



UNIVERSITY OF TWENTE.

Faculty of Behavioural, Management and
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Predictive policing

Human advice versus system advice: The influence of advice
origin and justification on trust and acceptance of advice

Klara Blaimer

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Supervisors:

Prof. dr. J.H. Kerstholt
W. Schreurs, MSc.

Faculty of Behavioural, Management and Social Science
Department of Psychology of Conflict, Risk & Safety
University of Twente
P.O. Box 217
7500 AE Enschede
The Netherlands

Abstract

The use of technology is increasing day by day. Computer systems act more and more in an advisory role to give people assistance. Also in the range of police work technologies provide new possibilities. An example is predictive policing, which applies computer software to locate hot spots and identifies people who are prone to commit a crime. As the outcomes of such systems influence the allocation of time and effort, trust in computer systems is an important component to consider. This study is designed to provide insight into the decision making of police officers with regard to available advice. Examinations focused on the effect of the type of advisor and the type of advice on the level of trust and the acceptance of advice. Taken into consideration, in particular, were the differences between human advice and system advice and advice without underlying reasoning and advice with reasoning. Moreover the cognitive style need for cognition was examined, with respect to the relationship between trust and advice taking. Data was collected via a survey questionnaire. Results indicated no significant differences between the human/ system condition and the justification/ no justification condition. No connection of need for cognition with the relationship between trust and advice was found either.

Keywords: predictive policing, human-system interaction, advice taking, trust, need for cognition

Contents

1. INTRODUCTION	4
2. METHOD.....	9
2.1 DESIGN	9
2.2 PARTICIPANTS	9
2.3 MATERIALS.....	10
2.3.1 <i>Advice taking.</i>	10
2.3.2 <i>Trust.</i>	10
2.3.3 <i>Need for Cognition.</i>	10
2.3.4 <i>Demographics.</i>	11
2.4 PROCEDURE	11
3. RESULTS.....	13
4. DISCUSSION.....	17
4.1 TRUST	17
4.2 ADVICE TAKING.....	18
4.3 NEED FOR COGNITION	18
4.4 LIMITATIONS AND STRENGTHS.....	19
4.5 RECOMMENDATIONS	19
5. CONCLUSION	20
REFERENCES	21

1. Introduction

The future has already begun. The use of technology is increasing day by day.

Technology affects almost every section of our lives and we therefore all depend on it in some way (Mollenkopf & Kaspar, 2013). In the work environment technologies open up new possibilities to speed up services and cut down costs. Also in the private use we can see very big changes. Especially if we think of the past, when it was common to write letters, whereas nowadays technology offers the possibility to communicate in a much more timesaving and easier manner. Looking further ahead, technology also offers a significant influence on the security sector. Algorithms emerge to offer new possibilities to enable the detection of future threats (Raley & Amore, 2017).

New technological ways of working revolutionize policing. ‘Predictive policing’ is the keyword if talking about new possibilities in the range of police work. The aim of predictive policing is to reduce crime by detecting criminal activity before it happens (Ferguson, 2012). If thinking of the American science fiction film ‘Minority Report’, in which a specialized police department called ‘PreCrime’ arrests criminals based on forecasts provided from so-called ‘precogs’, it seems like science fiction to solve crime before it is committed. But science fiction has become reality. Not in the exaggerated way as in the film, but rather in a way based on analysing ‘Big Data’.

Big data is one of the mostly discussed topics in recent times. In 2011 more than 530 academic articles focussing on big data were published (Buhl, Röhlinger, Moser & Heidemann, 2013). But what is hidden behind the term big data? It is an evolving term that refers to a new method of data exploration and utilization (Zikopoulos & Eaton, 2011). Due to the enormous growth and diversity of data - in

fact more data has been recorded over the past two years than in all of the previous history – data is no longer manageable without new methods of data science (Waller & Fawcett, 2013). Thus, big data provides the capacity to utilize information in a novel way (Mayer-Schönberher & Cukier, 2013).

