Abnormal & Social Psychology, 1963, 66, 429-436.

CRAIG, K. D., & LOWERY, H. J. Heart-rate components of conditioned vicarious autonomic responses. *Journal of Personality & Social Psychology*, 1969, 11, 381-387.

DILOLLO, V., & BERGER, S. M. Effects of apparent pain in others on observer's reaction

time. *Journal of Personality & Social Psychology*, 1965, 2, 573-575.

KOBASIGAWA, A. Observation of failure in another person as a determinant of amplitude and speed of a simple motor response. *Journal of Personality & Social Psychology*, 1965, 1, 626-630.

Cross hearing—air conduction or bone conduction

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Unilaterally anacusic Ss were given pure-tone threshold tests in each ear, with and without the good ear plugged. The threshold shift produced by the plug was less for the bad ear than for the good ear. Since interaural attenuation was unaffected by the plug, it was concluded that cross-hearing occurs via bone conduction.

The phenomenon of cross-hearing has held interest by both auditory researchers and clinicians for some time. In recent years such lateralization has been accepted by most to occur via bone rather than air conduction. Recently, Chaiklin (1967) carried out an experiment on this subject and while the present writers were unaware of his research, the startling similarity between both methodology and results represents a strong reinforcement of Chaiklin's findings. The references found in Chaiklin's article provide the reader with excellent background of the theoretical and clinical concepts of cross-hearing.

METHODS AND HYPOTHESIS

The six Ss (four male, two female) ranged in age from 12 to 31, with a mean age of 19.7 years. All Ss had normal hearing in one ear and a total sensorineural hearing loss in the other.

A Grason-Stadler E-800 Bekesy audiometer with standard earphones and cushions was used. One phone was used for testing and the other was dead. Each S was given 2 min of fixed frequency tracing of auditory threshold for pulsed tones (attenuation rate 2.5 dB/sec) at octave points from 250 to 8,000 Hz. The following data were obtained: (1) Tracing the bad ear with the good ear unoccluded. (2) Tracing the good ear with the good ear unoccluded. (3) Tracing the bad ear with the good ear occluded by ear-mold fabrication material. (4) Tracing the good ear with the good ear occluded.

Since Ss with severe unilateral

sensorineural hearing losses were used, it could be inferred that whenever threshold measurements were taken at the poor ear (1), results were really the threshold of the good ear (2). The difference between Conditions 1 and 2 is the interaural attenuation (IA) for the particular frequency involved. If the measurements were repeated with a conductive loss simulated in the good ear and cross-hearing occurs by air conduction, the threshold measured at the bad ear should be elevated by the approximate amount of the conductive loss in the good ear. If, on the other hand, contralateralization occurs by bone conduction, the threshold measured at the bad ear (but really obtained from

Fig. 1. Mean shifts in thresholds measured at the good ear and at the bad ear.

Table 1
Means and Ranges of Interaural Attenuation

Frequency in Hz	Good Ear Open		Good Ear Plugged	
	Mean	Range	Mean	Range
250	60	40-65	74	60-80
500	58	50-65	62	45-75
1,000	62	55-80	59	50-75
2,000	62	50-70	62	55-80
4,000	73	65-85	69	60-85
8,000	62	50-80	59	40-65

the good ear) should be the same whether a conductive hearing loss is present or not.

RESULTS

The data analyzed were threshold differences 3-1 and 4-2 (cf. the conditions described above) at each test frequency. It is evident (see Fig. 1) that the threshold shift produced by plugging the ear was less for the bad ear than for the good ear, approaching zero in many cases in the bad ear. The randomization test (Siegel, 1956) showed significant differences ($p < .05$) between threshold shifts for the bad and good ears at all frequencies, except 250 Hz ($p = .063$).

Table 1 shows the IA for each S with and without a conductive loss in the good ear. These IAs are similar except for 250 Hz where there appears to be a greater IA in the occluded than in the unoccluded state. The randomization test failed to show any significant differences in IA between conditions where the good ear has a (simulated) conductive loss and where there is no conductive loss in the good ear.

DISCUSSION

The results show clearly that cross-hearing of an air-conducted signal occurs by bone conduction. It could be argued that contralateralization might have occurred initially by air conduction and was changed to bone conduction by the occlusion of the ear canal. If this were the case, the IA with the ear plugged would have been decreased by the amount of the occlusion effect, which apparently was not the case. If the sound had reached the ear by air conduction initially, changing to bone conduction would have meant that the earphone was an occluding device, and it is known that further occluding the ear by packing the ear canal should produce no further occlusion effect. Since cross-hearing apparently occurs by bone conduction, differences in phase angle may have contributed to the results observed in this experiment. No attempt was made to control for this.

REFERENCES

- CHAIKLIN, J. B. Interaural attenuation and cross-hearing in air-conduction audiometry. *Journal of Auditory Research*, 1967, 7, 413-424.
- SIEGEL, S. *Nonparametric statistics*. New York: McGraw-Hill, 1956.