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RESEARCH ARTICLE

Reconstructing with trace information: Does rapid identification information lead to better crime reconstructions?

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Abstract

Currently, promising new tools are under development that will enable crime scene investigators to analyze fingerprints or DNA-traces at the crime scene. While these technologies could help to find a perpetrator early in the investigation, they may also strengthen confirmation bias when an incorrect scenario directs the investigation this early. In this study, 40 experienced Crime scene investigators (CSIs) investigated a mock crime scene to study the influence of rapid identification technologies on the investigation. This initial study shows that receiving identification information during the investigation results in more accurate scenarios. CSIs in general are not as much reconstructing the event that took place, but rather have a "who done it routine." Their focus is on finding perpetrator traces with the risk of missing important information at the start of the investigation. Furthermore, identification information was mostly integrated in their final scenarios when the results of the analysis matched their expectations. CSIs have the tendency to look for confirmation, but the technology has no influence on this tendency. CSIs should be made aware of the risks of this strategy as important offender information could be missed or innocent people could be wrongfully accused.

KEYWORDS

confirmation bias, crime scene investigation, identification information, rapid identification technologies, scenario construction

1 | INTRODUCTION

Crime scene investigators (CSIs) aim at detecting physical traces and using traces to obtain information on the source and the events that produced them. A difficulty often neglected within this task is deciding which traces are actually left by the offender. Crime-related traces may easily be confused with traces produced by events before and after the crime (Delémont, Lock, & Ribaux, 2014). Despite the challenging but important task of CSIs, limited research is conducted on actual CSI decision making. Research in this field becomes even more important now that new technologies are under development that allow rapid analyses of fingermarks and DNA-traces. Currently, turn-around times for DNA traces can take up to 66 days for serious crimes (Mapes, Kloosterman, & Poot, 2015). The new so called "rapid identification technologies" (RI) will make it possible to perform real-time analysis of fingermarks and DNA-traces at the scene and compare them with existing databases. Thus, identification results can become available very early in the investigation (Holland & Wendt, 2015; (National Institute of Justice, 2014); Kurpershoek, 2009). The use of RI technologies may influence the selection of traces for analysis and hence the reconstruction of the crime, as identification information may guide CSIs in a different direction compared with investigating without this information. After all, more information at the beginning of an investigation makes it possible to test hypotheses and thus can lead to a more complete idea of what happened at the scene. The investigative team could get a name to follow up in an early stage of the investigation. A condition for this situation to occur would be that CSIs select and analyze all crime-related-traces and interpret them correctly to make an accurate reconstruction and link offender(s) with the scene of the crime. However, the difficulty for CSI decision-making remains the same: how to decide which traces have actually been left during the crime? If a crime scene and its traces are interpreted incorrectly, identification information can suggest misleading paths and, in the worst case, may result in innocent people being linked to the crime. Using RI technologies, an investigative team may identify a leading scenario in an earlier stage of the investigation. Literature shows that once an idea is formed, the risk that investigators will seek, interpret, and create information that fits into the leading scenario is considerable (Koehler, 1991; Nickerson, 1998). This is not a problem if the scenario is correct, but it is risky when the scenario is incorrect.

Presently, no empirical evidence is available on the degree to which early availability of identification information is altering CSIs investigative behavior. In the present study, we will examine the influence of getting rapid trace information during a crime scene investigation on the interpretation of the crime scene and its traces by crime scene officers.

2 | MAKING SENSE OF INFORMATION

Crime scene investigators are usually the first officers to investigate the scene of a crime. Two important tasks of a crime scene investigation team are to decide which traces to collect from the scene and, subsequently, which traces to send to a forensic laboratory for analysis (Fisher & Fisher, 2012). Whereas traces left during the crime can provide information on who or what left them, other, unrelated traces may cause bias in understanding the events that took place. Hence, decisions on the relevance of traces need to be made. Tversky and Kahneman (1974) argue that, when faced with uncertain situations, people use heuristics in order to quickly and intuitively order information, and for solving problems. People develop patterns based on experience in certain kinds of situations. These patterns represent the most important characteristics of a task and help structure large amounts of data (Kahneman, 2011). According to Klein's recognition primed decision making, domain-relevant cues will be recognized from a mental repertoire of patterns. These patterns or schemas help focussing on relevant cues from a case history and ignore irrelevant information (Klein, 1993). CSIs can categorize crime scenes based on their experience, which helps deciding where traces may be found and what traces may have been generated by the crime. Although using heuristics is, in general, an efficient way of thinking, it can also lead to errors when categorizations are incorrect (Gigerenzer, Todd, & ABC Group, 1999). For example, a crime scene can be wrongly perceived as a burglary instead of a domestic

violence case. Such a misclassification may lead to missing important traces associated with violence, as they are not to be expected in a case of burglary.

