Dimensions of Parental Alcohol Use/Problems and Offspring Temperament, Externalizing Behaviors, and Alcohol Use/Problems

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Background: Alcohol consumption (AC) and alcohol problems (AP) are complex traits. How many factors reflecting parental AC and AP are present in the large prospectively followed Avon Longitudinal Study of Parents and Children cohort? Would these factors be uniquely associated with various temperamental and alcohol-related outcomes in the children?

Methods: We factor-analyzed multiple items reflecting maternal and paternal AC and AP measured over a 12-year period from before the birth of the child (n = 14,093 families). We examined, by linear regression controlling for socioeconomic status, the relationship between scales derived from these factors and offspring early childhood temperament, externalizing traits, and adolescent AC and AP (ns ranging from 9,732 to 3,454).

Results: We identified 5 coherent factors: typical maternal AC, maternal AC during pregnancy, maternal AP, paternal AC, and paternal AP. In univariate analyses, maternal and paternal AC and AP were modestly and significantly associated with low shyness, sociability, hyperactivity, and conduct problems in childhood and early adolescence; delinquent behavior at age 15; and AC and AP at ages 15 and 18. AC and AP at age 18 were more strongly predicted by parental factors than at age 15. Maternal AC during pregnancy uniquely predicted externalizing traits at ages 4, 13, and 15.

Conclusions: Parental AC and AP are complex multidimensional traits that differ in their association with a range of relevant measures in their children. Controlling for background AC and AP, self-reported levels of maternal AC during pregnancy uniquely predicted externalizing behaviors in childhood and adolescence.

Key Words: ALSPAC, Alcohol Consumption, Parental Alcohol Use, Temperament, Externalizing Problems, Fetal-Alcohol Exposure.

ALCOHOL CONSUMPTION (AC) and the symptoms of alcohol use disorders (AUDs; which we here term "Alcohol Problems [AP]") are both strongly familial (Begleiter, 1995; Cotton, 1979). A range of twin and adoption studies in adults have suggested that genetic factors contribute substantially to resemblance in relatives for AP, although familial-environmental factors also play an etiologic role (Cloninger et al., 1985; Heath et al., 1997; Kendler et al., 1997). Studies in adolescence, by contrast, typically show that genetic effects on AC are modest and shared environmental influences considerably more important (Kendler et al., 2008; Koopmans et al., 1997; Viken et al., 1999).

A large body of work has examined children of parents with AUDs—so-called "children of alcoholics" (COAs) (Harter, 2000; Lieberman, 2000; Searles and Windle, 1992; Sher, 1991, 1997; Sher et al., 1991). In particular, COAs have been shown to have an elevated risk of a difficult temperament (Harter, 2000; Sher, 1997; Sher et al., 1991), internalizing symptoms and/or disorders (Chassin et al., 1999), and high levels of externalizing traits (Chassin et al., 1999; Edwards et al., 2006; Harter, 2000, 2000; Sher et al., 1991) as toddlers, children, and early adolescents, and increased rates of heavy AC and AP (Chassin et al., 1999; Sher et al., 1991) in later adolescence and adulthood. Importantly, the transmission of APs across generations appears in nearly all studies to be partly mediated by the increased rates of externalizing traits in offspring of alcoholics with much less evidence that internalizing traits play a mediational role (Chassin et al., 1999; Hussong et al., 1998; Lieberman, 2000; Ohannessian and Hesselbrock, 2007, 2008).

Prior studies have examined whether the negative effects of having a parent with APs are more potent for males

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versus females with generally mixed results (Belliveau and Stoppard, 1995; Edwards et al., 2006; Harter, 2000; Sher et al., 1991). As expected, in most such studies, the affected parent is the father. Limited research has been carried out comparing the impact of APs in the parents (e.g., Belliveau and Stoppard, 1995), with some evidence that the effects may be more severe for fathers (Stout and Mintz, 1996). A limitation of this methodological approach is that it dichotomizes complex patterns of alcohol use and misuse in parents into 2 categories ("nonalcoholic" and "alcoholic") rather than utilizing potentially more informative quantitative indices of parental AP.

Intrauterine exposure to alcohol can produce a wide range of developmental anomalies making up the "fetal-alcohol syndrome" (Riley et al., 2011). However, intrauterine exposure to doses of alcohol insufficient to produce the classic syndrome can still have appreciable behavior effects (Spear and Molina, 2005) including increased risk of externalizing behaviors (Sood et al., 2001) and early AC and AP in adolescence (Baer et al., 1998; Yates et al., 1998).

In this article, we explore the extensive measures collected over multiple waves on parental AC and AP in the Avon Longitudinal Study of Parents and Children (ALSPAC; Boyd et al., 2012). We have 2 major aims. The first is to clarify the structure of this risk domain. Is there only 1 robust dimension of parental AC and AP assessed over time or are multiple dimensions needed to capture these varied behaviors? Having clarified the structure of these measures, our second major aim is to examine their ability to predict a range of behaviors in their offspring, previously shown to be potentially abnormal in the COAs: early childhood temperament, externalizing traits from childhood to early adolescence, and AC and AP in mid-to-late adolescence. Our working hypothesis is that we will see multiple dimensions of alcohol-related behaviors in the parents which will differ in the observed pattern of associations with this range of traits in their offspring.

