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## The Influence of Rapid Identification Technologies on CSI Behaviour

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## **CHAPTER 7**

### **GENERAL CONCLUSION AND DISCUSSION**

The general aim of this dissertation was to study the influence of the availability of rapid identification technologies at the crime scene on the behaviour of crime scene investigators during the three phases of their investigation: the search for traces (1), the selection of traces for analysis (2) and the influence of rapid identification information on the interpretation of the crime scene (3). The present study is a first step towards a deeper understanding of CSI behaviour and the influence of new technologies. Hypotheses were formulated as to how the introduction of mobile identification technologies might influence the performance at the crime scene, as the first and fundamental activity of the forensic investigation process. This chapter presents an overview of the results of the mock crime scene experiment (design 1) and the virtual crime scene experiment (design 2) which are presented as sub-studies in the previous chapters. Furthermore, I will discuss strengths and weaknesses of the research, its scientific value, and I will suggest directions for future research and some practical implications.

## **7.1 Summary of key findings**

In Chapter 2 [influence technologies on visual attention] I investigated the influence of mobile technologies at the crime scene on the visual attention of CSIs during the first orientation phase of the investigation process. I hypothesized that having mobile technologies at one's disposal would influence the implicit goal and the visual attention of CSIs. To investigate this question, an experimental study was conducted with thirty CSIs distributed over three conditions, one control, one experimental rapid ID, and one experimental spectral camera condition, investigating a mock crime scene involving a violent robbery. In order to gain insights into CSIs' observations, a trainee asking clarifying questions was sent to the scene with them. Results show that in their search for traces, CSIs are not directed by the availability of technologies. Participants in the experimental conditions mentioned the same number and kinds of traces as participants in the control condition. Qualitative findings suggest that CSIs are generally more focused on analysing potential perpetrator traces than on reconstructing the event. Additionally, the results showed large variations within the three conditions. Different approaches can already be seen in the orientation phase of the investigation process.

The aim of Chapter 3 [reconstructing with trace information] was to study the influence of rapid identification technologies on the selection of traces for analysis and the interpretation of the crime scene. In this study, 40 experienced CSIs distributed over two conditions, one control and one experimental rapid ID condition, investigated the

same mock crime scene as in Chapter 2. The decisions of CSIs were analysed by means of decision trees, and this chapter further examined the impact of identification information on the final scenarios proposed by CSIs. This study shows that receiving identification information during the investigation results in more accurate scenarios. CSIs in general are not strongly orientated on reconstructing the event that took place, but rather have a “who-dunnit routine.” Their focus is on finding perpetrator traces, with the risk of missing important information at the start of the investigation. This study further revealed that one important trace was overlooked. Only ten out of forty CSIs found a bloodstain on the water tap that led to a second offender. Nine CSIs only secured this bloodstain. Finally, identification information was mostly integrated in their final scenarios when the results of the analysis matched their expectations.

In Chapter 4 [the interpretation of ID information] the influence of rapid identification information on the reconstruction of a crime and the evaluation of traces was studied by addressing two questions, namely 1) is scenario formation influenced from the moment that identification (ID) information is provided? and 2) do database matches influence the evaluation of traces and the reconstruction of the crime? I asked 48 CSIs from England to investigate a potential murder crime scene, presented to them on a computer. Both the moment that ID information was provided and whether or not the traces showed a match with the National Database were manipulated. Our findings show that the interpretation of the crime scene by CSIs is affected by identification information. This effect is even higher when ID information is provided *after* an initial scenario has been formed. In this case, providing the ID information after an initial scenario was formed did help CSIs to make a more accurate interpretation of the scene. Also, CSIs seem to attach great value to traces that produce matches with databases and hence yield the name of a known person. Receiving a database-match increased the relevance of those traces for CSIs, compared with identical traces that did not yield a match in the database, although the context in which the trace was found was not changed by this match.

Chapter 5 [influence of ID information on the perceived clues at a crime scene] builds on Chapter 4 by studying more thoroughly (1) exactly what investigative and forensic information was used by CSIs to construct their scenario, (2) what inferences were drawn from this information, and (3) what kind of evidence was selected at the crime scene to either prove or disprove this scenario. The same data were used as discussed in Chapter 4, but now I analysed a different portion of those data, namely participants’ explications of the information they used to construct a scenario and to select traces for analysis. The results show that the introduction of rapid ID information at the start of an investigation contributes to the recognition of different clues at the crime scene and to different interpretations of identical information, depending on the kind of information available

and the scenario one has in mind. CSIs drew on previous experience to recognize relevant cues, but the received information influenced the interpretation of the clues. Furthermore, not all relevant traces were recognised, showing that important information can be overlooked during the investigation. Mainly, CSIs seem to select traces for analysis in order to obtain verification of their scenario, and less so for falsification, although this is difficult to determine based on the results of this study. ID information caused a reduction in the amount of traces selected for analysis.