The detection of traces leads to the construction of hypotheses about their causes, an abductive reasoning process (Jamieson, 2004). Such hypotheses direct the search and collection of new traces. Subsequently, this new incoming information contradicts, reinforces, or discriminate the hypotheses (Delémont et al., 2014; De Poot, Bokhorst, Van Koppen, & Muller, 2004). Reasoning from effect to cause is difficult, as each effect usually can be explained by a variety of explanations. Thinking of possible scenarios that explain the traces helps CSIs to make sense of all the information available. Pennington and Hastie (1991) describe how jurors create narratives by reasoning from world knowledge and from evidence in order to make sense of all trial information and decide about what happened in the events described. Studies on police investigations show that detectives create a narrative event when they try to solve the crime (Innes, 2003; Wagenaar, Van Koppen, & Crombag, 1993). Narrative construction can be seen as a cognitive strategy that is part of a reasoning process used to achieve a plausible and coherent understanding of the situation (Pennington & Hastie, 1991). Eventually, CSIs have to create a scenario of the acts that took place at the scene, supported by the evidence.

3 | RECONSTRUCTING WITH TRACE INFORMATION

When traces can already be analyzed and compared with databases during a crime scene investigation, CSIs may get more dependable information about the persons who left the traces. Due to the hypothetico-deductive character of investigations, identification information could influence the further search for traces, as a continuous interaction occurs between new information and a provisional scenario. New information gathered by the CSI (i.e., the identification information) can influence his most plausible scenario and hence the search for and interpretation of new information (Roux, Crispino, & Ribaux, 2012). Scenarios will be preferably verified with the trace-information and further reconstructed and adapted during an investigation. Identification information might help reconstruct the crime that took place and identify the person or persons involved. In this way, more information can lead to a more accurate scenario. However, research shows that people (wittingly or unwittingly) recall information that supports expectations and hypotheses much better than contradictory information (Klayman, 1995, Nickerson, 1998), the so-called confirmation bias. Once we have formed some hypotheses, we want more certainty about them, which results in a search for evidence that confirms our presumptions. Information that contradicts an existing belief may be ignored or overlooked (Nickerson, 1998). In the case of RI at the crime scene, trace information might help reconstructing the crime, but it could also cause an undue focus on specific traces, or on just one suspect. Although our previous paper (De Gruijter, De Poot, & Elffers, 2016) showed no influence of RI technologies on attention during the orientation phase of the crime scene investigation, it did indicate that CSIs have an offender-oriented focus. This focus corresponds with the findings of Baber and Butler (2012), who showed that experienced CSIs look for possible evidence at the scene. This raises the question what will happen if the results show a match with a known person in the database. Will CSIs stop searching for other traces because they assume the trace to be the offender's, or will they continue to verify their hypotheses? Receiving a database-match with a known person does not instantly mean the perpetrator has been found. The context in which the trace is found needs to be considered, together with all other information gathered in the inquiry.

The aim of the present paper is to experimentally investigate the impact of RI technologies on the selection of traces for analysis and the interpretation of the crime scene. To our knowledge, the decision-making of CSIs in general and, more specifically, the influence of trace-information on their decisions have never been studied so far. This is the first study in which CSIs are individually asked to investigate a mock crime scene and had the possibility of using RI technologies, so it provides for the first time insights into the decision making process of CSIs. Participants in our experiment, all experienced CSIs, were divided into two groups, a control group that investigated the crime scene

in the traditional way and an experimental group that had the opportunity to use RI technologies for fingerprints and DNA-traces. As using the 'thinking out loud' method (Van Someren, Barnard & Sandberg, 1994) would make the investigation feel less natural and hence could affect the validity of the data, CSIs were sent to the crime scene accompanied by a trainee who asked about their thoughts and considerations. The paper analyses decisions of CSIs by means of decision trees and looks into the impact of trace information on final scenarios.

