

CHRIS MAKKINJE

Driving home for Christmas: Influences of music tempo and inhibition training on simulated driving performance

ORIGINAL PAPER

In modern society, a car is among the most used means of transportation. The amount of car accidents that involve young drivers increases every year and poses a serious societal problem in terms of personal, social and economic costs. An explanation for these accidents is given by a biological theory, which states that an immature prefrontal cortex results in riskier behaviour. The socio-environmental theory indicates environmental factors, such as peer pressure and education, as possible determinants of the increased risk in young drivers. The current study combines both theories by searching an effect of music tempo (environment) and response inhibition (biological) on driving performance. The results showed a main effect for impulsivity/inhibition on crash rates. This suggested that impulsive behaviour promoted focused attention, thus leading to a lower crash rate. An interaction effect showed a marginal music tempo effect on lap times, but only when showing impulsive behaviour.

Keywords: music tempo; response inhibition; driving

Chris Makkinje; Master Student Neuropsychology
University Maastricht, Maastricht, the Netherlands

ccc.makkinje@student.maastrichtuniversity.nl

“Risk comes from not knowing what you’re doing.” —Warren Buffett
(as cited in *Warren Buffet says*, 2009, p. 1).

INTRODUCTION

Risky behaviour in adolescence and young adulthood is a well-known and studied subject (Arnett, 1992; Casey, Getz, & Galvan, 2008; Jessor, 1992). Through years of research, different theories have risen to explain the nature of this behaviour and why it decreases on the road to adulthood. The explanations of these theories can be sorted in two main streams: The biological and socio-environmental explanations.

A *biological* explanation was drawn from the fact that during adolescence the prefrontal and striatal systems go through developmental changes which are linked to risky behaviour (Casey et al., 2008; Casey et al., 2010; Galvan, Hare, Voss, Glover, & Casey, 2007; Steinberg, 2008b). In accordance to these developmental changes, a dual process theory was formed. This theory states that the pre-frontal cortex is responsible for controlled and rational behaviour and the limbic system is responsible for intuitive and uncontrollable behaviour (Rivers, Reyna, & Mills, 2008; Steinberg, 2008a). A new theory was derived from the dual process theory in which an explanation was given for the risky behaviour shown by adolescents and young adults. Casey et al. (2010) called it the imbalance model. In this model, a development trajectory was proposed in which the maturation of the subcortical limbic system develops faster than that of the pre-frontal cortex. According to this model, risky behaviour is more likely to occur in adolescence because of the inability of the pre-frontal cortex to sufficiently control impulsive responses to rewarding stimuli due to an oversensitive limbic system.

A *socio-environmental* explanation for increased risk behaviour in adolescents was given by the Broad and Narrow Socialization Theory of Arnett (1995). This theory emphasizes the importance of the changes in the sociocultural environment and states that risky behaviour is derived from these changes. Peer influence for example is a supporting factor for this theory. It has been proven by various studies that peer influence can have great effects on risky behaviour. Peers have an influence on this type of behaviour through direct peer pressure or by indirect pressure via socialization effects (Gardner & Steinberg, 2005; Maxwell, 2002). One of these effects is the tendency of adolescents to modify their behaviour and attitude so it will resemble those of friends (Brechwald & Prinstein, 2011).

Driving is a scenario in which risk-taking behaviour of young adults poses a serious threat to society. In a study by Arnett, Offer, and Fine (1997), 139 high school students received a questionnaire about reckless driving. About 80% of the males and 70% of the females reported to engage in this kind of behaviour in the form of car racing, driving over a no-passing zone and driving intoxicated. This supports the conclusion of risky driving behaviour by adolescents and young adults.

A socio-environmental factor that might influence risky driving behaviour is the use of music. According to Dibben and Williamson (2007), over 75% of the British population engages in some sort of music listening while driving. To understand the effect of music while driving, music itself can be divided in different factors that might have an influence on driving behaviour. Music volume, or in other words, intensity is one of those factors. North and Hargreaves (1997) revealed that drivers who are caught up in heavy traffic will be more inclined to decrease the music volume. Music will be decreased because the loudness itself requires more

processing (North & Hargreaves, 1997). This would lead to a cognitive overload and would result in a higher accident rate. Beh and Hirst (1999) investigated the effects of loud music on driving performance. They wanted to examine whether loudness had a different effect on low demanding or high demanding driving tasks. In this experiment participants had to drive with either soft music (55 dBA) or loud music (85 dBA). The driving was done under two conditions: low-demanding single-task driving and high-demanding multi-task driving. The authors found that soft music did not show an effect on the reaction time during driving. However, louder music interfered significantly with the reaction time especially in the high-demanding task.