MATERIALS AND METHODS

ALSPAC is an ongoing population-based study investigating a wide range of environmental and other influences on the health and development of children (http://www.alspac.bris.ac.uk; Boyd et al., 2012). All pregnant women resident in the Avon district of South West England with an expected date of delivery between April 1, 1991, and December 31, 1992, were invited to participate in the ALSPAC. The achieved sample was 14,541 pregnant women (80% of those eligible) with 13,988 live infants at age 12 months. ALSPAC parents and children have been followed-up regularly since recruitment, with data obtained through questionnaires completed by mothers, children and teachers, and through clinical assessments. Full details of all measures, procedures, sample characteristics, and response rates are available at www.alspac.bris.ac.uk. Ethical approval for the study was obtained from the ALSPAC Ethics and Law Committee, and the Local Research Ethics Committee. To assist readers in understanding the temporal structure of the data analyzed in this report, we prepared Fig. 1 which shows the time of the individual assessments (in age in months of the ALSPAC proband offspring) for the 4 major domains considered in this report: parental AC and AP, offspring child temperament, offspring externalizing traits, and offspring AC and AP.

Factor Analysis

Our first goal was to clarify the underlying structure of the data collected on AC and symptoms of AUD in the mothers, and their partners in the multiple assessments covering times from before the pregnancy until the ALSPAC proband was 12 years old. We selected 82 candidate variables related to AC and abuse/dependence from interviews of mothers and their partners (hereafter fathers). Of these items, 43 were reports on alcohol-related behavior of mothers and 39 concerned alcohol-related behaviors in fathers. These items were made up of self-reports by mothers, self-reports by fathers, mother reports on fathers, and father reports on mothers. From the interview at age 8 months and beyond, the partner data were used only if the partner's questionnaire was filled out by the biological father of the child. For the derived scores described later, we chose families where the missing data on both mother and partner were <50% of these candidate variables. This reduced the overall sample to 4,231 mothers and 4,231 partners. The items assessing alcohol abuse and dependence symptoms were binary, while the remaining variables were ordinal with a few quasi-continuous measures (e.g., counts of AC in an interval of time). To avoid problems due to highly skewed variables and associated scaling issues, all these variables were converted to 5 level ordinal variables. Factor analysis was performed on these variables separately for mother and father to identify a minimal number of factors that adequately summarized the variables judged from overall fit of the factor model. Initial best estimates of the number of factors were based on scree plots. We then looked for factor models that made clinical sense and provided an adequate fit based on 3 fit indices which all reflected, from varying perspective, the model's balance of explanatory power and parsimony: the Tucker–Lewis Index (TLI; Tucker and Lewis, 1973), the Comparative Fit Index (CFI; Bentler, 1990), and the root mean square error of approximation (RMSEA; Steiger, 1990). For the TLI and CFI, values between 0.90 and 0.95 are considered acceptable, and ≥0.95 as good. For the RMSEA, good models have values ≤0.05.

In the course of these factor analyses, we discarded variables that failed to provide substantial loadings on any of the common factors. We also found that variables derived from a tally of daily AC for

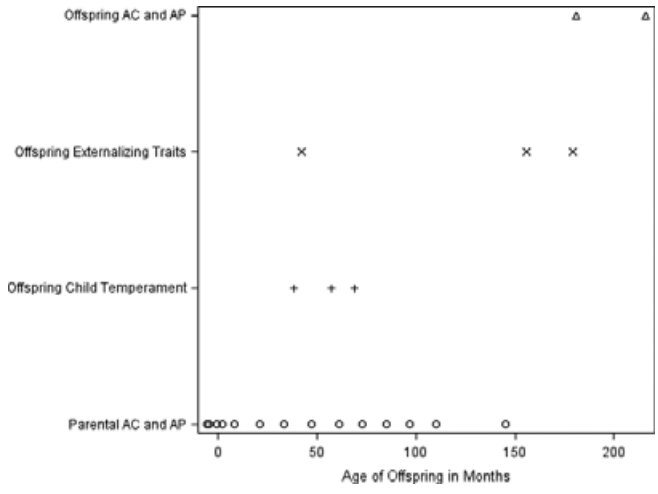

Fig. 1. The time of the individual assessments (in age in months of the Avon Longitudinal Study of Parents and Children [ALSPAC] proband offspring) for the 4 major domains considered in this report: parental alcohol consumption (AC) and alcohol problems (AP), offspring child temperament, offspring externalizing traits, and offspring AC and AP.

the past week (number of alcohol measures per week and maximum number of alcohol measures consumed in any day of the past week) were so highly correlated that if we included both sets of variables in the analyses, these variables formed their own factor. Therefore, candidate factor models were tested with weekly consumption measured at several times or maximum daily use measured at several times, but not both. We found that the weekly AC measures worked best in factor models for mothers, but maximum daily use worked best in factor models for fathers.

