An inverse relationship between typical alcohol consumption and facial symmetry detection ability in young women
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An inverse relationship between typical alcohol consumption and facial symmetry detection ability in young women

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Abstract

The relationship between monthly alcohol consumption over the past 6 months and facial symmetry perception ability was examined in young sober women with typical college-age drinking patterns. Facial symmetry detection performance was inversely related to typical monthly alcohol consumption, \( r(41) = -0.57, p < 0.001 \). Other variables that were predictive of facial symmetry detection included alcohol-related hangover and blackout frequency over the past 6 months, number of alcoholic drinks over the past week, early adolescent alcohol consumption and frequency of drug use. The relationship between alcohol use and symmetry detection could not be explained by individual differences in personality, family alcoholism history or other drug use. These findings suggest the possibility of a neurotoxic effect of alcohol on facial symmetry perception ability in female undergraduate students. As similar results did not emerge for a test of dot symmetry detection, the findings appear specific to facial symmetry. No previous studies have examined the effect of alcohol history on symmetry detection. The findings add to a growing literature indicating negative visuospatial effects of early alcohol use, and suggest the importance of further research examining alcohol and drug effects on sober facial perception in non-alcoholic populations.

Keywords
alcohol consumption, visual perception, symmetry detection, facial perception, personality, family history of alcoholism, substance use

Introduction

Sober individuals with a history of alcohol use disorders show decreases in visuospatial perception and ability (e.g. Gudeman et al., 1977; Sher et al., 1997b), visual memory and learning (e.g. Donat, 1986; Beatty et al., 1997; Cellucci et al., 2000) and visual attention, information processing and spatial search/scanning times (Bertera and Parsons, 1978; Beatty et al., 1996). (See reviews by Ellis and Oscar-Berman (1989) and Evert and Oscar-Berman (1995).) Studies of adolescents and young adults with alcohol use disorders have had mixed results regarding alcohol-related visuospatial effects (e.g. Moss et al., 1994; Sher et al., 1997b; Brown et al., 2000). However, research on rats indicates that adolescent brains show significantly more damage than adult brains in response to binge drinking (Crews et al., 2000). Furthermore, fMRI studies by Tapert et al. (2001, 2004) suggest that adolescents with alcohol use disorder require more brain activity than controls to complete a spatial working memory task, and that, by adulthood, similar female adolescents go on to perform worse than controls on this task, while showing decreased parietal and frontal lobe activity. The possibility that alcohol may negatively impact cognition or perception in alcoholic adolescents or young adults (see Monti et al., 2005) or in sober social drinkers (see review by Parsons and Nixon, 1998) is concerning and deserves further study.

Women appear to be more sensitive than men to the cognitive and motor effects of specific blood alcohol levels (Mills and Bisgrove, 1983; Minocha et al., 1985). One study even suggests that, while men develop tolerance to the motor effects of alcohol, women become sensitized to these effects over time (Dougherty et al., 1998). These findings are not surprising given that women achieve higher blood alcohol levels than men with similar doses, and develop alcohol-related physical illnesses at lower alcohol exposure levels than men (see Glenn, 1993, Nixon (1994) and Nolen-Hoeksema (2004) for reviews of alcohol effects in women). Given the above evidence that alcohol can negatively impact visuospatial ability and that healthy young women may be more sensitive to the cognitive effects of alcohol than young men, further

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research is needed to determine any potential long-term visuospatial effects of alcohol use in women of different age ranges.

Facial symmetry detection is a visuospatial perceptual skill that may impact social functioning. The ability to discriminate subtle differences in facial symmetry can impact people’s judgements of attractiveness and, potentially, mate choice (Thornhill and Gangestad, 1993; Rhodes et al., 1998). Rhodes et al. (2005) have suggested that facial symmetry detection may also be useful in ‘mind-reading’, as shifts in eye direction or head direction can signal the intentions and attentional focus of others. If alcohol use can alter visuospatial skills in sober individuals, it may have long-standing effects on the ability to detect facial symmetry, a visuospatial ability. Facial symmetry detection difficulties may impact both attractiveness judgements and the ability to perceive and benefit from subtle social signals conveyed by head and facial movements.

The only study examining the relationship between alcohol consumption history and symmetry perception ability thus far, offers some support for a relationship between alcohol history and facial symmetry perception. Oinonen (2003) assessed university-age women’s performance on two symmetry detection tests on two separate occasions. She found an inverse relationship between typical alcohol consumption and improvement on the facial symmetry detection task, \( r(45) = -0.38, p = 0.01 \). More specifically, women who reported histories of low typical levels of alcohol consumption (e.g. zero to three drinks per drinking occasion) showed improved performance on the second test (which may have been due to a practise effect) whereas women who reported histories of typical consumption beyond four drinks performed worse on the second test (a significant dose effect). No relationship was found between recent typical alcohol history and performance on a dot symmetry test. These findings fit with evidence for the involvement of different brain mechanisms in facial than dot symmetry detection (Wilson and Wilkinson, 2002; Rhodes et al., 2005). Such data suggest the possibility that past alcohol use may affect visual learning performance on a facial symmetry detection test in women.

