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A Viable Alternative Music Background As Mediated Intervention For Increased Drivers Safety

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ABSTRACT

In-car music listening requires drivers to process sounds and words, and most sing/tap along. While it may difficult to assess music as a risk-factor for distraction, previous studies have reported: momentary peak levels in loud-music disrupt vestibulo-ocular control; loud music causes a decrease in response time; arousing music impairs driving performance; and quick-paced music increases cruising speed and traffic violations. It is indeed worrying that drivers underestimate the effects of music, or perceive decreased vehicular performance due to in-car listening. In the current study we produced an alternative music background proposed to maintain aural stimuli at moderate levels of cognitive awareness – in an effort to decrease music-generated distraction. After a group of everyday listeners confirmed the background as suitable for driving in a car, we implemented two studies: 22 drivers each drove 4-trips while listening to driver-preferred music brought from home (2-trips) or to the alternative background (2-trips); 31 drivers each drove 10-trips while listening the alternative background. In Study1 we found criterion related validity, and the alternative background preoccupied less attention. In Study2 we found habituation effects, as well as increased feelings of driver safety and ever-increasing levels of positive mood. Music designed for driver safety is an important contribution in the war against traffic accidents and human fatality. One day, such applications might become a standard form of mediated intervention – especially among young drivers who often choose music that is highly energetic and aggressive, consisting of a fast-tempo accentuated beat, played at strong intensity levels of elevated volumes.

I. INTRODUCTION

A. Background

Everyday drivers anticipate taking their music along for the ride, and they have been doing so since the 1920s. Today there are an infinite number of possibilities to outfit and customize vehicles as optimal aural-environments with remote-controlled built-in audio components including compact-disk players, changers, amplifiers, equalizers, and speakers of every configuration, as well as PC-downloadable portable devices. *In-car background music* has truly become a principle component of driving as demonstrated by a host of survey studies in North America and Europe (Arbitron/Edison, 1999; Dibben & Williamson, 2005; Quicken Insurance, 2000; Rentfrow & Gosling, 2003) and naturalistic driving studies (Stutts *et al.*, 2003, 2005). For the most part, drivers assume that listening to music enhances driving skills and vehicular performance, and specialty compilations of songs to drive with has increasingly flooded the commercial market. Insurance groups such as *Direct Line* and Britain's *RAC Foundation* advocate driving with recommended titles (BBC, 2004; RAC, 2004; USA Today, 2004), and lists of favorite driving-tunes recommended by auto enthusiasts are readily available from motor-magazines such as *AutoTrader*; the most recommended driving tune was *Come Away with Me* (Norah Jones) while the most dangerous soundtrack was *Ride of the Valkyries* (Wagner). Cars elicit a range of feelings from the *pleasure* of driving to the *thrill* of speed (Sheller, 2004), and drivers envisage feeling *secure* by driving a safe car. Therefore, the last thing anyone would think about is: How safe is it to turn on the radio, toggle a channel knob, adjust the volume, flip a cassette tape, or swap a CD? (Power, 2009). After all, if digital music systems are installed as features of intelligent vehicles that the auto-industry has referred to as 'smart-cars', then *how unsafe could it be*? Clearly the popular belief about in-car music listening as causing *little-to-no-risk* is widespread (Patel, Ball, & Jones, 2008; Titchener, White, & Kaye, 2009; White, Eiser & Harris, 2004). But, the frequency of music-related automobile accidents is not known, and perhaps this statistic is too difficult to account for while investigating accidents, especially as neither traffic-accident researchers or police investigators are mindful of the risks associated with *music* itself.

B. Music-Generated Cognitive Distraction

The swell of in-vehicle entertainment systems in recent years ought to raise concern about driver distraction and effects on hazard recognition and vehicle control (Bellinger *et al*, 2009). Both American and British surveys (ACF, 2009; Daily Telegraph, 2009; Dibben & Williamson, 2005; Milne, 2009; Quicken, 2000) indicate that drivers mainly choose to travel with highly energetic music played at strong intensity levels; the selections heard in the vehicle usually contain aggressive accentuated beat performed at a fast-tempo. If safe and effective driving necessitates detection of auditory information embedded in a background of continuously changing sounds (Slawinski & MacNeil, 2002), then there is every possibility that the presence of *music* along with road noise in vehicles not only covers the sounds of external auditory warning signals such as sirens and horns, but also masks self-monitoring sounds that serve as sources for vehicle feedback such as engine revs (Dibben & Williamson, 2007; Ho & Spence 2005, 2008).

