

FINAL REPORT

Key findings:

- i) Alcohol consumption during pregnancy remains high (60-70%) and relatively unchanged over the past 4 years
- ii) The behaviour of the fetus is influenced by maternal alcohol consumption reducing its movements and response to sound
- iii) Maternal alcohol consumption during pregnancy influences infant habituation at 5 months of age
- iv) The behavioural effects observed indicate maternal alcohol consumption has influenced, possibly permanently, the functioning of the brain and CNS of the fetus and infant
- v) These effects are observed at low levels of maternal alcohol consumption (5-6 units per week) and this raises questions regarding the 'safe' level of alcohol during pregnancy

Abstract:

The study examined the effects of maternal alcohol consumption on the behaviour of the fetus. As the behaviour of the fetus directly represents the functioning and integrity of the brain and CNS the effect of maternal drinking on fetal brain function can be assessed. Low levels of consumption, 5-6 units per week: reduced spontaneous movements; decreased the likelihood of a startle reaction; and, influenced habituation performance in the fetus. At 5 months of age differences in habituation performance were still evident. The results indicate that maternal alcohol consumption exerts a 'permanent' effect on the fetus's brain function at levels lower of consumption than currently recommended as safe by the Government.

Summary of results:

Incidence of drinking during pregnancy

(data from 1999 have been added to the graph for comparison)

The number of women drinking (assessed by questionnaire) has changed little over the past four years, despite numerous campaigns warning of the dangers of drinking (Figure 1). There is a slight decrease over the period examined from 70% to 60% but a large number of women continue to drink during pregnancy. Perhaps more worryingly the number of women drinking over 14 units per week remains stable and averages around 17%.

Figure 1. The percentage number of women (n=300 per year) who report drinking during their pregnancy and the percentage number of women who report drinking more than 14 units per week during their pregnancy.

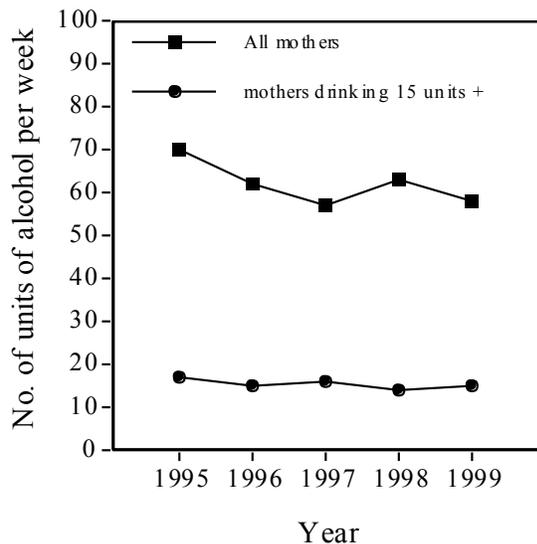
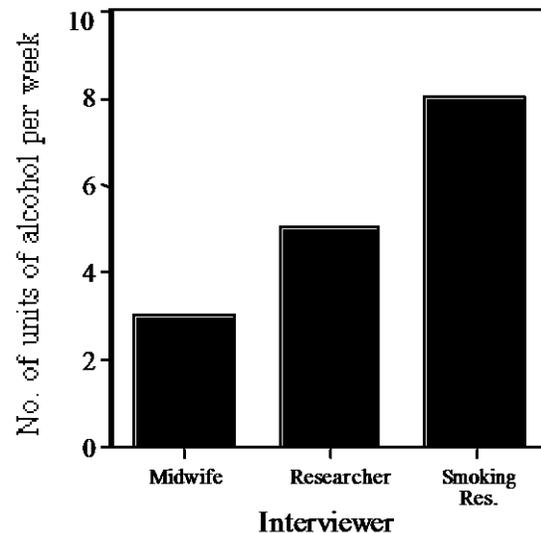


Figure 2. The number of units drunk per week as reported to a midwife, a researcher, and the same researcher indicating she herself drank



Amount drunk

Figure 2 represents the amount of alcohol drunk per week reported by the same women to either a midwife (midwife in midwife uniform), the researcher, and the researcher giving an indication that she drank (this was achieved by having a couple of bottles of drink in the room and explained away by the fact that the individual was going to a party later). As can be seen the reported amount drunk varied dependent on the situation.

This result is perhaps not surprising since it is expected that individuals under-report the amount of drinking they undertake. Moreover all mothers acknowledged that heavy drinking was detrimental to the pregnancy and thus were aware of the dangers of drinking. In a hospital setting mothers may thus under-report drinking levels. In more relaxed surroundings the same mothers

report, perhaps, a more accurate figure regarding their drinking. This study illustrates the difficulty of determining the actual amount drunk by women during the course of their pregnancy.