As already mentioned, predictive policing is built on using big data. According to Cornish and Clarke (1990) there is evidence that crime is predictable. Criminals commit crimes more likely in areas where they are familiar with and in a manner with which they had success earlier. Predictive policing thus applies computer software that analyses big data with the aim of achieving patterns and structures that indicate future risk. Thereby the focus lies on one side on locating hot spots and on the other side on identifying people who are prone to commit a crime (Gless, 2016). To put it briefly, predictive policing is ‘the application of analytical techniques to identify likely targets for police intervention and prevent crime by making statistical predictions’ (Perry, 2013, p.1). Hence, police officers get advice from a statistical method about where crimes most likely will take place.

In regard to the rapid progress of technologies, trusting in computer systems is an increasingly important component to consider. Intelligent decision systems - such as software that analyses big data in the domain of predictive policing - are designed to assist decision makers to take decisions more efficiently (Madsen & Gregor, 2000). Previous research showed that trust affects how much people accept and rely upon systems (Jian, Bisantz & Drury, 2000). Madson and Gregor (2000) defined human-computer trust in their study as ‘the extent to which a user is confident in, and willing to act on the basis of, the recommendations, actions, and decisions of an artificially intelligent decision aid’ (Madson & Gregor, 2000, p.1) It was found that the factor trust is important to understand automation reliance decisions (Dzindolet, Peterson,

Pomranky, Pierce & Beck, 2003). Moreover, findings from Briggs, Burford, De Angeli and Lynch (2002) indicate that trust affects the acceptance of advice. Considering these reflections lead to the assumption that also in the domain of predictive policing trust in a system that predicts crime has influence on the decision that will be made by a police officer.

When talking about trust there also arises the question whom to trust. Early investigations showed concern with issues of trust in both human operators and technical devices. Statements such as ‘human operators are not to be trusted’ and ‘concern about trust in automation is also understandable’ (Hoffmann, Johnson, Bradshaw & Underbring, 2013, p.1) demonstrate the difficulty to decide whom to trust. However Önköl, Goodwin, Thomson, Gönül and Pollock (2009) pointed out that there is a tendency to rely more on human experts. According to Armstrong (1980) the reliance on experts is reasoned by a shifting of responsibility, experts could be blamed if they give inaccurate advice. However it was found that this is not the case when advice comes from a statistical method (Harvey & Fischer, 1997). Therefore, also in the domain of predictive policing, it is expected that decision makers are more likely to rely on human advice than advice coming from a system.

As regards the technical side, it was found that the major risk felt by individuals using a machine is a loss of control of the machine. There is a tendency to override a machine if operators have the feeling that the machine leads them towards a situation they think they cannot control. This phenomenon is a consequence of a low level of trust in the machine (Hoc, 2001). Several studies have examined individual differences in the tendencies to express appropriate levels of trust. In addition connections were found between cognitive styles and trust assessment (Bruine de Bruin, Parker & Fischhoff, 2007). It is widely recognized that cognitive styles have

impact on individuals' behavior. They refer to individuals' differences in preferred ways of processing information and thereby in the ability of making a decision (Kickul, Gundry, Barbosa & Whitnack, 2009). In the case of using assistive technology to predict crime, the cognitive style need for cognition could have influence on the decision making process. According to Cacioppo and Petty (1982), need for cognition is 'the tendency for an individual to engage in and enjoy thinking' (Cacioppo & Petty 1982, p.116). Prior research is showing that need for cognition influences receptivity of messages (Petty, Cacioppo, Sreathman & Priester, 2005). Applied to the topic of predictive policing that could indicate that the need of cognition of police officers could have influence on the receptivity of a message from a system or another police officer. Since previous research indicated, that individuals low in need for cognition are characterized as more likely to rely on others (Cacioppo, Petty, Feinstein & Jarvis, 1996), it is expected that low need for cognition is beneficial to the level of trust, and thereby also to advice taking.