Besides music intensity, music complexity also has an influence on driving behaviour. North and Hargreaves (1999) conducted an experiment on the effects of music complexity while driving. They hypothesized that high arousing music would lead to slower lap times in comparison to low arousing music due to an overload of cognitive functioning and therefore impaired driving skills. In their study, 5 laps had to be raced in a computerized environment. These laps were conducted under influence of either a low demanding driver task or a high demanding driver task. Combined with the driver task, either low arousal music (80 BPM at 60 dBA) or high arousal music (140 BPM at 80 dBA) was presented. In their results it was concluded that the worst lap times coincided with presentation of high arousing music and a high demanding driver task, thus providing support for the cognitive overload hypothesis.

In the previous studies both music intensity and complexity could influence driving behaviour. A third possible factor that is entwined within these studies is musical tempo. Fast tempo music has shown to lead to higher arousal levels (van der Zwaag et al., 2011). For example, the presentation of fast-paced music led to significant faster shopping in the supermarkets and caused faster drinking and eating (Herrington, 1996; McElrea & Standing, 1992). An effect of musical tempo in driving has been shown by Brodsky (2001). He discussed that arousing music was more cognitively demanding than non-arousing music because of a larger number of temporal events (for example more beats in a shorter period of time). Therefore higher music tempo could lead to a cognitive overload. In the experiment, it was hypothesized that fast paced music would have an effect on simulated race driving reflected in decreasing simulated lap-time (measured in accelerated speeds) and an increase traffic violations. These outcomes would reflect faster driving and more reckless behaviour. In this study subjects had to drive eight laps of six miles each through the city of Chicago. For this experiment the computer game 'Mid town madness' was used, which provided not only traffic but also traffic rules (stop signs, traffic lights etc.). Each of the eight laps was divided into three zones, of which two were accompanied by slow, medium or high tempo music. In his results, Brodsky found a main effect for tempo. Participants drove faster and caused more traffic violations when presented with fast-tempo music.

In conclusion, music has shown in many ways that it can have an influence on driving behaviour. In the studies of Brodsky (2002) and North and Hargreaves (1999), this influence was hypothesized to result from a high arousal effect of the music. This arousal is seen as a predictor of impulsive behaviour and therefore risky

behaviour (Anderson & Revelle, 1994; Mattila & Wirtz, 2001).

A biological factor that might influence risky driving behaviour is the development of response inhibition. According to the biological explanation, risky behaviour lies within an immature pre-frontal cortex. One of the functions of the pre-frontal cortex, which has been researched for years, is executive functioning. A lot of this research has been reviewed by Pennington and Ozonoff (1996). According to their review, executive functioning selects appropriate actions in each situation, depending on the context. The most important functions that lie within the executive functions are: set-shifting, planning, working memory, and response inhibition. The latter is one of the most important functions since response inhibition facilitates the suppression of actions that are not of any use and actions that do not fit in the context. Therefore it is essential for goal-directed behaviour, and needs to be adaptable to many different contexts. Driving performance is a highly goal-directed task, which requires adequate functioning of the prefrontal cortex. An immature prefrontal cortex and consequently not properly developed response inhibition may produce impairing effects on driving performance (Jongen, Brijs, Komlos, Brijs, & Wets, 2011). In a study by Jongen et al. (2011) this inhibitory control was measured via a stop signal reaction task. In this task, a participant had to respond to a stimulus and inhibit this response whenever a sound was given prior to this stimulus. It was hypothesized that inhibitory control would improve with age and therefore improve driving skills. Subjects were divided into two groups based on age. The first group consisted of participants aged 17 to 18 and a second group aged 22 to 24. Both groups had no more than 2 years of driving experience. They concluded that the first group had lower inhibitory control, due to an immature pre-frontal cortex. This resulted in riskier driving skills, measured via different methods such as speeding, red light running and number of collisions.