Oinonen (2003) suggested three possible explanations for the negative association between typical alcohol consumption and facial symmetry perception, any or all of which might account for associations between alcohol use history and cognitive ability. These include a neurotoxic effect, premorbid biological differences and personality differences. The numerous potential explanations for the relationship between alcohol use and cognitive ability introduce a complexity that has plagued this area of research for decades (e.g. see reviews by Tarter and Alterman (1984) and Parsons and Nixon (1998)). However, three possible explanations are each described briefly below.

**Neurotoxic effect**

Many studies have supported the hypothesis that alcohol consumption may result in damage to the brain’s structure and function (see reviews by Parsons and Leber, 1981; Leber and Parsons, 1982; Riley, 1990; Oscar-Berman et al., 1997; Berman and Hannigan, 2000). Of particular concern is a finding that non-alcoholic adults whose average alcohol consumption was seven or more drinks per week (a relatively low number) exhibited smaller brain size as measured by ventricular and sulcal size, compared to those who did not consume any alcohol (Ding et al., 2004). Each additional drink per week was associated with evidence of slightly greater brain atrophy. This study suggests that a one drink per day average has the potential to affect brain structure.

Overall relative brain functioning appears to be altered in individuals with a history of alcohol dependency. Alcoholics show reduced event-related potential (ERP) P3 amplitudes (see review by Oscar-Berman, 1987) and seem to compensate for cognitive deficits by using higher-level cognitive systems than control subjects when completing the same task (e.g. De Rosa et al., 2004; Fama et al., 2004). Similarly, fMRI studies indicate that alcoholic brain activity patterns differ from controls during spatial working memory tasks (Pfefferbaum et al., 2001; Tapert et al., 2001). Given the obvious effects of alcohol on the alcoholic brain, it is important that the impact of alcohol use be studied at all levels of use, in all populations and with all cognitive-perceptual abilities.

**Premorbid biological differences**

Lower visuospatial ability in individuals with a history of high alcohol use may have a familial or genetic component and thus be antecedent to alcohol use. Individuals with a family history of alcoholism show deficits in processing visuospatial information and deficits in visuospatial learning, regardless of age or history of alcohol use (e.g. Schandler et al., 1988; Schandler et al., 1992; Garland et al., 1993; Schandler et al., 1993; Schandler et al., 1995). While such deficits in children of alcoholics may be genetic in origin, they could also be due to prenatal alcohol exposure and associated fetal alcohol syndrome (FAS) or effects (FAE) (Olson et al., 1998; see review by Mattson and Riley, 1998). Additionally, the alcoholic family environment may deny the child adequate stimulation and education, or, because it can be particularly stressful (e.g. Sher et al., 1997a), it may cause high stress hormones to affect the brain negatively. Thus, individuals with high alcohol consumption history and a family history of alcoholism may perform more poorly on visuospatial tasks for reasons antecedent to the alcohol use that are either genetic, biological or environmental in origin.

**Personality differences**

It is possible that personality differences account for lowered visuospatial performance in individuals with high alcohol consumption. Individuals with higher alcohol exposure may be predisposed to have a higher need for excitement. These individuals may drink more alcohol as a result. Due to their need for excitement, such individuals may also become bored more easily and give less effort on testing. Thus, lower visuospatial scores in individuals with high alcohol consumption may be due to low effort or boredom (related to personality factors), rather than an actual decrement in visuospatial ability.

Previous research indicates that the following personality characteristics are associated with higher alcohol use: behavioural
disinhibition (Sher and Trull, 1994), high novelty seeking and low harm avoidance (Cloninger et al., 1988; Cloninger et al., 1995; Masse and Tremblay, 1997), and sensation- or excitement-seeking (Brown, 1996; Finn et al., 2000; Mustanski et al., 2003). Some previous studies have controlled for affects and a history of childhood learning disorders (see review by Parsons and Nixon, 1998). However, researchers have not consistently examined whether personality variables can account for lower visuospatial performance in high alcohol users (e.g. Moss et al., 1994; Beatty et al., 2000). Given that some personality factors (e.g. excitement-seeking and boredom susceptibility) may cause individuals both to drink alcohol and give less effort on tests, such factors should be controlled when examining the effect of alcohol on cognition or perception.

The present study

This study examined the preliminary finding of an inverse relationship between alcohol use history and facial symmetry detection abilities in young women with typical undergraduate student drinking patterns (Oinonen, 2003). The impact of typical monthly alcohol consumption on symmetry detection ability was examined in 45 women who completed tests of symmetry detection twice. Family history of alcoholism and personality variables that may be related to both alcohol use and test-taking were also examined. However, the primary focus of the study was to examine the relationship between alcohol use history and facial symmetry detection.

