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COGNITIVE EFFECTS

Deficits in Affective Prosody Comprehension: Family History of Alcoholism versus Alcohol Exposure

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Abstract — Background: Abstinent alcoholics have deficits in comprehending the affective intonation in speech. Prior work suggests that these deficits are due to alcohol exposure rather than preexisting risk factors for alcoholism. The present paper examines whether family history of alcoholism is a contributor to affective prosody deficits in alcoholics. **Methods:** Fifty-eight healthy, nonabusing young adults with and without a family history of alcoholism or other substance abuse (29 FH+ and 29 FH−) were compared on affective prosody comprehension using the Aprosodia Battery. A secondary analysis was done comparing affective prosody comprehension in FH+ and FH− detoxified alcoholics from an earlier study (17 FH+ and 14 FH−). **Results:** Performance on the Aprosodia Battery was not related to FH status in either the healthy, nonabusing sample or in the detoxified alcoholic group. **Conclusions:** The present study lends support to previous research suggesting that deficits in affective prosody comprehension observed in detoxified alcoholics are associated with a history of heavy drinking rather than with a family history of alcoholism.

INTRODUCTION

The present study was carried out to determine if a family history of alcoholism (FH+) predicts impaired emotional comprehension in otherwise healthy young adults. Alcohol and other substance use disorders may involve dysregulation of emotional and motivational systems in the brain and in turn, persons at risk for such disorders may have preexisting alterations in emotional regulation (Koob, 2000; Lovallo, 2006). In keeping with this idea, patients with substance use disorders show impaired comprehension of emotionally relevant stimuli. Alcoholics and patients with opiate dependence have impaired recognition of emotions displayed in faces (Kornreich *et al*., 2003), both at the end of detoxification (Philippot *et al*., 1999) and 3 months later (Foisy *et al*., 2007).

Emotional comprehension deficits in detoxified alcoholics are not confined to facial emotions but also involve emotional cues in speech (Monnot *et al*., 2001). Affective prosody is the ‘melody of speech’ that provides emotional and attitudinal information to the listener during discourse (Monrad-Krohn, 1963; Ross, 2000). Such cues are very important in conveying the speaker’s state of mind, and listeners normally give greater weight to emotional information in speech when these cues conflict with the purely linguistic message (Bolinger, 1972; Ackerman, 1983). By extension, an inability to correctly perceive emotional intonation in speech can adversely affect psychosocial functioning and impair social relationships (Carton *et al*., 1999; Wymer *et al*., 2002). We previously reported, using the Aprosodia Battery (Ross *et al*., 1997), that detoxified alcoholics scored 2 standard deviations below the mean of a healthy control group when assessed on their ability to comprehend affective prosody (Monnot *et al*., 2001). Interestingly, an early age of onset of drinking predicted poorer comprehension of affective prosody. This led to the question of whether persons with more alcoholism risk factors were likely to have affective-prosodic comprehension deficits or if the deficit was associated with early alcohol exposure.

To address the influence of one risk factor for future alcoholism, we administered the Aprosodia Battery to a series of young adults taking part in the Oklahoma Family Health Patterns Project. FH+ is a major risk factor for future alcoholism, and it may be associated with altered motivation and emotional processing. Healthy, nonabusing FH+ young adults have reduced amygdala activation during exposure to emotional faces, have blunted stress cortisol responses and are more behaviorally impulsive than their FH− counterparts (Sorocco *et al*., 2006; Glahn *et al*., 2007; Saunders *et al*., 2008). These findings suggest that FH+ might differ from FH− in how they process the emotional content of social cues and threats from the environment during mental stress. As an examination of a possible role of FH+ in such deficits among alcoholics, we also examined the influence of FH+ on affective-prosodic comprehension deficits in a reanalysis of our earlier sample of detoxified alcoholics.

MATERIALS AND METHODS

Overview

A group of nonabusing FH− and FH+ young adults, who were enrolled in the Oklahoma Family Health Patterns Project (OFHP), agreed to participate in the current study. The major hypothesis of the OFHP is that alcoholism is most likely to occur in FH+ persons who have functional alterations in brain systems serving emotional experience and expression. One of the goals of the OFHP is to study non-alcohol-dependent FH+ and FH− individuals, ages 18–30 years, to identify if there are markers in the domains of temperament, cognitive function, behavior or psychophysiological reactions that predict a high risk for substance use disorders. In order to examine the influence of FH+ on affective prosody comprehension among alcoholics, we reanalyzed performance data from an earlier sample of detoxified alcoholics based on their family history classifications (Monnot *et al*., 2001).