Finally, given the special circumstances under which CSIs in one country operate, in Chapter 6 [differences between English and Dutch CSIs] the robustness and generalizability of the findings presented in Chapter 4 are studied by replicating the study within a different police environment. Dutch CSIs (N=65) participated in exactly the same study and the results are compared with the English findings to test whether identical decision-making phenomena are found. First, English and Dutch CSIs show differences in the perceived goal of crime scene investigations. According to English CSIs, the aim is to find a suspect, whereas Dutch CSIs see the investigation as a means to reconstruct the event. Regardless of the aim of the investigation, the results demonstrate the robustness of the previous finding showing that ID information influenced the interpretation of the crime scene, even more when this information was provided after CSIs had constructed a provisional scenario. Secondly, this study uncovered differences in decision making: English CSIs used ID information to make efficient decisions by prioritising traces with direct investigative opportunities and disregarding those without direct investigative opportunities. Dutch CSIs appeared less prone to bias towards traces that produced database-matches. Dutch CSIs were more focussed on the relation of the trace with the crime, while English CSIs were more focussed on the database-match. Consequently, important information about a second offender was overlooked by English CSIs. Table 7.1 shows a summary of the key findings from the two experiments named design 1 and 2.

**Table 7.1:** Summary of key findings based on two experiments.

| RESULTS  | Chapter | Experimental design                                 | Country               | N       | Conditions   |
|--|---------|---|-----------------------|---------|--|
| <i>CSIs are not directed in search for traces by availability of techniques</i>                        | 2       | <u>Design 1</u><br>Mock crime scene                 | Netherlands           | 30      | 1. control<br>2. rapid ID<br>3. spectral           |
| <i>Perpetrator focus in selection of traces</i>  | 2 & 3   | <u>Design 1</u><br>Mock crime scene                 | Netherlands           | 40      | 1. control<br>2. Rapid ID                          |
| <i>ID info influences interpretation of crime scene, even more after constructing scenario</i>         | 4 - 6   | <u>Design 2</u><br>Virtual crime scene              | England & Netherlands | 48 & 65 | 1. Late ID<br>2. Early ID                          |
| <i>Much value attached to traces with database-match</i>   | 4       | <u>Design 2</u><br>Virtual crime scene              | England               | 48      | 1. match on trace set A<br>2. match on trace set B |
| <i>ID information helped reconstruct more accurate crime scenarios</i>                                 | 3 - 6   | <u>Design 1&amp;2</u><br>Mock & virtual crime scene | Netherlands & England | 40 & 48 | 1. NO ID info<br>2. ID info                        |
| <i>Differences between countries in decision making with respect to importance of database-matches</i> | 6       | <u>Design 2</u><br>Virtual crime scene              | England & Netherlands | 48 & 65 | 1. match on trace set A<br>2. match on trace set B |
| <i>Type of prior information influences recognition and interpretation of traces</i>                   | 5       | <u>Design 2</u><br>Virtual crime scene              | England               | 48      | 1. No ID info<br>2. ID info                        |
| <i>Important traces can be overlooked or are not recognised</i>  | 2 & 5   | <u>Design 1&amp;2</u><br>Mock & virtual crime scene | Netherlands & England | 40 & 48 | No relation with conditions                        |
| <i>Different approaches within conditions</i>  | 1 & 2   | <u>Design 1</u><br>Mock crime scene                 | Netherlands           | 50      | No relation with conditions                        |

## 7.2 Overall discussion

### 7.2.1 The power of identification information

The main influence of the introduction of rapid identification technologies pertains to the interpretation of the crime scene and its traces. The virtual experiment demonstrated an effect of ID information on the interpretation of the crime scene: interpreting the crime scene with ID information led to different interpretations compared to interpreting the scene without this information. Moreover, as also stated by Dror, Peron, Hind & Charlton

(2005), interpretation differences occur when information that should be interpreted is ambiguous. The mock crime scene used in the first experiment was rather simple and although more correct details of the crime were mentioned when rapid ID information was obtained, this information did not lead to large differences in the interpretation of the crime scene. The virtual crime scene in the second experiment was more ambiguous. The powerful effect of ID information was not influenced by the CSIs' perceived goal of crime scene investigations. Although people's goals and intentions can influence the way information is processed (Chun & Wolfe, 2008; Yantis, 1998), the different goals of English and Dutch CSIs did not affect the overall influence of ID information on the interpretation of the crime scene. This may be due to the fact that trace material is often held to be more objective than alternative sources of evidence (Granhag, Ask, & Rebelius, 2008; Innes, 2003). Innes (2003) also found that evidence based on trace material is frequently pivotal in a scenario that is being constructed by police detectives, due to the perceived objectivity of this information.