Whether some advice will be taken into account or not depends on *what* is advised, *by whom* it is advised and *to whom* it is advised (Tzioti et al., 2014). However, decision makers are prone to outweigh their own opinions, instead of following an advisors' recommendation. This phenomenon, that people give more weight to their own estimations than to those of others, is described as 'egocentric discounting effect' (Tzioti et al., 2014). It was found that there are several variables that reduce egocentric advice discounting. For example knowing that an advisor is a well-known expert, older or better educated than one self diminishes the egocentric discounting (Gino, 2008). According to the differential information explanation the discount of advice from others is also related to the fact that decision makers lack access to advisors' underlying reasoning while having access to the justification

behind their own opinions (Gino, 2008). If imagining receiving advice from somebody without explanation this seems to be clear. Why should somebody rely on someone who simply claims something? What changes if somebody argues that their gut feeling told them? You most likely would be sceptical about the quality and reliability of the advice, but what if they give you a credible explanation? This thought leads to the consideration, that if an advisor provides more information about the underlying argumentation, it would be beneficial to advice taking. Due to that it is hypothesised that decision makers are more likely to accept advice if a justification is provided. Moreover a justification could have influence on the level of trust. According to Djupe and Calfano (2009) the assessment of trusting a source depends on whether one elaborates the decision making process. Based on that claim it is assumed, that also with regard to predictive policing, a provided justification could have a positive effect on the level of trust.

As previous research showed there are connections between the type of advisor and both the acceptance of advice and the level of trust in the advisor. Moreover early studies found that providing a justification has influence on the decision-making process as well as on the reliance on the advice. These associations will be examined in the present study with regard to predictive policing. In addition, due to the fact that early research showed a connection between trust assessment and cognitive styles, and trust to be related to the acceptance of advice, the cognitive style need for cognition will be examined more closely.

This leads to the following hypotheses:

Hypothesis 1: The type of advisor has influence on the level of trust; decision makers are more likely to rely on human advice than advice coming from a system.

Hypothesis 2: The type of advice has influence on the level of trust; decision makers are more likely to rely on advice if a justification is provided.

Hypothesis 3: The type of advisor has influence on the acceptance of advice; decision makers are more likely to accept human advice than advice coming from a system.

Hypothesis 4: The type of advice has influence on the acceptance of advice; decision makers are more likely to accept advice if a justification is provided.

Hypothesis 5: The relationship between trust and advice taking is mediated by need for cognition; individuals low in need for cognition are more likely to accept advice.

2. Method

2.1 Design

The current study has a two by two between-subjects design. There were two independent variables with two levels. One independent variable was ‘type advisor’ with the levels ‘from a human’ and ‘from a system’, the other independent variable was ‘type of advice’ with the levels ‘justification’ and ‘no justification’. ‘From a human’ means that participants got advice from a police officer, ‘from a system’ stands for advice coming from a system. ‘Justification’ means that the participants got information about the background of the advice and therefore it was clear how the advice was justified. Whereas ‘no justification’ means that it was not clear for the participant how advice was justified. The dependent variables were ‘trust’ and ‘advice taking’. Further there was one mediating variable ‘need for cognition’.

2.2 Participants

The data that was used to be able to give answer to the research questions was retrieved from a convenience sample of 85 students. Of the respondents, 60 (71%)

were female and 25 (29%) male. Participants' age was ranged from 18 to 28 years ($M = 21.37$; $SD = 2.28$). Of all participants, 60 (71%) were German, 15 (18%) were Dutch and 10 (11%) had a different nationality.

2.3 Materials

The participants were asked to put themselves in the position of a police officer and to answer five questions about the advice they received and one question about the extent to which they trust the advisor. Moreover they had to fill in a questionnaire about their need for cognition and were asked about their demographics. In total, the survey contained twelve statements and three demographic questions. Participants were asked to rate the extent to which they agreed with each of the statements on a scale from 0 – 100, with 0 meaning totally disagree and 100 meaning totally agree.

2.3.1 Advice taking.

There were five questions with regard to a given advice. The questions were operationalized to measure the acceptance of the advice. 'What is the chance that you will go to area A?', 'How certain are you of your decision?', 'What is the probability that you would follow the advice again?', 'Are you satisfied with the advice you received?', and 'Do you have the idea that you have enough information to make a choice?'. The scale was found to be highly reliable ($\alpha = .85$).

2.3.2 Trust.

There was one question to measure the extent to which respondents trust the advisor. It was formulated as follows: 'Do you trust your advisor?'.

