Emotion Regulation for Frustrating Driving Contexts

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ABSTRACT
Driving is a challenging task because of the physical, attentional, and emotional demands. When drivers become frustrated by events their negative emotional state can escalate dangerously. This study examines behavioral and attitudinal effects of cognitively reframing frustrating events. Participants (N = 36) were asked to navigate a challenging driving course that included frustrating events such as long lights and being cut-off. Drivers were randomly assigned to three conditions. After encountering a frustrating event, drivers in a *reappraisal-down* condition heard voice prompts that reappraised the event in an effort to deflate negative reactions. Drivers in the second group, *reappraisal-up,* heard voice prompts that brought attention to the negative actions of vehicles and pedestrians. Drivers in a *silent* condition drove without hearing any voice prompts. Participants in the *reappraisal-down* condition had better driving behavior and reported less negative emotions than participants in the other conditions.

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In-car interfaces, emotion regulation, voice interfaces.

ACM Classification Keywords
H5.2. Information interfaces and presentation: User interfaces.

INTRODUCTION

Often frustration is referred to as a gateway emotion that leads to anger, and ultimately to aggressive road rage [2]. As the number of vehicles on the roadways increase, drivers encounter more frustration-inducing scenarios. As a result, road rage is now an escalating problem and is the primary cause of many accidents and driving fatalities. Given the implications of driving under the influence of negative emotional states, it is important to be able to minimize driver frustrations when possible. While some previous work has addressed the question of how to address drivers if their emotional state is known [9], near-term solutions should use available knowledge of the road to anticipate driver frustrations.

Emotion Regulation

The field of psychology provides a significant body of work to aid in addressing negative emotions and promoting healthier states. The process model of emotion regulation [3, 5] posits that emotions may be regulated at one of five points during the time course of emotion: selection of the situation; modification of the situation; deployment of attention; change of cognitions; and modulation of the response. If we aim to improve frustration during everyday circumstances, not all of these stages are feasible points for an intervention.

Considering the selection of the situation, drivers can choose low-traffic routes or travel during off-peak hours, but these choices may not be available given schedules and might not entirely prevent the driver from encountering frustrating situations. Modifying the situation is also difficult. Driving occurs in a complex environment of pedestrians, cyclists, cars, and traffic signals, so there a little opportunity to the driver to personally minimize frustrating events. Attentional deployment could increase driver distraction, and modulation of responses by means of suppression would likely increase the experience of negative emotions.

Because of the timing and distraction issues posed by the other points of emotion regulation, we see the most obvious opportunity for an intervention to be changing cognitions immediately after frustrating events. Although driving is a complex task and there are issues of fatigue [1] and workload [12] with the cognitive effort required to reframe the situation, it might remain possible to change cognitions, and this is what the current study addresses. Cognitive reappraisal is one method of changing cognitions and in other contexts it has been more effective than other interventions [e.g., 4]; it requires that the potentially emotion-inducing event is reframed immediately after its occurrence in order to diminish or prevent a negative response before a full emotional response can occur.

Implementing an Effective Voice Interface

Considerable research has been done under the "computers are social actors" paradigm [10] to show that people respond to computers, technology, and media, as if they

were other people [7, 8, 10]. In a variety of domains we find that interfaces can affect liking, attitudes, task performance, and behavior. Whether the interaction is with a desktop computer, through a web interface, or with an in-car voice interface, properly designed media has the power to affect users at emotional, cognitive, and physiological levels. It is for this reason that we believe that an effective yet unobtrusive strategy for emotion regulation is to design a voice interface that encourages cognitive reappraisal.

Technology for Context-aware Responses

To test the effects of cognitive reappraisal on drivers, a challenging course and the ability to respond to frustrating events was required. With the driving simulator software STISIM *Drive* [11] we created events and placed obstacles in a driving course that would cause frustration. Pre-recorded cognitive reappraisal voice prompts would be played precisely after an incident occurred, but before the event was fully cognitively processed. Simulating a context-aware car interface in this way is straightforward, and even though all of the necessary technologies are not widespread now, it is foreseeable that future vehicles will be more intelligent via on-board sensors and networked information.