Moreover, contrary to expectations based on theories of confirmation bias and belief perseverance (Klayman, 1995; Nickerson, 1998), the influence of ID information on the interpretation of the scene was even more outspoken when this information was provided *after* an initial scenario was formed. In accordance with studies about the effect of context information on the interpretation of a crime scene or trace analysis (Dror & Hampikian, 2011; Kassin, Dror, & Kukucka, 2013; Osborne, Woods, Kieser, & Zajac, 2014; Van den Eeden, De Poot, & Van Koppen, 2016), the interpretation of the crime scene was influenced by context information when no ID information was provided. However, instead of interpreting new incoming ID information in line with their most likely initial scenario, the majority of CSIs changed their provisional scenario to a different one based on the received ID information. The number of participants constructing a scenario based mainly on the ID information was even higher in the group that received this information after they formed their initial scenario, compared to those receiving it at the start of their investigation.

It seems that, in general, ID information is better to interpret when it can be used to test an initially constructed scenario than when a scenario has to be constructed based on this and other information. This may be due to the limitations on the amount of information people are able to receive, process and remember at the same time (Miller, 1956). CSIs make sense of their observations at the scene, whereby they form hypotheses that best describe their data. The inference process that leads to a hypothesis or scenario regarding what may have happened is called abduction. If a provisional explanatory scenario is present, later incoming ID information can be used to test this scenario. At this point in the investigative process, it may be more evident that the information suggests a

different scenario and therefore will lead to an adjustment of the provisional scenario (Roux, Crispino, & Ribaux, 2012). This process of hypothetico-deductive reasoning where information is not provided all at once but is distributed over time may ease scenario construction and testing by easing the cognitive load at the start, and may ultimately improve the accuracy of the outcome. This effect may be strengthened by the perceived objectivity of the ID information (Innes, 2003; Lynch, 2013). Of course, we should not neglect the possibility that providing the ID information exclusively at a later stage in the investigation may have elicited the feeling that the information was important and therefore ought to be used. In order to diminish attention on one explicit information moment, it may be wise to continue the study of this effect by varying both the kind of information that is provided during an investigation and the moment at which it is provided.

In both experiments, the identification information helped to reconstruct a more accurate scenario, compared to the reconstruction without this information. In the first experiment, the ID information confirmed the most likely initial scenarios but allowed CSIs to incorporate more information in their final scenario, resulting in more accurate scenarios than the CSIs who had no rapid technologies at the scene. In the second experiment, the ID information could lead to different scenarios due to the more ambiguous crime scene. Although this information helped to construct more accurate scenarios in both studies, we cannot conclude that this information always leads to more accurate reconstructions of the crime. Given the demonstrated power of the identification information during the crime scene investigation, it is particularly important to thoroughly consider the relation between the trace and the crime. Especially the traces that provided a match in the second experiment were not obviously crime-related. Of course, a match with a known individual provides interesting investigative information, but CSIs should be aware of the relation between the trace that provides this information and the crime. Given the possible further actions that database-matches can produce in investigations, CSIs may enjoy a feeling of satisfaction after receiving a match, like forensic fingerprint experts can feel after discovering a fingerprint match (Charlton, Fraser-Mackenzie, & Dror, 2010). ID information may be assigned too much value as a result of such feelings. Furthermore, accuracy of the scenarios was measured with our ground truth. Although this truth was based on a real crime case, it was still randomly chosen and could have equally been different. Future research should further investigate this issue.

### **7.2.2 The importance of database-matches**

Our findings in Chapter 4 [the interpretation of ID information] show that English CSIs strongly focus on traces that show a match with a known person in the database. Receiving a database-match made traces more important than similar traces left by an unknown person, although the context in which the trace was found did not change by finding such a match. Pursuing a database-match can be a very fruitful selection strategy, as these matches provide direct investigative opportunities, whereas traces that cannot be identified do not immediately provide lines of inquiry. In cases where traces are obviously left by the perpetrator, the narrowed focus of the English CSIs will usually lead to correct results. Generally, using shortcuts and narrowing your focus contributes to efficient decision-making as relevant information needs to be distinguished from irrelevant information in order to make sense of all the available information (Gigerenzer & Brighton, 2009; Gigerenzer, Todd, & ABC Research Group, 1999). Focusing is also essential during police investigations (Liedenbaum, De Poot, Van Straalen, & Kouwenberg, 2015; Snook & Cullen, 2008) because it is impossible to perceive and process all information during an investigation. However, as demonstrated in Chapter 4, it can also lead to blindness for important information. Traces without a match can still be of significant value for the reconstruction of the crime. Because CSIs overlooked the relevance of the traces providing a non-match, they did not consider scenarios with two offenders (the actual number of offenders in this study).