Method

Participants

A total of 257 women in introductory psychology courses completed a screening questionnaire for a study on ‘factors affecting women’s health’ (73% return rate). Fifty-two women were selected for the laboratory phase of the study. From this group, 45 women (ages 17 to 25 (M=19.56, SD=1.79) completed the entire study. Participants demonstrated a range of drinking patterns typically seen in female undergraduate students. In order to examine adequately whether three variables were related to facial symmetry detection, participants were selected with the goal of obtaining roughly equal numbers of women in both levels of the following variables: family history of alcoholism (FHP, n=24; FHN, n=21), typical alcohol consumption (low, n=22; high, n=23) and total personality score (low, n=22; high, n=23). ‘Low’ typical alcohol consumption women reported current typical consumption of less than or equal to those described earlier, and the number of times they vomited due to alcohol use (0 (never) to 4 (more than 12 times); 6 month blackout frequency), and (c) frequency of drinking alone (0 (never) to 4 (every time I drink); past 6 months was measured using two questions assessing: (a) ‘average number of drinks’ per drinking occasion over the past 6 months (0 (none), 1 (one to three), 2 (four to seven), 3 (eight to twelve), 4 (more than twelve)) and (b) ‘typical frequency of alcohol consumption’ (0 (never), 1 (once or twice a month or less), 2 (once or twice a week), 3 (three to four times a week), 4 (almost every day)). These questions have high 17 day test–retest reliability, r(65)=0.92, p<0.001; r(65)=0.80, p<0.001, respectively (Oinonen, 2003). The two items were used to create an estimated typical number of drinks per month score (based on the past 6 months) (e.g. Cellucci et al., 2000). Using the lowest and highest possible number of drinks per month, a mean typical number of drinks/month score was calculated. For example, typical consumption of four to seven drinks once to twice a week has a possible range of typical monthly alcohol consumption between 16 and 56 drinks/month. Mean typical number of drinks/month over the past 6 months would be 36. This method of calculating typical drinks/month captures month-to-month variability in drinking patterns, provides an interpretable measure of consumption, and was highly correlated with number of drinks over the past week, r(42)=0.89, p<0.001. The same method (i.e. calculating a mean based on lowest and highest possible responses) was used to calculate typical drinking frequency per month and typical number of drinks per drinking occasion.

Additional alcohol exposure variables were assessed. During the second testing session, participants reported the number of alcoholic drinks consumed in the past week (number of drinks between test sessions). Participants also provided the age they ‘first took one or more drinks of alcohol’ (age of first alcoholic drink) and age of first alcohol intoxication. Five-point scales were used to assess frequency of: (a) waking up with a ‘hangover’ due to alcohol use the previous night (0 (never) to 4 (most mornings); 6 month hangover frequency), (b) waking up to find that you cannot remember part of the evening before (0 (never) to 4 (more than 12 times); 6 month blackout frequency), and (c) frequency of drinking alone (0 (never) to 4 (every time I drink); past 6 months drinking alone frequency). Alcohol exposure history for the following age ranges was also assessed: 7–8, 9–10, 11–12, 13–14 and 15–16 years. For these time periods, participants indicated their typical frequency of alcohol consumption and average number of drinks per drinking occasion (using two scales similar to those described earlier), and the number of times they vomited due to alcohol use (0 (never) to 4 (more than 12 times/year)). An alcohol exposure up to age 16 score was calculated by summing responses on the three scales for the five age ranges.

Family history of alcoholism

Participants were classified as FHP for alcoholism or FHN, based on three criteria. FHP women
Alcohol and test-taking personality measures  A personality scale was created to measure traits that may influence both alcohol use and test-taking behaviour. Three scales were included: the NEO-PI-R’s (Costa and McCrae, 1992) excitement-seeking scale from the extraversion domain (eight items), the dutifulness scale from the conscientiousness domain (eight items) and an adaptation of Zuckerman’s (1994) Sensation Seeking Scale V boredom susceptibility scale (18 items). For consistency between scales, the NEO-PI-R’s excitement-seeking scale was used as the sole family alcoholism indicator.

Two additional scales were created (low stimulation and low effort) to measure level of reported stimulation, motivation and effort during the second testing session. Both measures used the same Likert scales as in the above personality measures. High scores on the low stimulation scale (five items; alpha = 0.72) reflected a lack of excitement and high boredom during the symmetry tests. High scores on the low effort scale (four items; alpha = 0.79) indicated lower conscientiousness and sense of duty to do one’s best on the tests. These scales allowed for a more direct assessment of test-taking behaviour and motivation.

Other drug use  One item on the screening questionnaire provided an estimate of drug use other than alcohol. Using the same five-point scale as the typical frequency of alcohol consumption scale, frequency of using ‘recreational/illegal drugs such as marijuana, hash, cocaine, LSD, etc.’ was assessed.

Facial symmetry detection test (FSDT)  A computer-based FSDT (Oinonen, 2003) was administered through Microsoft PowerPoint. The test consists of 120 items (paired male faces), which differ only in terms of bilateral symmetry. The pairs are presented one at a time and the participant is asked to determine which of the two faces is more symmetrical. As work in our laboratory previously found an effect of alcohol on this facial symmetry detection without using a time limit (Oinonen, 2003), no time limit was imposed per slide. The test takes about 20 minutes to complete and is scored on the basis of the number of faces that are correctly identified as more symmetrical. Possible scores range from 0 to 120. The current study indicated good test–retest reliability over a mean of 7.7 days, \( r(45) = 0.84, p < 0.001 \).

The 120 items in this test were created from 20 black and white photographs of different male faces. Using Microsoft Photodraw, Gryphon’s Morph software, and a variation of the procedure outlined in Rhodes et al. (1998), the facial shape symmetry of each face was altered while controlling for texture/colour variations. Four versions of each face that differed in terms of level of symmetry were created: low, normal, high and perfect (see Fig. 1 for an example). Symmetry ratings of the 80 individual faces indicated that the relative perceived symmetry of the faces was in the expected order: perfect > high > normal > low (Oinonen and Mazmanian, 2006). Each item in the FSDT included two faces that differed in symmetry (i.e. low–normal, low–high, low–perfect, normal–high, normal–perfect, or high–perfect).

