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Alcohol effects on variability of timing responses to single-ear or dual-ear stimulation

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University students were given timing tasks after a 30-min ingestion period of alcohol (0.4 g/kg). Intertone intervals to be matched were presented either to both ears or to the left ear only. Compared with controls, subjects receiving alcohol were found to show reduced timing variability (time estimate variance and Fourier transforms of the estimates) when tones were presented to both ears, but not to the left ear only. Control subjects displayed a smaller variability of timing responses for tones presented to the left ear than for tones presented to both ears, but these differences were either reversed or eliminated by alcohol. The results are discussed in terms of a variability hypothesis of alcohol effects.

It has been suggested that behavioral variability is dependent upon the functional complexity of the nervous system (Crow, 1977, 1985). Various kinds of brain lesions and drug effects have been shown to reduce behavioral variability in both rats and humans (Crow & Hirdler, 1985; Crow & McWilliams, 1979).

Lateralization of hemispheric efficiency in processing auditory information has been shown by single-ear sound presentation for several tasks, including reaction time (Provins & Jeeves, 1975) and melodic pattern appreciation (Kimura, 1967). For several tasks, smaller within-subjects variance has been noted for monaural than for binaural stimulation (Bryden, 1978; Crow, Converse, & Jones, 1987).

The present study was undertaken to extend the findings that bear on the hypothesis (Bryden, 1978) that within-subjects variance differences in single- versus dual-hemispheric activation are due to intrinsic functional differences between the right and the left hemispheres.

METHOD

Subjects

The subjects were students at Western Washington University. There were 27 in the alcohol group and 31 in the control group.

Apparatus

An Atari PC was used to produce the tones via stereo headphones and to perform the data analysis. Timing latency variances were obtained on-line after each five-tone set. An IBM PC was used for the Fourier analysis.

Procedure

The subjects were instructed to match varying tone intervals that were presented through headphones. There were five sequences of five intertone sets in which the sounds were spaced 3 sec apart, followed by five additional sequences of five intertones (sets) spaced 5 sec apart. Tone (2500 Hz) durations were 0.5 sec. There was a 15-sec intertrial interval between each five-intertone set. The monaural group received tones via the left ear only, and the binaural group received tones in both ears.

Alcohol

The subjects in the experimental group were given ethanol via table wine in an amount that was 0.4 g/kg. A 30-min ingestion period was followed by the approximately 20-min experimental timing session.

RESULTS

Timing accuracy scores (mean response times for each of the two matching conditions, 3 sec or 5 sec) were obtained on-line for each subject during the course of the session. The variance of these responses (timing variance scores) for each subject was also obtained on-line from the total of all time-matching responses. The means of the subjects for particular presentation conditions were computed subsequently.

In addition, fast Fourier transforms were obtained for the first eight timing responses for each subject. Since successive coefficients get closer and closer to zero, estimates of variability were obtained by subtracting from the first sine coefficient the remaining "residual" coefficients. Data presented in the tables represent means of this Fourier variability index for each subject. Larger negative numbers reflect smaller variability scores.

Table 1 gives a summary of the response variability data for control subjects for the left-ear and both-ear stimulus presentation conditions for each timing condition. Both the intersubject variability (individual variability), shown as Variance, and the intrasubject variability (response variability), shown as Mean, are less in the monaural condition than in the binaural condition. *F* ratios for sample variances are significant. There were no significant differences in mean timing accuracy between the left-ear and both-ear control groups for either the 3-sec or the 5-sec interval [$t(29) = .716$; $t(29) = .655$].

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Table 1
Timing Variance and Fast Fourier Transform Data for Control Subjects in Left-Ear and Both-Ear Stimulus Presentation Conditions

	Condition		
	Left-Ear	Both-Ear	$F(14,15)$
	3-sec Tone Interval		
Variance	1.152	724.510	628.91
M	1.159	7.902	6.82
	5-sec Tone Interval		
Variance	0.760	188.220	247.66
M	1.085	4.975	4.56
	Fast Fourier Transform		
	−5.538	−3.988	

Table 2 shows analogous data for those subjects given alcohol prior to the tests. The differences between the monaural and binaural presentations are either reversed or eliminated. There were no significant differences in timing accuracy between the groups for either the 3-sec or the 5-sec interval [$t(24) = 1.495$; $t(24) = .035$].

Considering the control and alcohol grouping, by all measures, alcohol reduced the inter- and intrasubject variability of behavior in the binaural condition. With *df* = 14 and 13, the *F* ratios for variance and mean for the 3-sec and 5-sec time periods were 2863.7, 13.93, 1214.3, and 8.09, respectively. There also was no difference between accuracy of control and alcohol groups for either the 3-sec or 5-sec intervals [$t(26) = .672$; $t(26) = .634$].

DISCUSSION

The results support earlier studies that indicated greater intersubject variance (individual variability) with binaural than with monaural stimulus presentation conditions (Bryden, 1978). The present results also are consistent with previous work (Crow et al., 1986) that indicated greater intrasubject variability in timing responses (response variability) with binaural than with monaural stimulation. In addition, the present results suggest that this apparently hemispheric differential in response variability is eliminated by alcohol. The results that bear on the effects of alcohol upon timing variability in those subjects receiving only binaural stimulation support the general body of findings that relate to alcohol-induced behavioral stereotypy (see Crow, 1985).

Table 2
Timing Variance and Fast Fourier Transform Data for Alcohol Subjects in Left-Ear and Both-Ear Stimulus Presentation Conditions

	Condition		
	Left-Ear	Both-Ear	$F(12,13)$
	3-sec Tone Interval		
Variance	1269.390	0.253	5017.35
M	14.701	0.567	25.93
	5-sec Tone Interval		
Variance	0.635	0.155	4.096
M	0.682	0.615	1.11
	Fast Fourier Transform		
	−5.161	−6.274	

If lower timing variances are equated with higher levels of performance, a left-ear (or right-hemispheric) superiority is not surprising, because timing is usually associated with the right side of the brain. By the same token, a left-brain interference (both-ear stimulation) may be considered a basis for the larger variances seen under those conditions. Alcohol effects on the timing behavior using left-ear (right-brain) stimulation are, if anything, to increase variability that could be considered disruptive. This account of the data is consistent with Bryden's (1978) view that functions peculiar to each hemisphere explain the difference in variances seen with monaural versus binaural stimulation.

The fact that alcohol's main effect was to decrease timing response variability (in only one of the four instances, 3-sec tone interval to the left ear, was alcohol not associated with low variance) leads one to consider, in addition, that common functions within each hemisphere were altered, as well as those that were hemisphere-specific. It has been reported, for example, that the alcohol induction of stereotypic behavior by rats is blocked by central acetycholine depletion, which suggests a specific basal forebrain involvement (Stridham & Devenport, 1987).

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