On the most basic level, listening to songs while driving requires one to process sounds as well as words, and often results in tapping along to the rhythm or singing aloud (Dibben & Williamson, 2007). It is worrying that drivers underestimate the importance of considering the dangers of in-car distractions and activities, which are widely acceptable but not necessarily safe, involving a range of mundane activities such as simply *listening to music* (Petel *et al*., 2008 ; RoSPA, 2007; RSC, 2006; White *et al.,* 2004). Yet, for some time, it has been known that the greater the complexity of the music, the larger the effects on critical tasks necessary to safely operate a motor vehicle. For example, momentary peak levels in loud-music have been seen to play a role in disrupting vestibulo-ocular control – an explanation why loud music decreases response time to unexpected rear break lights (Ayres & Hughes, 1986; Consiglio *et al*, 2003; Horberry *et al*, 2006; McEvoy, Stevenson, & Woodward, 2007; Turner, Fernandez, & Nelson, 1996). Further, the tempo of background music has been linked to cruising speed as well as to the frequency of traffic violations (including: speeding, collisions, lane weaving, and disregarded red traffic-lights) in simulated driving (Brodsky, 2002). As a result, efforts to promote safe driving have been publicized via popular and social media. One example is Britain's *ACF Car Finance* who published *Billboard* chart listings (Betts, 2009) whereby the weekly Top-10 Hits were re-ranked in order of the safest-driving tracks; *Love Story* (by Taylor Swift) was most recommended while warnings were cited against driving to *Just Cant Get Enough* (by The Saturdays).

In an effort to explore a platform that is proactive towards mediated intervention, the current research package developed an original background music program that could serve as an optimal listening environment for driver safety.

C. Developing an Alternative In-Car Music Background

The car is a unique listening environment; one must account for a dynamic temporal flow that is required to achieve functional congruency between the aural conditions of driving and critical perceptual/motor tasks necessary for safely operating a motorcar. In this connection, we view *music-complexity* (portrayed as a bi-polar dimension) as the crucial feature in execution of the necessary perceptual processes; the higher the complexity the greater the cost on attention resources and mood states (arousal). A composer of popular music (the second author) re-mastered music tracks originally written and recorded by professional studio players as a playback accompaniment for an admired vocal artist of yesteryear; we note that the music remains effectively unknown to the public. The music program is an 8-track 30-minute blend of easy listening, soft-rock, light snappy up-beat smooth-jazz, with a touch of ethnic world-music flavor. The tracks were chosen and mixed to attenuate medium-quality tone frequencies, instrumental ranges, arrangements, voicing textures, tempos, intensities, and rhythmic activity. Most outstandingly, each track employs lush tonal harmonies with accompanying sophisticated syncopated melodic fragments, but yet, none have a specific memorable melody line. We propose that this architecture will furnish a driving environment that maintains alertness and positive mood without diverting cognitive resources. The proposed background has no previous memories for the driver to dwell on, there are no vocal contents and thereby no language processing, nor is there a clear melody line to sing along with while driving.