Dot symmetry test (DST)  The DST (Oinonen, 2003) is a computer-based test presented through Microsoft PowerPoint that is used to examine the ability to detect symmetry in non-facial stimuli. The stimuli consist of 40 different dot patterns that are either completely symmetrical or are slightly asymmetrical (see Fig. 2 for two examples). The dot patterns were created by Evans et al. (2000). Each dot pattern is presented on the screen for two seconds and then participants are asked to indicate whether or not it is symmetrical. The test takes about 5–7 minutes to complete. Participants receive one point for each correctly identified dot pattern. Possible scores range from 0–40. Test–retest reliability in the current study was \( r(45) = 0.49, p = 0.001 \). A previous study indicated the following correlations between the DST and the FSDT: \( r_s(76,65) = 0.28, r_p = 0.007, 0.001 \) (Oinonen, 2003).

Procedure  
Stage 1: screening  Students were asked to participate in a study examining factors affecting women’s health. Interested students voluntarily completed the screening questionnaire. Women were
selected for the rest of the study based on their typical alcohol consumption, family history of alcoholism and personality score.

**Stage 2: first session** Participants completed two tasks: (1) the facial symmetry detection test and (2) the dot symmetry test. The session lasted approximately 30 minutes.

**Stage 3: second session** One week after the first session ($M = 7.73$ days, $SD = 4.48$), participants returned for the second session where they completed the same FSDT and DST. They also completed the second session questionnaire.

**Analyses**

Two main types of analyses were conducted. First, one-tailed Pearson product moment or Spearman correlations were calculated to assess the relationship between the two symmetry perception scores (facial and dot symmetry scores) and three predictor variables (i.e., typical drinks/month over the past 6 months, family history of alcoholism and the total personality score). The mean facial symmetry perception score (MFSPS) and mean dot symmetry perception score were calculated by taking the mean of each participant’s symmetry perception test scores from the two laboratory sessions. Second, standard multiple regression analyses were conducted to determine the extent to which the predictor variables could account for the mean facial symmetry perception scores. Supplementary analyses further explored the relationship between alcohol use and facial symmetry detection. An alpha level of 0.05 was adopted.

**Results**

**Data screening**

Before conducting the main analyses, the multiple regression assumptions (normality, linearity, skewness, kurtosis and univariate and multivariate outliers) were examined. Three univariate outliers were found based on the standards suggested by Tabachnik and Fidell (2001). No multivariate outliers were found. Two of the univariate outliers and one additional data point showed a high residual score indicating that they did not fit well with the rest of the data. Each variable was reasonably normally distributed after the four outliers/discrepant scores had been removed, and skewness and kurtosis values fell within an acceptable range. Results were similar regardless of whether outliers were included or excluded. However, the analyses are presented here without outliers in order to meet best the assumptions of the statistical tests.

**Descriptive data and preliminary analyses**

Means and standard deviations for the two symmetry detection tests and the three predictor variables are as follows: facial symmetry perception scores ($M = 107.21$, $SD = 5.15$), dot symmetry perception scores ($M = 29.76$, $SD = 3.16$), number of alcoholic drinks/month over the past 6 months ($M = 10.05$, $SD = 12.52$), family history of alcoholism (22 (53.70%) FHP; 19 (46.3%) FHN) and total personality score ($M = 53.21$, $SD = 9.00$). The number of alcoholic drinks/month over the past 6 months was associated with the personality scale, $r(41) = 0.45$, $p = 0.002$; but did not differ based on family history of alcoholism, $r(39) = –0.10$, $p > 0.05$.

One-tailed correlation coefficients were computed between the three predictor variables and the two symmetry perception tests (see Table 1). Dot symmetry perception was not significantly related to any of the three predictor variables. However, women reporting higher monthly alcohol consumption over the past 6 months performed more poorly on the facial symmetry detection test (see Fig. 3). The total personality score was also negatively related to facial symmetry perception, indicating that women who scored higher on excitement-seeking and boredom susceptibility and lower on dutifulness performed worse on this test. Examination of correlations between facial symmetry detection and the three individual personality scales revealed that excitement-seeking was the best personality predictor of facial symmetry perception: excitement-seeking, $r(41) = –0.24$, $p = 0.068$, boredom susceptibility, $r(41) = –0.21$, $p = 0.094$, and dutifulness scores, $r(41) = 0.14$, $p = 0.199$. Finally, family history of alcoholism and facial symmetry perception were not significantly related. Thus, while family history of alcoholism is not related to facial symmetry perception performance, one’s typical monthly alcohol use over the past 6 months and one’s personality are relevant. However, the relationship between alcohol use and symmetry detection appears to be specific to faces.