4 | METHOD

The method used for this study is identical to the one described in (De Gruijter et al., 2016). We complemented the data in our previous study with 20 new CSIs, who investigated the same crime scene. In the present study, a total of 40 CSIs investigated a mock crime scene of an armed robbery. Half of the participants investigated the scene in the traditional way and the other half was able to use RI technologies to analyze fingerprints and DNA-traces. In order to make the investigation as realistic as possible, a police officer, a trainee, and a lab worker were present at the scene.

4.1 | Design

A total of 40 participants were divided into two groups: one control group and one experimental group. The control group had to investigate the crime scene in the traditional way. The experimental rapid ID group ("RI" for short) had the option of using RI techniques for fingerprints and DNA traces. The equipment used by the experimental group is presently not available to CSIs during their normal police work, so they had no experience with these new technologies. To make sure that differences between the groups were not affected by background characteristics, all participants were asked to fill out a questionnaire with background characteristics prior to the start of the study. Based on this information, the participants were divided equally over the groups before the experiments started. The experimental condition was treated as explanatory variable.

4.2 | Participants

A total of 40 CSIs from nine different police regions were recruited via police management to participate in this study. The group consists of 33 men and 7 women in an age range of 25 to 61 years (M = 43, SD = 10), and their experience within the forensic investigation department ranged from 2 to 34 years (M = 9, SD = 8). Their experience with cases similar to the case in our study ranged from 0 to 31 years, with an average of 8 years (M = 8, SD = 8). There was no difference in age, region, education, sex, and experience between the two conditions.

5 | MATERIALS

5.1 | The experimental crime scene

The researchers in our group created a mock crime scene in the CSI-lab of the academy of the Netherlands Forensic Institute. The researchers created the scenario. The simulated crime was an armed robbery committed by two co-offenders. The crime was composed of elements from several real life cases. The crime scene consisted of a street, a hall, a living room, a bathroom, and a bedroom. An observation room was positioned next to the crime scene, from where the researchers followed the participants at the crime scene on cameras and audio.

The mock crime was re-enacted with actors (criminology students), who followed a detailed scenario to make sure that traces were left in realistic places. Table 1 shows the scenario (our ground truth) divided into pieces, and it shows how the participants could find the pieces of information (i.e., by receiving information from the police officer present at the scene or by analyzing traces and receiving RI information). Some traces were more difficult to find than others.

TABLE 1 The ground truth divided in story elements, the trace that could provide information and the information coming from the analysis. An X means there was no way to find that piece of information via that source

Story	Information coming from	Trace linked with story element	Information obtained from traces with RI
Two youngsters, Alin Radu (AR) and Wesley Markant (WM), have heard that the inhabitant of the house Simon Oud (SO) may have lots of cash.	X	X	X
They follow SO home and attack victim while he opens the front door	Colleagues hospital (victim had jacket on)	Keys	DNA: mixed profile Dacty: partial from SO
They attack SO throw him against bathroom door and SO leaves blood stain on bathroom door	X	Bloodstain on bathroom door	DNA: match with SO
WM puts tape on mouth SO (which is later pulled off again) and ties SO down in bedroom	X	Tape short	Tape short: middle: DNA SO Ends: not enough DNA
AR tries to tape hands of victim, but this does not work and put gloves off	X	two latex gloves	DNA match with AR
Tape still does not work and AR leaves tape on floor	X	Tape roll Tape long	Tape roll: fingerprint: match AR Tape long: not enough DNA
AR ties victim down with tie wrap	Police officer finds victim tied down with tie wrap	Tie wrap	Tie wrap: DNA middle: match victim DNA ends: not enough DNA
SO leaves blood on bedroom floor	X	Three bloodstains bedroom floor	Match with SO
WM searches the house	Situation house = turned upside down	Traces that indicate disorder	
WM grabs a knife from kitchen and stabs SO (shallow wound through jacket)	Info from colleagues hospital: victim has a shallow stab wound	X	X
WM gets wounded and washes hands	X	Bloodstain water tap bathroom and blood in washbasin	Match with WM
AR and WM hear the neighbor yelling and flee	Neighbor states that she shouted to ask if SO was OK	X	X
AR throws balaclava in trash bin outside	X	Balaclava in trash bin	Match with AR

In total, the researchers planted 30 objects/traces, 21 crime-related, and 9 not crime-related.[1] An object was scored as crime-related if it had a direct link with our scenario and possibly contained traces of the offender, such as bloodstains on the bedroom floor, a tie-wrap, or pieces of tape. Five of the related traces are traces that indicate disorder in the house. As designers of the crime scenario, the researchers knew the ground truth in this case. This truth is used as reference frame within the analysis.