The present study tries to combine both the biological- and the socio-environmental perspective. It has been discussed how music could influence driving via three main factors: music intensity, complexity and tempo. The first two factors have been investigated in quite a large extent compared to the latter. Therefore music tempo is used as a socio-environmental factor to investigate its effect on driving. In this study a racing game is used to simulate driving, and the lap time and the number of crashes is being used as variables to measure risky driving. The hypothesis is that the lap times will become faster and crashes will be more frequent as the tempo of the music is raised.

It has also been discussed how immature response inhibition can have a great influence on driving behaviour. In this study a stop signal task is used in order to elicit an inhibitory state or an impulsive state. According to a study by Guerrieri, Nederkoorn, Schrooten, Martijn, and Jansen (2009), using this task before the testing procedure and not as a post-condition measurement tool, would lead to an inhibitive state. They reasoned that the response inhibition learned in this task would reduce impulsivity. Furthermore, Guerrieri et al. (2009) pose that the original stop signal task can be altered to elicit an impulsive state. This state can be achieved by ignoring the no-response stimuli and focussing mainly on quick responding. The current hypothesis is that lap times will be slower and crashes will be less frequent after having conducted the response inhibition task as opposed to the impulsive

task. An interaction is predicted between impulsivity/inhibition and music tempo. This third hypothesis states that response inhibition will not lead to an effect of music tempo in contrast to response impulsivity, which might even facilitate the effect of music tempo.

METHODS

Participants

This study was approved by the psychology ethical committee at Maastricht University. Participants were deemed eligible if they were between 18 and 22 years old at the time of testing. This study consisted of 9 male and 25 female subjects. Their age varied from 18 to 22 years, ($M = 20.23$; $SD = 1.07$). All the subjects were psychology undergraduates and they received credit points in return for their participation.

Design

This study used a 3×2 design in which all participants were randomly assigned. The experiment varied the tempo of the music (Slow tempo, Normal tempo, High tempo) as a within subject factor and inhibitory control (inhibition vs. impulsivity) as a between-subject factor.

Materials

The music that was used in this research had to be played with a few factors in mind such as the complexity and pitch changes. The song Nara of E.S Posthumus was selected because it did not have a high complexity nor did it have high pitch changeability. These factors could both act as a confounder. It was played in every condition with a headphone and connected to a Hp pavilion dv5 laptop. The beats per minute, 60 BPM, 100 BPM or 130 BPM, could be changed throughout the entire experiment using Virtual DJ Pro. The constant intensity of ± 85 decibel (Brodsky, 2002) was measured with a calibrated decibel meter. The stop signal task, which was used to evoke inhibition or impulsive behaviour, was presented via the program *presentation*® on a Dell Intel core 2 quad q8400 computer.

The simulator consisted of a Samsung ps-42c91h plasma TV connected to an Intel core 2 duo e8200 computer. The driving material used consisted of a bucket seat and Logitech gearbox, steering wheel, sound system and pedals. The game used for this experiment was *Racedriver Grid*. This game allowed the use of the simulator and it also gave the possibility to change the sensitivity of the pedals and the steering wheel. The simulator was used because the settings of these materials ensured the resemblance of driving in real life.

Measures

Sensation Seeking Scale

Zuckerman, Kolin, Price, and Zoob (1964) developed a questionnaire, the sensation seeking scale. This scale is used to predict sensation-seeking behaviour. The SSS₅ consists of 40 questions posed in an A vs. B manner. These questions represent the 4 factors of this scale: thrill and adventure seeking, experience seeking, disinhibition and boredom susceptibility (Zuckerman, 1994).

Barratt Impulsivity Scale

The BIS-11 scale consists of thirty questions rated on a 4-point scale (rarely/never, occasionally, often, and almost always/always). These questions reflect 3 different sub traits of impulsiveness: motor impulsiveness, additional impulsiveness and non-planning impulsiveness (respectively acting without thinking, not focusing on a task and a lack of future orientation) (Guerrieri et al., 2009; Patton, Stanford, & Barratt, 1995).

