

The Effect of Communicational Signals on Drivers' Emotion States

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ABSTRACT

Negative emotions seriously impair drivers' decision making and driving behaviors. As the primary channel of on-road communication between drivers, vehicle signals (e.g. turn signals, hazard lights and horn) provide an effective approach to reduce on-road conflicts and improve drivers' emotion states. Present study evaluated the emotion induced by communicational signals upon drivers with varied personality characteristics. Correlation between decoded meanings, attitude and emotion was further analyzed to explain the mechanism from personality to emotion states in the scope of signal communication during driving. The results suggested that drivers with lower extraversion and agreeableness, higher neuroticism were easier to become negative when perceived aggressive signals. However, appropriate signals with kindness could remarkably improve drivers' emotion and attitude towards others.

Keywords: communication, emotion, attitude, meaning decoding, driving safety

INTRODUCTION

During daily driving, anger, stress, depression and other negative emotions seriously affect drivers' decision making and behaviors, causing serious impairments and accidents (Berdoulat, Vavassori, & Sastre, 2013). When a driver interacts with other drivers (e.g. a scenarios of overtaking or merging), he/she first perceives others' driving behaviors, and then takes action based on the according appraisal and expectation. In such scenarios, any inappropriate behaviors could potentially lead to the conflicts, provoke driver's negative appraisal and bad mood, and start a chain of negative reactions, which may in turn spread road range and risky driving from driver to driver.

Improve emotion with interpersonal communication

From everyday experience, it is assumed that good communication is an effective approach to improve interpersonal relationship. For drivers, actions with vehicle signals (e.g. turn signals, hazard light) would let others have more time to reaction and reduce conflicts. In such circumstance with signal communication, a driver perceives signals, decodes meanings of signals, appraises and reacts accordingly. In addition, signals could provide supplementary information to improve understanding between drivers. Our previous research (Ba, Zhang, Yang, & Salvendy, 2013) has demonstrated the remarkable effect of the vehicle signals on drivers' visual attention, attitude and emotion with stimuli of real driving films in different driving scenarios with signal communication.

Personality traits and emotion states

Risky driving and accident involvement are highly related to the drivers' personality traits (Larsen & Ketelaar,

1991; Ulleberg & Rundmo, 2003). However, the mechanism from personality to unsafe driving is still unclear. One reasonable explanation is that drivers with certain types of personality are easier to be influenced and became emotionally negative.

A large number of fundamental psychological studies has suggested that the personality traits strongly correlate with subjects' emotion states which were generated by various stimuli (DeNeve & Cooper, 1998; Izard, Libero, Putnam, & Haynes, 1993; John & Gross, 2004; Larsen & Ketelaar, 1991). Among these researches, the majority of results demonstrated the significant effect of extraversion, neuroticism and agreeableness on the positive or negative emotional reaction. In a early study using subjective rating scales (Larsen & Ketelaar, 1991), positive emotion strongly related to extraversion, and negative emotion strongly related to neuroticism. This results was confirmed in the followed studies (Izard, et al., 1993). In another meta-analysis examining the personality constructs as correlates of subjective wellbeing, neuroticism was also found as the strongest predictor of negative emotion. Positive effect on emotion was predicted equally well by extraversion and agreeableness (DeNeve & Cooper, 1998). Thus, in the present study, we assumed that drivers with lower extraversion and agreeableness, higher neuroticism would tend to be more negative when perceived others' driving behaviors and interpersonal signals.

The framework of on-road emotional communication

The primary purpose of the present study was to evaluate the effect of communicational signals on the emotional states across drivers with varied personality. In addition, we also considered the decoded meanings, attitude towards others as intermediate dependent variables to explain the mechanism from personality to emotion states. The framework of current study is illustrated in Figure 1 and five questions were proposed in this study:

Q 1: How do personality traits affect drivers' emotion states induced by signal communication?

Q 2: How do personality traits affect the drivers' attitude induced by signal communication?

Q 3-5: What's the relationship between decoded meanings, attitude and emotions?