The researchers also planted traces that were not crime-related and could lead to misleading interpretations. The non-related traces were as follows: four cigarette butts at the doorstep (unknown persons), a viewing trace on the window (match with neighbor Henrike), two beer bottles in the kitchen (one match father victim P. Oud), an earring

[1]The numbers differ from the numbers mentioned in our first paper as traces are now separated for the analysis. For example, cigarette butts are separated in four cigarette butts.

in bed (match with neighbor Henrike), a dishcloth with blood (match with victim), and the combination lock of the safe in the bedroom (the safe was crime-related but the lock provided a match with a person who was not the offender, namely father P. Oud).

5.2 | Mobile lab

The participants in the experimental group had a simulated mobile laboratory with a lab worker at their disposal. The lab worker was a member of our research team. The participants of the RI group had the option of sending their traces to the mobile lab for RI. The lab worker provided the results of the analyses of fingerprints in 15 min and of DNA in 30.

6 | PROCEDURES

6.1 | Phase 1: briefing

Each experimental session started with a briefing in which the study was explained. The researchers stated that the goal of the study was to examine decision-making processes of CSIs at a crime scene. It was stated emphatically that the study was not about personal performance, and the participants were asked to investigate the crime scene as they would normally do in practice. For members of the experimental groups, the new technologies available to them were explained, how they could be used, and when they would receive the results. The other few exceptions to their daily practices, such as the individual decisions about when and where the secured traces should be analyzed (which are normally made in consultation with colleagues) were explained, and then the study started.

6.2 | Phase 2: investigation of the crime scene

6.2.1 | Start of experiment

Before individual participants were sent to the crime scene, they were provided with initial information by one of the researchers who played the role of a member of the police force's emergency room. The information provided: there has been a robbery, witness has seen one offender, victim has been taken to hospital, and more information might be obtained from the police officer present at the crime scene.

Once the participants entered the crime scene, they would meet the police officer who was the first person that had arrived at the scene, played by a member of the research team. The participants were free to ask the police officer questions about the crime scene, witnesses, the victim etc. during the investigation. After 1 hr at the scene, the participants received a phone call from colleague investigators who were at the hospital and had information about the wounds of the victim. To control the presentation of information and ensure consistency between all participants, all the information that could be provided to the participants (depending on the questions asked by the participant) was written down and literally recited by the researcher.

6.2.2 | Choices and decisions

To gain insight into the choices and decisions made by the CSIs, the thought processes of the CSIs needed to be identified. The decision was made to work with a "trainee," also a member of the research team, who would visit the crime scene with the CSI. Each participant was asked to explain his or her approach and actions to the trainee and to tell the trainee what they observed and thought while conducting the investigation. The trainee could also ask the participant about his or her thoughts and decisions, with neutral questions such as "what are you looking at?", "why are you doing that?" The questions were designed to be as objective as possible to not influence the participants' decision-making. Most of the participants (77.5%) were used to working with a trainee in practice. The trainee made notes during the investigation and wrote a report with all information after the experiment.

Next, the participants were asked to decide about the purpose of the secured traces. Boxes were placed at the crime scene in which traces could be deposited after securing them. Participants could choose between a box to send the trace to a forensic lab for analysis and a box to keep it in storage. The RI experimental group, which had the option of analyzing the traces for RI, had an additional box labelled "rapid identification."

Once the participants had finished their investigation, they were asked to answer a question about what they thought had happened and why. All participants answered this question on a computer, and there were no restrictions on how to answer this question.

6.3 | Phase 3: interview

To learn more about their decision-making, the researcher discussed all collected traces with the participant and finished the study with an interview. Figure 1 presents a flowchart of the experiment and the data collected.