Stop signal task

The stop signal task was created by Logan, Schachar, and Tannock (1997) as a way to measure impulsive behaviour in terms of a lack in response inhibition. This task consisted of 96 trials in each of the 4 blocks. The task consisted of 2 parts; first a choice reaction task (go-signals), in which the subjects were told to press the button related to the stimulus as fast as possible (in this case X or O). These stimuli were presented on a computer screen and disappeared when the right answer was given. After a few go signals, the same trial was given but with an external sound, cueing the participants to inhibit their response. In 25% of all the trials, this inhibition cue was given. Before this task, the participant's attention was focused on the importance of inhibiting the stimuli when cued by an external sound. According to Guerrieri et al. (2009), this focus should lead to an increase in response inhibition, and therefore inducing an inhibitive state.

Furthermore, Guerrieri et al. (2009) argued that it was possible to elicit impulsive behaviour by adapting the stop-signal task. In this adapted task, only the instructions were changed. The task itself remained the same as the one created by Logan (1997). The participants were told to ignore the inhibition cue and focus on the task as if the whole task consisted of only go signals. By treating the task as if it was a choice reaction task without inhibition cues, impulsive behaviour was elicited by focussing on the speed of this task.

Both tasks were used in this experiment in 2 separate conditions to obtain either an inhibitory or impulsive state.

Procedure

Upon entering the room the subjects were asked to read and accept the informed consent. This was followed by a test with the headphones. Normal tempo music was played for a brief moment of approximately 10 seconds at the same volume

as it would be in the experiment. This was done to ensure that there wouldn't be any dropouts due to the loud music. The participants were then seated in front of the stop-signal task computer and were asked to fill in the BIS₁₁, SSS₅ and some demographic questions.

When the questionnaires were completed, participants were placed inside the simulator for a practice trial in game mode with the same settings as there would be in the experiment. During the 5 laps of practice, the experimenter followed a memorized script in which several important things were explained to the subject such as how to drive through corners, the slippery effect of track side sand and grass, and how to steer properly.

As the practice session ended, the participant was instructed to take place behind the task computer. Participants were randomly assigned to the inhibition task or impulsive task. After a short practice task of 29 trials in which no inhibition cue was given, subjects performed either the inhibition or impulsive task for 15 minutes.

After the stop-signal task was performed, the subjects were asked to take seat in the driving simulator. The instructions for the driving experiment were given by the experimenter to execute the experiment properly. These instructions were always the same. After the three races, participants were asked to complete a last questionnaire on the stop-signal task computer. In this questionnaire musical preference and the purpose of this study was asked according to their own opinion.

A few weeks after the experiment was finished and all the data was collected, a debriefing was sent to all participants in which the true purpose was revealed.

Statistical analysis

All obtained data were analysed using IBM SPSS 19[®] with a repeated measures ANOVA on corrected lap times and crashes. The beats per minute were used as within subject factor and inhibition vs. impulsivity as between subject factors. Sex was not used as a between subject factor due to an imbalance of women to men ratio. The BIS and SSS scale were used as covariates and were centered due to a high correlation with the dependent variable. Age and driving experience were not further used during analysis as they proved to be non-significant when used as covariates.

RESULTS

Lap times

Lap times appeared not to be different between the three sessions with different music tempo, $F(2, 29) = .174, p = .841$. In addition, lap times did not differ between the group performing the inhibition task and the group performing the impulsivity task, $F(1) = .686, p = .414$. However, a significant Inhibition by Music Tempo interaction effect was found, $F(2, 29) = 4.334, p = .023$.

The interaction effect was further analysed with the use of simple effects. A marginal significant effect for Music Tempo was found in the impulsivity condition, $F(2, 13) = 2.492, p = .101$. This effect was not found in the inhibition condition, $F(2, 13) = 1.812, p = .202$, indicating that Music Tempo seems to have a stronger effect on impulsivity when participants were not asked to inhibit their responses on the computer task. As a post hoc testing, paired sampled t-tests were conducted on the lap times in the impulsivity condition. A significant effect was found between the low tempo music and the normal tempo music, $t(16) = -2.387, p = .03$, and a trend was found between normal tempo music and high tempo music, $t(16) = 1.475, p = .16$.

