Car-Cophony

The effect of sound localization on speed consistency

horizon DOCTORAL TRAINING CENTRE

Research

The choice of an inappropriate speed for the current driving context is a common phenomenon. In this respect, researchers have investigated whether perceptual distortion effects can “trick” drivers into thinking they are travelling faster than reality, for instance by using specific road markings on the approach to a key junction. In this research, we consider the potential for altering speed perception through the spatial adaption of music within a vehicle.

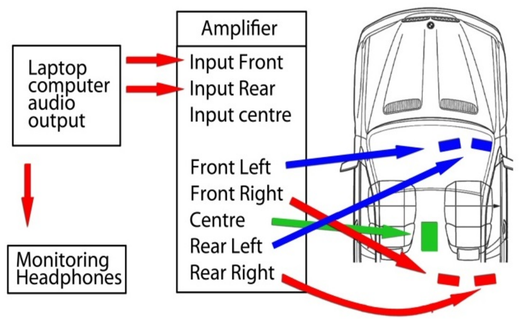
Hypothesis

Car drivers experiencing a fade of a music source from front to rear speakers will drive more slowly than drivers who experience no fade? This hypothesis considers a driver immersed within a sound source delivered on the median plane through front and rear monitors. If the music source is then faded with emphasis to the rear of the median plane would the driver perceive a shifting localization, inferring that they have moved ahead, or in the case of driving, increased their velocity of speed? If so, would the driver then sub-consciously reduce speed to be re-enveloped by the sound?

Experiment

The study took place in the University of Nottingham fixed-base driving simulator, which utilises the front half of a right-hand drive 2001 Honda Civic.

The simulator comprises of a 270° forward image, plus side and rear projection, alongside a multi layered sound environment. STISIM software was used to develop the driving scenarios and measure driving performance (i.e. speed variability, lane position). A total of 16 participants took part in the study, covering a range of ages and backgrounds. All participants held a UK driver’s license and were fairly regular drivers.



The music stimulus was a single, instrumental music selection: *Valley of the Dolls* by Mylo, taken from his album ‘Destroy Rock & Roll’ (Breastfed 2004 - catalogue no. BFD007CD). The music was broadcast via a 4.1speaker system with two monitors configured to the right-hand of the stereo channel, placed in the rear of the simulator and two monitors configured to the left-hand of the stereo channel, placed in the front of the simulator.

The study consisted of 10 measures: 5 control measures with no fade applied to the stimulus and 5 measures containing the fade from front to rear monitors. These 10 measures combined to form one continuous stimulus lasting the duration of the drive. The order of the measures were randomised across the participant group. Each measure was divided into 5 sections.

1: 0–16 sec - subjects drive at 70mph using the simulator speedometer to regulate speed.
2: 16-25 sec -subjects drive at 70mph with the speedometer turned off.
3: 25-45 sec - fade in the stimulus from front to rear monitors takes place whilst subjects aim to maintain 70mph without aid of speedometer.
4: 45-65sec - subjects continue to maintain consistent speed and drive under the influence of the fade.
5: 65-75.53 sec - a constant sine wave tone sounds over the music, providing a cue for the subjects to reduce their speed to a perceived 60mph.

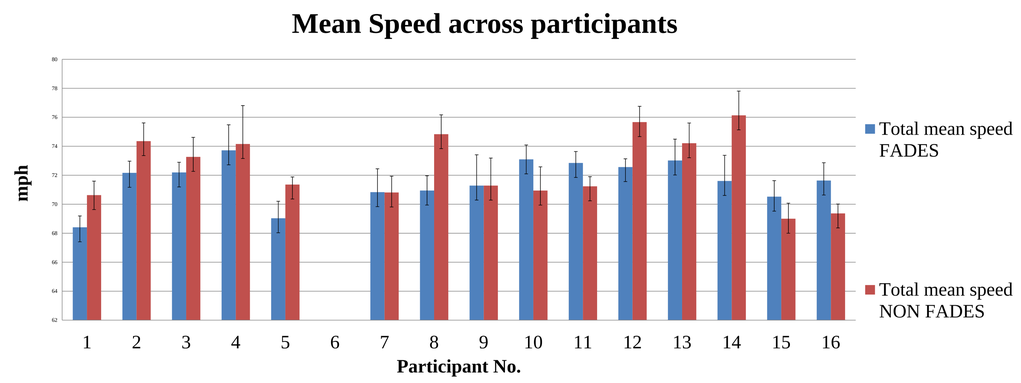
Time (sec)	0-16	16-25	25-45	45-65	65-75.53
Measure	Calibrate to 70mph		Pan	Drive	Sine Wave Tone
			Active period		
Speedometer	**ON**	**OFF**			