Initially, the music program was assessed for face validity through a questionnaire survey during a university gala social reception. Twenty-five questionnaire cards were returned, but three were discarded because of missing data. The final sample of 22 guests was evenly split between the genders, with an average age of 45 years old (sd = 16.05, range 25-65). Prior to the gala reception, sets of 5"x7" survey cards were placed on pedestal tables dispersed throughout the garden. Each guest rated the 'suitability' of the music as a background for five activities of everyday life (home chores, learning, office work, social reception, and driving a car); *suitability* was judged with a 4-point Likert scale (1 = 'Not At All Suitable'; 4 = 'Highly Suitable'). The background music was heard already when the guests arrived. The music was supplied from a DJ-quality CD-player to four 2-way 100w powered speakers on tripod stands; the music was presented with a flat EQ. The music program was heard twice (with the exception of a 10-minute break for reception greetings). The guests returned their completed survey card to a slotted ballet-box when leaving the reception. The results indicated that the background music was considered to be highly-suitable for a *social reception* (m = 3.48, sd = 0.75), moderately-suitable for *driving in a car* (m = 2.68, sd = 1.13) and *home chores* (m = 2.62, sd = 1.20), but only slightly-suitable for *learning* (m = 1.60, sd = 0.88) or *office work* (m = 1. 66, sd = 0.51). There were no differences between the genders or age groups. In addition, the music was judged significantly more-suitable for *driving in a car* than for *learning* (t = 3.445, df = 19, $p < .05$) or *office work* (t = 2.645, df = 20, $p < .05$). As a first phase we developed an 8-track 30-minute music program with the intent of employment as a background for driving in an automobile. Although the guests judged the music as most appropriate for a social reception (a bias due in part to the priming effects of the circumstances), the findings seem to confirm that listeners across both genders from a wide range of ages (20-70 years old) rated the alternative music background as suitable for in-car music listening.

II. ON-THE-ROAD EXPLORATION

To explore how drivers respond to the proposed alternative music background in a real-world setting, two on-the-road studies were implemented. Study1 compared between experimenter-designed music versus subject-preferred driving music CDs brought from home; Study2 evaluated repeated listening exposure across ten driving sessions throughout a one-month period.

A. Study1

Participants. Initially 26 undergraduates participated in the study, but four were dropped because of self-reported unlawful driving histories; each received extra credit points. The remaining (N = 22) drivers were 64% male, on average 26.3 years old (sd = 1.83, range = 23-31), with a valid drivers' license for at least five years (M = 8.6, sd = 2.38, range = 5 - 10). Almost all (95%) reported to listen to music *all of the time* when driving; 82% played background music at intensity volumes described as *moderately-loud* or *very-loud*, and 72% reported to listen to tracks portrayed as *relatively-fast* or *extremely-fast* pieces.

Materials. A 13-page booklet was allocated for each driver: a 1-page survey for background details; four 2-page diary-like questionnaires; and two 2-page surveys outlining the playlists of music they brought from home. Among the background information solicited was history of traffic violations, and music-related driving behavior. The trip diaries were in three parts: (1) descriptive information about the journey (including: *time of day*, trip-*duration*, trip-*distance*, and estimated trip-*speed*); (2) seven 4-level rating scales (1 = 'not at all'; 4 = 'very much') to judge *feeling at-ease*, *control over the car*, *awareness of music*, *enjoyment of music*, *attention to musical elements*, *music-effects on driving performance*, and *music-generated distraction*; and (3) a 32-item adjective list from four 8-item subscales of the *Profile of Mood States* (McNair, Lorr, & Droppelman, 1971) to assess positive affect (*PA = friendly + vigor* subscales) and negative affect (*NA = tension + fatigue* subscales). The playlists allowed each driver to provide the names of the performers and CDs they brought from home as their preferred music to listen to while driving.

Procedure. Each participant drove a total of four trips paired with another participant-driver who served as a passenger throughout, and then subsequently both switched roles. On two trips experimenter-designed background music was heard in the cabin, while driver-preferred music CDs were played during the other two trips; the order of the listening conditions was randomly implemented. The majority (82%) of the CDs brought by the drivers were musics of various styles, including: Pop, Rock, Hip-Hop, Reggae, Ethnic, and Jewish-Soul; other genres were World music (9%), Classical music (5%), and movie soundtracks (4%). All four trips were completed within one calendar month in springtime dry weather, between 6am-12am, on routes involving urban boulevard and/or highway intercity traffic. The protocol banned short trips (i.e., < 30 minutes), as well as two journeys within the same day/time zone (i.e., less than six hours apart). The participants drove their own automobiles – five European brands and five brands from the Far East. All of the vehicles were fitted with a CD-player and at least two pairs of reproduction speakers. In total, there were 88 journeys; the average trip was 45 minutes (*sd* = 13.62), across a distance of 60 kilometers (*sd* = 30.03 [37.3 miles]), at a speed of 98.7kph (*sd* = 9.25 [61.3mph]). Each driver completed a trip-diary questionnaire upon completion of each trip.