Other studies have also identified a blindness for important information due to cognitive processes such as confirmation bias and belief perseverance. For example, O'Brien, (2009) demonstrated that participants who articulated a hypothesis early in their investigation of a mock police case showed bias in seeking and interpreting evidence to support that hypothesis and were less attentive to disconfirming evidence. Other studies support this finding (Ask & Granhag, 2005; Dror et al., 2005; Eerland & Rassin, 2012). Addressing the risk of selectivity based on database-matches, I agree with Broeders's observation, that *"it's not whose DNA it is, but how did it get there"* (Broeders, 2003). CSIs should consider the relation between a trace and the crime based on observations at the scene, without information about the sources. ID information can then be used to test scenarios instead of constructing a scenario with this information. It reduces the chance of reasoning based on database-matches.

Although the selectivity showed by English CSIs is in line with existing knowledge about common information processing strategies, the comparative study presented in Chapter 6 [differences between English and Dutch CSIs] demonstrated that this kind of selectivity is not simply attributable to a different police environment. While English CSIs were focused on the information provided by the trace, and more specifically on the database-match, Dutch CSIs were more attentive to the relation between the trace and

the crime and treated traces as equally important regardless of a match, but solely in light of the context. The difference in interpretation of information is also reflected in the finding that Dutch CSIs more often than English CSIs considered scenarios with two offenders. Instead of common police decision-making, there seems to be an additional factor that influences the interpretation of this ID information. Although the different goals of English and Dutch CSIs had no effect on the overall influence of ID information on the interpretation of the scene, these diverging goals may have influenced the way database-matches were interpreted. According to English CSIs, the aim of a crime scene investigation is mainly to find a suspect, whereas Dutch CSIs see the investigation as a means to reconstruct the event. Moreover, English CSIs seem to operate in an environment with an emphasis on efficiency, whereas Dutch CSIs operate within a context with more emphasis on precaution and less on efficiency (Groenendaal & Helsloot, 2014; De Maillard & Savage, 2016; Winsor, 2016). Cultures in which people operate also form a context and shape people's intentions and hence may influence the way information is processed. The present finding corresponds with findings of Granhag, Rebelius & Ask (2011) who asked investigators to process criminal evidence in a case. One part of the participants was primed with norms associated with efficiency while the other part was primed with norms associated with thoroughness. The findings showed that efficiency norms sped up their processing of the evidence and reduced their openness to late provided evidence. Hence, decision making can be shaped by the context in which people operate. Although both police communities pay attention to the risks of bias within police investigations (ACPO, 2006; Forensic Science Regulator, 2015; Jones, Grieve, & Milne, 2008; Liedenbaum et al., 2015), the high emphasis on efficiency and effectiveness within the English policing culture may contribute to their more focused way of decision-making. Their efficient way of decision-making is also reflected in the finding that the influence of the information that was provided to English CSIs on their interpretation of the scene was stronger, compared to Dutch CSIs. Dutch CSIs show more variation within the conditions and seem to take a more nuanced approach, whereas English CSIs show less variation. This is in line with a strong protocolled environment with more emphasis on efficiency and less on the risks of the multi-interpretability of information.

### **7.2.3 The influence of prior knowledge**

The influence of the human factor on how crime scene investigations are conducted is shown to be present through the entire investigation process, from observation of the scene until the interpretation of identification information. The way cognitive processes shape information processing is a continuous process. My hypothesis stating that the

technologies would influence the goal of CSIs and would as a result also influence their observations during the observational phase of the investigation was not supported. CSIs mentioned the same kind and same number of traces during their observation of the scene. The awareness of having mobile technologies available at the crime scene did not interfere with their common goal of the investigation. However, we should not neglect the possibility that the absence of such an effect may have been a consequence of small sample sizes. Regardless of the technologies, the expectations and experiential knowledge of CSIs seem to have influenced their observations and interpretations. Both in the mock crime scene experiment and in the virtual experiment, the CSIs overlooked some crime-related traces which would have yielded information leading to a significant twist in the scenario. In the mock crime scene experiment, a bloodstain on the water tap in the bathroom linked to the second offender was not observed by a majority of the participating CSIs. In the virtual experiment, described in Chapter 5 [influence of ID information on the perceived clues at a crime scene], two potential murder weapons were indeed observed, but not perceived as important objects by some CSIs, or were only perceived as important after obtaining ID information linked with this object.