Factor loadings were obtained using robust maximum likelihood estimation (with less restrictive assumptions on missing data) and a Crawford-Ferguson quartimax rotation. With this rotation, we achieved very similar results with both MLR (mean- and variance-adjusted maximum likelihood) and WLSMV (mean- and variance-adjusted weighted least square) estimation.

Factor-derived scores were created from these factors by converting each individual item score into a *z*-score. Then, the mean of all *z*-scores from all nonmissing items constituting a factor was used to create an overall factor mean score. For regression models, the factor mean scores were normalized by the method of Blom (1958) and standardized to mean 0 and variance 1. Factor-derived scores were calculated for all parents with any nonmissing data as well as the proportion of missing data among the items used to construct the scores. This resulted in 14,093 families with scores on at least 1 of the parents.

Prediction of Traits in Offspring

Covariates for the regression models included sex of the offspring, age of mother at 12 weeks gestation, highest educational attainment of mother or partner, and a measure of social class based on occupation of mother or partner. The latter 2 items were measured at 32 weeks gestation. This reduced the sample used for regression models to 11,393 families. For regression, all variables were normalized by the method of Blom (1958) and standardized to mean 0 and variance 1, so effect sizes are all based on a common standard metric. Regression models were fit using weighted least squares where the weighting was based on the proportion of nonmissing data from the mother, partner, or both mother and partner for models of factors derived on mother or partner or both mother and partner (for multivariate models).

To assess the validity and predictive capacity of the factors derived from parental AC and APs, we examined their association with 14 variables.

Early Childhood Temperament. As detailed elsewhere (Dick et al., 2013), we utilized information about temperament as reported by the mother at 38, 57, and 69 months. Developmentally appropriate instruments were used (Buss and Plomin, 1984; Carey, 1977; Elander and Rutter, 1996). For this report, we factor-analyzed factor-derived sum scores we developed previously (Dick et al., 2013) to produce dimensions, which contained 5 items each and reflected 4 trait domains: "activity," "emotionality," "shyness," and "sociability." Valid scores at each individual interview were obtained for those who answered at least 3 of the 5 items, and the overall score was based on standardizing all scores at individual interviews and taking the mean of available scores. The available sample size for these regression analyses was ~9,732.

Conduct difficulties and hyperactivity at 42 months were assessed by the Revised Rutter Parent Scale for Preschool Children questionnaire (Elander and Rutter, 1996) given to the mother using 8 and 4 items, respectively. Scores were standardized, and the overall mean of the standardized scores was used. Available sample size for our regression analyses was ~9,069.

Conduct symptoms at age 13 were assessed using maternal reports on the conduct problems scale of the Strengths and Difficulties Questionnaire (Goodman, 1997). This scale consists of 5 items, such as "often lies and cheats" and "often loses temper," and mothers are asked to report whether these statements are "not true," "somewhat true," or "certainly true." This questionnaire is widely used and psychometrically valid (Smith and McVie, 2003). We created a sum score across the items, with a higher score representing higher levels of conduct problems. In the case of partial data, individuals with at least 3 of the 5 items were included, and the sum of those items was scaled to be proportional to those with complete data. Available sample size for this variable was ~6,236.

Antisocial behaviors at age 15 were assessed by the administration to the adolescent during an in-person clinic a 22-item scale derived from the Edinburgh Study for Youth Transitions and Crime questionnaire (Schuckit et al., 1997; Smith and McVie, 2003), aimed at measuring a variety of antisocial behaviors (e.g., breaking into a vehicle, shoplifting, etc.). Each item was scored 0 to 3. For those that answered at least half the items, the scores were summed and mean responses were multiplied by 22 for a potential score of 0 to 66. These scores were normalized and standardized as described previously. The available sample size for this variable was ~4,735.

Alcohol Consumption and Problems. At the age 15.5 in-person clinic, ALSPAC subjects were asked a series of questions about their AC and associated alcohol-related symptoms/problems that correspond relatively well to the DSM-IV criteria for alcohol abuse and dependence. These 16 items were extracted from the Semi-Structured Assessment of the Genetics of Alcoholism interview, developed by the Collaborative Study on the Genetics of Alcoholism (Bucholz et al., 1994; Hesselbrock et al., 1999). Quasi-continuous variables were collapsed into ordinal variables, and ordinal variables were collapsed to avoid extreme categories with few responses that would lead to excessively skewed factor scores. Exploratory factor analysis in MPLUS using Crawford-Ferguson quartimax rotation yielded 2 correlated factors (RMSEA = 0.038, CFI = 0.984, TLI = 0.978, $r = 0.67$). The first factor reflected AC and the second problems associated with alcohol use. Factor-derived scores were constructed for individuals responding to at least 8 of the 16 items by converting individual variables to *z*-scores, and for those that answered at least half the items, the mean *z*-score per item were calculated and normalized, and standardized as described previously. Available sample sizes for regression models were ~3,996 for the consumption factor and ~4,001 for the problems factor.