All subjects signed a consent form approved by the Institutional Review Board of the University of Oklahoma Health Sciences Center and the Veterans Affairs Medical Center in Oklahoma City, OK, and were paid for their participation.

Subject groups

Nonabusing young adults. The present sample consisted of 58 healthy young adults, 22 men (41%) and 34 women (59%). Twenty-nine adults were FH+ and 29 were FH−. They were recruited through community advertisement from the general population of Oklahoma City, OK. They averaged 23.3 years of age and 15.1 years of education. Their race and ethnicity was 89% European American, 5% African American, 2% Native American, 2% Hispanic and 2% others. The FH subgroups were from the same socioeconomic status (SES) level. Participants were in good health, free of prescription medications and did not meet criteria for a current Axis I mental health disorder as defined by the Diagnostic and Statistical Manual of Mental disorders, 4th edition (APA, 1994). Subjects were required to pass a urine drug screen and alcohol breath test on each day of testing.

Family history classification was established using the Family History Research Diagnostic Criteria (FH-RDC; Andreasen *et al.*, 1977). The FH-RDC has a high degree of inter-rater reliability (0.95) for reports of substance use disorders (Andreasen *et al.*, 1977; Zimmerman *et al.*, 1988). Persons were considered FH+ if biological father or mother met criteria for alcohol or substance use by subject report. FH− were those reporting an absence of alcohol or substance use disorders in their biological parents and grandparents. Confirmation of the FH-RDC report by the proband was obtained by parent interview in all possible cases (79% of the total sample), disconfirmed subjects were excluded and by extrapolation, an estimated 91% of all subjects were accurately classified. Individuals were also excluded if either they or a family collateral informant indicated possible fetal exposure to alcohol or other drugs due to mother's abuse history.

Physical health was assessed through a medical history and report of current good health. Psychological functioning was assessed using the computerized version of the Diagnostic Interview Schedule-IV (DIS-IV) conducted by a research assistant certified in its administration and through the Beck Depression Inventory II (Beck *et al.*, 1996). Alcohol and drug use were assessed through the Cahalan Drinking Habits Questionnaire (Cahalan *et al.*, 2004), the Alcohol Use Disorders Identification Test (Babor *et al.*, 1992) and a Drug Use Questionnaire. The Shipley Institute of Living Scale (Zachary *et al.*, 1985) was used in combination with years of education to assess intellectual abilities.

Abstinent alcoholics. This group consisted of a subset of detoxified alcoholics (n = 31; 17 FH+ and 14 FH−) composed of 29 men (94%) and 2 women (6%) from a previous study (Monnot *et al.*, 2001) on whom reliable family history reports were available and from which subjects with a presumed history of fetal exposure were excluded. All participants previously had received treatment in a US Department of Veterans Affairs Substance Abuse Treatment Center and had received a primary diagnosis of alcohol dependence, although some also had abused other substances. Participants were recruited through advertisements posted at the Oklahoma City VA Medical Center. Subjects were included in the study if they met Diagnostic and Statistical Manual of Mental disorders, 4th edition (APA, 1994), criteria for an alcohol use disorder in remission and had maintained sobriety for at least 21 days. The median number of days from the last drink was 53. They averaged 47.1 years of age and 13 years of education. Their race and ethnicity was 45% European American and 55% African American.

Family history classification was established using the same interview techniques as described above for the nonabusing group. Although parents were not interviewed, a detailed family genogram of substance use was obtained from each subject. Depression was assessed using the Beck Depression Inventory II (Beck *et al.*, 1996). Alcohol and drug use were assessed through patient's medical records specific to their substance abuse assessment and treatment at the Oklahoma City Veterans Affairs Medical Center. Alcohol use was also assessed through the participant's self-reported Quantity–Frequency Index estimating the average number of ounces of absolute ethanol consumed per day 6 months prior to the last treatment. The Shipley Institute of Living Scale (SILS; Zachary *et al.*, 1985) was used in combination with years of education to determine intellectual abilities.