Several cognitive factors may underlie this. The traces that are observed by CSIs are partly dependent on the scenarios they can imagine, their routines, experiential knowledge and expectations. It shows a clear top-down / bottom-up process; these cognitive factors add a context to the search for information (De Poot, 2011; Dror & Stoel, 2014). The bedroom and living room of the mock crime scene in the first experiment were turned upside down and showed obvious traces of a potential criminal activity, whereas the bathroom, the room with the bloodstain on the water tap, looked rather untouched. Consequently, based on the appearance of the bathroom – bottom-up information – and their general knowledge about the appearance of a room after a criminal activity – top-down information – CSIs may not have expected to find related traces in the bathroom. Several studies have demonstrated that something that is not expected can go unnoticed (Mack & Rock, 1998; Simons & Chabris, 1999). The expectations of the CSIs may also have influenced their search in the bathroom. In the virtual experiment, the possible murder weapons were observed but not perceived as crime-related. The search for crime-related information is guided by schemas about the traces that may have been left or objects that may have been used during the event of the crime. Due to world knowledge and their experience, CSIs have developed schemas about offenders' behaviour and the traces that may emerge during a crime. These previously built schemas help to draw inferences from information and to distinguish between relevant and irrelevant information (Nee & Ward, 2015). However, as also shown by the present study, this can result in overlooking important information if this

information is not recognised as important based on existing schemas about how crimes are committed. New incoming information about the crime is something that could trigger new searches for information. For example, information obtained from the body of the victim could place certain objects and traces in context and could lead to the recognition of traces that were not considered before. However, it is not always possible to investigate a crime scene multiple times. CSIs should be aware of this pitfall and should consciously consider alternative explanations for their observations and use these explanations in the search for new and unexpected information (Hirt & Markman, 1995; Van Koppen, 2011). The knowledge gained through these experiments can be used to develop better strategies for CSIs.

The virtual experiment shows that experiential knowledge is used to recognise relevant cues. Participants stated notable cues, such as 'drawers were searched' or 'no signs of damage' but how these cues were interpreted depended on the available information and the scenario one had in mind. Without identification information, the search for cues at the crime scene was framed by the investigative information. When identification information was provided together with the investigative information, the ID information seems to provide a framework. As a result, identical information was interpreted differently and other information was noticed. Hence, the availability of ID information does not increase a use of forensic information in comparison to investigative information for forming a scenario, but it does lead to different interpretations of forensic information.

Moreover, experiential knowledge helps in the recognition of relevant stimuli, but prior information partly determines which of these relevant stimuli are observed and colours the way the stimuli are perceived. This is in line with multiple studies conducted with forensic experts that showed that their observations and conclusions are influenced by the kind of context information about the case (Kassin et al., 2013). A recent study by Van den Eeden, De Poot & Van Koppen (2016) examined the influence of prior information on the interpretation of the crime scene and its traces. They asked CSIs to investigate a virtual crime scene and manipulated the kind of information that was provided to the participants prior to the investigation. Their study showed that this prior information influenced their interpretation of the scene. In sum, information helps CSIs when it is correct, but it hinders when it is incorrect. This constitutes a complex dilemma, as prior information is necessary to provide a context for the crime scene and its traces and it helps CSIs in their search for relevant traces. Based on research conducted with forensic experts, measures are taken to protect them from context information that may influence their observation and conclusions (Saks, Risinger, Rosenthal, & Thompson, 2003; Stoel, Berger, Kerkhoff, Mattijssen, & Dror, 2015). It is too complex to implement

similar measures at a crime scene. During these investigations, there is a continuous interaction between the information collected at the crime scene and the provisional scenario. Moreover, it is impossible to conduct the investigation without any context information. More research is needed to obtain a better understanding of the biasing effects of information on crime scene investigations and to enable the development of focused countermeasures.

With the introduction of the mobile identification techniques, ID information will be interpreted in the light of context information and CSIs' expectations. The analysis and interpretation phase will then shift to the scene of the crime and even more information needs to be processed at the crime scene. By understanding the processes that influence CSIs' information processing and more specifically the interpretation of ID information, we can better manage the moment ID information should be provided to the CSIs. The present research showed that CSIs can differ in their interpretations of the crime scene and its traces, as a function of the information that is available at the crime scene and of the moment ID information is provided. Knowledge about the underlying processes should yield a deeper understanding of the influencing effects of the moment at which information becomes available.

#### **7.2.4 Who-dunnit strategy**

In line with many studies, CSIs in our study were mainly looking for confirmation and were less focused on disconfirming information. Not only did some traces remain unnoticed if they were beyond what CSIs expected and disconfirmed their belief, but CSIs in general were more focused on analysing possible perpetrator traces than on reconstructing the crime and testing different hypotheses. As already mentioned, CSIs used their experiential knowledge to anticipate and to recognize certain signs at the crime scene, and their ideas about what happened helped them to determine which traces may have been left by the offender and which traces are related to the victim.