Further examination of Fig. 3 suggested that the relationship between typical monthly alcohol use over the past 6 months and

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**Figure 2** Sample symmetrical and asymmetrical stimuli used in the dot symmetry test (DST). Participants are presented with one dot stimulus (e.g., one of the patterns on the right) and are asked to indicate whether the pattern is symmetrical or asymmetrical. Stimuli used with permission from C. S. Evans, P. Wenderoth, and K. Cheng, whose stimuli appeared in ‘Detection of bilateral symmetry in complex biological images’, 2000, Perception, 29, p. 35. Pion Limited, London.
facial symmetry detection may be non-linear. For women who reported consuming any alcohol, higher consumption was associated with lower facial symmetry detection performance, $r(32) = -0.63$, $p < 0.001$. However, non-drinkers showed a trend toward performing slightly worse ($M = 107.56$, $SD = 2.62$) than women reporting very low consumption (i.e. one to three drinks once or twice a month or less ($mean of three drinks/month); M = 110.20$, $SD = 3.14$), $t(17) = -1.98$, $p = 0.064$. In order to determine whether the alcohol–symmetry relationship was better characterized by a linear or non-linear relationship, sequential regression was conducted. The original typical drinks/month (past 6 months) variable was entered on the first step and the same variable was squared and entered on the second step. The squared predictor variable did not contribute to the prediction of symmetry detection above and beyond the original predictor, $R^2$ change $= 0.05$, $F(1,38) = 2.72$, $p = 0.11$. Higher order polynomials did not increase prediction either ($p < 0.05$). Thus, an inverse linear relationship appears to describe best the relationship between typical drinks/month (past 6 months) and facial symmetry detection.

Two partial correlation coefficients were conducted to examine whether each of the significant predictor variables would continue to have a significant relationship with facial symmetry perception when other predictor variables were controlled. When typical drinks/month (past 6 months) was controlled, the relationship between total personality score and facial symmetry perception disappeared, partial $r(38) = -0.01$, $p = 0.48$. However, the correlation between typical drinks/month (past 6 months) and facial symmetry perception remained highly significant when total personality score and family history of alcoholism were controlled, partial $r(38) = -0.52$, $p < 0.001$.

Main analysis

A multiple regression was conducted to determine whether mean facial symmetry perception scores could be predicted using the three predictor variables. The linear combination of the three predictors was significantly related to participants’ performance, $F(3,37) = 6.14$, $p = 0.002$, $R = 0.58$, and accounted for 33.2% of the

Table 1  Correlations between mean symmetry perception test scores and the three predictor variables ($n = 41$)

<table>
<thead>
<tr>
<th></th>
<th>Mean facial symmetry perception scores</th>
<th>Mean dot symmetry perception scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical number of drinks/month (past 6 months)</td>
<td>$-0.57^{**}$</td>
<td>$-0.11$</td>
</tr>
<tr>
<td>Personality score</td>
<td>$-0.26^{*}$</td>
<td>$-0.14$</td>
</tr>
<tr>
<td>Family history of alcoholism$^a$</td>
<td>$-0.12$</td>
<td>$-0.20$</td>
</tr>
</tbody>
</table>

Note: $t$-tests for both symmetry tests also indicated that the women with and without a family history of alcoholism did not differ in terms of symmetry perception performance (both $p > 0.05$).

* $p < 0.05$, ** $p < 0.001$. 

Figure 3  A dose–effect relationship is shown between the typical number of alcoholic drinks per month over the past 6 months and mean facial symmetry perception scores (mean of the two sessions), $r(41) = -0.57$, $p < 0.001$. Higher alcohol consumption in female undergraduate students is strongly associated with poorer facial symmetry detection abilities. The solid line is the best fitting linear regression.
variability in the mean facial symmetry perception scores (adjusted $R^2 = 0.28$). Examination of the predictor variables indicated that the women’s 6-month typical monthly alcohol consumption was the only significant unique predictor of facial symmetry perception, ($\beta = -0.55$, $t = -3.66$, $sr^2 = 0.27$, $p = 0.001$). The personality variable did not show a unique contribution, ($\beta = -0.02$, $t = -0.16$, $sr^2 = 0.00$, $p = 0.874$). These results indicate that a woman’s typical monthly alcohol consumption over the past 6 months is highly predictive of facial symmetry perception ability and that neither personality nor family alcoholism history can account for this relationship.

**Supplementary analyses**

Numerous additional measures provide evidence that higher alcohol exposure is associated with lower facial symmetry perception performance (see Table 2). Women with lower facial symmetry perception scores had a higher frequency of hangovers in the past 6 months ($r = -0.43$), an earlier age of first intoxication ($r = 0.44$), a higher frequency of memory loss due to alcohol use (blackouts) within the past 6 months ($r = -0.37$) and higher typical alcohol consumption between the ages of 11 and 12 ($r = -0.37$). A sequential multiple regression was conducted to determine whether the four significant variables in the bottom portion of Table 2 add to the prediction of symmetry performance above and beyond typical monthly alcohol use over the past 6 months. Hangover, blackout and drinking alone variables were transformed into dichotomous variables reflecting presence/absence of the behaviour. The four new predictors did not significantly add to prediction of facial symmetry detection beyond recent typical alcohol consumption. $R^2$ change = 0.09, $F(4,35) = 1.29$, $p = 0.292$. In addition, typical number of drinks/month over the past 6 months remained a significant unique predictor of facial symmetry detection ($\beta = -0.46$, $t = -2.69$, $sr^2 = 0.17$, $p = 0.011$).