Cognitive Reappraisal Implementation

In contrast to some previous studies of emotion regulation, and to make the implementation more realistic for the driving context, drivers were not given any cognitive reappraisal training or instructions before beginning the driving task. There were two implementations of cognitive reappraisal: *reappraisal-down* and *reappraisal-up*. The *reappraisal-down* prompts were designed to decrease driver frustration by reframing the frustrating events the occurred in the course so that the driver did not believe the actions of others were as offensive potentially interpreted initially. By contrast, the *reappraisal-up* prompts were designed to increase negative driver emotion by suggesting the actions of others were intentional or careless. A *silent* condition was added to compare the effects of the voice conditions to standard driving conditions.

The *reappraisal-up* condition was included so that we could distinguish the effects of a voice in the car from the effects of the voice interface's content. It is possible that the calmness of the voice (the same for both conditions) could cause emotional contagion, and result in a more positive state of the driver, regardless of the content. Without the *reappraisal-up* condition, we would not have enough evidence to prove the effect of the voice interface content. Thus, we arrive at our research question: will employing a supportive social agent with cognitive reappraisal commentary have the same or any effects as cognitive reappraisal training and approaches found in less-cognitively demanding settings?

- H1: Drivers who experience the *reappraisal-down* prompts will be less negatively affected by the frustrating driving scenario than drivers with *reappraisal-up* prompts or no voice at all, and consequently have better driving performance.
- H2: Drivers with the *reappraisal-up* reinforcement will be adversely affected and exhibit poorer performance than drivers in the silent condition.
- H3: Drivers in the *reappraisal-down* condition will be in a more positive emotional state and have more favorable attitudes towards the driving partner than drivers in the *reappraisal-up* condition.

STUDY DESIGN

Participants

Thirty-six participants were included in this study, with eighteen males and eighteen females balanced between conditions. Participants were university students ages 18 to 24 years old and had between two and ten years of driving experience (M = 5.1, SD = 1.84). Participants were randomly assigned to one of three conditions: *reappraisal-down* (n = 12), *reappraisal-up* (n = 12), and *silent* (n = 12).

Procedure

After arriving at the lab participants drove a five minute practice course while being supervised by an experimenter. The role of the experimenter was to make sure the participant was comfortable in the driving seat and understood the essential operations of the driving simulator (brakes, accelerator, shifting views, etc.). Before beginning the drive participants were reminded to obey all traffic rules and to drive as safely as possible. Drivers who were in the voice conditions were also told that as they would hear a driving partner comment on the driving scenario

The 38,500-foot course was filled with challenging elements such as heavy traffic, merging cars, long stoplights, curvy roads, slippery surfaces, and low-visibility. The course elements were programmed based on distance in the course, not elapsed time, so all participants experienced the same course elements at the same positions in the course. All participants completed the course without technical problems or experiencing simulator sickness.

Participants in the voice conditions heard ten statements, each following one of the frustrating events (Table 1).

Event	Reappraise-Up	Reappraise-Down
traffic	The behavior of overly aggressive and inconsiderate drivers leads to traffic congestion.	Heavy traffic results from limited routes, not the behavior of other drivers.
cut-off	The driver must have chosen to change lanes despite the danger of running into your car.	The driver must not have seen you; otherwise, he would not have chosen to change lanes.

Table 1. Example Prompts

Participants in the *silent* condition drove without prompts.

After the drive, participants completed a questionnaire that included items about their emotional state, their attitudes about the car, and the driving experience.

Measures

Bad Driving

The software used to create the driving simulation, STISIM *Drive,* collects behavioral data during each drive. The following measures were automatically recorded during the test drives: *off-road accidents, collisions, speeding tickets, traffic light tickets, stop signs missed, centerline crossings,* and *road edge excursions.* These items were combined to create a *bad driving* measure ($M = 0$, $SD = 1$).

Run Length

Run length (in seconds) was the time it took participants to complete the course ($M = 1094.3$, $SD = 300.9$).

Car Evaluation

Participants rated the following descriptions and statements in response to "How well do the following statements describe how you feel about the car?": *trustworthy, friendly, annoying, boring, intelligent, frustrating, I would buy, fun to use, well-designed, I would want to have, high in quality, helpful, likeable, I would use again, reliable,* and *I would recommend it to a friend or family member*. The items were rated on a 10-point Likert scale with anchors "Describes very poorly" and "Describes very well." Negative items were reverse coded; a higher score represented a more positive evaluation ($M = 0$, $SD = 1$).