The analysis mainly focused on the traces that CSIs assumed originated from the offender. This is in line with the study of Baber & Butler (2012) who found that expert CSIs were focussed on objects that could be used as evidence and could thus help to convict the offender, whereas novices attempted to reconstruct the event by checking more objects that could be related with the crime. Focusing on offender-related objects is a very efficient strategy, as investigations are conducted ultimately to find and convict the perpetrator. Rapid identification of individuals can speed up the investigation when they quickly lead to the perpetrator. However, such a focus also entails the risk of getting side-tracked on misleading paths, when alternative explanations of a trace are not thoroughly considered and analysed traces are in fact not crime-related, or when

important traces are incorrectly considered as victim-related and therefore overlooked. According to Dutch CSIs, the main goal of a crime scene investigation is the reconstruction of the crime. In order to reconstruct the event and differentiate between hypotheses, CSIs should more explicitly consider alternative explanations for the traces. For example, if they assume that a trace has been left by the victim, they should also consider the possibility that the trace has actually been left by the offender and should search for information that verifies or falsifies this idea. If both explanations are plausible, CSIs should distinguish between these hypotheses by analysing the trace (Crombag, 2010; De Poot, Bokhorst, Van Koppen, & Muller, 2004; Van Koppen, 2011). Mostly, the traces that were assumed to have been left by the victim were still secured. In that case traces can always be analysed at a later moment in the investigation, for example when new information indicates that the trace is in fact related with the offender. However, in one case during our mock crime scene experiment, a bloodstain was not secured due to a strong belief that it belonged to the victim, and so the only link to the second offender was left at the crime scene. Overall, the present study showed that alternative explanations are not considered carefully during the investigation and important information that could speed up the case is overlooked due to a strong focus on perpetrator traces.

### **7.2.5 Different approaches**

To my surprise, the results of our mock crime scene experiment also showed large variations in the way the investigation is performed by CSIs, regardless of any technology. Instead of a standard approach, different methods seem to be present in the investigation process. For example, although all Dutch participants received similar training, they showed variation in the amount of time for their investigation and the number and kind of traces they collected and analysed. The data suggest that different strategies and preferences are developed once CSIs become operational. Experts using different strategies for the same task, raises the question how expertise should be defined. Expertise involves more than just doing the job for several years (Ericsson, Prietula, & Cokely, 2007; Fahsing & Ask, 2016). What strategy leads to the best outcome?

Currently, the quality assurance of forensic technical examination processes outside laboratories is a point of discussion that has arisen in response to the EU-framework concerning accreditation requirements within Forensic Research (Annual report of the Government Chief Scientific Adviser, 2015). Forensic-technical standards to monitor the quality of the process of locating and securing traces are described in handbooks, but guidelines for how CSIs should formulate and test scenarios and interpret information at the crime scene is lacking (Inman & Rudin, 2001; Van Amelsvoort & Groenendal, 2013). In

order to establish the most efficient and effective strategy for investigating the scene, standard procedures ought to be specified that guarantee that the highest quality will be achieved, by establishing evidence-based quality standards for crime scene investigations. Reproducing representative situations in a lab setting is a useful methodology to test different strategies and deal with these challenges (Ericsson et al., 2007).

### **7.3 Limitations**

The studies presented in this thesis provide us with new insights into the behaviour of CSIs at the crime scene, but of course the research has several clear limitations as well. A first obvious limitation is the fact that participants were asked to conduct a crime scene investigation at a simulated crime scene. Although the first experiment was conducted at a mock crime scene which was made as realistic as possible, it is still not representative of CSIs' actual work. A lot of external factors influencing the investigation in the real world, such as time pressure, caseloads, working in teams, were eliminated during the experiments. By eliminating these factors, the ecological validity of the study is affected. Whether the results found in a simulated setting are an accurate reflection of CSIs' behaviour in the real world, and thus to what extent the results of the study can be generalized, remains an important question and should be studied further, e.g. by testing the findings in real life investigations. However, testing findings in real life investigations is difficult because the ground truth is unknown. Although CSIs participating in the first experiment stated that conducting their investigation at a mock crime scene did not influence their behaviour, and that they would have acted in the same way at a real crime scene, the artificial setting remains an issue. CSIs investigating the computerized scene (Chapters 3-5) indicated that they had some difficulty interpreting the artificial scene as a real crime scene. Notice, however, that the main aim of the latter experiment was to examine the influence of ID information on the interpretation of the crime scene. I approached this question by comparing the interpretation of a crime scene in different conditions, which enabled me to investigate the influence of the information. Moreover, this limitation applies to any experimental research in this area, and yet this kind of research has been able to demonstrate the influence of information in similar controlled experimental settings (Ask & Granhag, 2005; O'Brien, 2009; Van den Eeden et al., 2016). However, this validity issue asks for further research.