Typical monthly alcohol consumption over the past six months was highly correlated with typical frequency of illegal/recreational drug use, $r_r(41) = 0.61$, $p < 0.001$. Given the negative relationship between mean facial symmetry perception scores and frequency of illegal/recreational drug use ($r_r(41) = -0.40$, $p = 0.005$), a sequential regression was undertaken to examine whether typical number of monthly drinks (past 6 months) predicted facial symmetry detection above and beyond illegal/recreational drug use (categorical variable: yes/no). The linear combination of the two predictors was significantly related to mean facial symmetry perception scores, $F(2, 38) = 10.25$, $p < 0.001$, $R^2 = 0.35$, adjusted $R^2 = 0.32$. In addition, typical number of drinks per month contributed to prediction over and above illegal/recreational drug use, $R^2$ change = 0.13, $F(1,38) = 7.62$, $p = 0.009$. Thus, illegal/recreational drug use cannot fully account for the observed relationship between alcohol use and facial symmetry detection ability.

As indicated in Table 3, the number of drinks between the two sessions (mean = 2.33, range = 0–12) was highly correlated with performance on the facial symmetry perception test during the second session, $r_r(41) = -0.46$, $p = 0.001$. Although symmetry perception appears more highly correlated with alcohol use during the week prior to testing (test 2, $r = -0.46$) than the week after testing (test 1, $r = -0.19$), these correlations are not significantly different from each other. Number of drinks during the past week and facial symmetry detection remained highly correlated when reported levels of stimulation and effort during the test were controlled for, partial $r(37) = -0.44$, $p = 0.002$; providing further evidence that personality factors and effort do not account for the alcohol–symmetry detection relationship. A significant correlation also remained when typical frequency of illegal drug use was

### Table 2

Means, standard deviations, and correlations between alcohol exposure measures and both the mean facial symmetry perception score (MFSPS) and facial symmetry improvement score (FSIS)

<table>
<thead>
<tr>
<th>Alcohol exposure measure</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>MFSPS</th>
<th>FSIS</th>
<th>r</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical drinks/month (past 6 months)</td>
<td>41</td>
<td>10.05</td>
<td>12.52</td>
<td>-0.57***</td>
<td>-0.28*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>typical drinking frequency/month</td>
<td>41</td>
<td>1.87</td>
<td>2.25</td>
<td>-0.46**</td>
<td>-0.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>typical number of drinks/occasion</td>
<td>41</td>
<td>3.66</td>
<td>2.83</td>
<td>-0.16</td>
<td>-0.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age of first alcoholic drink</td>
<td>40</td>
<td>14.15</td>
<td>2.56</td>
<td>0.33*</td>
<td>0.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age of first alcohol intoxication</td>
<td>35</td>
<td>15.26</td>
<td>2.23</td>
<td>0.44**</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Past 6 months hangover frequency</td>
<td>41</td>
<td>0.71</td>
<td>0.90</td>
<td>-0.43**</td>
<td>-0.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Past 6 months blackout frequency</td>
<td>41</td>
<td>0.51</td>
<td>0.90</td>
<td>-0.37**</td>
<td>-0.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Past 6 months drinking alone frequency</td>
<td>41</td>
<td>0.09</td>
<td>0.05</td>
<td>-0.31*</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol exposure up to age 16 score</td>
<td>40</td>
<td>4.55</td>
<td>3.81</td>
<td>-0.17</td>
<td>-0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of alcohol vomiting – age 11–12</td>
<td>40</td>
<td>0.08</td>
<td>0.27</td>
<td>-0.18</td>
<td>-0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical drinks/month – age 11–12</td>
<td>41</td>
<td>0.61</td>
<td>1.48</td>
<td>-0.37**</td>
<td>-0.32*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: a: FSIS = facial symmetry improvement scores (session two facial symmetry perception score minus session one facial symmetry perception score). Higher scores reflect greater improvement. b: excludes women who have never had this experience.

*p < 0.05, **p < 0.01, ***p < 0.001.
controlled, partial $r(38)=-0.33, p=0.02$. While a measure of drug use during the past week would have been optimal, the latter finding suggests that alcohol use within the past week may have an effect on facial symmetry detection performance that is unique to other drug use.

Additional sequential multiple regressions examined whether alcohol exposure over the past 6 months and early adolescent alcohol use contribute to facial symmetry detection performance beyond the effects of alcohol use during the past week. Alcohol consumption at ages 11–12 ($r=-0.37, p=0.008$) predicted symmetry detection over and above the number of drinks during the past week, $R=0.58, R^2=0.34, R^2\text{ change}=0.12, F(1, 38)=6.98, p=0.012$. While sequential regressions revealed a trend toward consumption over the past 6 months affecting symmetry detection above and beyond consumption over the past week, $R=0.53, R^2=0.29, R^2\text{ change}=0.07, F(1, 38)=3.83, p=0.058$; the opposite pattern was not found ($p>0.05$). Furthermore, alcohol use at ages 11–12 increased prediction over and above consumption over the past week and past 6 months, $R^2\text{ change}=0.09, F(1, 37)=5.00, p=0.031$. These results suggest the possibility of a cumulative effect of alcohol use on facial symmetry perception over time.

## Discussion

### Summary of the findings

The results indicated an inverse relationship between typical number of alcoholic drinks/month over the past 6 months and facial symmetry detection performance in female undergraduate students. The personality score was also related to performance on the facial symmetry perception test. However, family history of alcoholism was not related to facial symmetry perception performance, and none of the three main predictor variables were related to dot symmetry perception. The main multiple regression analyses provided support for the neurotoxicity hypothesis, as typical monthly alcohol consumption over the past 6 months was the only significant unique predictor of facial symmetry detection.

