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Differences in facial affect recognition between non-offending and offending drivers ☆

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ABSTRACT

It is assumed that emotion recognition is a complex process related to prosocial and antisocial behaviour (Marsh & Blair, 2008). The present study focuses on the connection between recognizing emotions and safe/unsafe driving. We studied whether there are differences in response time in facial emotion recognition. Fifty-one non-offenders and 41 offenders completed a Pictures of Facial Affect test (Ekman & Friesen, 1976) wherein photographs of prototypical facial emotional expressions were presented. Results show differences between the groups in response time to all emotions whether answers were correct or incorrect. Data show that non-offenders are faster in recognizing emotions than are offenders. These findings demonstrate that offenders exhibit specific deficits in response time for facial affect expressions.

1. Introduction

The global status report on road safety (WHO, 2015) states that approximately 1.25 million traffic-accident fatalities occur every year. It is estimated that as many as 97% of accidents in the Czech Republic are due to the human factor or to combinations of the human factor and other causes (CDV, 2016). It is obvious that risky behaviour of drivers significantly increases the probability of an accident. The various manifestations of risky behaviour in traffic include driving under the influence of drugs or alcohol, speeding, distraction (e.g., using mobile phones), and such other offences as failing to wear seatbelts or driving without a driving licence (Police of the Czech Republic, 2018).

Significant progress has been made in many countries towards improving road safety legislation and the safety of vehicles. Despite this, the numbers of accidents and fatalities remain high. An analysis of the drivers' tasks and accidents has shown that adequate psychomotor skills and normal physiological functions are not sufficient for good and safe performance as a driver (Hatakka, Keskinen, Gregersen, Glad, & Hernetkoski, 2002). Many measures can be used to reduce risky behaviour on the road. Aside from the punishments and sanctions system there are many measures focused on the psychological characteristics of drivers. Psychological assessment can be used for identifying extremely risky drivers. Rehabilitation

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programmes and driving improvement courses can be significant preventative measures against repeat traffic offences. On the other hand, both assessment and driving improvement courses have problematic aspects. Experience shows that performance characteristics cannot be taken as a predictor of risky tendencies. High scores in driving skill tests correlate with recidivism rates and overestimation of one's own capacities (Poll & Kluppels, 2015). It is assumed there might be subtle aspects of personality traits that should be subject to investigation when spotting for potentially risky attributes of an individual. At the same time, there are serious concerns about the efficacy of rehabilitation and therapy for traffic offenders. Research has shown strongly positive outcomes from driving improvement courses for DUI ("driving under the influence") offenders but questionable effect on non-DUI offenders (Poll & Kluppels, 2015).

Safe driving is a complex task that requires specific skills as well as matured personality, and it also depends on cultural aspects and a person's lifestyle (Hatakka et al., 2002). According to the Goals for Driver Education Matrix (Hatakka et al., 2002), driving behaviour can be divided into four hierarchical levels: vehicle manoeuvring, mastery of traffic situations, goals and context of driving, and goals for life and skills for living (Siegrist, 1999). The current system of driver training focuses on the first two of these, which are necessary but not in themselves sufficient for safe driving. Rehabilitation programmes focus on the two "higher" levels and, thus, have the potential for long-term change in drivers (Řezáč, Kurečková, Zámečník, & Trepáčová, 2017). Empathy and prosocial behaviour seem to be an important part of fitness-to-drive over and above pure skills and performance attributes.

It is assumed that increased prosocial tendencies and empathy might help reduce risky behaviour. Empathy has been found to increase prosocial and socially competent behaviour and to reduce aggression. Empathy is a crucial factor in social interaction, and it may be important for dangerous driving behaviour because driving takes place in a social context (Nordfjærn & Şimşekoğlu, 2014). Developmental, behavioural, and clinical research shows that distress cues elicit empathy in those who observe them (Hoffman, 1987; Marsh & Ambady, 2007; Nichols, 2001; Preston & de Waal, 2002), and this is generally associated with decreased antisocial behaviour (Eisenberg, 2000; Marsh, Adams, & Kleck, 2005). The empirical findings provide support for the assertion that empathy is related to some forms of prosocial behaviour (Batson & Shaw, 1991; Eisenberg & Miller, 1987; Stocks, Lishner, & Decker, 2009).