Results. Ratings from all outcome variables were averaged across both trips in each condition, and then entered into within-groups repeated measures analyses of variance. No significant differences surfaced between the music listening conditions for trip-*time*, trip-*distance*, estimated trip-*speed*, perceived *control over the car*, *attention to musical elements*, *music-generated distraction*, or *ill-effects of music*. However, there were significant differences between the musics for mood states involving both *positive-* and *negative-affect* (*PA*: $F_{(1, 21)} = 14.37$, $MSe = 0.1191$, $p < 0.001$, $\eta^2_\rho = 0.41$; *NA*: $F_{(1, 21)} = 10.17$, $MSe = 0.0998$, $p < 0.01$, $\eta^2_\rho = 0.33$). Overall, these findings indicate that mood states were more positive and less negative for driver-preferred musics. Nevertheless, the results indicate that in both music types *PA* was significantly higher than *NA*, but the difference between these two diametrically opposed mood states was greater for driver-preferred music ($M = 1.40$ [$sd = 0.64$] *vs* $M = 0.70$ [$sd = 0.74$]; $F_{(1, 21)} = 13.68$, $MSe = 0.3968$, $p < 0.01$, $\eta^2_\rho = 0.40$). In addition, significant differences between the music types surfaced for ratings of *feeling at-ease* ($F_{(1, 21)} = 78.51$, $MSe = 0.2110$, $p < 0.0001$, $\eta^2_\rho = 0.79$), *awareness of music* ($F_{(1, 21)} = 4.40$, $MSe = 0.2903$, $p < 0.05$, $\eta^2_\rho = 0.17$), and *enjoyment of music* ($F_{(1, 21)} = 42.43$, $MSe = 0.5833$, $p < 0.0001$, $\eta^2_\rho = 0.67$); for these variables ratings were higher for driver-preferred music.

Discussion. Study1 found no differences between the alternative music background and driver-preferred music as regards travel parameters (*duration*, *distance*, and estimated trip-*speed*) or perceptual-motor parameters (levels of *distraction*, *control*, and *performance*). These findings are compelling *prima facie evidence* in a first effort to demonstrate criterion related validity. However, one paramount finding of Study1 is that the alternative music background was rated significantly lower for *awareness* of the aural environment. We note that awareness of the heard music connotes cognitive space – i.e., taking up less resources of central attention while driving. Yet, we wonder if the latter finding could be an artifact of inattention. After all, familiarity is indicative of experience, and hence, it is warranted to raise the question of repeated exposure and habituation.

B. Study2

Participants. Initially 33 undergraduates participated in the study, but two were dropped because of self-reported high number of collisions/accidents or missing data; each received extra credit points. The remaining (N = 31) drivers were 65% female, on average 25.5 years old (*sd* = 2.07, range = 21-32), with a valid drivers' license for at least five years (*M* = 8, *sd* = 2.21, range = 4 - 15). Almost all (94%) drivers reported to listen to music *all of the time* when driving; 88% played background music at intensity volumes described as *moderately-loud* or *very-loud*, and 93% reported to listen to tracks portrayed as *relatively-fast* pieces.

Materials. A booklet was allocated for each driver (similar to Study1), but with ten identical 3-part diary-like questionnaires (and no playlist surveys). The trip diaries were in three parts: (1) descriptive information about the journey (including: *time of day*, trip-*duration*, trip-*distance*, estimated trip-*speed*, *road type*, and *number of passengers*); (2) three 4-level rating scales (1 = 'not at all'; 4 = 'very much') to judge *awareness of music*, *enjoyment of music*, and *level of driver caution*; and (3) 32-item adjective list to assess *PA* and *NA* mood states.