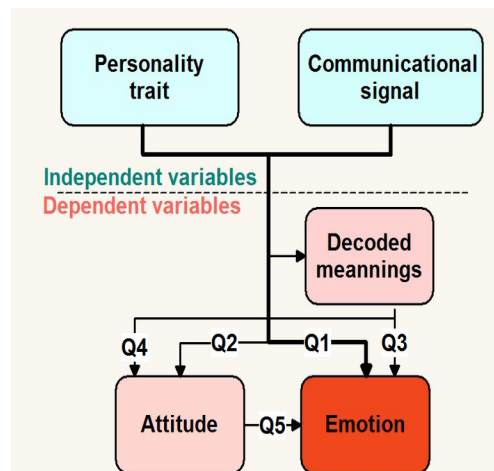


Figure 1 Framework and questions of emotional communication

METHODOLOGY

Participants

Twenty male drivers (from 21 to 29 years old) were recruited from a university population through campus Online Bulletin Board. All participants were required to have a minimum of three years of active driving experience with valid license and more than 20,000 kilometers' total driving distance without accident records during the past year. Before experiment, participants were required to sign an institutionally approved informed consent form and

complete a questionnaire gathering demographic information. After experiment, each participant was provided with the compensation of RMB 100 Yuan (approximately 15 U.S. dollars).

Driving scenarios with communicational signals

Consistent with our previous study (Ba, et al., 2013), eight scenarios were included in current experiment (Table 1). Each scenario concerned one common circumstance that subject’s vehicle interacted with another vehicle (signaling vehicle). In order to test the effect of signals on dependent variables, each scenario included two paired scenes (none-signal vs. signal-use). In the none-signal scenes, signaling vehicle conducted the same behaviors as it did in the signal-use scenes, i.e. entering the subject’s lane without any signal (scenario 3 non-signal scene) versus entering the subject’s lane with turn signals (scenario 3 signal-use scene).

Table 1 List of interactive scenarios and signals use

No.	Signal type	Description of Scenarios
1	Hazard Lights	Signaling vehicle in front is parked
2	Hazard Lights	Signaling vehicle in front is traveling at low speed
3	Left Turn Signal	Signaling vehicle in front is starting and intending to enter the subject’s lane
4	Right Turn Signal	Signaling vehicle in front is stopping into the park lane
5	Left Turn Signal	Signaling vehicle behind is moving left to overtake subject’s vehicle
6	Right Turn Signal	Signaling vehicle is merging from left lane
7	Horn	Signaling vehicle is intending to overtake after (slower) subject’s vehicle yield the way
8	Horn	Signaling vehicle is requesting (slower) subject vehicle to move out of the way

Adopted from “Interpersonal signal processing during interactive driving scenarios”

All scenarios were presented in a fixed based driving simulator (Figure 2) with the views of road ahead (3.2×2.5m flat screen, 3m from driver’s seat) and mirrors (LCD displays embedded in the cab’s mirror position). Sounds were provided by a set of stereo speakers inside the cab.

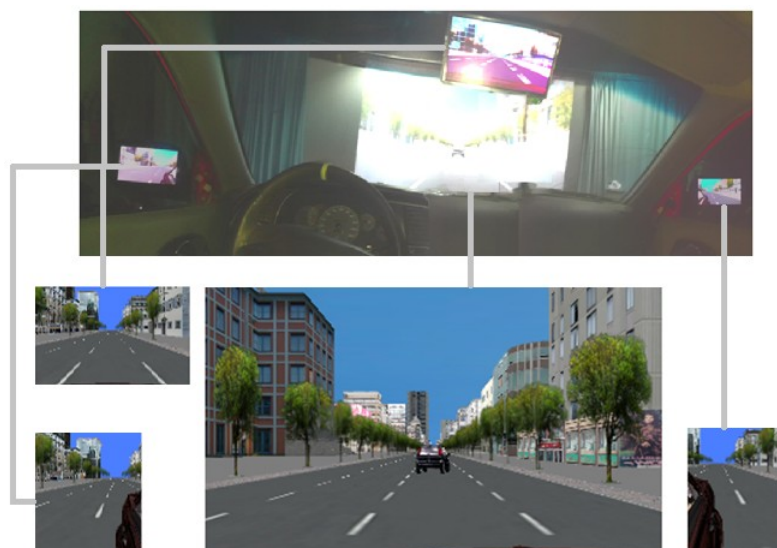


Figure 2 Illustration of driving scenarios presented in simulator (scenario 6)

Measurements

The drivers' personality traits were measured with 240-item NEO inventory (five-point) based on the theory of Five Factor Model. The five dimensions are openness, conscientiousness, extraversion, agreeableness, and neuroticism. Here, we only considered extraversion, agreeableness, and neuroticism, which demonstrated significant correlation with emotion in previous studies. $Personality_{Comprehensive} = Extraversion + Agreeableness - Neuroticism$.