Aprosodia battery

The Aprosodia Battery assesses production and comprehension of affective prosody in speech (Ross *et al.*, 1997). Production is assessed by acoustically analyzing spontaneous speech production and the ability to repeat sentences with varying emotions using three levels of decreasing verbal-articulatory demands. Comprehension is assessed by an Identification task using three levels of decreasing verbal-articulatory demands (see below), a Discrimination task and a newly developed Attitudinal task (Orbelo *et al.*, 2005). The Attitudinal task was not yet developed when the abstinent alcoholic group was tested, so data from this subtest are only available for the nonabusing young adults. Although the Aprosodia Battery was developed originally to distinguish different profiles of affective prosodic deficits observed after right versus left focal brain damage (Ross *et al.*, 1997; Ross and Monnot, 2008), it has also been used to study several clinical populations with very robust results, including patients with fetal and early-life exposure to alcohol (Monnot *et al.*, 2001, 2002), Alzheimer disease (Testa *et al.*, 2001), leukoaraiosis (Ross *et al.*, 2005), multiple sclerosis (Beatty *et al.*, 2003), schizophrenia (Ross *et al.*, 2001) and also healthy older adults (Orbelo *et al.*, 2003, 2005). In patients with left brain damage reducing the verbal-articulatory demands improves performance, whereas in patients with right brain damage reducing the verbal-articulatory demands does not improve performance (Ross *et al.*, 1997; Ross and Monnot, 2008). Alcoholics appear to have a pattern of deficit that is a mixture of right and left brain damage with relatively normal performance on the Discrimination task (Monnot *et al.*, 2002). In the present study, only the comprehension portion of the Aprosodia Battery was administered and the Attitudinal task was only given to the nonabusing group.

The comprehension stimuli for the Aprosodia Battery were recorded on a compact disk and played through a loudspeaker at a comfortable listening level. The exemplars for the Word, Monosyllabic and Asyllabic Identification subtasks were sets of randomized utterances representing progressively reduced verbal articulatory content. Each of the sets consisted of 24 vocal stimuli uttered using two renditions of each of six emotions (happy, sad, disinterested, neutral, surprised and angry), with one rendition having emphatic stress early in the utterance and the other having emphatic stress late in the utterance. For Word Identification, the utterances were carried by the sentence 'I am going to the other movies', for Monosyllabic Identification the utterances were carried by 'ba ba ba ba ba ba ba' and for Asyllabic Identification the utterances were carried by 'aaaaahhhhh'. Subjects were asked to identify the emotional intonation of each utterance by choosing the appropriate affect from a vertical array of six line drawings of faces expressing different affects, next to the corresponding written label of 'neutral', 'happy', etc. Before testing, each subject demonstrated the ability to identify the facial expressions and to read the written label.

The Discrimination stimuli were the same as those used for Word Identification, but they were first subjected to band-pass filtering between 70 and 300 Hz (using a Krohn–Hite Model 3550 Variable filter), a process that distorts the phonetic information while leaving prosodic information intact (Lenhardt, 1978). Twenty-four pairs of stimuli were recorded; the members of 12 of the pairs had the same affective intonation but with different stress patterns, while the members of the other 12 had different intonations but with the same stress pattern. Subjects were asked to indicate whether the emotions represented within each pair were the same or different. The scores for each task were the total number of correct responses out of 24.

The Attitudinal stimuli, consisted of 10 sentences, such as 'This looks like a safe boat' and 'That was a smart thing to say', recorded twice by a female speaker, once with a sincere tone of voice and once with a sarcastic tone of voice. The resulting 20 sentences were randomized and recorded twice on audio compact disk for a total of 40 test sentences. Subjects were asked to decide if the statements were 'true' for a sincere tone of voice or 'false' for a sarcastic tone of voice.

Statistical analysis

Demographic variables were analyzed by Student's *t*-test and the χ^2 test. The results of the Aprosodia Battery were analyzed using multivariate analysis of variance (MANCOVA; SPSS 8.0, SPSS Inc., Chicago, IL, USA). Alpha was set at 0.05 and no correction was made for multiple comparisons to prevent committing a Type II statistical error because we did not want to overlook a potentially subtle effect. Effect sizes are indicated by omega-squared (ω^2). Homogeneity of variance between FH groups was assessed using Levene's Test of Equality of Error Variances. Variances were found to be equal between the groups across all DVs (Ps > 0.05).

RESULTS

Nonabusers

Demographic variables in nonabusers are reported in Table 1. FH subgroups did not differ on the Shipley Institutes of Living Scale, as a measure of intelligence, or on use of alcohol as measured by the Cahalan Drinking Habits Questionnaire and AUDIT. The FH− group was slightly younger than the FH+ group ($t = -2.20$, $P = 0.03$). The FH+ reported significantly lower SES than the FH− ($t = 2.71$, $P = 0.01$), although both groups remained within the same social stratum (medium business, minor professional, technician). FH+ scored higher than FH− on the BDI-II ($t = -3.10$, $P = 0.003$), but neither group scored in the clinically significant range for depression.