The introduction of the sine wave, alongside the task of speed reduction was used to mask and distract the participants from a re-calibration of the default audio balance between the front and rear monitors in preparation for the next measure.

Results

For testing for significance, one-tailed paired t-tests were used throughout and found that: There was a near significant difference in the mean speed throughout the *active period* (p=0.066) when comparing the periods when the music exhibited a fade compared to when the music maintained a fixed spatial presentation (Fig. 1). Participant 6 was excluded from analysis due to misinterpretation of study task.

Figure 1:



Specifically, participants generally drove slower throughout the *active* period when the music faded from front to rear (mean=71.6mph; SD=1.49mph) compared to when there was no fade (mean=72.5mph, SD=2.29mph) (Fig. 2).

Figure 2:

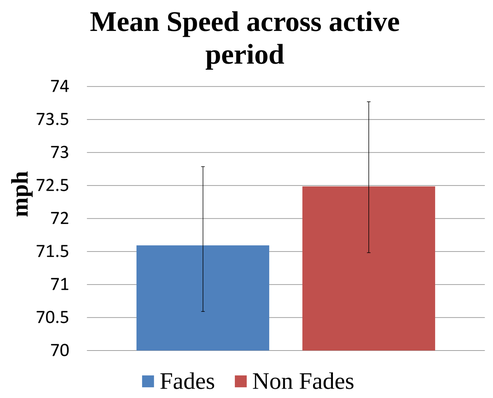
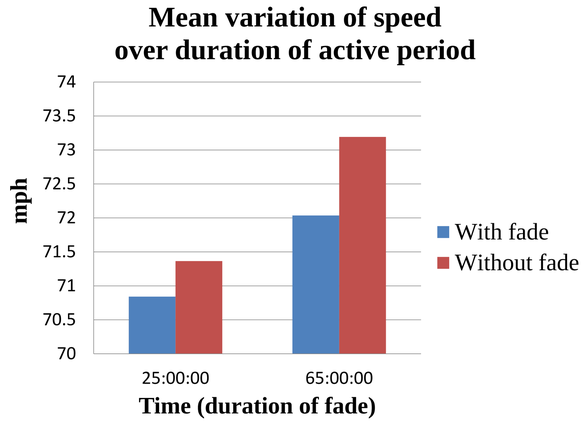


Figure 3:



Participants showed a tendency to speed up over the duration of the *active period* across both sets of fade and non-fade measures, although the fades measures demonstrated a lower increase of speed (Fig. 7). There was a significant difference in the mean speed at the end of the *active period* (p=0.035) when comparing the periods the music exhibited a fade compared to when the music maintained a fixed spatial presentation. Specifically, participants drove slower at the end of the *active period* when the music faded (mean=72.0mph; SD=2.55mph) compared to when there was no fade (mean=73.2mph, D=2.79mph)(Fig. 3).

Discussion

The near significant difference between mean speeds across the measures hints at an active response to the fade, but is not conclusive. The significant difference observed at the end of the *active period* (p=0.035) provides a positive indication of the original hypothesis. Although a gradual acceleration was observed throughout the active period over both sets of measures, those with a fade produced a consistently lower increase. The differing speed at the start of the *active period* (0.52mph) between the fade and fixed spatial measures is not significant (p=0.133), lending further weight to the measures with fade exhibiting some degree of influence on the participants speed. Post study interviews revealed that participants were not aware of alterations in the spatial presentation of the music. Such results suggest drivers naturally slowed when the music faded from front to rear speakers in an unconscious attempt to re-envelope themselves within the sound bubble. Further work will consider other variables with a larger sample.

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