We conducted a factor analysis on a total of 25 items relating to alcohol use and misuse assessed at age 18 from the Self-Rating of the Effects of Alcohol (SRE) scale (Schuckit et al., 1997), the AUDIT (Babor et al., 2001), and DSM-IV symptoms of alcohol abuse and dependence (American Psychiatric Association, 1994), using a quartimin rotation. Examination of eigenvalues and interpretability of factor loadings led to the selection of a 3-factor solution. The first factor captured initial ethanol sensitivity, while the second reflected current AC and tolerance: current SRE items, as well as 3 AUDIT items pertaining to drinking frequency and quantity, load onto this factor. The third factor captured drinking problems, with the remaining AUDIT items and all the DSM items loading onto this factor. The current consumption and current problems were only modestly correlated ($r = 0.32$). Rotated factor scores were used as outcome variables. For these analyses, we used only the second and third factors reflecting AC and AP, as we assumed the origins of alcohol sensitivity were unlikely to be related to parental behaviors. Available sample size for these variables for our regression analyses was ~3,454.

Many statistical tests are presented in this study. We regard as potentially significant only those with a *p*-value of under 0.01.

RESULTS

Factor Structure of Maternal Alcohol Consumption and Problems

An analysis of the scree plot based on 4,231 individuals and 34 variables indicated the presence of 3 factors, and these were readily interpretable and provided a good fit to the data (RMSEA = 0.051, CFI = 0.978, and TLI = 0.973). Factor loadings by Crawford-Ferguson quartimax rotation are seen in Table 1. The first factor had consistently high loadings on 12 variables which reflected maternal AC and drinks per week as measured by both self- and partner report from before the pregnancy through age 145 months (Fig. 1). We called this factor *typical maternal AC*. It had a Cronbach's standardized alpha of 0.95.

The second factor had consistently high loadings on 15 variables which assessed, via self- and partner report, binge-drinking and AP from the time of the pregnancy through age 110 months. We termed this factor *maternal AP*. The third factor had high loadings on 6 self-report measures, which reflected AC and drinks per week during gestation. We called this factor *maternal AC during pregnancy*. It had a Cronbach's standardized alpha of 0.88.

The typical maternal AC factor correlated +0.51 with maternal AP factor and +0.45 with latent factor reflecting maternal AC during pregnancy. The factors for maternal AP and AC during pregnancy were correlated +0.19. For our subsequent analyses, we constructed factor-derived scales using the items with substantial loadings on each of the factors (those bolded in Table 1). It had a Cronbach's standardized alpha of 0.85.

Factor Structure of Paternal Alcohol Consumption and Problems

An analysis of the scree plot based on 4,231 individuals and 35 variables indicated the presence of 2 clear factors. These were readily interpretable and provided a relatively good fit to the data (RMSEA = 0.066, CFI = 0.980, and TLI = 0.977). Factor loadings by Crawford-Ferguson quartimax rotation are seen in Table 2. The first factor had consistently high loadings on 13 variables which reflected paternal AC as measured by both self- and maternal report from before pregnancy through age 145 months. We called this factor *paternal AC*. It had a Cronbach's standardized alpha of 0.96. The second factor had consistently high loadings on 15 variables which assessed, via self- and maternal report, binge drinking, and AP from the time of the pregnancy through age 145 months. We termed this factor *paternal AP*. It had a Cronbach's standardized alpha of 0.85. The latent paternal AC factor was correlated +0.42 with paternal AP factor. For subsequent analyses, we constructed factor-derived scales using the items with substantial loadings on each of the factors (those bolded in Table 2).

We then examined the observed correlations of the factor-derived scales, which are expected to be higher than those of the latent factors. Indeed, the factor-derived AC and AP scales were correlated +0.68 and +0.75 in mothers and fathers, respectively. Maternal and paternal AC and AP factor-derived scales were correlated +0.62 and +0.49, respectively.

Prediction of Early Childhood Temperament

We examined 4 broad dimensions of early child temperament as assessed at 3 time points (Fig. 1) that reflected (i) general activity, (ii) emotionality, (iii) shyness, and (iv) sociability. As seen in Table 3, in the univariate analyses, general activity was significantly and positively predicted by maternal and paternal AP, and by only maternal AP in the multivariate analysis. Emotionality had a modest positive association only with maternal AC during pregnancy in the multivariate analyses.

In the univariate analyses, all 5 dimensions of parental alcohol use and problems significantly predicted lower levels of shyness and higher levels of sociability. In multivariate analyses which control for socioeconomic status and all the other dimensions of parental alcohol use and problems, only maternal AC significantly predicted sociability.

Externalizing Traits

As seen in Table 4, conduct difficulties and hyperactivity assessed at 42 months were significantly and positively predicted, in the univariate analyses, by all 5 dimensions of parental alcohol use and problems. For both traits, only maternal AC during pregnancy remained a significant predictor in the multivariate analyses.

In univariate analyses, conduct disorder symptoms at age 13 were significantly and positively, albeit weakly, predicted by only maternal AC during pregnancy. In the multivariate analysis, maternal AC during pregnancy and paternal AP were significant predictors. Antisocial behavior measured at age 15 was significantly predicted by all measures although, probably because of colinearity among the predictor variables, none were significant in the multivariate analysis.

