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Situational (state) anger and driving

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ABSTRACT

Aggression and anger have been related to crash involvement, but the direct causal relation between situational anger and driving choices and abilities has not been examined empirically. In this study, 15 licensed drivers drove twice in a driving simulator, each time following one of two emotion inductions based on event recall: angry and neutral. Following anger induction, the drivers crossed more yellow traffic lights ($p < .01$) and tended to drive faster (non-significant). However, performance on emergency manoeuvres were unaffected by anger. In conclusion, it appears that state anger affects driving behaviour by increasing risk taking, without necessarily compromising the skilled driving behaviour, at least as far as these behaviours were evaluated in emergency situations in simulated driving.

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1. Introduction

Road rage and aggressive driving seem to play a major role in road safety. Studies (e.g. Li, Li, Long, Zhan, & Hennessy, 2004) show a connection between aggressive driving and general tendency of being involved in an accident or performing a violation. In an extensive Gallup survey (EOS Gallup Europe, 2003), of 13,673 drivers, 75% of American drivers and 80% of the European and Australian drivers indicated that the aggressiveness of drivers has increased in the past few years. In the same Gallup survey, 66% of the American participants claimed that they were subjected to aggressive driving in the last year.

Shinar (2007, p. 328) defines *aggressive driving* as:

Aggressive driving is defined as a syndrome of frustration-driven instrumental behaviors which are manifested in (a) inconsiderateness towards or annoyance of other drivers (tailgating, flashing lights, and honking at other drivers), and (b) deliberate dangerous driving to save time at the expense of others (purposefully running red lights and stop signs, obstructing path of others, weaving).

On the basis of the "Driving Anger Scale" (Deffenbacher, Oetting, & Lynch, 1994), Sullman (2006) defines four main categories of driving-related anger provoking situations: progress impeded, risky driving, hostile gestures, and discourteous driving. Other studies show evidence that aggressive driving is influenced by: (1) the driving environment, day of the week, and time of the day (see Shinar (1998) for a review), (2) the car type, with drivers of high performance cars tending to perform more aggressive actions (Smart, Stoduto, Mann, & Adlaf, 2004), and (3) individual differences such as age and gender, as younger males tend to perform more aggressive manoeuvres (e.g. Smart et al., 2004; Van Rooy, Rotton, & Burns, 2006; Özkan

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& Lajunen, 2005). Additionally, there is evidence that mildly aggressive driving is common to most drivers (Wells-Parker et al., 2002). Nesbit, Conger, and Conger (2007) maintain that unlike other manifestations of anger, expression of driving anger seems to be a frequent and relatively socially acceptable outlet for negative emotions.

Most of the studies that deal with aggression and driving focus on 'Trait Driving Anger', which is one's general tendency to become angry while driving (Deffenbacher, Lynch, Oetting, & Swaim, 2001) as opposed to 'State Driving Anger' which is a driver's current level of anger (e.g. Stephens & Groeger, 2008). This distinction is based on a widely accepted distinction in psychology between state-related and trait-related behaviours. Cattell and Scheier (1961) were first to define the general State-Trait model which posits that emotions can be experienced in one of these two ways: either as a temporary mood state (labelled 'State') or as a more continuous, stable personality dimension (a 'Trait'). This definition was initially developed to describe anxiety. However, in emotion research it is vastly utilized to explain anger (Stradling & Parker, 1996). Matthews (2002), in his *transactional model of driver stress*, maintains that drivers show anger (reflected in aggressive tendencies) in specific situations and drive accordingly. The model maintains that drivers with high Trait-Anger are more likely to make hostile traffic situation evaluations and therefore drive faster, more erroneously and in a riskier manner. Other studies support this model. For example, trait driving anger has been shown to be associated with the frequency of being involved in accidents, aggressive and risky driving, anger towards other road users, and edginess when driving a car in traffic (Dahlen, Martin, Ragan, & Kuhlman, 2004). Relative to low Trait-Anger, drivers with high Trait-Anger levels have been shown to prefer higher driving speeds (Sullman, 2006), experience more near-accidents, lose their concentration more often, and drive in a less-controlled manner (Deffenbacher et al., 2001).

