228.56 (247.15)	119.23 (127.04)
lhid	807.33 (113.10)	780.50 (206.98)	601.57 (302.53)
tret	805.27 (110.68)	900.00 (0.00)	686.10 (165.81)

npupsb	12.70 (1.00)
eyes open	14.00 (0.00)
uncurled	2.00 (0.00)
wtgest	343.46 (7.72)
wtlact	344.50 (24.25)
wtadapt	253.83 (9.72)
fladapt	50.76 (13.14)
flgest	86.56 (6.80)
fllact	81.76 (5.75)
gestlength	23.1 (0.60)
gestgain	89.70 (5.62)
birthwt	47.53 (3.01)

Means and Standard Deviations
for Alcohol-partial/Alcohol-partial Condition

	Day 2	Day 5	Day 8
Pup Weight	53.47 (1.82)	85.74 (6.66)	113.14 (11.11)
npupb	6.0 (0.00)	6.0 (0.00)	6.0 (0.00)
npupd	4.60 (1.14)	3.40 (2.30)	4.40 (1.81)
npupa	5.40 (1.34)	5.60 (0.54)	5.40 (0.89)
fnest	0.20 (0.44)	0.00 (0.00)	0.00 (0.00)
dnest	14.98 (33.42)	0.00 (0.00)	0.00 (0.00)
tnest	14.98 (33.42)	0.00 (0.00)	0.00 (0.00)
fpnur	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
dpnur	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
tpnur	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
fanur	0.40 (0.58)	0.00 (0.00)	0.00 (0.00)
danur	0.82 (1.61)	0.00 (0.00)	0.00 (0.00)
tanur	0.82 (1.61)	0.00 (0.00)	0.00 (0.00)
fcont	33.00 (11.55)	33.60 (4.16)	25.00 (10.79)
dcont	3.32 (1.83)	2.26 (0.72)	2.84 (2.22)
tcont	99.40 (41.29)	74.65 (21.46)	67.50 (51.90)

flick	2.00 (1.87)	0.40 (0.54)	2.00 (1.87)
dlick	5.20 (7.71)	4.64 (6.68)	9.94 (15.14)
tlick	14.32 (24.17)	5.34 (6.24)	17.78 (18.22)
fexpl	12.20 (3.76)	18.20 (7.19)	13.30 (5.68)
dexpl	59.80 (44.48)	37.44 (16.93)	23.43 (34.74)
texpl	479.20 (226.25)	587.20 (85.26)	669.14 (116.02)
fsdir	9.80 (5.40)	19.75 (19.75)	5.17 (5.17)
dsdir	15.22 (7.80)	16.84 (14.94)	14.48 (9.53)
tsdir	132.47 (105.82)	122.06 (105.52)	113.38 (58.20)
fbuild	6.60 (6.84)	13.20 (9.75)	7.40 (7.30)
dbuild	12.86 (10.72)	11.68 (7.78)	10.82 (11.24)
tbuild	111.38 (175.46)	174.96 (117.07)	91.94 (149.04)
finact	0.80 (0.44)	0.40 (0.89)	0.00 (0.00)
dinact	8.20 (9.68)	3.16 (7.06)	0.00 (0.00)
tinact	8.20 (9.68)	6.30 (14.08)	0.00 (0.00)
lret	217.58 (171.38)	59.24 (31.46)	69.58 (65.01)
lhid	669.08 (245.71)	531.64 (280.43)	511.42 (368.77)
tret	787.95 (173.02)	686.61 (314.61)	680.32 (314.21)

npupsb	13.00 (1.00)
eyes open	14.40 (0.54)
uncurled	2.20 (0.44)
wtgest	343.73 (11.04)
wtlact	344.50 (24.25)
wtadapt	253.83 (9.72)
fladapt	50.77 (13.15)
flgest	86.57 (6.80)
fllact	81.77 (5.75)
gestlength	23.1 (0.60)
gestgain	89.10 (5.62)
birthwt	46.14 (2.38)

VITA

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