Prediction of Alcohol Consumption and Alcohol Problems at Ages 15 and 18

As seen in Table 5, in the univariate analyses, both AC and AP at age 15 were positively and significantly predicted by all dimensions of parental AC and AP. In the multivariate analysis, age 15 AC was significantly predicted by both maternal and paternal AP, and age 15 AP predicted by only maternal AP.

In univariate analyses, both AC and AP at age 18 were significantly predicted by all 5 parental alcohol factors. In multivariate analyses, age 18 AC and AP were both significantly predicted by maternal and paternal AP.

Two trends in these analyses are of possible interest. First, in the univariate analyses for age 15 AC and AP, the

Table 1. Crawford-Ferguson Quartimax Rotated Factor Loadings for Variables on Maternal Alcohol Consumption and Alcohol Problems—Robust Maximum Likelihood Loadings

Variable	Reporter	1 Maternal alcohol consumption	2 Maternal problem drinking	3 Maternal alcohol consumption during pregnancy
AC—before pregnancy	Self	**0.70**	−0.17	0.29
AC—gestation 1–3 months	Self	0.10	−0.02	**0.73**
AC—gestation—since baby first moved	Self	0.19	−0.09	**0.83**
AC—gestation—last 2 months	Self	0.41	−0.07	**0.62**
AC—8 weeks	Self	**0.65**	−0.06	0.32
AC—21 months	Self	**0.74**	0.02	0.17
AC—33 months	Self	**0.79**	0.07	0.08
AC—61 months	Self	**0.84**	0.08	0.01
AC—21 months	Partner	**0.75**	0.04	0.12
AC—33 months	Partner	**0.77**	0.12	0.04
AC—47 months	Partner	**0.85**	0.07	−0.02
AC—73 months	Partner	**0.82**	0.17	−0.06
AC—110 months	Partner	**0.77**	0.12	0.04
AP (past year)—61 months	Self	0.12	**0.77**	−0.09
AP (past 3 years)—110 months	Self	0.18	**0.67**	−0.15
AP (past 2 years)—145 months	Self	0.13	**0.66**	−0.02
AP (past 2 years)—110 months	Partner	0.19	**0.73**	−0.18
AP (past 2 years)—145 months	Partner	0.30	**0.56**	−0.09
BD—18 weeks gestation	Self	−0.29	0.47	**0.68**
BD—32 weeks gestation	Self	−0.23	0.49	**0.63**
BD—8 weeks	Self	−0.02	**0.53**	0.27
BD—8 months	Self	0.09	**0.51**	0.23
BD—33 months	Self	0.10	**0.62**	0.17
BD—61 months	Self	0.20	**0.59**	0.13
BD—21 months	Partner	0.13	**0.54**	0.18
BD—33 months	Partner	0.12	**0.64**	0.14
BD—73 months	Partner	0.20	**0.64**	0.04
BD—110 months	Partner	0.16	**0.62**	0.05
D/wk—8 weeks gestation	Self	0.11	0.00	**0.73**
D/wk—18 weeks gestation	Self	0.11	0.00	**0.79**
D/wk—32 weeks gestation	Self	0.32	−0.05	**0.66**
D/wk—85 months	Self	**0.63**	0.24	0.02
D/wk—97 months	Self	**0.62**	0.26	0.01
D/wk—145 months	Self	**0.54**	0.30	0.00

AC, alcohol consumption; AP, alcohol problems; BD, binge drinking; D/wk, drinks per week.

magnitude of the associations seen for maternal factors were somewhat stronger than those seen for paternal factors. However, by age 18, paternal measures were generally more predictive than maternal measures. Second, both maternal and paternal AC and AP were considerably more predictive of AP at age 18 than at age 15.

Maternal Age and Interactions with Sex of Offspring

Maternal age was included as a covariate in all analyses. In 4 of the 12 dependent variables we examined, maternal age was significantly (and always negatively) related to levels of emotionality, sociability, hyperactivity, and conduct disorder symptoms. We examined interactions between the sex of the offspring and our 12 dependent measures across all 5 parental alcohol-related factors. None of these 60 interactions were significant at the 1% level.

DISCUSSION

This report had 2 main goals. First, we sought to determine whether the rich longitudinal data available about maternal and paternal AC and a range of AP in the ALSPAC cohort could be well represented by a single dimension or required multiple dimensions. The answer to this was clear. Five factors were needed to explain the diversity of items on AC and AP in the mothers and factors. These factors were coherent and easily interpretable. Three of these factors described aspects of the mother's alcohol use: her general level of consumption, her drinking during the pregnancy of the ALSPAC proband, and her level of AP. The AP factor emerged from 2 major sets of items—those that reflected patterns of binge drinking and those that reflected AP. The clarity of the factor reflecting maternal AC during pregnancy was perhaps surprising as was its low correlation with maternal AP (+0.19).