A recent meta-analysis (Elfenbein & Ambady, 2002) has indicated that, despite some cross-cultural variations, basic emotional expressions are recognized across cultures at levels too high to have resulted from social learning alone. Recognition of facial affect serves a communicatory function in that it imparts specific information to the observer (Mineka & Cook, 1993). The ability to accurately decode and interpret facial expressions is crucial for efficient social functioning. While facial expressions have been shown to serve some physiological functions (e.g., Zajonc, Murphy, & Inglehart, 1989), the primary function of these expressions is most likely social. Emotional facial expressions play an important role in modulating interpersonal behaviour (Marsh & Blair, 2008), particularly for socialization and normal social interaction (Corden, Critchley, Skuse, & Dolan, 2006). The results from the meta-analysis point to a robust link between antisocial behaviour and specific deficits in recognizing the displays of facial affect (Marsh & Blair, 2008). Similarly, the ability to perceive distress cues is commonly associated with prosocial behaviour (Nichols, 2001), which includes both sympathy and the intent to help another person. Like the emotional expression itself, identifying an emotional expression is also a complex task. It requires visual scanning, perceptual processing, effortful attention, working memory, and semantic processing (Marsh & Blair, 2008). Kring and Bachorowski (1999) state that different functional components play their roles in the recognition of emotional facial expressions. It has been suggested that facial affect recognition might interact with such skills as the cognitive understanding of social interactions and the expression of empathy (Cooley & Triemer, 2002).

In spite of a general lack of empirical studies examining empathy in relation to unsafe driving behaviours, several studies have shown that individual devotion to the welfare of other individuals is linked to lower levels of aberrant driving behaviour (Lucidi et al., 2010; Ulleberg & Rundmo, 2003). As suggested by Dula and Geller (2003), driving behaviours that endanger or have the potential to endanger others should be regarded as points on a behavioural spectrum of dangerous driving. This spectrum of behaviours could take several forms, ranging from intentional acts of aggression towards others, through negative emotions experienced while driving, to risk-taking. Empathy and conformity could influence drivers' tendencies to collaborate with, or imitate, the behaviours of other drivers (Nordfjærn & Şimşekoğlu, 2014). It is expected that individuals who score high on the trait empathy are less likely to commit driving errors and violations than are lower-scoring drivers, because more empathetic individuals may be more sensitive to the behaviour of other drivers and have a stronger ability to interpret their emotions and behavioural intentions while on the road (Nordfjærn & Şimşekoğlu, 2014).

When speaking about empathy's effect on driving behaviour, it should be noted that this effect might itself be influenced by several variables. On a general level, there is the variable of culture. How empathy and prosocial behaviour are valued within a society influences decision making and behaviour. On a more concrete level, there are norms (how individuals value social norms is based in part on empathy, as more ego-centred people are less prepared to accept social feedback and influence from others), habits (because driving behaviour is to a great extent habit-based, it occurs in part automatically and thus the roles of rationality and emotions are less influential than in cases of more "aware" behaviours), and many others (e.g., attitudes and beliefs). Although these variables have been well described and often are elements in behavioural theories (e.g., the theory of planned behaviour or the norm activation model), the influence of empathy remains unclear and even contradictory (Ajzen, 1991).

For example, Owsley, McGwin, and McNeal (2003) have reported that older drivers who report driving errors tend to have more empathetic personalities. These authors also found no significant association between empathy and traffic violations. One explanation for this is that empathetic people may feel the need to be more candid when making disclosures to others

about the quality of their driving. Another explanation is that individualistic attitudes are associated with higher levels of driving errors and violations, while more collectivistic attitudes are related to lower levels of violations (Nordfjærn & Şimşekoğlu, 2014). In contrast with previous findings by Owsley et al. (2003), Nordfjærn and Şimşekoğlu (2014) found that empathy is related to lower levels of driving errors and lower levels of traffic violations.

Thus, research data suggest there might be differences in empathy between non-offenders and offenders. The question of interest in this study is whether the two populations also differ in recognizing facial expressions.