Procedure. The participants were required to drive a total of ten trips without accompanying passengers while listening to the alternative music background. The 10-trips were completed within one springtime calendar month during dry weather conditions; trips were implemented during three *drive time*s (i.e., morning, afternoon, night), and on three *road type*s (i.e., residential, boulevard, intercity highway). The protocol banned short trips (i.e., < 30 minutes), as well as two journeys within the same day/time zone (i.e., less than six hours apart). All participants drove their own automobiles; there were 8 brands from the Far East, 7 European brands, and one American *Chevrolet*. All of the vehicles were fitted with a CD-player and at least two pairs of reproduction speakers. In total, there were 310 journeys; the average trip was 53 minutes (*sd* = 23.91), across a distance of 55 kilometers (*sd* = 26.78 [34.2 miles]), at a speed of 92 kph (*sd* = 11.44 [57.2 mph]). Each driver completed a trip-diary questionnaire upon completion of each trip. It should be pointed out that although the participants were directed to drive alone, on 66 trips (21%) drivers reported to have been accompanied by passengers; as result of this unexpected methodological violation, we add this independent variable into the analyses.

Results. Ratings from all outcome variables were averaged across all ten journeys. In general, the participants were moderately *aware of the music* playing in the background (M = 2.85, sd = 0.54), and expressed a moderate level of *enjoyment* (M = 2.28, sd = 0.61). Further, an overall moderate level of *positive affect* was maintained throughout: *PA* (M = 2.68, sd = 0.55) was higher than *NA* (M = 1.63, sd = 0.32), and these differences were statistically significant (t = 7.731, df = 30, p < .000001). Similarly to other studies (Parncutt & Marin, 2006), a significant positive correlation surfaced between *enjoyment of music* and *PA* (r = .50, p < 0.05). Finally, the drivers perceived an overall high level of *driver caution* (M = 3.69, sd = 0.31). Subsequently, the outcome measures were entered into repeated measures ANOVAs to explore main effects of 'time.' No effects surfaced for trip-t*ime*, trip-*distance*, estimated trip-*speed*, perceived level of *driver caution*, or *enjoyment of music*. However, main effects surfaced for *awareness of music* ($F_{(9, 270)}$ = 4.4134, MSe = 0.4633, p < 0.0001, η^2_ρ = 0.13); this finding is a significant demonstration of habituation. See Figure 1. Further, while no effects were found for *NA*, significant main effects of 'time' surfaced for *PA* ($F_{(9, 270)}$ = 2.7823, MSe = 0.1940, p < 0.01, η^2_ρ = 0.08). See Figure 2. Finally, all outcomes were tallied for 'drive-time,' 'road-type,' and 'passengers' as independent grouping variables. Subsequently, these were entered into repeated measures ANOVAs. There were no significant differences of 'drive-time' for trip-*duration*, trip-*distance*, estimated trip-*speed*, perceived level of *driver caution*, *awareness* and *enjoyment of music*, or *PA/NA*. When considering 'road-type' there was a near-significant difference for trip-*distance* ($F_{(2, 8)}$ = 3.855, MSe = 1639.9, p < 0.06, η^2_ρ = 0.49) as well as statistically significant differences for estimated trip-*speed* ($F_{(2, 8)}$ = 20.312, MSe = 159.41, p < 0.001, η^2_ρ = 0.84); both findings indicate that drivers journeyed for longer distances at perceived higher speeds during highway intercity driving than they did during local trips. However, no other significant effects surfaced for perceived level of *driver caution*, *awareness* and *enjoyment of music*, or *PA/NA*. Finally, when comparing between trips involving driving-alone versus driving-with-passengers, while there were no differences in trip-*duration* or trip-*distance*, statistically significant differences surfaced for estimated trip-*speed* ($F_{(1, 11)}$ = 6.5390, MSe = 73.238, p < 0.05, η^2_ρ = 0.37) indicting that trips with passengers were perceived to be at higher speeds than when driving alone, as well as higher positive mood states with the presence of passengers (*PA:* $F_{(1, 11)}$ = 11.887, MSe = 0.0150, p < 0.01, η^2_ρ = 0.52). Finally, differences surfaced for *awareness of music* ($F_{(1, 11)}$ = 8.4717, MSe = 0.1830, p < 0.025, η^2_ρ = 0.44); that is drivers reported to be much more attentive to music heard in the vehicle when driving alone.