One result of this finding was that mothers were divided into two groups for the analysis of behaviour. During the discussions Jennifer Little had during the research with mothers it became apparent that most mothers continued to drink during pregnancy and although some may have given up for a while the majority of mothers in the 'stopped drinking once they became pregnant' group, later drank during their pregnancy, albeit at a reported lower level. It was decided that mothers who drank but stopped could not be identified accurately and hence the analysis should concentrate on mothers who drank and those who did not drink.

Spontaneous behaviour

The spontaneous behaviour of the fetus was examined at 3 gestational ages, 18-20 weeks, 27 weeks and 36-38 weeks gestation. Fetuses were observed for 45 minutes at each gestational age using ultrasound scanner. All scans were recorded on video tape for later analysis. Movements observed included startles, general body movements, mouthing movements, hiccups, breathing movements and overall activity levels.

Results

18-20 weeks gestation

Maternal alcohol consumption influenced fetal mouthing as significantly more mouthing was observed in fetuses of mothers who drank than non-drinking mothers.

27-28 weeks gestation

Fetuses exposed to maternal alcohol consumption exhibited significantly less mouthing movements than fetuses of non-drinking mothers. Fetuses of drinking mothers were significantly less active than fetuses of non-drinking mothers.

36-38 weeks gestation

Fetuses exposed to alcohol displayed significantly less mouthing and breathing compared to fetuses of non-drinking mothers. Fetuses of mothers who drank alcohol during pregnancy were also less active than fetuses of mothers who did not drink alcohol.

Summary

Maternal alcohol consumption appeared to generally decrease fetal movement, especially later in gestation. Fetuses of drinking mothers exhibited decreased mouthing, breathing and activity compared to fetuses of non-drinking mothers.

Fetuses exposed to alcohol exhibited greater variance in their behaviour as a group than fetuses of mothers who did not drink during pregnancy, i.e. their range of scores was greater than non-drinking mothers. This suggests that the group of fetuses of drinking mothers were a less cohesive group in terms of performance than fetuses of non-drinking mothers and some fetuses in this group were more affected than others.

Elicited behaviour

The effect of alcohol and smoking on the elicited behaviour of the fetus was investigated using the startle response and habituation.

Startle response

The startle response of the fetus, defined as the response of the fetus to a single auditory stimulus, was examined at 25 weeks gestation. The fetus was observed using ultrasound. Following a period of fetal inactivity, i.e. no observable fetal movement, lasting 120 seconds a 2 second vibroacoustic stimulus (provided by a Model 146 Fetal Acoustic Stimulator) was presented to the fetus. The fetus was considered to have responded if it moved its head, upper body or arms within 4.5 seconds of stimulus onset. The video tape for each fetus was replayed and the presence or absence of a startle response recorded.

Results

A highly significant difference in the presence of a startle response was found between fetuses of mothers who drank compared to mothers who did not drink. Only 39.6% of fetuses of mothers who drank elicited a startle reaction compared to 66% in fetuses of mothers who did not drink.

Habituation

The habituation response of the fetus was examined at 32 and 38 weeks of gestation. Habituation was examined slightly later than originally planned as pilot studies suggested that the effect of maternal alcohol consumption on the fetus became greater later in pregnancy. Fetuses were observed using ultrasound and their response to a repeated sound stimulus (pure tone sine wave) noted on each presentation of the stimulus.

Results

Number of trials to habituate across gestation

A significant interaction between maternal drinking and gestational age on the number of stimuli required before the fetus stopped responding (habituated) was found. At 32 weeks there was little difference in the number of trials to habituate between fetuses of drinking and non-drinking mothers. However at 38 weeks gestation fetuses exposed to maternal alcohol habituated faster than fetuses of non-drinking mothers. This supports the suggestion that the effects of maternal alcohol consumption are greater later in pregnancy. See Figure 3.

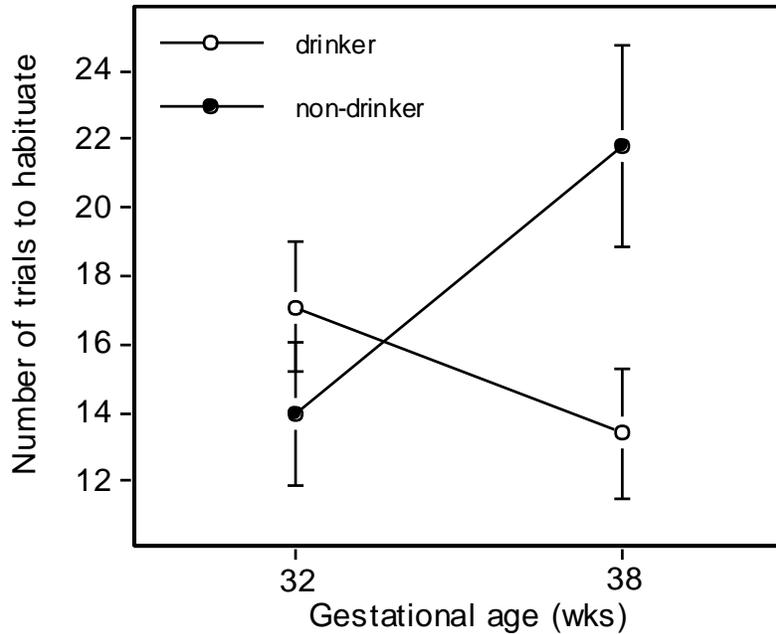


Figure 3: Mean number of trials (\pm s.e.) to habituate at 32 and 38 weeks of gestational age for fetuses of mothers who drank alcohol (drinker) and mothers who did not drink alcohol (non-drinker).