2. Materials and methods

2.1. Sample

The research sample consisted of 92 drivers, 51 of whom were non-offenders and 41 of whom were offenders. The Czech Republic is among the countries which introduced the demerit point system in the 2000s (Zámečník, Gabrhel, Kurečková, & Řezáč, 2016). The demerit point system estabilished an administrative procedure that can lead to driving licence suspension. Offenders were chosen from a group who had lost their driver's licences because of serious offences (e.g., driving under the influence of alcohol; extreme speeding; illegal overtaking; driving in reverse, turning around, or driving in the wrong direction on the motorway; and leaving the scene of a traffic accident) or repeated less serious offences (e.g., failure to wear a seat belt, use of a mobile phone while driving, exceeding the speed limit but by less than 20 km/h in urban areas). Attendees of rehabilitation programmes mostly have had their driving licences suspended due to multiple offences. The conditions of rehabilitation programmes and number of attendees did not allow for selecting offenders for only certain types of violations. This was not feasible also because attendees typically have committed multiple offences. Offenders were not asked about the number and characteristics of their violations, as the key selection criterion for participating in this study was the fact of driving licence suspension as a result of receiving the specified number of points in the demerit point system. All offenders were recruited after they had undergone a rehabilitation programme for traffic offenders. The rehabilitation programme was run three times per year, and it would have been unmanageable to arrange participation in the experiment for all offenders prior to the start of the programme. Therefore, their participation in the experiment was arranged after the end of the programme. Because access was not permitted to the database of traffic offenders kept by the Czech Republic's Ministry of Transport, it was possible to contact only those who had attended the rehabilitation programme.

The rehabilitation programme for offenders was focused on changing attitudes regarding traffic safety, risk awareness, and creating a strategy to prevent future offences. The theoretical framework for this programme is based on the European Union's Goals for Driver Education (GDE) and on Prochaska and DiClemente's transtheoretical model of behaviour change (Prochaska & DiClemente, 2005). Ten percent of those entering the rehabilitation programmes did not complete them due to acute cases of drug addiction relapse or acute psychiatric disorder relapse. Nearly 10% of attendees refused to take part in the experiment, mostly for reasons of time.

Non-offenders were recruited through job recruitment websites and selected using self-reported data. Participants were asked about any traffic offences during the preceding 3 years. Only people without criminal records were included into the study. Non-offenders had to provide confirmation of having no criminal record or they were excluded.

Tables 1 and 2 describe the samples, which were comparable in terms of gender composition (Table 1), age (Table 2), income (assessed subjectively), and education. The majority of respondents were single (69%) and had secondary school educations (60%). Regarding economic status, just 47% of them were employed, The second most frequent group consisted of students (27%). Most of the participants considered themselves to be in a low-income (56%) or middle-income group (37%).

2.2. Data collection

Participants were asked to classify the emotional expression on each of two adult male and two adult female Caucasian faces (where each of the faces were used across all affects) in a fixed order, using photographs of prototypical facial affect, sometimes referred to as Pictures of Facial Affect (Ekman & Friesen, 1976), which are intended to measure the ability to recognize facial expressions. The presented photographs were shown in the following order: Happy, Neutral, Surprise, Neutral, Happy, Neutral, Neutral, Happy, Anger, Fear, Fear, Sad, Sad, Fear, Anger, Surprise, Surprise, Disgust, Happy, Anger, Sad, Anger, Fear, Disgust, Surprise, Sad, Disgust, Disgust.

Table 1
Gender frequencies for offenders and non-offenders.

	Offenders		Non-offenders		Total	
	n	%	n	%	N	%
Male	37	90	45	88	82	100
Female	4	10	6	12	10	100
Total	41		51		92	100

Table 2
Age characteristics for offenders and non-offenders.

	n	M	SD	Mdn	Minimum	Maximum
Offenders	41	32.3	11.1	32	18	66
Non-offenders	51	30.5	9.6	27	20	60
All	92	31	10.3	24	18	66