Despite the clear connection between Trait-Anger and driving behaviours, driving is probably seriously affected by State-Anger as well (Matthews, 2002; Nesbit et al., 2007). Moreover, trait-related information may not be very useful for policy makers. The reason is that except in extreme situations it would be publicly unacceptable to deny individuals with high Trait-Anger the right to have a driving license. In contrast, understanding how State Anger affects driving is more likely to affect policy and other preventive changes that would reduce the causes for anger. One potential outcome was found in a work done by Lerner and Keltner (2001) in which the authors show that angry people tended to express optimistic risk estimates and to take risk-seeking choices. Despite that, very little is known about the influence of State-Anger on driving behaviour. Below we review in brief the extant literature on this topic.

James and Nahl (1998) noted 23 aggressive behaviours (such as speeding and crossing intersections in yellow light) that are expressed when driving while angry. These behaviours were based on content analysis of self-reports taped by drivers while driving. Underwood, Chapman, Wright, and Crundall (1999) showed that drivers who have relatively frequent angry feelings while driving also recorded a greater number of near-accidents that resulted from their own behaviour. A potential shortcoming of these studies is that they were based on self reports. This aspect poses a problem because recalled or imagined behaviours may not be valid representations of actual driving. Moreover, self-reports of driving behaviour, like other self reports, may be influenced by demand characteristics and social desirability. Mesken, Hagenzieker, Rothengatter, and de Waard (2007) had drivers provide verbal ratings of anger, anxiety or happiness while driving in real traffic. The results showed that drivers reporting anger drove faster and exceeded the posted speed limit more often than drivers who did not report feelings of anger, but only in high speed zones (more than 100 km/h). This study, although done in real traffic, also suffers from several shortcomings such as lack of control over the driving situation, the influence of concurrent questioning on driving performance, and being correlational in nature, meaning that it is difficult to know if the angry state influenced driving behaviour, vice versa, or if both driving and anger resulted from a common factor such as Trait-Anger. The latter shortcoming is especially likely given the fact that Trait-Anger has been shown to influence driving behaviour.

Stephens and Groeger (2008) did a simulation-based study, in which drivers encountered different on-road mood stimulating situations. The measure of state anger was based on self-reports of the drivers while driving rather than manipulated as part of the study design. As such, it is difficult to know the cause-and-effect relationship between the phenomena. Nonetheless, they found that anger-prone drivers drove relatively fast, and reported relatively high levels of anger in low anger-provoking situations. In addition they found an association between high levels of state anger and behaviours such as harsh acceleration and reduced steering. However, the authors did not find a significant relationship between the overall measures of driving behaviour and State-Anger. Stephens and Groeger speculated that the rating task itself may have affected the drivers' mood, causing them to drive in a manner consistent with their stated mood.

To summarize, there are some studies suggesting that situational anger compromises driving performance. Still, these studies fall short of establishing a cause-and-effect relationship that demonstrates that the angry state is the cause for the reckless driving. To establish this cause-and-effect relationship, we manipulated anger and examined how this manipulation influenced actual driving behaviour in simulated driving. To enable strict comparison between the conditions we employed a within-subjects experimental design in which each participant was examined in both the angry and the neutral state. Thus, this design focuses on how individuals change their own driving behaviour when angry. Another notable advantage of using this design is the relatively high statistical power, which means that effects can be reliably detected even with relatively small samples. Moreover, because we used a relatively homogenous sample we maximized the statistical power. We hypothesized, in accordance with Shinar's definitions, that inducing anger will cause relatively risky driving behaviours.

2. Method

2.1. Participants

Sixteen male paid students, ages 22–27, participated in this study. Due to a computer failure, the results of one of the participants were discarded completely, yielding a data set of only 15 participants. The reason for choosing only males was that males and females might differ in their experience and/or expression of anger, although this widely held belief has been questioned (Nichols, Graber, Brooks-Gunn, & Botvin, 2006; Sharkin, 1993). Nonetheless, because males are generally more aggressive in their driving than females (Shinar & Compton, 2004), to maximize the statistical power, we held this variable as a constant. All of the participants were licensed drivers with 4–9 years of experience. Half of the participants were tested in the neutral condition in Session 1 and the anger condition in Session 2 and half were given the reversed order. The participants, all Ben-Gurion University students, were recruited via advertisement published in a students' web site, which offered male drivers to participate in a simulator-driving experiment. The participants were informed that this is a two-part study, and that the two parts need to be done with a gap of 1–3 days between them. Consequently, each of the recruited participants participated in both sessions/conditions, with no dropouts. At the end of the two sessions each participant received the NIS equivalent of 20 USD for his participation.