Decoded meanings of perceived signals were measured with a scale with seven distinguished dimensional items: intention, demonstration, emphases, notices, orders, etiquette and displeasure. Each item was rated with a five-point scale, from 1- not mean this at all to 5- strongly mean this.

A five-point semantic scale based on the Planned Behavior Theory was adopted to measure participants' attitudes towards the signaling vehicle. Five adjective pairs were included: worthless- valuable, harmful- beneficial, unpleasant- pleasant, unenjoyable- enjoyable, bad- good. The attitude was calculated by the average score of five items. Here, we only considered the attitude change between paired none-signal scene and signal-use scene as the indicator of the effect of signals, $Attitude_{change} = Attitude_{signal\ use} - Attitude_{none\ signal}$.

The emotional states were measured with five-point Self-Assessment Manikin (SAM). SAM includes three independent dimensions: pleasure, arousal and dominance, which presented with pictorial rating. We only considered the emotion change caused by signals, $Emotion_{change} = Emotion_{signal\ use} - Emotion_{none\ signal}$.

Experiment protocol

During experiment, participants were first instructed to sit into the simulator. A five minutes free-driving scenario was then presented to let participants habituate to the experimental environment. 16 scenes were presented in simulator with different random sequences for each participant. After watching each scene, there was a short break to let driver rate the decoded meanings of signal (only for signal-use scenes), attitude and emotion. Finally, participants were required to complete the NEO inventory.

STATISTIC METHODS AND RESULTS

In order to analyze the effect of personality traits, twenty participants were split into two groups by the median of $Personality_{Comprehensive}$. Each group (high-score group and low-score group) contained 10 participants. No significant difference was reported between the two groups in terms of demographics with χ^2 test. We assumed drivers of high-score group could be more positive as the results of perceiving signals.

To answer Q1 and Q2, independent t test of $Emotion_{change}$ and $Attitude_{change}$ was conducted separately for each scenario to evaluate the effect of signals (compared to 0) and personality (compared between the two groups). To answer Q3, Q4 and Q5, we collapsed all data from eight scenarios together and used Pearson coefficient to evaluate the correlation between $Emotion_{change}$, $Attitude_{change}$ and decoded meanings. Error: Reference source not found and Error: Reference source not found shows the change of emotion and attitude for high-score group and low-score group in eight tested scenarios.