2.3.3 Need for Cognition.

To be able to measure the need for cognition of the respondents the (revised) Need for Cognition Scale (Cacioppo, Petty & Kao 1984) was used. The questionnaire contains

in its revised version 18 statements, participants are asked to indicate to what extent they agree with each statement using a 9-point scale. However, in the current study only the six statements mostly related to the examined domain were used. Further, in the recent study, a scale from 0-100 was used, with 0 meaning totally disagree and 100 totally agree, instead of a 9-point scale. It was chosen for this response option, since the whole study was built up with this kind of answer options.

The used statements were ‘I would prefer complex to simple problems’, ‘I really enjoy task that involves coming up with new solutions to problems’, ‘Learning new ways to think doesn’t excite me very much’, ‘I prefer to think about small, daily projects to long-term ones’, ‘I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought’ and ‘It’s enough for me that something gets the job done; I don’t care how or why it works’. Individuals who have a high score on the Need for Cognition Scale are more likely to engage in thinking about topics and enjoy the thinking process than people who score low on the scale. The reliability of the scale was acceptable ($\alpha = .67$).

2.3.4 Demographics.

To get information about the respondents’ demographics three questions were asked. ‘What is your age?’, ‘What is your gender?’ and ‘What is your nationality?’.

2.4 Procedure

The questionnaire survey was created by means of the research software ‘Qualtrics’. Before the questionnaire was published, the Ethics Committee from the University of Twente approved it. There were two requirements for signing up: the participant had to be a student and had to be fluent in the English language.

Participants were recruited in particular via SONA (Radboud Research Participation System) for students from the University of Twente in exchange for credits. Students from other universities also had the chance to participate in the study via a link that they got via e-mail.

Students were asked to fill in the online questionnaire on their own computer. At the beginning of the study respondents had to confirm that they agree with the informed consent. Then the procedure was designed as follows. Participants had to imagine being a police officer. Dependent on the experimental condition they either received advice from a human or from a system and either with justification or without justification. The conditions are presented in Table 1.

Table 1. Experimental conditions

	Advice from a system A system states that area A is at risk: a crime may happen	Advice from a human A police officer says that area A is at risk: a crime may happen
Justification	This evaluation is based on previous crimes. You understand how this probability is calculated.	This evaluation is based on an analysis of previous crimes. You understand how this probability was calculated.
No justification	This evaluation is based on Big Data, but it is not clear to you how this probability is calculated.	This evaluation is based on his gut feeling, but it is not clear to you how he justifies it.

Participants were faced with the decision whether to stay at work and thereby follow given advice or going home celebrating ones girl- /boyfriends' birthday which was promised and thereby to not follow the advice. Therefore they were asked what the chance was that they would follow the advice.

After that, the participants' task was to answer five questions concerning the advice and one question concerning the advisor. Following respondents were faced with six questions concerning the 'need for cognition scale'. After that, participants were asked three demographic questions about their age, gender and nationality. Afterwards they were thanked for their participation and informed about the goal of the study. Furthermore an email address was provided if they wanted to receive more information about the study.

3. Results

First we calculated the descriptive statistics of each variable. The means, standard deviations and correlations are reported in Table 2.

Table 2. Means, standard deviations and correlations of dependent variables.

	Mean	Advice taking	Trust
Advice taking	60.4 (sd 18.5)		
Trust	69.1 (sd 19.5)	0.58*	
Need for Cognition	65 (sd 13.9)	0.17	0.06

*Correlation is significant at the .05 level

To check if there are associations between the three variables we conducted a Pearson's correlation. Results indicated that there is a statistically significant correlation between trust and advice taking ($r = .577$, $n = 84$, $p < .01$). The other variables showed no statistically significant correlations. Need for Cognition is not correlated to trust ($r = .057$, $n = 84$, $p = .606$) neither to advice taking ($r = .167$, $n = 84$, $p = .130$).

A 2 x 2 (type of advice x type of advisor) factorial analysis of variance tested the effects of the type of advisor and the type of advice on respectively the level of trust and the acceptance of advice.