Two clear factors emerged for the fathers reflecting AC and AP. These factors look very similar, in terms of item loadings, to those seen in mothers. The interfactor correlations between AC and AP in mothers and fathers were moderate (+0.51 and +0.42, respectively), suggesting some sharing but substantial independence.

The second goal of this paper was to illustrate potential differences in the predictive power of these 5 factors.

Table 2. Crawford-Ferguson Quartimax Rotated Factor Loadings for Variables on Paternal Alcohol Consumption and Alcohol Problems—Robust Maximum Likelihood Loadings

Variable	Reporter	1 Paternal alcohol consumption	2 Paternal problem drinking
AC—18 weeks gestation	Mother	**0.96**	−0.15
AC—33 weeks	Mother	**0.70**	0.22
AC—47 months	Mother	**0.65**	0.27
AC—110 months	Mother	**0.50**	0.34
AC—145 months	Mother	**0.44**	0.36
AC—before pregnancy	Self	**0.93**	−0.04
AC—18 weeks gestation	Self	**0.95**	−0.06
AC—last 2 months gestation	Self	**0.92**	−0.04
AC—8 weeks	Self	**0.93**	−0.05
AC—21 months	Self	**0.76**	0.18
AC—33 months	Self	**0.72**	0.23
AC—47 months	Self	**0.65**	0.29
AC—61 months	Self	**0.63**	0.30
AP (since birth)—8 months	Mother	0.34	**0.36**
AP (since 8 months)—21 months	Mother	0.13	**0.63**
AP (since 18 months)—33 months	Mother	0.18	**0.50**
AP (past year)—47 months	Mother	0.11	**0.57**
AP (past 2 years)—110 months	Mother	−0.18	**0.90**
AP (since 10th birthday)—145 months	Mother	−0.04	**0.78**
AP (past year)—61 months	Self	0.07	**0.66**
AP (since 5th birthday)—73 months	Self	−0.04	**0.73**
AP (past 3 years)—110 months	Self	−0.11	**0.86**
AP (past 2 years)—145 months	Self	−0.13	**0.91**
BD—47 months	Mother	0.12	**0.74**
BD—110 months	Mother	0.07	**0.71**
BD—145 months	Mother	0.05	**0.71**
BD—8 weeks gestation	Self	0.38	**0.44**
BD—21 months	Self	0.22	**0.63**
BD—33 months	Self	0.20	**0.68**
BD—47 months	Self	0.11	**0.81**
BD—61 months	Self	0.16	**0.72**
Max/d—47 months	Self	0.06	**0.69**
Max/d—85 months	Self	0.07	**0.65**
Max/d—97 months	Self	0.06	**0.67**
Max/d—145 months	Self	0.04	**0.66**

AC, alcohol consumption; AP, alcohol problems; BD, binge drinking; Max/d, maximum drinks per day.

Table 3. The Prediction of Early Childhood Temperament by 5 Dimensions of Parental Alcohol Use and Problems

Outcome	Univariate/ multivariate	Maternal typical AC	Maternal AC during pregnancy	Maternal AP	Paternal AC	Paternal AP
Maternally reported active 38–69 months	Univariate b	0.005	−0.008	0.033**	0.013	0.027**
	SE	0.011	0.011	0.011	0.012	0.011
	Multivariate b	−0.029	−0.024	0.062***	−0.007	0.022
	SE	0.019	0.014	0.017	0.018	0.016
Maternally reported emotional 38–69 months	Univariate b	0.006	0.027	−0.005	−0.006	−0.007
	SE	0.011	0.011	0.011	0.011	0.010
	Multivariate b	0.005	0.038**	−0.029	−0.011	0.004
	SE	0.019	0.014	0.017	0.018	0.016
Maternally reported shyness 38–69 months	Univariate b	−0.073****	−0.059****	−0.068****	−0.060****	−0.061****
	SE	0.011	0.011	0.011	0.011	0.010
	Multivariate b	−0.033	−0.026	−0.020	0.006	−0.035
	SE	0.020	0.020	0.017	0.018	0.016
Maternally reported sociable 38–69 months	Univariate b	0.058****	0.039***	0.033**	0.046****	0.046****
	SE	0.011	0.011	0.011	0.011	0.010
	Multivariate b	0.058**	0.011	−0.028	−0.012	0.038
	SE	0.019	0.014	0.017	0.018	0.016

AC, alcohol consumption; AP, alcohol problems; SE, standard error; b, regression coefficient.
**$p < 0.01$, ***$p < 0.001$, ****$p < 0.0001$.
Covariates included in all models were the following: sex of the offspring, age of mother at 12 weeks gestation, highest educational attainment of mother or partner, and a measure of social class based on occupation of mother or partner.