Summary

Both the startle test and habituation test revealed exposure to alcohol resulted in the fetus's response being changed. As habituation has been argued to involve the cerebral cortices, alcohol is exerting an effect in the higher centres of the brain.

Postnatal habituation

An examination of new-born and infant habituation, using a visual attention task, was also conducted in order to evaluate the permanency of the neurobehavioural effects observed *in utero*.

There was no effect of maternal alcohol consumption in the new-born period.

There was a highly significant effect of maternal alcohol consumption during pregnancy on the infant's habituation response at 5 months of age. Infants exposed to maternal alcohol *in utero* habituated much faster than infants not exposed to maternal alcohol *in utero*.

Summary

Exposure of the fetus to alcohol during gestation had a 'long-term' effect on the individual. Faster habituation patterns seen before birth were also observed after birth at 5 months of age.

Discussion

The study of the behaviour of the fetus provides a means to assess the functioning and integrity of the fetus's CNS and brain function. The results obtained here demonstrate differences in the behaviour of fetuses following exposure to alcohol due to maternal drinking during pregnancy. This indicates that maternal alcohol is having an effect on the CNS and brain of the individual.

The study was performed on mothers who although drinking during their pregnancy had no alcohol within their bodies during the time of testing. Thus the effects observed cannot be attributed to an acute effect of alcohol but rather a more 'permanent' effect. This is supported by the finding that at 5 months of age individuals exposed to alcohol *in utero* were faster to habituate than individuals not so exposed.

As with many similar studies there are problems in identifying the amount drunk by mothers who, for various reasons, may be 'economical with the truth'. However studying the effects of maternal alcohol consumption on the fetus by observing the fetus negates these problems as it enables the effect of exposure to be studied directly. This is important since the results suggest that the response of the fetus to alcohol is individually determined. That is not all fetuses exposed to the same amount of alcohol are affected in the same way. Observation of the behaviour of the fetus enables the effects of maternal alcohol to be assessed directly in the individual.

Overall levels of alcohol consumed by the mothers were relatively low during pregnancy, i.e. 5-6 units per week. This is well below the Government 'approved' limit of 14 units per week. The fact that a neurobehavioural effect remained 5 months after delivery and exposure to alcohol during pregnancy suggests more work needs to be done to examine the effects of low levels of alcohol on neural functioning to determine exactly what a safe limit is.

N.B. Maternal smoking was also considered and found to exert an independent effect on the fetus, not cumulative or additive with maternal drinking.

Problems:

Two minor changes to the original design were undertaken during the study.

i) The group of mothers classified as 'stopped drinking once pregnant' were removed due to the fact that very few actually satisfied this criteria. Many reported initially that they had stopped drinking but in subsequent discussions it was found that they had continued to drink, perhaps at a lower level. Also given the problems found with accurately determining the amount drunk by women it was decided to examine 2 groups; those who drank and those who did not drink (confirmation of this latter category was sought by interview with family friends).

ii) Pilot studies indicated that a greater effect of maternal alcohol consumption could be found later in gestation. Thus the habituation tests were performed later in gestation and indeed supported this observation as an effect was found at 38 weeks of gestation.

No other problems were found. Mothers enjoyed the study and all have indicated a willingness to participate in follow-up studies.

Conference papers:

Little, J.F. and Hepper, P.G. "The neurobehavioural effects of maternal smoking and alcohol on habituation performance in the human fetus"
European Society for Pediatric Research, Belfast, September 1998

Little, J.F. and Hepper, P.G. "The effect of smoking and alcohol on the startle reaction in the human foetus"
British Psychological Society Annual Conference, Belfast, April 1999.

Published abstracts:

Little, J.F. and Hepper, P.G. (1998) The neurobehavioural effects of maternal smoking and alcohol on habituation performance in the human fetus. *Pediatric Research* 44(3): 448.

Little, J.F. and Hepper, P.G. (1999) The effects of maternal smoking and alcohol consumption on spontaneous behaviour in the human fetus at 18-20 weeks gestational age. *Pediatric Research*, 45(6): 910.

Little, J.F. and Hepper, P.G. (1999) The effect of smoking and alcohol on the startle reaction in the human foetus. *Proceedings of the British Psychological Society*, 7, 129.

Papers in preparation:

Fetal startle reaction and maternal alcohol consumption.

Maternal drinking and fetal habituation.