A further limitation associated with the previous one is the unanticipated influence of decisions made by the researcher on how the crime scene is set up and the kind of

information that is provided. For example, in the virtual experiment (experiment 2) I decided to implement a motive for the husband to murder his wife, namely an affair. I did not foresee the possibility that the affair would be considered as offender. As this scenario interfered with the goal of my study I had to exclude the participants who chose the affair as the offender from my data. Setting up this kind of experiment with mock crime scenes is a complex process. It is impossible to anticipate all the possible consequences of your decisions, especially since this field of research is still in its infancy and there are no studies to build on. Despite the pilot study that was used to test the design of the study, there were still unforeseen effects during the experiment. Conducting further similar studies should teach us more about the kind of decisions researchers need to make when designing such experiments.

A third limitation is the fact that participants were forced to make a decision for one preferred scenario. Especially participants in the virtual crime scene experiment stated that they had difficulty constructing only one preferred scenario at such an early stage of the investigation. It felt unnatural as they would normally try to stay open-minded during this phase of the investigation. Their final scenarios may ultimately have been different in the real world. Notice, however, that several studies have shown that information can unintentionally influence perception and future decision making (Kassin et al., 2013; Risinger, Michael, Saks, & William, 2002), which may result in CSIs generating a provisional preference for one scenario during this early stage.

Another limitation may be the fact that the rapid identification technologies are not operational yet and CSIs were asked to fulfil a hypothetical task. Asking participants to use techniques that are not yet used in practice makes their responses hypothetical instead of experience-based. This point mainly applies to the hypothetical task to select traces for the rapid technologies. CSIs have no experience with making such decisions yet and their behaviour may be different in real life situations once the technologies have been implemented.

A final limitation concerns the low power of the studies caused by the rather low sample sizes. The time-consuming character of the experiments and the effort that was asked of CSIs and researchers in combination with the small total population of CSIs made it difficult to obtain large sample sizes. As a consequence, null findings do not support the absence of an effect right away. Replication studies are desirable to test the present findings. However, we should bear in mind that the sample sizes are a substantial part of a rather small total population of CSIs. Also, CSIs showed large differences within the conditions. CSIs maintain different methods and strategies due to additional factors, making it difficult to demonstrate differences between the conditions. A limitation associated with this one is the lack of control over variables that co-vary with the

variables of interest. In the present studies, the variables of interest relate to differences between CSIs in their behaviour and decision-making at the crime scene, depending on the availability of rapid technologies. It was established in all studies that variations in age, experience and region did not account for the observed differences. However, due to other possible factors influencing CSI behaviour, such as personal experiences or personal routines, I cannot guarantee that other factors that are related to CSI decision-making caused differences between groups. As said, replication studies are welcome.

#### **7.4 Scientific value**

To my knowledge, this is one of the first studies examining decision-making processes among crime scene investigators at the crime scene. It provides first insights into several cognitive factors influencing the way information is observed, selected and interpreted, and a deeper understanding of the entire dynamic process of the investigation of a crime scene. It demonstrates the influence of expectation effects on the observation and interpretation of information by experts at the crime scene, and it shows how experiential knowledge is used to recognise relevant information. It also reveals how the moment at which information is provided influences the extent to which this information is used in the reconstruction of the crime. Overall, it has unearthed important findings on how information may be processed by experts at the scene of the crime and the cognitive factors that play a role.

With these studies, I have furthermore developed an experimental research method to test different strategies at the crime scene. Unique to these studies is that the ground truth is known, enabling the researchers to test the results of the strategy used during the investigation. I have used actual crime scene investigators and I have tested different strategies with two different methods: a mock crime scene and a simulated crime scene combined with a vignette study. For the mock crime scene, the crime had been composed of several real-life cases and had been re-enacted with actors, who followed a detailed scenario to make sure that traces would be left in realistic places. The ground truth that was used for the simulated crime scene study was also based on a real crime case. Knowing the ground truth allowed me to measure the influence of different strategies on the accuracy of an investigation, which is, to my opinion, a strength of this research. However, at the same time it has some drawbacks. Although based on real crime cases, the ground truth in our studies, as I mentioned before, was randomly chosen and it could equally had been different, whereby other traces would have been relevant or where traces had different meanings. Furthermore, the accuracy of CSI's scenarios is

inferred from their responses to a single, constructed case. As a number of factors can influence correctness in a single case (e.g., guessing, response bias), and correctness in one case does not necessarily predict correctness in another case, the findings regarding accuracy should be further studied. Both the issues of using a ground truth and measuring accuracy deserve further empirical study.

The findings show that both a mock crime scene and a simulated crime scene can be used to investigate CSI decision-making. With the simulated scene, I was able to demonstrate the influence of rapid identification information on the interpretation of the crime scene. The mock crime scene better approached reality and showed the entire dynamic process, but was also less controlled in terms of information moments. The preference for one of the two methods depends on the research question. A mock crime scene would be beneficial if the main purpose of the study is to study different methods used at a scene and to examine the dynamic process in its entirety. A more controlled setting with fixed information moments is preferable if the way information is selected or interpreted in different conditions needs to be examined more thoroughly. By developing these methods and by uncovering the influence of several cognitive processes on information processing, the current research has paved the way for future research.