Table 4. The Prediction of Externalizing Behaviors by 5 Dimensions of Parental Alcohol Use and Problems

Outcome	Univariate/ multivariate	Maternal typical AC	Maternal AC during pregnancy	Maternal AP	Paternal AC	Paternal AP
Maternally reported Rutter Scale 42 months conduct difficulties	Univariate b	0.075****	0.106****	0.075****	0.034**	0.048****
	SE	0.012	0.011	0.012	0.011	0.010
	Multivariate b	0.017	0.092****	0.013	−0.060**	0.007
	SE	0.020	0.014	0.018	0.019	0.016
Maternally reported Rutter Scale 42 months hyperactivity	Univariate b	0.049****	0.063****	0.052****	0.030	0.037***
	SE	0.012	0.012	0.012	0.012	0.011
	Multivariate b	0.001	0.052***	0.018	−0.017	0.029
	SE	0.020	0.014	0.018	0.019	0.017
Maternally reported conduct symptoms age 13	Univariate b	0.006	0.046**	0.034	−0.001	0.030
	SE	0.014	0.014	0.016	0.014	0.012
	Multivariate b	−0.046	0.059***	0.033	−0.057	0.060**
	SE	0.025	0.018	0.024	0.024	0.020
Self-reported antisocial behavior age 15	Univariate b	0.053**	0.071****	0.086****	0.041**	0.052***
	SE	0.016	0.016	0.018	0.016	0.014
	Multivariate b	−0.030	0.051	0.067	−0.020	0.041
	SE	0.029	0.020	0.027	0.028	0.023

AC, alcohol consumption; AP, alcohol problems; SE, standard error; b, regression coefficient.
**$p < 0.01$, ***$p < 0.001$, ****$p < 0.0001$.
Covariates included in all models were the following: sex of the offspring, age of mother at 12 weeks gestation, highest educational attainment of mother or partner, and a measure of social class based on occupation of mother or partner.

Table 5. The Prediction of Alcohol Use and Problems in Adolescence by 5 Dimensions of Parental Alcohol Use and Problems

Outcome	Univariate/ multivariate	Maternal typical AC	Maternal AC during pregnancy	Maternal AP	Paternal AC	Paternal AP
Self-report AC age 15	Univariate b	0.102****	0.088****	0.155****	0.079****	0.109****
	SE	0.018	0.018	0.019	0.018	0.016
	Multivariate b	−0.023	0.022	0.127****	−0.029	0.086***
	SE	0.031	0.022	0.030	0.030	0.026
Self-report AP age 15	Univariate b	0.061***	0.069****	0.115****	0.054**	0.076****
	SE	0.018	0.018	0.019	0.018	0.016
	Multivariate b	−0.058	0.034	0.119****	−0.012	0.053
	SE	0.031	0.022	0.029	0.030	0.025
Self-report AC age 18	Univariate b	0.078****	0.052**	0.121****	0.133****	0.153****
	SE	0.019	0.018	0.021	0.019	0.017
	Multivariate b	−0.047	−0.012	0.085**	−0.010	0.121****
	SE	0.033	0.024	0.032	0.032	0.027
Self-report AP age 18	Univariate b	0.133****	0.112****	0.168****	0.143****	0.168****
	SE	0.019	0.019	0.021	0.019	0.017
	Multivariate b	−0.008	0.037	0.088**	−0.010	0.131****
	SE	0.033	0.024	0.031	0.032	0.027

AC, alcohol consumption; AP, alcohol problems; SE, standard error; b, regression coefficient.
**$p < 0.01$, ***$p < 0.001$, ****$p < 0.0001$.
Covariates included in all models were the following: sex of the offspring, age of mother at 12 weeks gestation, highest educational attainment of mother or partner, and a measure of social class based on occupation of mother or partner.

We chose to examine 3 major domains in the offspring previously shown to frequently differ in offspring of alcoholic parents (Neale, 1998; Searles and Windle, 1992). Controlling for maternal age and parental social class, we examined early childhood temperament, childhood and adolescent externalizing traits, and AC and AP at ages 15 and 18.

From the many reported results, 7 trends were noteworthy. First, all the relationships were statistically modest, explaining more than 1% of the variance in the dependent variable only when examining AC and AP at age 18. Second, the most consistent associations between parental AC and AP and early child temperament were positive with sociability and negative with shyness. We are not aware of prior studies reporting similar findings in COAs (Carle and Chassin, 2004; Jansen et al., 1995). In his review of temperamental features of COAs, Windle noted little prior evidence that "positive affective attributes" were more prominent in COAs versus controls (Searles and Windle, 1992) and Sher (1997) agreed with this conclusion with respect to the earlier literature. However, 2 prior studies have suggested that symptoms of social phobia and/or separation anxiety can reduce risks for high levels of AC or AP in adolescence (Frojd et al.,

2011; Kaplow et al., 2001). Furthermore, extraversion is associated with both AC (Malouff et al., 2007) and heavy drinking in the normal range (Martsh and Miller, 1997) in adults and adolescents and is moderately heritable (Loehlin, 1992). So, our findings might arise from genetic variants in parents that decrease social anxiety and increase extraversion and thereby increase AC (and perhaps some associated problems), which are in turn transmitted to children increasing sociability and decreasing shyness.

Third, consistent with a wide range of findings from COAs (Jansen et al., 1995; Searles and Windle, 1992; Sher, 1997), we found a modest association between measures of both AC and AP in parents and symptoms of childhood hyperactivity in their children. Fourth, on average, maternal and paternal AP contributed about equally to the traits examined in childhood and early adolescence. However, for the age 18 measures of AC and AP, paternal influences became somewhat stronger. It will be interesting to see whether this trend continues as the ALSPAC cohort ages into early adulthood.