Photos were shown on a computer screen and varied in affect intensity. The participants were exposed to each of the photographs for 8 s and after each face, a screen with a list of seven basic emotions (happiness, fear, anger, sadness, disgust, surprise, and neutral) automatically followed. Participants were asked to choose the correct answer. "Don't know" was provided as an eighth option. Participants were given unlimited time to classify each emotion. No feedback was provided. The instructions given to participants were as follow: *"You will now be presented with several photographs showing human emotions. Each photo will be displayed for eight seconds. From the menu, select the option that you think matches the emotion on that photograph. You will have an unlimited amount of time to answer. If you are unsure, select the 'Don't know' option. First, a training example will follow. As soon as you press the 'Continue' button, the test itself will start."*

Photographs were presented in a fixed order so that all participants in the experiment were exposed to the same conditions. Although the fixed order was set, the emotions were altered such that three or four images of a single emotion would not be presented in succession.

In order to protect anonymity, all information about the choices participants had made during the study were managed via Z-tree software (Fischbacher, 2007). Participants then answered several questions about sociodemographic characteristics, they were debriefed, they were paid for their participation (regardless of group), and thanked for participating. Overall, the study participation took approximately 30 min for each participant.

3. Results

This study aimed to determine whether groups of non-offenders and offenders differ in their ability to correctly recognize basic emotions and in their response time.

3.1. Response time for both correct and incorrect answers

No notable differences between offenders and non-offenders in answering correctly were observed for any of the displayed photographs. None of the respondents used the "Don't know" option. The groups did differ in response time, however. Response times were observed in the Pictures of Facial Affect test for each photograph, regardless of whether the answer was correct (see Table 3). The analysis focused on whether response time differed between the groups, between emotions, and between the groups concerning individual emotions. A series of generalized linear mixed models was employed for these purposes.

3.2. Data manipulation

Because the response times in two individual instances were markedly longer than were the response times for all available faces (31 s and 32 s, when both the median and interquartile range were 3 s), these two responses (made by different respondents) were removed from the data set prior to subsequent analyses (see Fig. 1).

Moreover, since the response time data contained zero-values due to rounding to the nearest integer during preprocessing, these values were recoded as 0.5 in order for the values to become logarithmically transformable (see Fig. 2).

Afterwards, the data were transformed to a long form with the response times aggregated into a single variable, so that each row in the data set represented a single response. In addition to identifying information, each row included a person covariate (i.e., to which group the respondent belonged) and two "item" covariates (to which face was the response made and which emotion did the face display).

Table 3
Model overview.

Model	Number of parameters	Deviance	LRT (Baseline model) p-value	LRT (previous model) p-value
Baseline model	4	12,431	–	–
Model 1	5	12,418	<.01	<.01
Model 2	11	12,410	<.01	.23
Model 3	17	12,407	<.05	.77

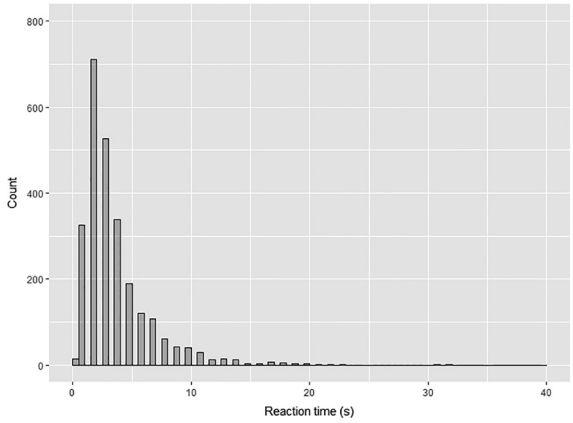

Fig. 1. Distribution of response times.

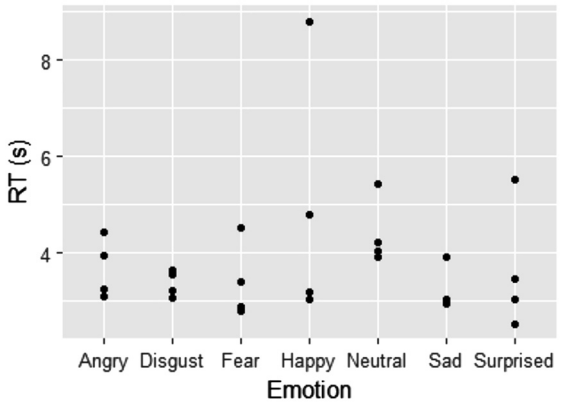

Fig. 2. Graph with reaction times for each emotion.