The first analysis of variance was calculated by using trust as dependent variable and type of advisor and type of advice as fixed factors. Results indicated no statistically significant main effect for the type advisor on the level of trust [$F(1,80) = 1.146, p = .288$]. Therefore the first hypothesis '*The type of advisor has influence on the level of trust; decision makers are more likely to rely on human advice than advice coming from a system.*' was rejected. In other words there was no difference between the human and the system condition with regard to the level of trust.

A statistically significant main effect for the type of advice on the level of trust was also not found [$F(1,80) < 1$]. That means that also the second hypothesis '*The type of advice has influence on the level of trust; decision makers are more likely to rely on advice if a justification is provided.*' was rejected. There was no difference between the condition that provided a justification and the condition without justification.

Furthermore there was no statistically significant interaction between type of advice and type of advisor [$F(1,80) < 1$]. Figure 1 shows the effects of type advice and type advisor on the level of trust.

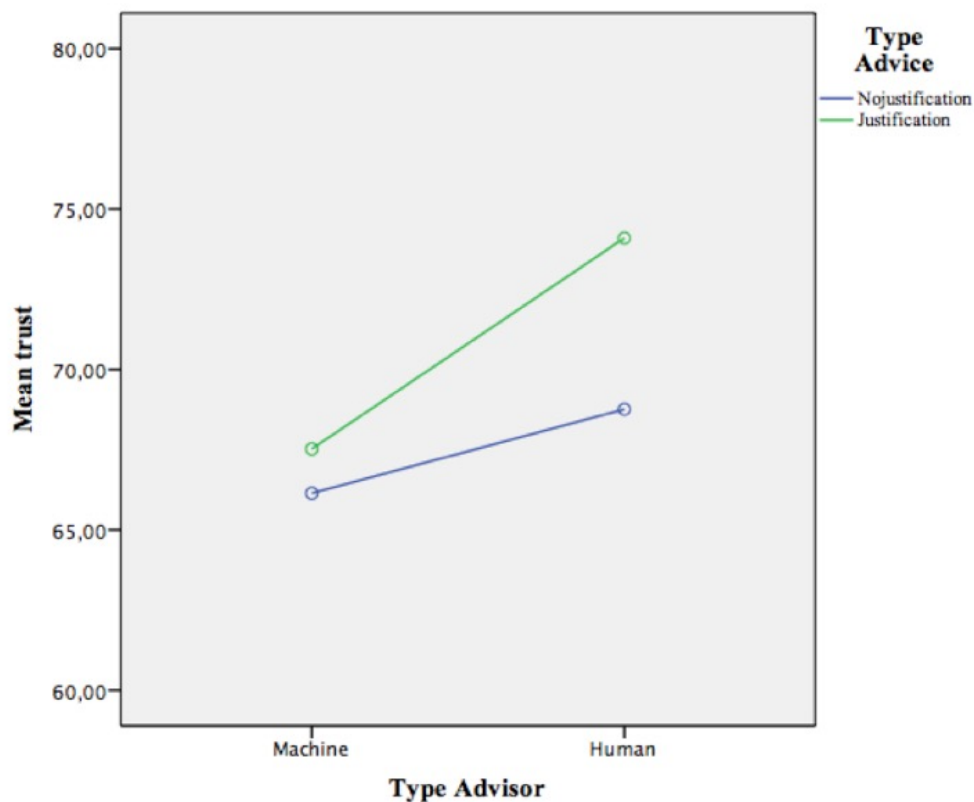


Figure 1. Effects of type advice and type advisor on the level of trust.

The second analysis of variance was analysed by using advice taking as dependent variable and type of advisor and type of advice as fixed factors. The ANOVA showed no statistically significant effect for the type advisor on the acceptance of advice [$F(1,80) < 1$]. That means that the third hypothesis ‘*The type of advisor has influence on the acceptance of advice; decision makers are more likely to accept human advice than advice coming form a system*’ was rejected. There was no difference between the human and the system condition with regard to the acceptance of advice.