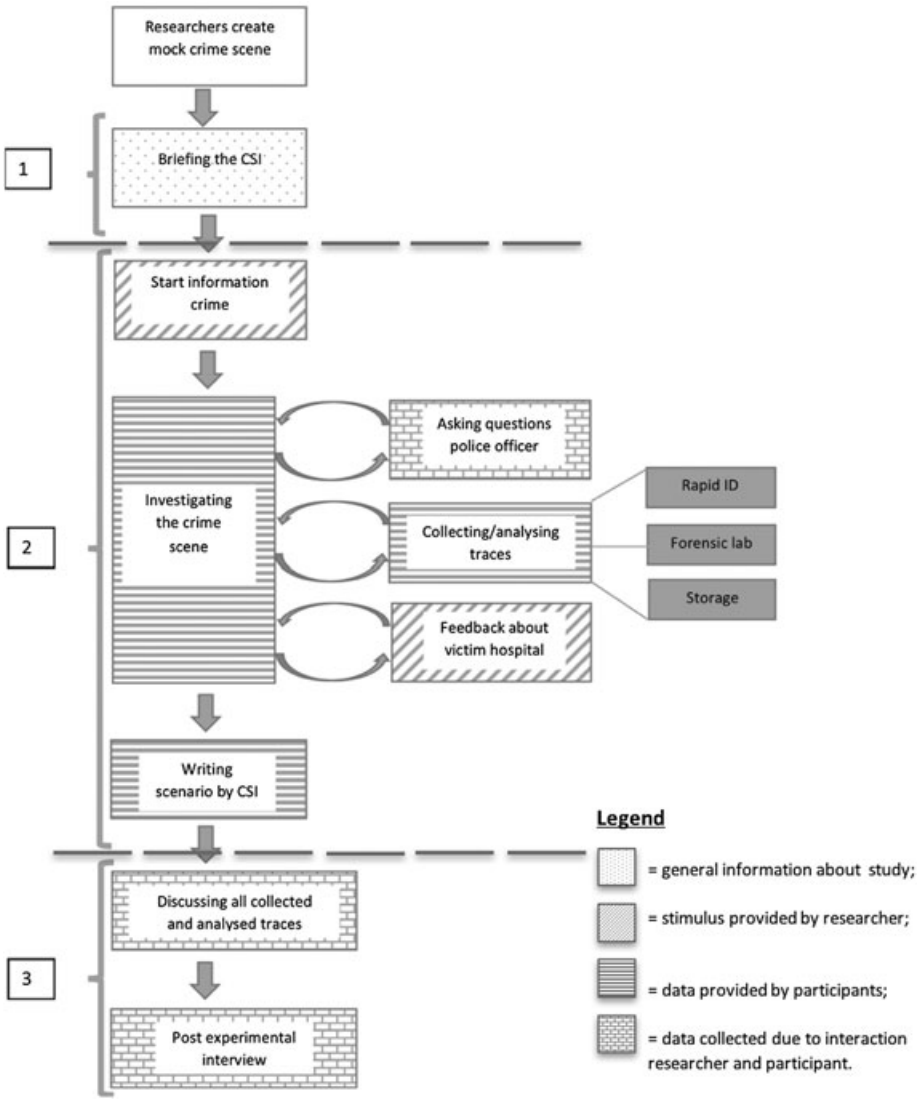

FIGURE 1 Different phases of the experiment and ways of data collection

6.4 | Data analysis

The "ground truth" is used as frame of reference in the data analysis. Knowing the ground truth makes it possible to investigate whether receiving trace information during the crime scene investigation improves the interpretation of the scene and the scenarios created after the investigation. It is important to note that thinking of other scenarios and testing them is not incorrect. However, we need a reference frame to test the influence of the RI technologies, and we decided to use the "ground truth" as reference frame. The data used for this study consists of the reports written by the trainee about the thoughts and decisions of the participants and the 40 written scenarios.

6.4.1 | Expectations and information in scenarios

All reports written by the trainee about all statements made by the participants during the investigation were analyzed to investigate the reasons why traces were analyzed with the RI technique: what was their hypothesis about the trace at that time? A decision tree was made for each trace for all participants to analyze all decisions from finding the trace until naming the trace/result in the scenario. This qualitative analysis shows whether the expectation has influence on the decision, whether a trace was analyzed and whether the trace/result was mentioned in the scenario.