3.3. Modelling

A series of generalized linear mixed models with a log link function were fit to the transformed data using the *glmer* function from the *lme4* package (Bates, Mächler, Bolker, & Walker, 2015) in R (Core Team, 2017). All models contained a random intercept for persons, a random intercept for "items" (individual faces regardless of emotion), and a fixed intercept (together, this set of parameters constitutes the baseline model). The models thus aim to accommodate individual differences in response time (while assuming such differences manifest consistently over all stimuli) and systematic face-dependent deviations in response time (while assuming such differences manifest consistently over all participants). The fixed intercept, simply put, represents the average response time over all stimuli. Model 1 contained a fixed effect for group membership (non-offenders vs. offenders) in order to model overall differences in reaction time between the two groups of drivers. Model 2 contained an additional fixed effect for emotion (dummy coded) in order to model differences in elicited response time between faces displaying different emotions. Finally, Model 3 contained not just the aforementioned fixed effects but also interactions between emotion and group membership in order to model differential effects of individual emotions in eliciting different response times between the two groups. As such, all models were nested within the baseline model and each model was nested within the more parsimonious models. By fitting more complex models and comparing the fit of each model to the previous model (and to the simplest – baseline – model), one can observe whether introducing additional fixed parameters results in any more explained variance of the dependent variable. This method allows for testing of hypotheses represented by the additionally included fixed parameters.

Likelihood-ratio tests (LRT) were performed to evaluate differential performance of all models with respect to the baseline model and the immediately preceding model (see Table 3). Although adding the fixed effect of group membership (Model 1) did improve the model, none of the added fixed effects in models 2 or 3 helped further to explain the data. Thus, the inclusion of parameters modelling the differences in response time over different emotions (Model 2) or the differences between the participant groups in response time over different emotions (Model 3) did not improve model fit. Therefore, the hypothetical effects modelled with these parameters are not supported by data.

Table 4
Overview for Model 1.

	Estimate (Std. Error)
Intercept	1.18 (.06)
Offender	.21 (.06)
SD of random effect – person	.62
SD of random effect – "item"	.60
Residual SD	2.44

Table 4 presents overview of the fixed effect and random effect estimates for Model 1.

4. Conclusions

The data from this study suggest that the non-offenders respond faster than do offenders in facial affect recognition. Previous data have shown deficits in facial affect recognition that were found in young offenders who had been involved in acts of delinquent driving behaviour (Carr & Lutjemeier, 2005). One possible explanation for this is that offenders have more difficulty in recognizing emotions and, at the same time, difficulties experiencing and perceiving their own emotions. Therefore, they are unable to detect potential emotional warning signals in risky situations. The difficulties in experiencing and perceiving emotion may also lead to impaired manifestation of emotions. The group of offenders was far more likely to have a long response time for almost all of the facial expressions, even when they had sufficient time to assess the presented photographs. It should be noted, however, that the present study found no evidence of any differences in the quality of facial affect recognition, only a difference in the speed of that recognition. Hypothetically, in real-life situations, slower facial affect recognition might result in an inability to recognize emotional expression in time and thus in not utilizing situational cues to their full extent.

Numerous factors – including general intelligence, age, attention, verbal ability, and task-specific motivation – can be associated with deficits in facial affect recognition scores (Herba & Phillips, 2004). A certain level of impaired self-reflection (or its absence) could be expected in traffic offenders when they are evaluating driving situations. According to Saarni (1999), awareness of one's own emotions is regarded as an important attribute for their regulation. Perceiving facial expressions, their decoding and interpretation together constitute an important part of efficient social functioning (Corden et al., 2006) related to empathy and prosocial behaviour. People manifesting signs of dangerous or antisocial behaviour also have deficits in recognizing emotions. Our research suggests that offenders, when compared to non-offenders, manifest slower detection of all the fundamental emotions but not deficits in emotion recognition. This could suggest some deficits in empathy. One possible explanation is that offenders do not attribute so much importance to facial affect recognition as do non-offenders, hence their slower response time. Driving could play an important role in their lives and constitute a part of self-realization that is placed above the needs of other drivers or other traffic participants. This could lead to a need for longer response time in order to recognize the affective state of others.