Table 1. Subject characteristics of the nonabusing group

Subject characteristics	FH− ($N = 29$)	FH+ ($N = 29$)		
Demographics				
Men (%)	52	31	–	–
Age (years)	22 (0.5)	24 (0.7)	−2.20	0.03
Caucasian (%)	97	83	–	–
SES ($N = 54$)	50.4 (2.3)	41 (2.8)	2.71	0.01
Education	15.6 (0.38)	14.6 (0.38)	1.92	0.06
Shipley vocabulary	29.9 (0.68)	30.1 (0.53)	−0.20	0.84
Shipley abstraction	15.7 (0.75)	16.1 (1.1)	−0.36	0.72
Shipley mental age	14.2 (0.24)	14.3 (0.27)	−0.33	0.74
Self-report measures				
AUDIT	3.2(0.47)	2.9 (0.46)	0.47	0.64
Cahalan volume	49 (6.4)	40 (6.0)	1.02	0.31
BDI-II	3.4 (0.6)	6.5 (0.82)	−3.10	0.003

Entries show M (SE).

Table 2. Comprehension scores and MANCOVA results for the nonabusing group

Subtests	FH− mean (SEM)	FH+ mean (SEM)	$F(1, 46)$[a]	P-value	ω^2
Word	22.2 (0.4)	21.8 (0.4)	0.53	0.47	−0.07
Monosyllabic	22.4 (0.4)	20.8 (0.4)	5.72	0.02	0.09
Asyllabic	20.5 (0.6)	19.7 (0.6)	0.67	0.42	0.20
Discrimination	22.5 (0.6)	21.2 (0.5)	2.01	0.16	−0.05
Attitudinal	35.8 (0.7)	34.4 (0.6)	2.12	0.15	0.13

[a]Univariate *F*.

FH subgroups were comparable on Aprosodia subtest scores (Table 2). For the Identification subtests, the FH− subgroup had 89.4% accuracy and the FH+ subgroup had 87.6% accuracy in their attempts to correctly identify the emotion in the recorded exemplars. On the Discrimination task, the FH− subgroup was 92.9% accurate and the FH+ subgroup was 89.6% accurate. On the Attitudinal task, the FH subgroups were also identical in their accuracy in identifying sincere versus sarcastic tones of voice (accuracy FH− group = 87.8%; accuracy FH+ group = 87.5%).

MANCOVA, controlling for age, sex, SES, BDI and education, revealed no significant differences between FH groups the comprehension tasks [Wilks' Lambda $F(5, 42) = 1.17$, $P = 0.34$]. Despite this non-significant effect across the comprehension tasks, when examined individually there was a significant effect of FH on the monosyllabic task when controlling for age, sex, SES, BDI and education [$F(1, 46) = 5.72$, $P = 0.02$].

Abstinent alcoholics

Demographic variables are reported in Table 3. There were no significant differences between age and education for FH subgroups. In terms of alcohol consumption prior to treatment, the detoxified alcoholic FH subgroups did not differ on the Cahalan Quantity Frequency Index (Cahalan *et al*., 2004). The FH subgroups also did not differ in intellectual abilities as

Table 3. Subject characteristics of the detoxified alcoholic group

Subject characteristics	FH− ($N = 14$)	FH+ ($N = 17$)	t	P
Demographics				
Men (%)	100%	88%	–	–
Age (years)	47.1 (1.9)	47(1.8)	0.05	0.96
Caucasian (%)	57%	35%	–	–
Education	12.9 (0.4)	13.1 (0.3)	−0.27	0.79
Shipley vocabulary	16.2 (0.6)	16.0 (0.6)	0.16	0.88
Shipley abstraction	13.0 (0.9)	14.1 (0.7)	−0.94	0.36
Shipley mental age	14.4 (0.7)	15.1 (0.7)	−0.69	0.49
Self-report measures				
QFI	12.3 (2.3)	15.5 (3.03)	−0.79	0.44
BDI-II	18.9 (3.5)	14.9 (3.8)	−0.75	0.46

Entries show M (SE).

Table 4. Comprehension scores and MANCOVA results for the alcoholic group

Subtests	FH− mean (SEM)	FH+ mean (SEM)	$F(1, 22)$[a]	P-value	ω^2
Word	20.5 (0.7)	19.9 (0.6)	0.39	0.54	−0.12
Monosyllabic	18.3 (0.8)	18.5 (0.6)	0.05	0.83	−0.02
Asyllabic	17.3 (0.8)	18.4 (0.7)	1.01	0.33	0.06
Discrimination	22.0 (0.5)	20.5 (0.4)	4.28	0.05	0.20

[a]Univariate *F*.

measured by the Shipley Institute of Living Scale (Zachary *et al.*, 1985).