There was also not found a significant main effect for the type of advice on the acceptance of advice [$F(1,80) < 1$]. Therefore the fourth hypothesis ‘*The type of advice has influence on the acceptance of advice; decision makers are more likely to accept advice if a justification is provided*’ was also rejected. There was no difference between the condition that provided a justification and the condition without

justification regarding to the acceptance of advice. Moreover, there was no significant interaction between type of advice and the type of advisor [$F(1,80) < 1$]. Figure 2 shows an interaction, but as mentioned, it is not significant.

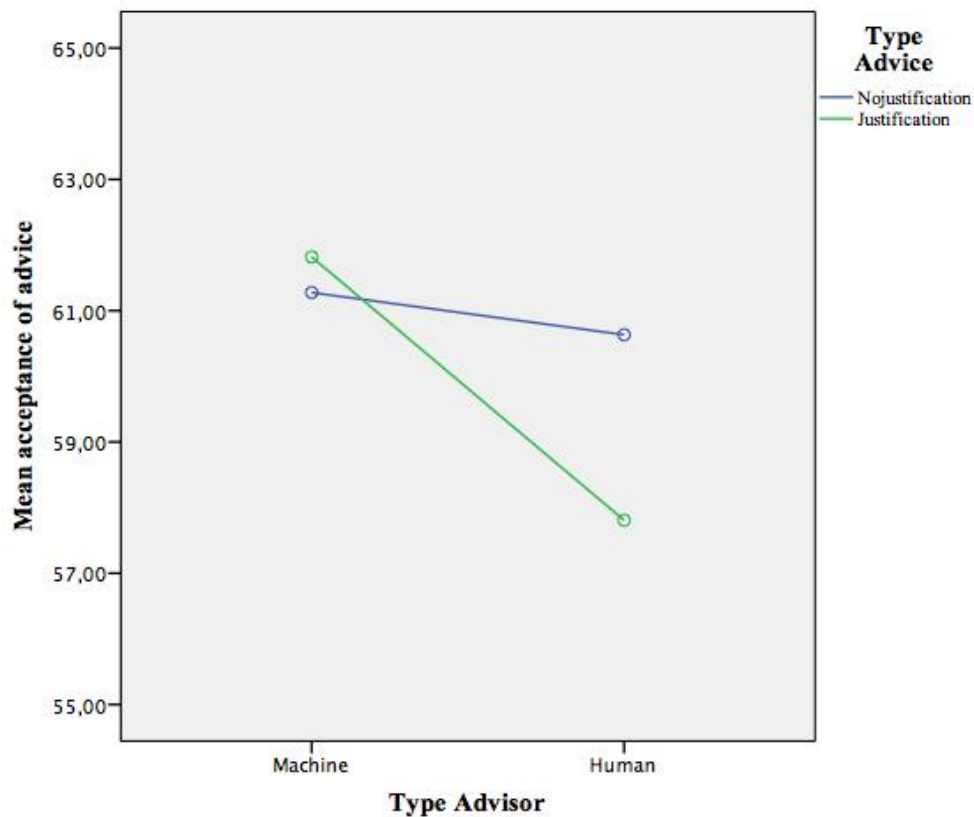


Figure 2. Effects of type advice and type advisor on the acceptance of advice.

To check if need for cognition would mediate the association between the two variables trust and advice taking, it was required to find correlations between all three variables. As mentioned earlier there was only one significant correlation between trust and advice taking. This means that need for cognition cannot have an indirect effect on the relationship between trust and advice taking, and no further analyses were therefore done. The fifth hypothesis *'The relationship between trust and advice taking is mediated by need for cognition; individuals low in need for cognition are more likely to accept advice.'* was rejected.

4. Discussion

The present study examined whether the type of advisor, thus advice from a human or advice from a system, affects the level of trust and the acceptance of advice.

Moreover this study focused on the effect of the type advice (justification/ no justification) on the level of trust and the acceptance of advice. In addition it was examined if need for cognition has an impact on the relationship between trust and advice taking.

4.1 Trust

Contrary to our expectations, results indicated that there was no significant difference between the human and system condition on the level of trust. That means that the type of advisor had no influence on the level of trust. A possible explanation could be the low reliability of the way level of trust was measured, there was merely one question to determine the level of trust ('Do you trust your advisor?').

It could lead to other results, when the level of trust was measured by means of a reliable questionnaire instead of operationalizing only one question.