## **7.5 Future research**

This study is one of the first studies investigating CSI behaviour and decision-making at the crime scene and more specifically, the first one investigating the influence of rapid identification technologies on CSI behaviour. Crime scene investigations are the fundamental phase of the forensic investigation as the decisions made by CSIs can shape the ongoing investigation process. Given the significant influence of CSI decision-making, it is extremely important to continue with research in this field. By understanding the way information is processed by experts at the crime scene, we can better manage the kind of information that should be provided to CSIs while conducting their investigation, and the moment at which this information should be provided. The current studies are only the start of a new research field and raise numerous relevant questions. First of all, the robustness of the findings should be tested by varying several factors. In our study, the identification information was exclusively provided at a later stage and the number of matches was identical in the conditions. In future studies, it would be useful to provide different kinds of information at different moments during the investigation to reduce the attention for one specific information moment. This would also provide more insights into the scenario construction process and into the moment at which confirmation bias

and related processes come into play. Varying the number of matches and non-matches in an experiment would provide more insight into the use of matches and non-matches and their significance in the reconstruction process. Furthermore, the kind of crime and associated crime scene, e.g. murder, robbery or burglary, should be varied in order to test robustness of the current findings within different cases. The revealed differences with respect to the importance of matches between two countries and the potential influence of police organisational culture also deserves more attention in future research.

The current studies exclusively examined the investigation at the crime scene. It would be very valuable to study the influence of the outcomes of the crime scene investigation on the ongoing police investigation. Police detectives need to interpret the information gathered from the crime scene investigation in the light of other information that is available, and decide on future actions. A suspect could be identified quickly and questioned on the basis of rapidly obtained identification information. However, given the early stage of the investigation and the multi-interpretability of ID information, detectives should remain open to additional information and should not let the ID information influence the interpretation of other lines of evidence. The moment any database-matches are provided to the detective team may also influence the way the information is interpreted and the course of actions associated with this interpretation.

An additional finding of the present studies is the diversity in how CSIs perform an investigation. In order to establish more unity in how investigations are conducted and to uncover the most efficient and effective investigation strategy, more research into the different approaches and quality standards is needed.

## **7.6 Practical implications**

Introducing new technologies that allow an acceleration of the current investigation process, such as a spectral camera or rapid identification technologies, is a welcome improvement. However, it is important to recognise both the positive effects and the risks of such an improvement in order to ensure an optimal implementation of the techniques in practice. The decisions based on the techniques may have a strong impact when they point to the involvement of individuals in criminal activities and, therefore, may contribute to the conviction of these individuals. Incorrect interpretations may ultimately contribute to wrongful convictions, as well as to unsolved crimes. The relevance of the research into the implementation of the technologies may be argued in several ways. First of all, cognitive theories that are developed in laboratory situations are now tested in complex situations that better approach reality, and the material shows the

presence of several cognitive processes during the crime scene investigation. The mock crime scene experiment provided useful material for the education of CSIs by yielding film material that beautifully displays the presence of these processes while real CSIs conduct their investigation. Secondly, the findings showing the influence of rapid identification information on the interpretation of the crime scene and the different value that is attached to traces depending on the database-match underlines the importance of this study. On the one hand, the technologies will help CSIs in their reconstruction of the crime by providing them with information about the sources of the traces. On the other hand, the same information can mislead them when this information is wrongly interpreted. This research on prospective technologies may help to recognise and consider the pros and cons of their implementation. Any negative consequences of rapid identification technologies that are discovered in scientific research can be prevented in the real world. The obtained knowledge about the influence of timing of ID information and of database-matches on the valuation of traces can be used to think about strategies for using rapid identification technologies. Based on the present findings, it may be wise to let CSIs think about the reconstruction of the crime and the possible relevance of traces before ID information is provided. Furthermore, research into the influence of information on the interpretation of a crime scene may ultimately enable us to discover effective information provision strategies, which is very helpful for practitioners and contributes to an effective police investigation. Although this research unravelled the presence of several cognitive processes during the investigation of a crime scene with the use of rapid identification technologies, this is also only the first study and more research is needed before a prescriptive model can be presented.

I would like to finish my thesis by emphasizing that studying CSI decision-making is a complex and challenging operation, but, above all, a very fascinating and valuable process. Crime scene investigation is not a matter of simply collecting traces; the human factor plays a significant role within the entire process at the scene, and CSIs' observations and decisions can influence the further direction of the ongoing police investigation. This impact of their decision-making makes understanding CSIs' behaviour of significant value to both the scientific world and to practitioners. I truly hope my research has helped pave the way for future research and that it will stimulate other scientists to join me in this largely unexplored but fascinating field.