Negative Emotion

Participants were asked to respond to "How well do the following words describe your present feelings or emotions?" on the following items: *angry, disgusted, aggressive, distaste, distressed, ashamed, fearful, hostile, mad, repulsion, sad, scared, shocked, afraid, dislike, upset, and frightened.* The items were rated on a 10-point Likert scale with the same anchors as above. A higher score represented more negative feelings ($M = 0$, $SD = 1$).

RESULTS

A one-way analysis of variance was used to compare the between-group differences, with Fisher's least significant difference (LSD) test used for the post-hoc comparisons. Error bars represent 95% confidence intervals.

Bad Driving

The ANOVA revealed a significant difference in the *bad driving* behavior between groups ($F(2, 33) = 3.75$, $p = .034$). The post-hoc tests revealed significant differences for two out of the three comparisons. For both *silent* versus *reappraise-down* ($p = .022$), and *reappraise-down* versus *reappraise-up* ($p = .026$), participants in the *reappraise-down* condition had lower bad-driving scores than their counterparts in the other conditions (see Figure 1).

Run Length

There was also a significant difference between groups for the time it took to complete the course ($F(2, 33) = 4.03$, $p = .027$). Participants in the *reappraise-down* condition took a longer time to complete the course than those in the *reappraise-up* ($p = .013$) or *silent* ($p = .033$) conditions (Figure 2). Although slower driving can sometimes signal indecision or confusion in the case of older drivers [6], with this younger population we interpret slower driving as indicating more careful, cautious behavior, and therefore a positive effect.

Car Evaluation

There was a significant difference between groups ($F(2,33) = 3.71$, $p = .035$), with post-hoc tests showing a difference between the *silent* and *up* groups ($p = .01$), and a marginal difference between the *reappraise-up* and *reappraise-down* groups ($p = .10$). In all comparisons, the *up* participants rated the car lower than the *silent* or *down* drivers (see Figure 3).

Negative Emotion

There was a marginal significant difference ($F(2, 33) = 2.65$, $p = .086$) for negative emotion; this likely resulted from a dampening effect associated with the similarity of the *silent* and *reappraisal-up* groups (see Figure 4).

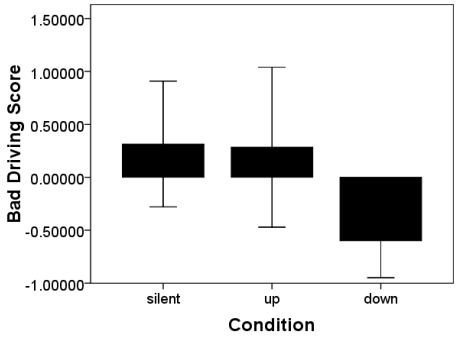

Figure 1. Bad Driving Score.

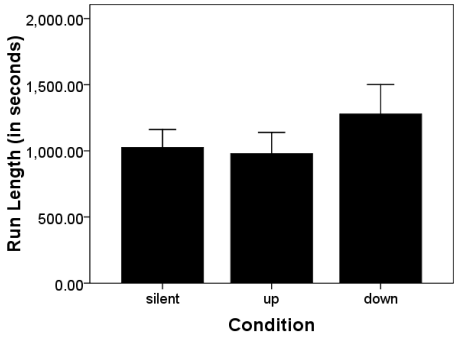

Figure 2. Run Length.

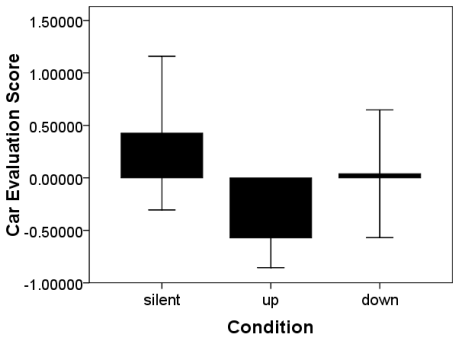

Figure 3. Car Evaluation Score.