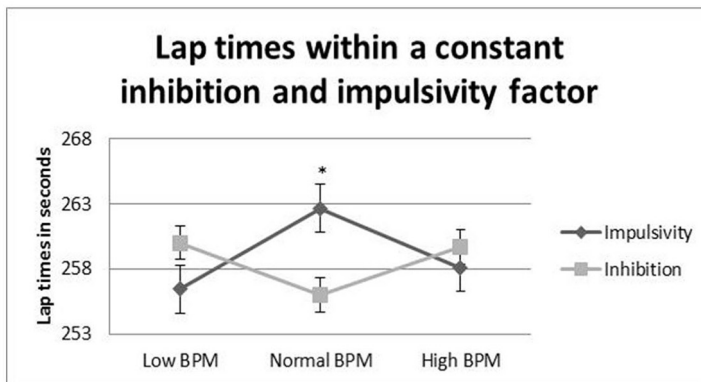


Figure 1: Lap times on the different music conditions while the inhibition and impulsivity factor were kept constant. A significant effect was found in the impulsivity condition between Low and Normal BPM. * = $p < 0.05$

Crash rates

With the use of the same method, the crash rates between the three conditions were compared. There appeared to be no main effect for Music Tempo on crash rates, $F(2, 29) = .316, p = .732$. In addition there was no interaction effect between BPM and inhibition, $F(2, 29) = .265, p = .769$.

However a significant main effect for inhibition vs. impulsivity was found, $F(1) = 6.953, p = .013$, showing that across music tempo conditions, those in the impulsivity condition had less crashes compared to those in the inhibition condition (see Figure 2).

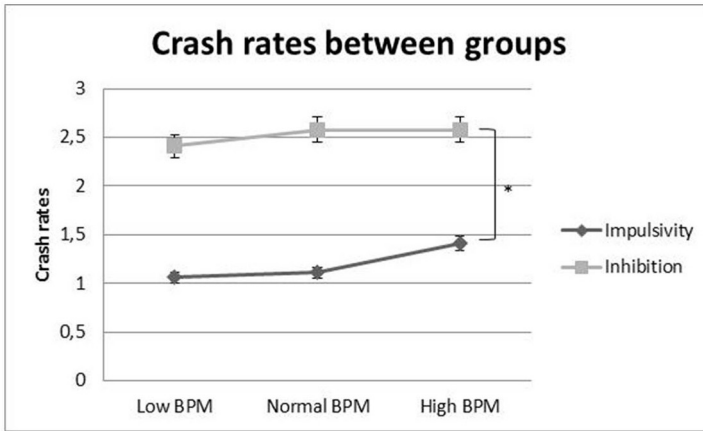


Figure 2: The crash rates for inhibition and impulsivity. This figure shows a main effect between impulsivity and inhibition. * = $p < 0.05$

DISCUSSION

The current study investigated possible factors that might influence driving behaviour. Driving is a high demanding task in everyday life, which can be influenced in a good or bad manner. In this study, music was used as a factor that could influence driving behaviour in a negative way, since it contributes to the cognitive load. Response inhibition versus impulsivity was used as a factor that might facilitate driving because a calm and inhibitive state might aid in driving. A driving simulator was used in combination with different music tempo and an adapted stop-signal reaction task to create an environment in which these factors could be measured.

In this study two main hypotheses and an interaction hypothesis were formed regarding the influence of these factors. Those could be measured via lap times and crash rates because these variables lend themselves in a race game. The first hypothesis investigated the effect of music tempo by posing that crash rates would increase and lap times would decrease in response to higher tempo of the music. The second hypothesis investigated the effect of inhibition versus impulsivity by posing that inhibition would lead to lower crash rates and slower lap times.

Studies conducted by Brodsky (2002) and North and Hargreaves (1999) revealed a musical tempo effect for driving speeds within a race game. The results of this study are not completely in line with those of previous studies. A main effect of music tempo was not found for lap times nor was it found for crash rates. The results show a non-significant, though increasing trend in crash rate in association with increasing music tempo. This appears to indicate that the results of the present study corroborate with previous findings. Probable power issues may explain the lack of significance.

The combined results of Logan et al. (1997) and Guerrieri et al. (2009) implied the possibility to elicit either an inhibitory mental state or an impulsive mental state by using a modified inhibition task. The results of this study did not show a main effect for inhibition vs. impulsivity on lap times but it did for crash rates. The hypothesis states that crash rates would be lower if inhibition was used. The results derived for crash rates showed a significant main effect in the opposite direction. Crash rates were lower in an impulsive mental state as opposed to an inhibitive mental state. This might be explained by posing that impulsivity would lead to a more focussed mental state that would aid in difficult situations, such as a more difficult corner in the game. Another explanation could be given by assuming that this effect would be the opposite when compared in real driving because of a generalization problem of race games with respect to driving in a real life situation. The generalization problem would occur because of the complexity of decisions that need to be made in a crowded environment, instead of a relatively simple estimation of when to steer in difficult corners.