There was also no significant difference between the justification and no justification condition. Thus the type of advice had no influence on the level of trust. This finding contradicts with findings from Djupe and Calfano (2009), who claimed that the assessment of trusting a source depends on whether a justification is provided. A possible reason could be that participants in the justification condition also felt to have no justification. The justification was given in form of a statement. In the system condition the statement states: '*This evaluation is based on an analysis of previous crimes. You understand how this probability was calculated.*' The justification given in the human condition states: '*This evaluation is based on previous crimes. You*

understand how this probability is calculated.’. These sentences simply claim that participants have an insight into the background of the advice. As can be seen, even the justification scenario does not provide a clear justification. It could lead to other results if participants would get transparent information about the underlying reasoning of advice, for example by providing understandable descriptions how the system works, or by giving insight into the underlying reasoning of advice from a human. Thus it would have been better to give a real justification instead of simply claiming that participants have one.

4.2 Advice taking

In contrast to previous findings we found no evidence that decision makers are more willing to accept human advice than system advice (Önkal, Gönül & Lawrence, 2008). There was no difference between the human condition and the system condition. Moreover, results indicated no significant finding with regard to the type of advice, the type of advice had no influence on the acceptance of an advice. Due to the fact that the variable advice taking was investigated by means of the same scenarios as the variable trust, the limitation mentioned above could also be applicable here.

4.3 Need for Cognition

In accordance with the findings of Briggs, Burford, de Angeli and Lynch (2002) that trust affects the acceptance of advice, we found a significant correlation between trust and advice taking. However there was no significant effect of the cognitive style need for cognition on the relationship between trust and advice taking. Due to that need for cognition was measured by means of only six statements from the Need for Cognition Scale that contains in its revised version 18 statements, the reliability was rather low.

The reduction to six statements could also have affected the construct validity. To get more reliable and valid results it might have been better to use all 18 statements.

4.4 Limitations and strengths

The method of data collecting via e-mail and SONA (Radboud Research Participation System) employed in this study enabled us to contact a considerable number of participants. However, the fact that this study was a convenience sample - all participants were students - was a limitation. It could lead to other results of decision making when older people were asked, who generally have more experience with taking responsibility in a professional life than students.

It was a strength that the study was carried out by means of an online questionnaire, which made it possible for participants to take part in the survey whenever it suited them. The fact that the respondents were able to choose the point of participation themselves, increased the likelihood of an attentive reading and response. Moreover, the survey took only about 5 minutes, so that participants could maintain their concentration. The simple construction, with a constant response option, all statements were to assess on a rate from 0 -100, was also a strength of this study.

4.5 Recommendations

The restrictions mentioned above lead to some suggestions for improvements for the current study. In particular, it would be beneficial to conduct the study with conditions that are clear distinguished from each other. This could be implemented by providing understandable justifications. Moreover, the constructs trust and need for cognition should be measured in a more reliable and valid way.

In addition, in the course of the study some issues have emerged, which lead to a need for further research. Areas for further research include the exploration of other factors that could have influence on the decision-making process. To allege an example it would be interesting to investigate the influence of a police officers' knowledge about the error and success rate of a system on the decision-making. The same applies for the advice from another police officer; does it have influence if a police officer has knowledge about the success rate or professional experience of the advisor? Moreover, further investigations should include the examination of professionals, in this case police officers. Further research could also be conducted to determine if the difference in age has influence on the level of trust in systems, considering that younger people are probably more familiar with technology than older generations. Another aspect that would be important to consider, is the investigation of human-system interaction and the associated trust and advice taking in other fields besides police work. Particularly as technology affects almost every section of our lives it is necessary to look at the issue from various angles. Generally, additional research will add to the understanding of human-system interaction.

5. Conclusion

Assistive technologies are increasingly taking on numerous roles in society. Computer systems will act more and more in an advisory role to give people help, suggestions and assistance. This study lays the foundation for understanding decision-making processes with regard to human-system interaction, in the domain of predictive policing. In general, much research is still needed in this field. Particularly as more and more information is available, as well as exploring tools, it would be useful to know under which conditions advice coming from such tools is accepted.

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