6.4.2 | Scenario analysis

The correct scenario is divided into elements used as variables to score the scenarios of the participants. The correct elements within our scenario are shown in Table 1. It is analyzed for each participant whether the elements were written in the correct form (yes/no). Hypotheses that deviate from the ground truth are scored as "other explanations." Subsequently, a *t*-test was conducted to investigate the differences in the dependent variable "number of correct elements" and "other explanations" between both groups.

6.4.3 | Information provided by traces

Several objects or traces present at the crime scene could provide identification information that corresponded with the correct elements. A rapid analysis of these traces could bring the participant closer to the correct scenario as the results were provided within half an hour. However, not all traces contained full DNA profiles or usable fingerprints. Traces that provided identification information can be found in Table 1. The amount of testable elements in the scenario (dependent variable) is compared with a *t*-test between the control, and RI group to investigate whether receiving information about these traces leads to a more accurate scenario.

7 | RESULTS

Although the control group did not have the opportunity of letting their traces be analyzed at the crime scene, they were asked to decide whether they wanted to analyze the trace at a forensic lab. The number of to be analyzed traces by the control and experimental group were analyzed first. The experimental group had to choose between RI and a regular forensic lab. The control group could only choose the regular forensic lab.

8 | ANALYZED TRACES

The control group and the RI group collected approximately the same number of traces, 28.8 traces for the control and 26.6 for the RI group. Table 2 shows that participants from the RI group analyzed a higher percentage of their collected traces compared with participants of the control group.[2] The difference is however not significant.

[2]The number of traces that could be analyzed is higher than the number of traces that could be collected due to the fact that participants sometimes asked for two different analyses for one object. For example, fingerprints and DNA obtained from one glove. However, this has no effect on the differences between the control group and RI group.

TABLE 2 Number of traces analyzed by the control and rapid ID group

	Control (*n* = 20)	Rapid ID (*n* = 20)
Mean	14.0 (SD = 6.1)	15.8 (SD = 5.3)
Min	6	5
Max	28	25
% analyzed of collected traces	48.3	61.2
% analyzed with rapid ID of collected traces	X	58.5
% analyzed of crime related traces	37.1	43.5

Differences are difficult to demonstrate due to the large standard deviations. The table also shows that the RI group analyzed most of their collected traces with the RI technologies. Again, the differences within the group are high with a range from 20 to 100%.

9 | TRACES ANALYSED WITH RAPID ID

Both groups wanted to analyze a similar amount of traces, the RI group however received identification information of the traces they sent to the mobile lab that could help them constructing a scenario. During the interviews all participants were asked whether they thought using RI technologies would have an influence on their scenario construction. In the control group 17 of the 20 participants thought it would have an influence, and only 11 of 20 participants in the RI group thought it did influence their scenario construction. The possibility of discriminating between traces and hence adjusting your scenario were reasons given by the ones who thought it would influence their scenario construction. Participants who thought it did not have influence stated that the name of the offender was not important for their scenario. Insights into the decisions made by the participants will show whether trace information does have an influence on the interpretation of the crime scene.

10 | CORRECT ELEMENTS

Table 1 in the former paragraph showed our ground truth with the correct elements of the scenario. As mentioned before, writing and testing different scenarios is actually good as investigators should test different scenarios to finally come to the most plausible one. An example of another scenario mentioned is a scenario in which a woman is involved as co-offender in the crime. It is a logical thought based on an earring that was found in the bed of the victim. Although it is a logical thought, it does not correspond with our ground truth and is therefore not scored as a correct element. Table 3 shows the mean number of correct elements, based on the ground truth, mentioned in the scenarios of the participants of the control and experimental group. The participants who wrote multiple interpretations of one trace of which one was good are not counted within the correct elements.[3] The difference between both groups is not significant $t(38) = -1.205$, n.s.