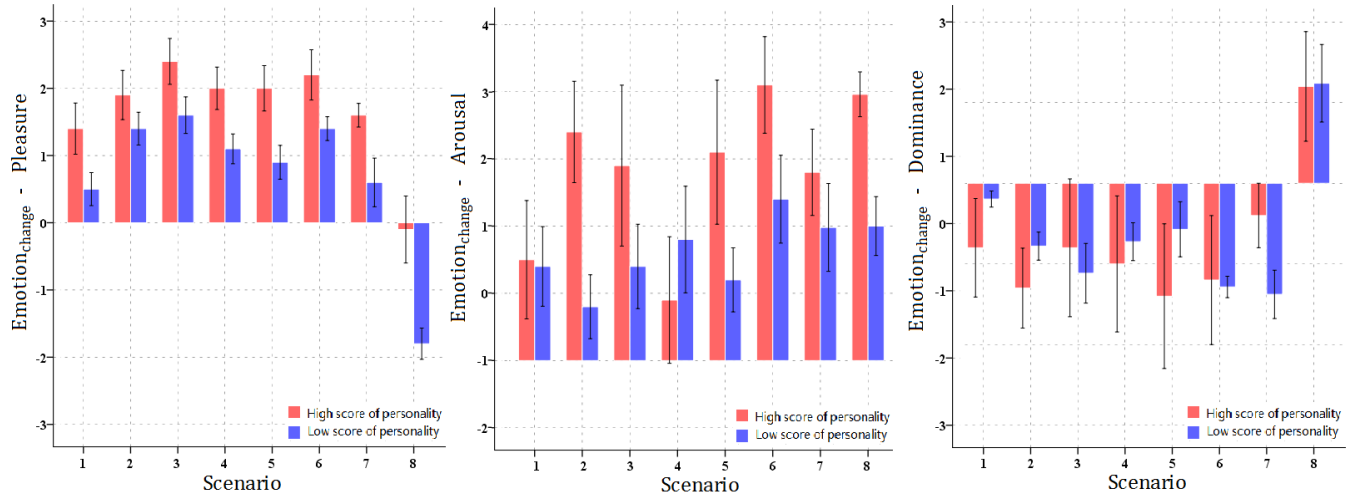


Figure 3 Change of pleasure, arousal and dominance (Mean±SE) for high and low personality groups

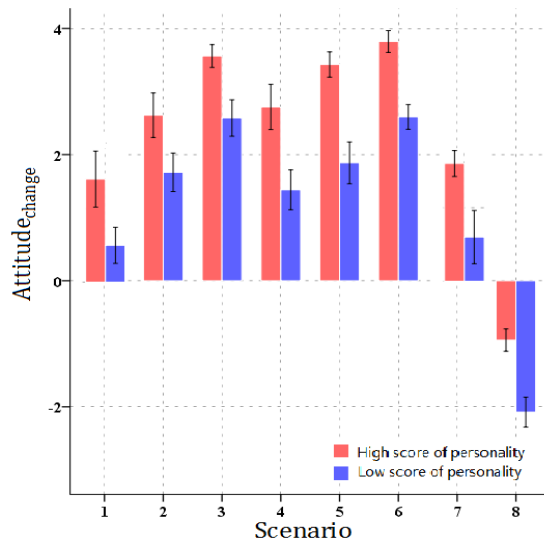


Figure 4 Change of attitude (Mean±SE) for high and low personality groups

Change of emotion and attitude induced by signal communication

Consistent with the previous study with stimuli of real driving film (Ba, et al., 2013), communicational signals in simulation environment significantly impact drivers' emotional state and attitude (Table 2). The signals significantly improved drivers' pleasure and attitude in scenario 1-7. In scenario 8, horn from behind contained some obviously negative meanings, and drivers' pleasure and attitude scores significantly decreased. In all scenarios, drivers' arousal significantly increased, which implied that drivers' emotional states become simulated when perceiving others' signals. The significantly change of dominance only established in scenarios 2, 4, 6 and 8. However, the change tendency of domination appeared opposite to it of pleasure and attitude. Lower domination indicated that drivers became more cooperative in such interactive scenarios.

Table 2 Effect of signals on emotion and attitude

Scenario	Change of emotion						Change of attitude	
	Pleasure		Arousal		Dominance		t_{19}	p
	t_{19}	p	t_{19}	p	t_{19}	p		
1	3.23	<0.01	2.19	0.04	-2.13	0.11	5.97	<0.01
2	6.02	<0.01	3.05	<0.01	-3.68	<0.01	7.17	<0.01
3	7.11	<0.01	2.25	0.04	-1.24	0.22	12.9	<0.01
4	6.05	<0.01	2.58	0.02	-2.19	0.04	6.41	<0.01
5	5.08	<0.01	2.54	0.02	-0.22	0.81	8.96	<0.01
6	6.73	<0.01	4.62	<0.01	-2.91	<0.01	15.22	<0.01
7	4.07	<0.01	3.71	<0.01	-1.95	0.06	4.39	<0.01
8	-2.45	0.02	6.72	<0.01	2.91	<0.01	-6.78	<0.01

Effect of personality on emotion and attitude

As assumed, drivers with high personality score demonstrated more positive change of emotion and attitude than drivers with lower personality score (Table 3). In all scenarios, signals induced more pleasure for drivers of high-score group and the significance established in scenarios 5 and 8. In scenarios 8, the horn from behind almost had no negative effect on pleasure of drivers with high-score. As to the arousal, drivers of high-score group tended to be more simulated than drivers of low-score group. However, no significance established may be partly due to small sample size. Personality had no distinguishable effect on the demonstration and no consistent difference between high-score and low-score group was found across scenarios. The effect of personality on attitude was more obvious than emotions. Drivers of high-score group showed much more positive attitude to signaling vehicles than drivers of low-score group.