An interesting result that this study found was an interaction effect between music tempo and inhibition vs. impulsivity. A marginal significant main effect of music tempo was found only in the impulsivity condition. The main effect was further investigated by a post hoc test, which revealed a significant effect for low tempo compared with normal tempo and a marginal significance for normal vs. high tempo music. However, these results are not entirely in line with the expectations because it seems that low tempo music reduces lap times. An explanation could be that when in an impulsive state, low tempo, and therefore low arousing music, would interfere less with driving resulting in better lap times. In conclusion, these results aid to the hypothesis of an effect of music tempo that was masked in this experiment due to the mental state factor. An explanation could be that inhibition training does have an effect on driving behaviour by inhibiting the effects of music tempo.

In order to interpret these results correctly, the limitations of this study need to be considered. One major limitation of the study was that there were bits of subjectivity that were impossible to erase. The lap times used in the analyses were corrected for crashes. So it could be possible to obtain slightly different lap times due to these time corrections. This might influence the effects of both inhibition and music. Another limitation was the use of a race game instead of the driving software. Although a driving simulator was used, a race game may not be entirely generalizable in every day driving due to the complexity of real driving scenarios. It could also be possible that there were small flaws in the design of the study. For example, the presence of the experimenter during the race could interfere because of an unintentional attention shift during driving. The use of headphones for presenting the auditory stimuli could also have an effect because it is unnatural to drive with headphones. The amount of participants could also have great effects on this study. If a higher number of participants could be tested, it might alter the results to find more significant effects and therefore might give more conclusive results in relation to the hypotheses that were made. A final major limitation was the use of the stop signal task. Guerrieri et al. (2009) showed that these tests could be used to induce either an inhibitive or an impulsive state. However, the duration

of these effects have not been studied as of yet. So it could be that these effects were not long lasting enough through the entire experiment.

In conclusion, the current study provides some insights into the role of music while driving and people's capacity to mitigate possible negative influences of music. Even though a conclusive result cannot be given, it seems that music effects are present during driving and especially high tempo music results in faster driving and a trend in higher crash rates which implies that high tempo music contributes to riskier driving.

This study also examined the relation between an impulsive and an inhibitive mental state. Even though no main effects were found, interaction between these factors and BPM suggests an inhibitive effect on music tempo.

Acknowledgements

I would like to thank my two supervisors, Loes Kessels and Rob Ruiter, for their help during the research and for granting me their permission to publish this study.

REFERENCES

- Anderson, K. J., & Revelle, W. (1994). Impulsivity and time of day: Is rate of change in arousal a function of impulsivity? *Journal of Personality and Social Psychology*, *67*(2), 334-344.
- Arnett, J. J. (1992). Reckless behavior in adolescence: A developmental perspective. *Developmental Review*, *12*(4), 339-373.
- Arnett, J. J. (1995). Broad and narrow socialization: The family in the context of a cultural theory. *Journal of Marriage and the Family*, *57*(3), 617-628.
- Arnett, J. J., Offer, D., & Fine, M. A. (1997). Reckless driving in adolescence: "State" and "trait" factors. *Accident Analysis & Prevention*, *29*(1), 57-63.
- Beh, H. C., & Hirst, R. (1999). Performance on driving-related tasks during music. *Ergonomics*, *42*(8), 1087-1098.
- Brechwald, W. A., & Prinstein, M. J. (2011). Beyond Homophily: A Decade of Advances in Understanding Peer Influence Processes. *Journal of Research on Adolescence*, *21*(1), 166-179. doi: 10.1111/j.1532-7795.2010.00721.x
- Brodsky, W. (2001). The effects of music tempo on simulated driving performance and vehicular control. *Transportation Research Part F: Traffic Psychology and Behaviour*, *4*(4), 219-241.
- Casey, B. J., Getz, S., & Galvan, A. (2008). The adolescent brain. *Developmental Review*, *28*(1), 62-77.
- Casey, B. J., Jones, R. M., Levita, L., Libby, V., Pattwell, S. S., Ruberry, E. J., . . . Somerville, L. H. (2010). The storm and stress of adolescence: Insights from human imaging and mouse genetics. *Developmental Psychobiology*, *52*(3), 225-235.
- Dibben, N., & Williamson, V. J. (2007). An exploratory survey of in-vehicle music listening. *Psychology of Music*, *35*(4), 571-589.
- Galvan, A., Hare, T., Voss, H., Glover, G., & Casey, B. J. (2007). Risk-taking and the adolescent brain: Who is at risk? *Developmental Science*, *10*(2), F8-F14.
- Gardner, M., & Steinberg, L. (2005). Peer Influence on Risk Taking, Risk Preference, and Risky Decision Making in Adolescence and Adulthood: An Experimental Study. *Developmental Psychology*, *41*(4), 625-635.
- Guerrieri, R., Nederkoorn, C., Schrooten, M., Martijn, C., & Jansen, A. (2009). Inducing impulsivity leads high and low restrained eaters into overeating, whereas current dieters

