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Intergenerational preferences for radio loudness during automobile driving

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ABSTRACT

Introduction: The comparative contribution to human noise exposure from the vehicular radio is unknown, as are the radio volume preferences of different generations when driving an automobile.
Materials and Methods: A single vehicle was used to measure radio listening level in decibels of three generations (age 16–17 years, age 32–50 years, and age 51–73 years) in various conditions, ranging from engine off with windows closed to 60 miles per hour (mph) with windows open.
Results: No differences in radio loudness based on the sex of the driver were found. Statistically significant differences were identified in preferred signal to noise ratio among multiple vehicular paradigms, with the youngest generation preferring the largest signal to noise ratio in conditions with low background noise.
Conclusions: The youngest generation favored the largest signal to noise ratio (radio level above background noise), a preference which waned with increasing background noise.

1. Introduction

The old tend to consider the young to be brash, inconsiderate, and loud. This study sought to determine if the youngest generation, in fact, enjoys the radio more loudly in the automobile than older generations. Most Americans have at some point pulled up to a traffic signal only to be accosted by the excessive decibels of a neighboring vehicle whose occupants seem to be invariably young to the affronted observer. Common prejudice also suggests that men are noisier than women, but whether this is true for vehicular radio usage is unknown.

Motor vehicles create noise through a variety of means. The engine, wind, tires, and radio all create sound energy. The first three factors are all known to increase with vehicle speed [1] while the impact of the radio has not been previously studied. Americans listen to an average of between 12 and 15 h of radio per week, with members of older generations listening more [2]. About 44% of radio listening occurs in the car [3] and the average American drives for 46 min per day and covers 29.2 miles [4]. The contribution of radio to overall noise exposure in a motor vehicle remains unclear.

Previous research has shown that motor vehicles can be a source of damaging noise for occupants [1,5]. Motorcycles [6] and trucks tend to be louder than automobiles and convertible vehicles generally result in more noise exposure for occupants when the roof is open [5].

Noise-induced hearing loss can occur from excessive noise exposure. Noise exposure is measured on a logarithmic scale using decibels (dB). The United States National Institute of Occupational Safety and Health (NIOSH) and the United States Occupational Safety and Health Administration (OSHA) have both established a time-weighted average maximum acceptable noise exposure (85 dB, A-weighted scale [85 dBA as an 8-h TWA]) for workers in noisy environments. NIOSH utilizes an 8 h time-weighted average permissible exposure limit of 85 dB with a 3 dB trading ratio. OSHA utilizes an 8 h time-weighted average permissible noise exposure limit of 90 dB with a 5 dB trading ratio. A trading ratio of 5 dB means that the allowable exposure time is halved for each 5 dB increase in noise level [7,8].

2. Materials and methods

This study was deemed exempt by the Institutional Review

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Board (IRB). All study participants used the same vehicle/radio to conduct the tests, a 2004 silver Acura MDX with a 3.5 L V6 engine. The four speakers in the car (one on the driver side, one on the front passenger side, and one at the base of each rear door) were set to the standard setting, equal balance between left and right (BAL 0) and equal fade between front and rear (FAD 0). The speakers were also set to the standard 0 for bass (BAS 0) and treble (TRE 0).

The measurements were performed by having the test subject sit in the driver's seat and place a digital sound monitor (Sound Meter 840029, Sper Scientific, Scottsdale, Arizona, USA) to their left ear, like a mobile phone. The fast response setting and A weighting were utilized. The device was calibrated by InnoCal, Illinois, USA. The device recorded the decibel level the ear was exposed to during the test. While conducting the stationary tests (engine off and engine idling), the subject set the radio to their preferred/normal listening volume. During the driving tests (30 mph and 60 mph), the volume was adjusted for them, and the subject would say to raise or lower it to achieve their preferred listening level prior to any measurements. The volume remained at their preferred volume level for that test condition. The tests were conducted in the same order for each subject: engine off, engine idle, driving at 30 mph, driving at 60 mph. For each one of these, either both of the window-up tests or both of the window-down tests would be conducted back to back. The opposite set, which had not been done, would then be conducted. During each condition, a total of 10 successive decibel measurements were manually transcribed by the investigator into a laboratory notebook at a comfortable pace. Decibel measurement during each test paradigm thus required approximately 20–30 s. A total of 160 measurements from 16 different test conditions were made from each participant. Peak SPL levels were not recorded.

During all measurements, there was no conversation between the occupants, the forced air mechanism of the vehicle was turned off, and there was no rain or other inclement weather. Measurements were conducted when the subject vehicle was not under any underpasses and not driving immediately adjacent to another vehicle. Measurements that occurred with the engine off or at idle were conducted with the subject vehicle at least 5 m from the nearest building to avoid noise echo from such structures.

2.1. Statistical analysis

Analysis of the signal to noise ratio (SNR) was performed. SNR was defined by subtracting the average decibel level with the radio off from the equivalent average decibel level with the radio on. SNR provided a measure of the sound level above background noise attributable to the radio at each of the measured conditions.