Strong relationships were found between facial symmetry perception and a number of indicators of alcohol exposure over the past 6 months (e.g. hangover and blackout frequency) and early alcohol exposure (i.e. age of first alcohol intoxication and alcohol exposure at ages 11–12). The number of alcoholic drinks consumed in the week prior to testing was also highly related to performance on the facial symmetry perception test. Other drug use could not account for these relationships. Overall, the results suggest that higher alcohol use (i.e. 36 drinks/month average over 6 months) is associated with poorer facial symmetry detection in women, and that both recent (i.e. past week and past 6 months) and early (i.e. ages 11–12) alcohol use contribute to this effect.

### A possible neurotoxic effect of alcohol on facial symmetry perception abilities in female undergraduate students

This study demonstrated support for the hypothesis that sober non-alcoholic women reporting higher alcohol consumption patterns exhibit poorer facial symmetry perception ability than those with lower levels of consumption. No published studies have examined this relationship. However, these results are consistent with the dissertation findings of Oinonen (2003), who found an inverse relationship between a woman’s typical number of drinks consumed and improvement on this same facial symmetry detection test over two sessions. Taken together, these two studies suggest that as typical alcohol consumption increases in young women, facial symmetry perception performance decreases. Ding et al. (2004) found that consumption of greater than or equal to 28 drinks/month (seven drinks/week) may affect the brain’s structure (i.e. enlarged ventricles and sulci). Examination of the regression line in Fig. 3 suggests that consumption of 28 drinks/month also affects facial symmetry detection ability. As neither personality nor family alcoholism history could account for the relationship between alcohol use and performance, this study supports the hypothesis that alcohol may have a neurotoxic effect.

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**Table 3** Intercorrelations between number of alcoholic drinks between the two testing sessions, facial symmetry perception scores and scales measuring stimulation level and effort/conscientiousness during the two tests ($n=41$)

<table>
<thead>
<tr>
<th>Measure</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Number of drinks* (between test sessions)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2. Facial symmetry test one</td>
<td>–0.19</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3. Facial symmetry test two</td>
<td>–0.46**</td>
<td>0.84**</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4. mean facial symmetry score</td>
<td>–0.38**</td>
<td>0.96***</td>
<td>0.96***</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>5. FSP improvement score^b</td>
<td>–0.33*</td>
<td>–0.37**</td>
<td>0.58**</td>
<td>0.16</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>6. Low stimulation scale</td>
<td>0.45**</td>
<td>–0.01</td>
<td>–0.15</td>
<td>–0.10</td>
<td>–0.17</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>7. Low effort scale</td>
<td>0.12</td>
<td>0.02</td>
<td>–0.15</td>
<td>–0.08</td>
<td>–0.19</td>
<td>0.16</td>
<td>–</td>
</tr>
</tbody>
</table>

Note: a: number of drinks between symmetry tests one and two (mean=2.33, range=0–12, $n=41$); b: FSP improvement score=facial symmetry perception improvement score (facial symmetry test two score – facial symmetry test one score).

*p<0.05, **p<0.01, ***p<0.001.
The supplementary analyses provide further evidence of a potential neurotoxic effect of alcohol and drug use on symmetry detection performance. First, indicators of early alcohol exposure (e.g., age of first alcoholic drink, age of first alcohol intoxication and total alcohol consumption at ages 11–12) were related to facial symmetry perception scores and are consistent with findings indicating early adolescent sensitivity to alcohol’s neurotoxic effects (e.g., White and Swartzwelder, 2004). Second, indicators of negative alcohol effects (e.g., past 6 months hangover frequency, past 6 months black out frequency) were associated with lower facial symmetry perception performance. The hangover frequency findings are consistent with other studies indicating that with-drain episodes are related to decreases in visuospatial (Tapert and Brown, 1999; Brown et al., 2000) and memory (Glenn et al., 1988) functioning in alcoholics. Based on a self-report question on alcohol use within the past 24 hours, we were able to rule out an acute hangover effect as an explanation for the current findings. However, performance on visual tasks appears to be significantly affected during the acute hangover phase (Kim et al., 2003). Combined with Kim et al.’s study, the present results suggest that repeated hangovers may lead to decreased visuospatial functioning. Third, higher illegal/recreational drug use was also associated with lower facial symmetry perception performance. While illegal drug use could not account for the relationship between alcohol and facial symmetry perception, alcohol abuse is associated with visuoperceptual effects similar to individuals who abuse both alcohol and other drugs (Beatty et al., 1997). Thus, the effects of specific types of illegal drugs (e.g., cannabis and cocaine) on facial symmetry perception deserve further research. It remains possible that an interaction between alcohol and other drugs is responsible for the perceptual effects.

The present findings are consistent with a growing number of studies indicating that neurotoxic effects of alcohol may arise from drinking patterns other than only long-term chronic high use. That is, fairly moderate use of alcohol (see review by Parsons and Nixon, 1998; Ding et al., 2004) or early use of alcohol (e.g., Sher et al., 1997b) appear to be associated with lowered cognitive or perceptual abilities. The effect of such patterns of alcohol use on cognition deserves further research.