- stick to their diet. *Appetite*, 53(1), 93-100.
- Herrington, J. D. (1996). Effects of music in service environments: a field study. *Journal of Services Marketing*, 10(2), 26 - 41.
- Jessor, R. (1992). Risk behavior in adolescence: A psychosocial framework for understanding and action. *Developmental Review*, 12(4), 374-390. doi: [http://dx.doi.org/10.1016/0273-2297\(92\)90014-S](http://dx.doi.org/10.1016/0273-2297(92)90014-S)
- Jongen, E. M. M., Brijs, K., Komlos, M., Brijs, T., & Wets, G. (2011). Inhibitory control and reward predict risky driving in young novice drivers – a simulator study. *Procedia - Social and Behavioral Sciences*, 20(0), 604-612.
- Logan, G. D., Schachar, R. J., & Tannock, R. (1997). Impulsivity and inhibitory control. *Psychological Science*, 8(1), 60-64.
- Mattila, A. S., & Wirtz, J. (2001). Congruency of scent and music as a driver of in-store evaluations and behavior. *Journal of Retailing*, 77(2), 273-289.
- Maxwell, K. A. (2002). Friends: The role of peer influence across adolescent risk behaviors. *Journal of Youth and Adolescence*, 31(4), 267-277.
- McElrea, H., & Standing, L. (1992). Fast music causes fast drinking. *Perceptual and Motor Skills*, 75(2), 362-362. doi: 10.2466/pms.1992.75.2.362
- North, A. C., & Hargreaves, D. J. (1997). Experimental aesthetics and everyday music listening *The social psychology of music*. (pp. 84-103). New York, NY US: Oxford University Press.
- North, A. C., & Hargreaves, D. J. (1999). Music and driving game performance. *Scandinavian Journal of Psychology*, 40(4), 285-292.
- Patton, J. H., Stanford, M. S., & Barratt, E. S. (1995). Factor structure of the Barratt Impulsiveness Scale. *Journal of Clinical Psychology*, 51(6), 768-774.
- Pennington, B. F., & Ozonoff, S. (1996). Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry*, 37(1), 51-87.
- Rivers, S. E., Reyna, V. F., & Mills, B. (2008). Risk taking under the influence: A fuzzy-trace theory of emotion in adolescence. *Developmental Review*, 28(1), 107-144.
- Steinberg, L. (2008a). A dual systems model of adolescent risk-taking. *Developmental Psychobiology*, 52(3), 216-224.
- Steinberg, L. (2008b). A social neuroscience perspective on adolescent risk-taking. *Developmental Review*, 28(1), 78-106.
- van der Zwaag, M., Dijksterhuis, C., de Waard, D., Mulder, B., Westerink, J., & Brookhuis, K. (2011). The influence of music on mood and performance while driving. *Ergonomics*, 55(1), 12-22.
- Zuckerman, M. (1994). *Behavioral expressions and biosocial bases of sensation seeking*. New York, NY US: Cambridge University Press.
- Zuckerman, M., Kolin, E. A., Price, L., & Zoob, I. (1964). Development of a sensation-seeking scale. *Journal of Consulting Psychology*, 28(6), 477-482.