Descriptive statistics were used to analyze respondents' characteristics. Normality was assessed using the Kolmogorov-Smirnov test, and the assumption was met for all outcomes. An independent samples *t*-test and one-way ANOVA were used to assess the association between gender and age groups and the various outcomes, respectively. Bonferroni corrections were applied to adjust for multiple significance testing. Analyses were performed using SAS Version 9.4 (SAS Institute Inc, Cary, North Carolina). Statistical tests were two-tailed and the significance level set at $p < 0.05$.

3. Results

A total of 43 participants were studied at an average age of 45 years, of which 53.5% were males. The distribution of age group was as follows: 27.9% age 16–17 years, 39.5% age 32–50 years, and 32.6% age 51–73 years. An independent samples *t*-test revealed that there was no statistically significant difference between males and females for all the outcome variables (Table 1).

Table 2 contains the results of the one-way ANOVA with Bonferroni adjustments. When the engine was off and car windows open, individuals who were 16–17 yrs old were more likely to listen to the radio at a higher decibel (62.8 dB) compared to those age 32–50 (54.1 dB) and 51–73 years (62.8 dB), but such difference did not exist between those age 32–50 and 51–73 years. Similarly, when the engine was off and car windows closed, individuals who were 16–17 yrs old were more likely to listen to the radio at a higher decibel (63.9 dB) compared to those age 32–50 (53.8 dB) and 51–73 years (56.1 dB), but there was no difference between the 32–50 and 51–73 age group.

When the vehicle was idle with windows open, the younger individuals, age 16–17 years, were more likely to listen to the radio at a higher decibel (64.4 dB) compared to those age 32–50 (55.2 dB) and 51–73 years (57.2 dB). Likewise, with an idle vehicle and closed windows, individuals age 16–17 years were more likely to listen to the radio at a higher decibel (64.5 dB) compared to those age 32–50 (54.1 dB) and 51–73 years (58.5 dB). When the vehicle was driven at 30 mph, and the windows were open or closed, younger individuals (16–17 years) were more likely to listen to the radio at a higher decibel compared to the older counterparts (40 + years). When the vehicle was driven at 60 mph with closed windows, a statistically significant difference was found between the three age groups, with those age 16–17 years more likely to listen to the radio at a higher decibel. However, there was no statistically significant difference between the three age groups when the vehicle was driven at 60 mph with open windows.

With regards to SNR, individuals age 16–17 years were more likely to listen to the radio at higher decibel compared to those age 32–50 and 51–73 years in all of the following conditions: when the engine was off with windows opened or closed, when the vehicle was idle with windows closed, and when the vehicle was traveling at 30 mph with windows opened or closed. However, there were no differences between individuals age 32–50 and 51–73 years for all of the above outcomes.

Table 1
An independent samples *t*-test evaluating the association between gender and various outcomes, (N = 43).

	Mean ± SD		
	Males	Females	*p*-value
Engine Off Radio Off Windows Closed	39.3 ± 1.6	39.3 ± 2	0.688
Engine Off Radio Off Windows Open	47.6 ± 6.0	45.1 ± 5.1	0.777
Engine Off Radio On Windows Closed	57.4 ± 7.7	57.3 ± 7.5	0.608
Engine Off Radio On Windows Open	58.0 ± 6.6	56.5 ± 6.0	0.644
Idle Radio Off Windows Closed	44.4 ± 3.0	44.4 ± 3.5	0.482
Idle Radio Off Windows Open	50.5 ± 6.7	48.0 ± 4.0	0.076
Idle Radio On Windows Closed	59.3 ± 7.1	57.5 ± 7.2	0.785
Idle Radio On Windows Open	59.5 ± 6.0	57.2 ± 6.3	0.674
30 mph Windows Closed Radio Off	61.8 ± 2.2	61.4 ± 1.6	0.204
30 mph Windows Closed Radio On	66.9 ± 4.1	66.8 ± 5.5	0.867
30 mph Windows Open Radio Off	70.5 ± 2.9	69.3 ± 2.3	0.755
30 mph Windows Open Radio On	73.3 ± 3.6	71.9 ± 4.3	0.939
60 mph Windows Closed Radio Off	67.0 ± 1.9	66.7 ± 1.4	0.223
60 mph Windows Closed Radio On	72.3 ± 3.5	71.2 ± 4.1	0.891
60 mph Windows Open Radio Off	83.0 ± 2.9	82.2 ± 2.1	0.147
60 mph Windows Open Radio On	84.8 ± 3.6	83.5 ± 2.3	0.098
SNR Engine Off Windows Closed	18.1 ± 7.6	18.0 ± 7.6	0.510
SNR Engine Off Windows Open	10.4 ± 6.6	11.3 ± 5.0	0.053
SNR Idle Windows Closed	14.9 ± 6.7	13.1 ± 5.9	0.301
SNR Idle Windows Opened	9.0 ± 6.7	9.2 ± 4.8	0.295
SNR 30mph Windows Closed	5.1 ± 4.6	5.4 ± 5.4	0.848
SNR 30mph Windows Open	2.8 ± 3.4	2.6 ± 2.6	0.177
SNR 60mph Windows Closed	5.2 ± 4.0	4.5 ± 4.0	0.728
SNR 60mph Windows Open	1.8 ± 3.0	1.3 ± 2.5	0.404

Note: mph = miles per hour; SNR = signal to noise ratio