Women with a family history of alcoholism did not exhibit decreased symmetry detection ability

Family history of alcoholism does not appear to be related to a woman’s performance on tests of symmetry detection. One possible explanation is that family history of alcoholism is not as predictive of alcohol use (e.g., McGue et al., 1992) or visuospatial deficits (e.g., Garland et al., 1993) in women as it is in men. It is also possible that previous findings relating family history to visuospatial performance occurred because of the timed nature of these tests combined with the possibility that FHP individuals have difficulty with response inhibition (e.g., Schweinsburg et al., 2004). The present findings suggest that any link between poor visuospatial abilities and a family history of alcoholism (e.g., Schandler et al., 1992, 1993, 1995) cannot account for the negative relationship between high alcohol consumption and low facial symmetry detection abilities.

Given that facial symmetry detection ability may affect the ability to interpret subtle facial social signals (Rhodes et al., 2005), it is possible that deficits in facial symmetry detection are premorbid to alcohol use (for reasons other than family history of alcoholism), and that these deficits may predispose individuals to increased alcohol use. That is, individuals who have difficulty predicting other people’s intentions, based on their eye and facial movements, may feel more uncomfortable in social situations. This social discomfort may initiate and maintain higher alcohol use. In the present study, women reporting a greater tendency to drink alcohol because ‘it makes me feel less self-conscious’ performed worse on the facial symmetry detection test, \( r(41) = -0.40, p = 0.005 \). However, this tendency to drink due to self-consciousness could not account for the relationship between mean monthly alcohol use (past 6 months) and facial symmetry detection, as the relationship remained when the self-consciousness variable was controlled, partial \( r(38) = -0.47, p = 0.001 \). These results seem to rule out the possibility that poor premorbid facial symmetry is the sole explanation for the alcohol–facial symmetry detection relationship. However, it remains possible that low facial symmetry detection ability predisposes women to drink alcohol and that alcohol use has further adverse effects on facial symmetry detection. This possibility deserves further study.

**Personality (excitement-seeking, boredom susceptibility, dutifulness) cannot explain the relationship between alcohol use and facial symmetry perception in women**

The results support the hypothesis that certain personality traits associated with higher alcohol use are related to lower facial symmetry detection performance. A measure reflecting high excitement-seeking, high boredom susceptibility and low dutifulness appears to be related to both alcohol consumption \( (r=0.45, p<0.01) \) and performance on the facial symmetry test \( (r=-0.26, p<0.05) \). However, the effect of these personality variables on test-taking behaviour could not fully account for the inverse relationship between alcohol consumption and symmetry perception performance, as the relationship remained when personality was controlled for.

No previous studies have examined whether personality traits affect facial symmetry detection performance. Furthermore, studies on the relationship between alcohol and cognition do not consistently control for personality (e.g., Beatty et al., 1996; 2000; see review by Parsons and Nixon, 1998). While the relationship between personality and symmetry perception performance requires replication, and our study suggests that neurotoxicity of alcohol is the more important factor affecting symmetry perception, these findings indicate that it may be useful to control for personality in future studies examining the relationship between alcohol use and cognition or perception.

**Facial symmetry detection mechanisms**

Facial symmetry detection ability is a visuospatial perceptual skill that may be unique from other types of facial perception and other
types of symmetry perception. Experiments by Rhodes et al. (2005) indicate that although facial symmetry detection shares characteristics with other aspects of face perception (i.e. better for upright normal faces than inverted faces or contrast-reversed faces), facial symmetry detection differs in that it is more sensitive to $45^\circ$ deviations from vertical. They also found that facial symmetry detection differs from low-level symmetry detection (e.g. dot symmetry) in that facial symmetry detection is sensitive to spatial scale. The latter finding fits with Wilson and Wilkinson’s (2002) study suggesting that separate symmetry detection mechanisms may underlie the perception of symmetry in dot patterns versus faces. Our findings provide further evidence that dot and facial symmetry detection involve different symmetry detection mechanisms and, likely, different cortical areas. However, while our study suggests that the mechanisms underlying facial symmetry detection (e.g. V4, Wilson and Wilkinson, 2002) may be more sensitive to the effects of alcohol, it is necessary to replicate these findings using two symmetry tests that are identical (e.g. stimulus presentation times) other than the type of stimuli used (i.e. faces vs dots).

**General discussion and Summary**

The main limitations of this study are the lack of controls for intelligence and history of head injury, and the sample size. However, the sample size is comparable to other studies on cognitive effects of alcohol (e.g. Schandler et al., 1992; Beatty et al., 1996) and the relationship between alcohol use and symmetry perception appears to be a strong robust one. This study has four primary strengths. First, it examined facial symmetry perception, a perceptual variable that has not previously been examined in the alcohol literature. Second, three potential confounds of the relationship between cognition and alcohol were controlled: family alcoholism history, personality and illegal drug use. Third, the dependent variable, facial symmetry detection performance score, was measured twice in order to obtain a more reliable mean score. Fourth, each predictor variable was measured using multiple questions. This enhanced the reliability and validity of the final scores.

This study provides support for the hypothesized inverse relationship between typical monthly alcohol consumption and facial symmetry detection test performance in female undergraduate students. These results are consistent with numerous other studies that have suggested a detrimental effect of alcohol on visuospatial ability. Although personality was related to symmetry detection performance, personality could not account for the effects of alcohol consumption. Family alcoholism history could not explain the relationship either. Overall, the findings suggest that some young sober non-alcoholic women may already have reduced perceptual visuospatial abilities due to alcohol use. Potential implications of decreased facial symmetry perception ability include: altered perceptions of facial attractiveness and difficulty inferring emotions and intentions from minor facial movements.

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