Discussion. Study2 most certainly highlights compliancy; 31 participants drove ten trips, totaling 310 journeys, covering an overall distance of 17,799 kilometers (i.e., 11,060 miles), while listening to the alternative music background. Study2 found that while the drivers consistently rated only moderate-levels of enjoyment from the listening experience, they indicated no avoidance, irritation, or negative affect; throughout the study positive affect remained significantly high, and was consistently rated higher as the sessions proceeded. Finally, the drivers' perceived level of *driver caution* remained stable throughout. Considering these findings, we view the results of Study2 as validation to the structural architecture design of the experimental alternative music background. It is interesting to note that there were no effects of the music with regard to *drive-time* or *road-type*. On the other hand, comparing between trips whereby the driver was alone in the vehicle versus those in which there were accompanying passengers, participants reported to have experienced increased mood states of *friendliness* and *vigor*, as well as estimating their cruising *speed* to be significantly higher than when driving alone.

III. General Discussion and Conclusion

Studies seeking to target possible effects of *in-car listening* usually put into operation stratagem based on telephone surveys, pen & paper questionnaires, and laboratory simulations – albeit a few roadway studies do exist. For the most part, these researchers seek to focus on the contribution of music to driver distraction by advocating empirical approaches that support observation, encourage deduction, and promote documentation; the typical study explores the nature, frequency, and circumstances in which background music might cause distraction. However, it also seems warranted to implement another more proactive approach advancing a mediated form of intervention that would explore *potential methods to deal with the ill-effects of music*. This was the goal of the current study.

Listening to music in the car will not be given up simply because it may place drivers more at risk. Therefore, we wondered if a music program that employed a structural acoustic design for in-car listening and increased driver safety, could serve as an alternative background environment. In truth, we would not expect such music to replace drivers' preferred music CDs, but rather, might prove to be more adaptive in specific circumstances of higher risk (such as fatigue or under the influence). Overall, the study found that listeners perceived the alternative music background different from other *aural wallpaper*, much more suitable for driving a car, and the two on-the-road studies demonstrated that the music was functionally more effective than driver preferred CD brought from home.

We are optimistic that alternative music backgrounds, such as the one we developed herein, may someone day become a form of self-mediated intervention for drivers. We acknowledge the need for further more precisely controlled investigations, employing larger samples of drivers, in naturalistic on-the-road studies. Given the current times in which we live, and our society's passionate preoccupation with automobility, we recognize that cars are here to stay, and *in-car music* listening will forever be part of vehicular performance. Especially considering this last point, the current study explored a viable alternative music background for in-car listening with improved driver safety.

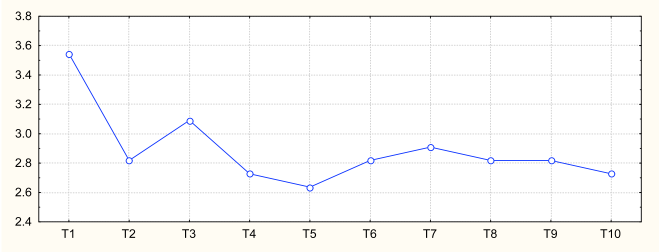

Figure 1. Null-effect of 'Time' on *Awareness of Music*.

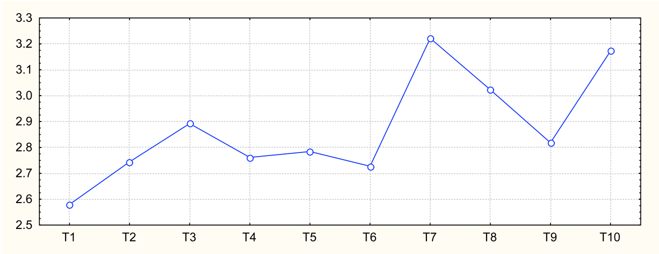

Figure 2. Main-effect of 'Time' on *Positive Affect.*

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