Fifth, we did not find strong evidence for specificity in the predictions of maternal AC and AP. That is, in univariate analyses, maternal AC did not predict AC in their offspring much better than it predicted offspring AP and vice versa. Rather, there was a general trend for parental AP to be more strongly associated than parental AC with both offspring AC and AP. We speculate that this might arise because moderate to heavy drinking in adolescence might reflect risk factors more closely associated with problematic drinking rather than moderate social drinking in adulthood.

Sixth, all 3 of our measures of externalizing behaviors, measured at ages 3½, 13, and 15, were significantly predicted by maternal AC during pregnancy. Most of these effects persisted in multivariate analyses that included typical maternal AC and maternal AP. These results are consistent with the hypothesis that these effects are the result of fetal exposure to the intrauterine effects of alcohol, but they could also result from the mother–child transmission of personality traits that increase the risk of maternal AC during pregnancy. They are consistent with prior evidence for behavioral effects of intrauterine alcohol exposure (Spear and Molina, 2005), including specifically increased risk of externalizing behaviors (Sood et al., 2001). We examined whether these results could be driven by a small subgroup of mothers with quite high AC during pregnancy by looking at the relationship between AC during pregnancy—divided into 10 ordinal classes—and levels of conduct difficulties. The association was broadly linear over the range of AC, suggesting that the findings were not driven by rare outliers with very high consumption during pregnancy. Maternal AC during pregnancy was also associated with AC and AP at age 15 and AP at age 18 but in multivariate analyses, none of these effects remained significant. Overall, our data provide modest support for the hypothesis that intrauterine exposure to alcohol has an independent influence on subsequent drinking behaviors (Baer et al., 1998; Yates et al., 1998).

Seventh, a number of prior studies have examined, with mixed results, whether the effects of being a child of alcohol parents varies in boys versus girls (Belliveau and Stoppard, 1995; Neale, 1998; Sher et al., 1991). Our results were clearly negative as we found no evidence of significant interactions between our 5 parental alcohol factors and any of the examined measures of early childhood temperament, childhood, and adolescent externalizing traits.

In aggregate, these results suggest a considerable richness in the multiple pathways from parental AC and problems to temperamental, behavioral, and consummatory outcomes in their offspring. These findings have direct relevance to efforts to articulate developmental models for the cross-generational transmission of APs (Ohannessian and Hesselbrock, 2008).

LIMITATIONS

These results should be interpreted in the context of 6 potentially important methodological limitations. First, the results of factor analysis are always limited to data being analyzed. Other factors of parental alcohol use and problems might have been evidence had we included other measures. Second, our analyses are vulnerable to effects of correlated errors of reporting. Mothers were the source of much of our information on parental drinking and on early childhood temperament and 2 of the 3 measures on externalizing behaviors. However, it is reassuring to see that father reported items and AC and AP in the mother clearly loaded with the self-report measures. Also, the association of our measures of parental AC and AP was actually stronger with our 1 externalizing trait measure obtained by self-report (at age 15) than to the 2 prior measures obtained using maternal report at 42 months and age 13. Furthermore, all our measures of AC and AP in the offspring were obtained by self-report. Third, working with large samples have many advantages but also the problem that statistical significance becomes a poor guide to conceptual importance. While a number of our results were statistically robust, the associated effect sizes were quite small and would typically go undetected in moderate sample sizes. Fourth, the 12 variables that we attempted to predict with our measures of parental AC and AP were to some extent arbitrary. Our goal was to illustrate rather than thoroughly characterize the associations between parental alcohol use and problems, and offspring behaviors. Fifth, we made no attempt to clarify, at a psychological or biological level, the mediating mechanisms underlying the observed associations. These are important questions that we hope to address in subsequent analyses. Finally, as the ALSPAC cohort age, sample attrition occurred which increased with the increasing age of the cohort (Boyd et al., 2012). To obtain a sense of the possible biases introduced thereby, we predicted the presence of data on all 12 of our outcome variables from a standardized score for our 5 parental alcohol factors. Surprisingly, these odds ratios (ORs) ranged from 1.00 to 1.26, indicating that higher parental alcohol factors

predicted greater cooperation, with the highest ORs generally seen for maternal AC (typically ~ 1.20) and the weakest (and mostly nonsignificant) for paternal AP with ORs from the other 3 factors generally ranging from 1.05 to 1.15.

CONCLUSIONS

Parental AC and AP reflect complex multidimensional constructs that are not well captured by a dichotomization into family history positive and negative for alcoholism. Parental AC and AP are modestly associated with both positive features of early temperament (e.g., sociability) and more negative features (e.g., hyperactivity), with measures of externalizing behavior from early childhood through adolescence, and to measures of AC and AP in middle and late adolescence. Maternal AC during pregnancy was consistently associated with childhood and adolescent externalizing behavior even when accounting for typical maternal AC and maternal AP.

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