The deficit in recognizing emotions could be considered a predictor of potentially dangerous and antisocial behaviour. This can be applied in the process of driver assessment and in future might be incorporated into new diagnostic tools for fitness-to-drive assessment. Facial affect recognition training can be applied in driver improvement courses. It also can have some therapeutic applications: If we assume that emotional intelligence constitutes a relevant part of prosocial behaviour, then therapy and rehabilitation of offenders should also focus on the emotional aspects and empathy. It is worth considering whether training in emotion recognition as a component of rehabilitation programmes can help increase empathy and thereby promote safer behaviour in high-risk drivers. This might lead to offenders improving their realization that their driving behaviour affects other traffic participants even though there is no direct contact among them. Empathy-supporting techniques are considered an important part of driving improvement courses (Řezáč et al., 2017). To date, however, not enough is known about all important aspects of empathy and so any new knowledge in this area might help to improve both rehabilitation programmes and psychological assessment of drivers.

4.1. Limitations

Several limitations of the present study should be emphasized. First, although the study was generally successful in detecting differences in response time for recognizing facial affect, all of the emotions used in the testing were relatively easy to classify. For each presented emotion, there was always some proportion of respondents who did not recognize it, but there was no statistically significant difference between groups in the ability or inability to recognize emotions.

Consequently, interpretation of the negative findings for correctness is unwarranted. A shortened time for the exposure to each of the photographs could show additional differences between non-offenders and offenders beyond just response time. Although Ekman and Friesen (1976) photographs of facial affect have been widely used, the specific display durations and stimulus sequences used in this study had not previously been tested. Only additional research can examine the replicability of response time with further tests (Kosson, Suchy, Mayer, & Libby, 2002). The length of exposure to each emotion could influence the absence of choosing the "Don't know" option. Also possibly having an influence is the fact that there was

no consequence or punishment for participants in the event of their giving an incorrect answer. If respondents were not sure about the correct answer, they might thus be more willing to choose one of the main options offered rather than "Don't know". Another explanation might lie in a perception that one's ability to recognize emotions is a basic competence and that to choose the "Don't know" option therefore indicates a lower level of this competence. Admitting that one does not know might therefore be unsettling to one's self-confidence.

Offenders tend to be very proud of their skills and are usually focused on performance. We can assume, therefore, that they wanted to succeed in recognizing the emotions and that, because proper recognition was more important than was the time needed to reach a decision, their reactions took more time. An inner motivation to succeed is not the only possible motivation that can confound the results. There might also be an impact due to the fact that participation in the rehabilitation programme led to suspension of the offenders' punishments. One reason is to help or show gratitude to people who helped them by taking them into the programme. A second reason could be a belief that there was some kind of connection between test results and their possible punishment or release therefrom. Offenders tend to be more suspicious, and they usually do not trust authorities. Thus, some of them might not fully believe assurances that the results of the voluntary testing will have no influence on their licence reinstatements.

An important confounding effect could also ensue from the rehabilitation treatment itself. Because impulsiveness and lack of self-reflection constitute in no small part the behavioural basis for the offences that landed the offenders in the rehabilitation programme, and because these very characteristics should be enhanced in taking the course, the longer response times are in this light possibly positive results of rehabilitation treatment inasmuch as we want participants to think more about their decisions and to react less recklessly. This should be taken into account in future research. For example, a pre-test might be added in order to have data to control for this confounding treatment effect.

Future research should also give more consideration to the length of time the photographs are displayed. Moreover, additional research should focus on evaluating other cohorts in somewhat different conditions, such as different age groups and groups committing traffic offences with varying degrees of severity.

In the present situation, the rehabilitation programme had not been focused on emotion recognition training but on changing driving behaviour. Therefore, the experimental setting was different from that of the rehabilitation programme. For this reason, it can be concluded that the rehabilitation programme did not in and of itself purposely influence this competence. It would be appropriate in future research also to test those offenders who did not participate in the rehabilitation programme.

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