2.2. Tools

2.2.1. Mood induction

The mood induction protocol was based on event recall. In the neutral condition participants were asked to recall an experience in which they were emotionally neutral, and in the anger condition – an experience that made them so angry that they “wanted to explode”. The specific instructions (based on Rusting and Nolen-Hoeksema (1998)) were: “During the next ten minutes, try to re-experience the memory you've retrieved as vividly as you can. Picture the event happening to you all over again. Picture in your “mind's eye” the surroundings as clearly as possible. See the people or objects; hear the sounds; experience the events happening to you. Think the thoughts you actually thought in that situation. Feel the same feelings you felt in that situation. Let yourself react as if you were actually there right now. As you're re-imagining the event, write about what happens, what you are thinking, and how you are feeling”. The instructions in the neutral condition were similar except that participants were asked to recall an event that “had no emotional effect on them whatsoever”. A recent study (Lobbstaël, Arntz, & Wiers, 2007) that compared four different methods for anger induction found this approach to be among the most effective.

2.2.2. Simulator

The driving simulator that was used in this experiment was a fixed-base, three-screen, 120°, PC-based interactive driving simulator that allows the driver to control and experience perceptual motor and behavioural aspects of driving (STISIM Drive Simulator. See <http://www.systemstech.com>). This simulator was found to be a good predictor of actual driving performance (e.g. Lee, 2003; Shinar & Ronen, 2007).

2.2.3. The simulator script

One simulator script was built for the purpose of this study. All of the participants went through the whole script, experiencing the very same driving situations, in the same order, twice: after angry-mood-induction and after neutral-mood-induction. The script involved city driving in heavy traffic, 12.33 km long, with the instruction to maintain a speed of 50 km/h. The drive included three different types of randomly presented (from drivers' point of view) emergency situations, with an average time gap between events of 81 s. All of the situations were presented in the same order in every drive. The three types of situations were:

Situation 1 – A light that changes from green to yellow, when the driver is approximately 50 m from the intersection. This situation appeared in five of the 17 intersections in the script. In all the other twelve situations, the light remained green. The driver has the opportunity to make an emergency stop, or, to speed and pass that intersection before the onset of the red phase.

Situation 2 – A car that suddenly weaves in, from the parking lane to the driving lane (appeared six times). In this case the manoeuvre of the weaving car is relatively slow, and the driver has enough time to brake in order to prevent the crash. The prevention of the crash depends on drivers' reaction time.

Situation 3 – A fast-walking pedestrian enters the road, from the sidewalk, between the parked cars, and into the driving lane (appeared five times). The driver can avoid hitting the pedestrian if he reacts fast enough.

2.2.4. Mood check

In order to independently assess the effects of the instructions on the participants' anger level, a short six-item questionnaire was used. The items included statements about the following moods: “I am happy”, “I am sad”, “I am calm”, “I am an-

gry”, “I am concerned”, and “I am surprised”, and the subjects rated their feelings on each item on a 10-point scale from 1 (not at all) to 10 (very much).

2.3. Procedure

Participants were tested individually in the driving simulator. They were randomly assigned to one of the two counter-balanced order of conditions (neutral in Session 1 and anger in Session 2, or the reversed order), with a 1–3 days separation between the two sessions. Each session consisted of the following seven stages:

1. A test-drive on the simulator (approximately 1 min).
2. Mood check.
3. Mood induction (10 min).
4. Mood check.
5. Driving in the simulator (approximately 18 min).
6. Mood check.
7. Watching a funny movie intended only to restore mood to a calmer state (5 min).