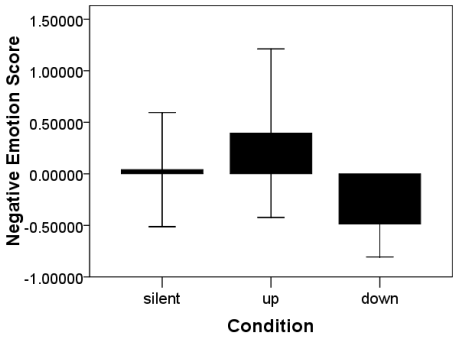

Figure 4: Negative Emotion Score.

DISCUSSION

The results from the study largely support the original hypotheses and point towards a hopeful solution for preventing driver frustration with a conversational in-car interface. We confirmed that carefully implementing a voice interface by situating reframing comments throughout a driving course yields dramatic effects on behavior, self-reported emotions, and attitudes. As hypothesized, the *reappraisal-down* participants had better driving performance and a better outcome emotional state than drivers in the *reappraisal-up* condition. More importantly, the system speaking in the *down* reframing condition did not have adverse effects in terms of performance or interface perceptions. On the contrary, the *down* participants drove better than those in the *silent* condition, and the two groups did not differ in terms of negative emotion or car evaluation. We did not find attitudinal differences between the *down* and the *silent* condition, but given that the prompts were subtle and not overly personal or emotional, the lack of significant differences is not necessarily surprising.

Limitations and Future Work

The study was an initial attempt to apply psychological theory and an emotion regulation strategy to the driving context. Although the results demonstrated the benefits of cognitive reappraisal, there was no real-time record of participants' frustration, attention, or cognitive load. The frustrating events were selected based on researcher experience and artifacts available through the software; additional studies should examine the effects of emotion regulation strategies on specific causes of driving frustration such as continuous (traffic) versus momentary (being cut-off) triggers. While this study provides promising evidence that drivers can be positively influenced without prior training or disruptive alerts, in order for these findings to be implementable reappraisal should be examined within the context of other car applications and in more realistic settings. As infotainment applications grow in the car, reappraisal prompts like the ones used in this paper could be weaved into the everyday interactions with a social or informational interface.

REFERENCES

1. Baumeister, R.F. and Heatherton, T.F. Self Regulation Failure: An Overview. *Psychological Inquiry 7, 1* (1996), 1-15.
2. Galovski, T.E. and Blanchard, E.B. Road Rage: A domain for psychological intervention? *Aggression and Violent Behavior 9,2* (2004), 105-127.
3. Gross, J. Antecedent- and Response-Focused Emotion Regulation: Divergent Consequences for Experience, Expression, and Physiology. *Journal of Personality and Social Psychology 74*, *1* (1998), 224-237.
4. Gross, J. The Emerging Field of Emotion Regulation: An Integrative Review. *Review of General Psychology 2,3* (1998), 271-299.
5. Gross, J.J. and Thompson, R.A. Emotion regulation: Conceptual foundations. In J.J. Gross's *Handbook of Emotion Regulation*, The Guilford Press, (2007), 3-24.
6. Jonsson, I.-M., Zajicek, M., Harris, H. and Nass, C. Thank you, I did not see that: in-car speech based information systems for older adults. *Ext. Abstracts CHI 2005*, ACM Press, (2005), 1953-1956.
7. Nass, C. and Moon, Y. Machines and mindlessness: Social responses to computers. *Journal of Social Issues 56, 1* (2000), 81-103.
8. Nass, C. and Brave, S.B. *Wired for speech: How voice activates and advances the human-computer relationship.* MIT Press, Cambridge, MA, 2005.
9. Nass, C., Jonsson, I.M., Harris, H., Reaves, B., Endo, J., Brave, S. and Takayama, L. Improving Automotive Safety by Pairing Driver Emotion and Car Voice Emotion. In *Proc. CHI*, ACM Press (2005), 1973-1976.
10. Reeves, B. and Nass, C. *The Media Equation: How people treat computers, television, and new media like real people and places.* Cambridge University Press, New York, 1996.
11. Systems Technology Inc. http://www.stisimdrive.com/, 2010.
12. Wegner, D.M. Ironic processes of mental control. *Psychological Review 101*, *1* (1994), 34-52.