Relationship between decoded meanings, attitude and emotion change

Pearson coefficient between decoded meanings, attitude and emotion change was listed in Table 4. Personality scores was significantly correlated to the pleasure and attitude and no significant correlation was reported between personality and arousal, personality and dominance. This confirmed the results demonstrated with t test. The strongest correlation was reported between attitude and pleasure. In addition, attitude also negatively related to dominance.

Interestingly, personality score was positively related to decode meanings of etiquette, which indicated that drivers with high personality score perceived more gratitude from other drivers' communicational signals. The meanings of etiquette, as well as demonstration, emphases were significantly related to pleasure and positive attitude. On the contrary, the meanings of order and displeasure were related to negative attitude and anger.

Table 3 Effect of personality on emotion and attitude

Scenario	Change of emotion						Change of attitude	
	Pleasure		Arousal		Dominance		t_{19}	p
	t_{19}	p	t_{19}	p	t_{19}	p		
1	1.59	0.13	0.07	0.95	-0.87	0.41	2.12	0.05
2	0.91	0.38	2.04	0.06	-1.25	0.23	2.22	0.04
3	1.47	0.16	0.78	0.45	0.39	0.71	2.31	0.03
4	1.86	0.08	-0.51	0.62	-0.14	0.91	2.21	0.04
5	2.09	0.05	1.13	0.27	-0.76	0.44	3.22	<0.01
6	1.55	0.14	1.25	0.24	-0.11	0.91	3.66	<0.01
7	0.29	0.06	0.62	0.54	2.01	0.06	2.18	0.05
8	2.88	<0.01	2.49	0.23	0.01	0.93	2.78	<0.01

Table 4 Correlation between decoded meanings, attitude and emotion

Variables	Etiquette	Emotion		Attitude	
		Pleasure	Dominance		
Personality	0.40**	0.33**	–	0.20**	
Decoded meanings	Intention	–	–	0.16**	
	Demonstration	–	0.32**	0.35**	
	Emphases	–	0.19**	–	0.25**
	Notices	–	0.31**	–	0.21**
	Order	–	–	–	-0.11*
	Etiquette	–	0.32**	–	0.14*
	Displeasure	–	-0.41**	0.36**	-0.44**
Attitude	–	0.70**	-0.36**	Na	

*p<0.05

**p<0.01

DISCUSSION AND CONCLUSION

In current study, we evaluated the emotion and attitude change induced by communicational signals upon drivers of varied personality. We also analyzed the correlation between decode meanings, attitude and emotion to further explain the mechanism from personality to emotion states in the scope of signal communication during driving.

Inter-driver communication with vehicle signals is an effective approach to improve drivers' emotional statues and attitude during driving. Appropriate signals could increase drivers' pleasure, emotional arousal and appreciation to others. However, the effect of signals partly depends on drivers' personality. The drivers with higher personality score (higher extraversion and agreeableness, lower neuroticism) could become more positive than others when perceive signals, which demonstrated by the results of scenario 1-7. On the contrary, drivers with lower personality score were easier to become negative when bad interaction experience occurred, which demonstrated by the results of scenario 8 with horn from behind vehicle. It's also reasonable to deduce that negative emotions and attitude could impair such drivers' decision making and lead to risky driving behavior.

Attitude towards other drivers was significantly correlated with emotions (higher pleasure and lower dominance). In addition, signal meanings of order and displeasure was significantly related to negative emotion or attitude. However, signal meanings of intention, demonstration, emphases and notices and etiquette was significantly related to positive emotion or attitude. Drivers with high personality score could perceive more etiquette from decoded signals. Thus, more genial and amicable communication should be encouraged to promote harmonious interpersonal relationships on roads.

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