At the end of Session 2, the participants were given a short debriefing in which the experiment’s rationale was explained.

2.4. Variables

2.4.1. Dependent variables

The following dependent variables measured participants’ performance in the simulator:

1. *Average speed* (a measure of risky driving).
2. Number of collisions with cars-weaving-in.
3. Number of pedestrians hit.
4. *Number of yellow light crossings*. A measure of self control because the driver could decide whether to take a risk, or brake. Served as a measure of risky driving behaviour.

2.4.2. Independent variable

Mood (angry or neutral). All participants drove the exact same route twice.

3. Results

First we evaluated the anger induction by comparing the mood checks made during the angry and neutral states using paired *t*-tests. The results indicate that the state anger induction was successful. The groups did not differ in their anger level before the induction, but differed significantly in the expected direction immediately before the drive and immediately after the drive (see Table 1), indicating that the induced anger lasted throughout the simulated drive.

Table 2 presents the means, standard deviations and the results of paired sample *t*-tests comparing the two conditions in terms of the driving behaviours. Average speed was adjusted by subtracting the time spent on waiting in traffic lights from

Table 1

Anger induction: means (and standard deviations), and the results of paired *t*-tests between the two conditions, for the 15 drivers with valid scores in the two conditions.

	Angry	Neutral	<i>t</i>	η^2	<i>df</i>	<i>p</i> (1-tailed)
Moodcheck1 (before induction)	1.33 (.49)	1.60 (1.55)	1.24	.04	14	.235
Moodcheck2 (after induction)	3.93 (2.34)	1.60 (1.12)	4.14	.53	14	<.001
Moodcheck3 (after driving simulator)	2.07 (1.28)	1.53 (1.06)	2.81	.30	14	.014

Table 2

Dependent variables: means (and standard deviations), and the results of paired *t*-tests between the two conditions, for the 15 drivers with valid scores in the two conditions.

	Angry	Neutral	<i>t</i>	η^2	<i>df</i>	<i>p</i> (1-tailed)
Speed (km/h)	46.60 (3.75)	45.93(3.43)	1.89	.14	14	.08
Pedestrians hit	3.27 (1.75)	3.73 (1.39)	1.36	.05	14	.194
Yellow light crossings	.60 (.83)	.07 (.26)	3.58	.43	14	.003
Collisions with other cars	1.13 (2.1)	1.00 (2.39)	0.87	.00	14	.400

the total drive time. In order to correct for the number of comparisons (four) we used the Bonferroni adjustment method and adopted $\alpha' = \alpha/4 = .0125$ instead of $\alpha = .05$. Although drivers were instructed to maintain speed of 50 km/h, speed was evidently higher in the angry state, but the increase was small and not significant ($p = .08$). The only significant difference ($p = .003$) was in the average number of yellow traffic light crossings. In the angry state drivers crossed most of yellow-lighted-intersections, whereas in the neutral state only one driver on one occasion crossed after the light had turned yellow.

Finally we checked order effects to see if the counter balanced design of the experiment helped on equalizing the conditions between the participants. Results show that the only variable that was affected by testing order is pedestrian hits in the angry condition. The number of pedestrian hits in the angry condition for participants who drove first in the angry condition (mean = 4.43, SD = 1.40) was significantly ($p = 0.01$, $t = -3.02$, $df = 13$) higher than the number of pedestrian hits in the angry condition for participants that drove first in a neutral condition (mean = 2.25, SD = 1.39). Thus, when first experiencing the driving scenario in an angry mood, as opposed to experiencing driving in an angry mood after driving in a neutral mood, the driver was more likely to hit a pedestrian in the angry condition than in the neutral condition.

4. Discussion

Despite previous claims relating situational anger to driving behaviour, data on cause-and effect relationship between a driver's current anger state and the driving behaviours are lacking. To address this issue, we used an anger induction protocol in a within-subjects design, comparing the driving behaviours of the same persons in a neutral mood and in an angry mood. Of the four measures used, we found that induced anger significantly increased the likelihood of crossing in yellow light and marginally-significantly increased speed. Thus, we obtained effects of state anger on some aspects of driving style, specifically risk-taking tendencies. We did not find any anger-related effects on frequency of collisions with other vehicles and pedestrian. Drivers' actions in these situations were immediate and appropriate: braking. In nearly all instances, when one of these two scenarios occurred, the driver braked in order to prevent the imminent crash. These results imply that the induced anger affected the drivers' style but not their driving skills, in the sense that drivers were able to maintain the same level of emergency control in both conditions.