As can be seen in Table 4, FH subgroups within the abstinent alcoholic sample were comparable on Aprosodia subtest scores. For the identification subtests, the FH− subgroup had 80% accuracy and the FH+ subgroup had 79% accuracy in their attempts to correctly identify the emotion in all the recorded exemplars. On the discrimination task, the FH− subgroup was 90.2% accurate and the FH+ subgroup was 85.5% accurate.

Similar to the nonabuser sample, a MANCOVA, controlling for age, sex, BDI and education, revealed no significant differences between FH groups across the comprehension tasks [Wilks' Lambda $F(4, 19) = 1.45$, $P = 0.26$]. Despite this nonsignificant effect across the comprehension tasks, when examined individually there was a marginally significant effect of FH on the discrimination task when controlling for age, sex, BDI and education [$F(1, 22) = 4.28$, $P = 0.051$].

DISCUSSION

The two analyses presented above show that FH+ subjects do not score lower than FH− across tasks assessing comprehension of affective prosody. Monnot *et al.* (2001) found that detoxified alcoholics scored 2 standard deviations below the control mean on affective prosody comprehension. These deficits in affective prosody comprehension among the alcoholics were more severe in those who had an earlier onset of regular alcohol consumption. This raises the question of whether the deficits in comprehending emotional cues in speech were a reflection of risk factors for alcoholism or if they derived from drinking itself.

To examine the effect of FH independent of a heavy drinking history, we compared healthy FH+ and FH− individuals from our sample of nondependent young adults. Subjects in the younger sample were not fetally exposed, were not alcohol dependent and did not have histories of heavy drinking or substance abuse. Their comparable performance on the comprehension subtest of the aprosodia battery therefore allows us to eliminate familial risk as a primary cause of deficient performance of the previously tested abstinent alcoholics. Thus, the present results allow us to more clearly interpret our earlier finding of affective-prosodic comprehension deficits in alcoholics as being due to alcohol exposure and not to preexisting factors, such as family history. This conclusion is bolstered by the fact that our earlier and older sample of abstinent alcoholics performed worse than their age-matched controls (Monnot *et al.*, 2001), suggesting that their deficits were not age related. The specific neural deficits caused by alcohol that impact affective prosody comprehension are not known at present. However, the findings point to a significant, partially debilitating social processing deficit in alcoholics as a function of an early age at first exposure and duration of heavy drinking. The negative effect of an early onset of heavy alcohol use on affective prosody comprehension suggests a vulnerability in parts of the brain that are not fully mature during adolescence, including the prefrontal cortex (Clark *et al.*, 2008).

A possible limitation that arises is the sensitivity of the Aprosodia Battery, which was originally designed to assess patients with focal brain lesions (Ross *et al.*, 1997). However, our sample of abstinent alcoholics was free of neurological impairment but nonetheless showed relatively severe comprehension deficits relative to the age-matched controls. The fact that we found no reduction in affective prosody comprehension in FH+ within the present population of healthy nonabusing young adults or within the earlier alcoholic sample would indicate that the results of the earlier study (Monnot *et al.*, 2001) are most likely due to alcohol exposure rather than FH+. A second question that arises is the effect of age in the alcoholic sample. Could the alcoholics' prosody comprehension deficits reflect their greater age? The multiple differences between these two subject samples preclude a simple analysis of the effect of age on affective-prosodic comprehension in a combined sample. However, Monnot *et al.* (2001) did not find that age was a factor in predicting severity of deficit in affective-prosodic comprehension in their expanded abstinent alcoholics and controls in a combined sample that ranged in age from 25 to 63 years. Also, research by Orbelo *et al.* (2003, 2005) shows that age-associated effects on comprehension of affective prosody are not present in healthy controls under the age of 65 years. The two groups examined here also had different proportions of male and female subjects. However, to date, no sex effects have been observed for any of the affective-prosodic comprehension subtests of the Aprosodia Battery (Orbelo *et al.*, 2003, 2005). Finally, other risk factors for alcoholism, such as exposure to traumatic life events, have not been assessed, but should be addressed in future research.

CONCLUSIONS

A positive family history of alcoholism is not associated with deficits in the comprehension of affective prosody. Deficits in the comprehension of affective prosody previously observed in detoxified alcoholics are more likely to be the direct result of toxic effects of ethanol on the brain.

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