Most interesting is the one significant and large effect that we obtained on the number of yellow light crossings, which is consistent with James and Nahl's (1998) claim that driving in an angry mood leads to this kind of an aggressive and risky driving behaviour. This suggests that we should distinguish between two, non-mutually exclusive, types of behaviours:

1. *A skilled driving behaviour*: Reflected in the ability to avoid a crash when faced with an imminent crash situation – such as a car cutting in or a pedestrian darting into the road. It was manifested by avoiding a collision with a weaving car cutting in, and a pedestrian darting out into the road. Based on our results this sort of behaviour does not seem to be affected by anger.
2. *A risk taking behaviour*: A 'risk taking' is a behaviour that increases the likelihood of an accident and includes speeding and running red/yellow lights. The driver has the option of either braking or speeding up when the yellow light comes on. A driver who decides to speed up rather than brake takes a risk. The results of the current study imply that risk taking behaviours increase when the driver is angry.

An alternative explanation for the higher number of traffic light crossings in the angry state might be the marginally significant difference in the average measured speed of the drivers between the states. It could be claimed that a "go" decision is more sensible than attempting to "stop" – when the speed is higher and the chance to cross the intersection increase before the light turns red increases. Unfortunately we could not test for this directly as we did not have the momentary speed of the drivers at the place and time of the appearance of the yellow light. Such information could not be retrieved in a reliable way from our data set. In addition, the drivers were instructed to maintain a speed of 50 km/h, but there was a small difference in average driving speed, with speed being higher when the drivers were angry. Although speed did not differ significantly as a function of mood, the trend of means indicated faster driving in the angry state and the p -value ($p = .08$) was not too far from the significance criterion. Given the fact that similar results were obtained by James and Nahl (1998), we consider this trend to be in line with these previous investigation. If we assume that this difference is meaningful, we can hypothesize that drivers in the angry condition manifested more reckless driving behaviour in general.

Order effects showed that more pedestrians were hit in the angry condition when that condition was first. A potential reason for this finding relates to the fact that the first drive involved driving on a novel route, which requires more attention and anger compromised attentional skills that were mostly needed when the route was novel.

Somewhat speculatively we suggest that our main result of the effect on anger on running yellow lights may reflect a more general principle according to which anger compromises self restraint in general. This speculation is consistent with neuropsychological findings that show that self restraint (or inhibition) is linked to the integrity of the left lateral prefrontal cortex (Aron, Robbins, & Poldrack, 2004), a region of the brain that is relatively inactive in angry states (Carver & Harmon-Jones, 2009). Thus, when angry, the brain region associated with exerting self restraint is relatively inactive and thus, less functional.

On the basis of the results of this study we can conclude that state anger affects driving behaviour by increasing risk taking, without necessarily compromising the skilled behaviour, at least as evaluated here in emergency situations. However, it

is possible that in situations where greater risk taking is combined with imminent crashes, anger would actually affect crash likelihood. To test this, future studies need to focus on the interaction between anger, risk taking, and crashes by creating situations in which the presentation of yellow lights would be combined with crossing traffic and crossing pedestrians.

This study has three notable limitations. The first is that it is based on driving in a simulator rather than real driving, but a controlled on-the-road study of the effects of state anger has obvious ethical concerns. Another limitation concerns our method of anger induction which may not be very potent relative to real-time (as opposed to recalled) situation. If this is so, then the effects of real anger may be even more severe than we observed and may extend into the actual skilled performance. Despite this limitation, though, the induction method was sufficiently strong to influence participants' driving. Finally, because we wished to provide unequivocal evidence that state anger *can* compromise driving behaviour, we made an effort to maximize the statistical power in our experimental design by limiting the study young male adults. Future studies need to examine whether our conclusions apply to older and to female drivers as well.

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