10.1 | Elements that are mostly correct

Figure 2 shows the percentages of the number of times the elements were correctly incorporated in the scenarios of the control and RI group. Victim was tied down, the house was searched, and offender left a balaclava in the trash bin were mentioned correctly by a majority. Crime is committed by two offenders, and one offender got injured was mentioned by only very few CSIs. A Wilcoxon signed rank test shows a significant difference between both groups

[3]Adding good elements of the multiple explanations to the number of correct elements does not change the results.

TABLE 3 Mean number and standard deviation of correct elements mentioned in the scenarios of the control and experimental group

	Control group	Rapid ID
Number of correct elements	4.75 (SD = 2.7)	5.75 (SD = 2.6)

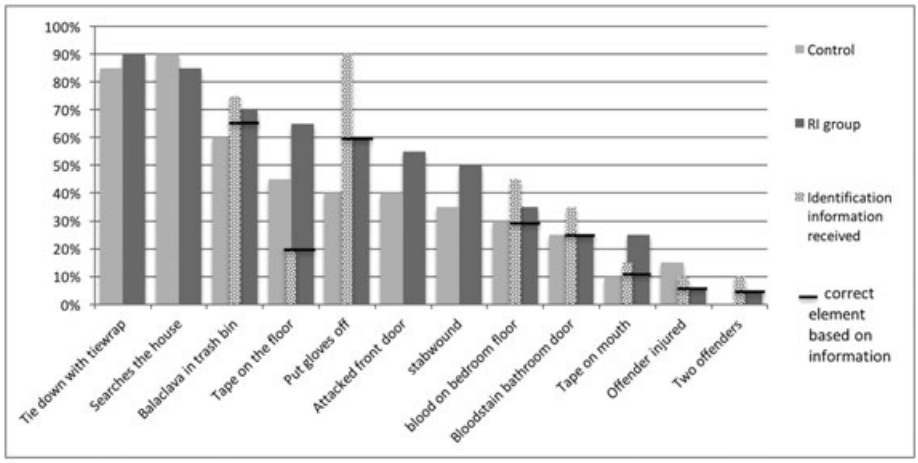

FIGURE 2 Percentages of the number of times the elements were written correct in the scenarios of the control and RI group, from high to low and the percentage that received identification information from the traces linked with the elements and the percentages that used the information and made a correct interpretation

$Z = -2{,}327$, $p < 0.25$. The RI group has a higher percentage of correct interpretations of the traces compared with the control group.

If participants received identification information about the traces linked with the correct elements, they nevertheless did not always mention the correct story element in their scenario. The majority of the participants sent in the gloves and balaclava, and they received information about the offenders. Both the blood on the bathroom door and bedroom floor was sent in for analysis by half of the participants, but not all of the participants received a match with the victim. In order to receive information about a match with the victim, the participants had to ask for a reference sample of the victim. In case they did not ask for the reference sample, they received a profile of an unknown person. Also, some participants of the RI group wrote correct interpretations even without receiving identification information. Figure 2 shows the percentage of participants in the RI group who received information and made correct interpretations based on this information.

Only three participants of the RI group received identification information coming from the short piece of tape coming from the mouth although eight participants send it in for RI. The victim was the only person that could be found on the inside of the tape, but not all participants asked for a reference sample. Furthermore, part of the participants was searching for the offender on the ends of the tape, but the amount of DNA was not sufficient to obtain a profile of the offender. They did not receive identification information. Due to the small number of people who received identification information, in the rest of the paper the short piece of tape is left out of the traces that provide identification information.

11 | INFORMATION IN SCENARIOS

An analysis of the number of crime related elements that provided identification information and were mentioned correct in the scenarios shows an average of 2.2 for the control group and of 2.7 for the experimental group. The

difference is not significant for the crime-related traces ($t(38) = -.992$, n.s.). The crime scene consisted of four unrelated traces that provided identification information of persons who did not commit the crime: the beer bottles, the lock of the safe, an earring, and a viewing trace on the window outside. The beer bottles were analyzed five times. Four of the participants did not mention the beer bottles and the result in their scenario. One of them correctly mentioned the father of the victim was found on the bottle, but probably had no link with the crime. The father of the victim was described as suspect in one of the scenarios, based on the DNA match with the father on the lock of the safe. An analysis of the number of incorrect interpretations mentioned based on the unrelated traces also shows no significant difference between the control and RI group ($t(38) = .946$, n.s.).

The former results show no large difference between the scenarios of both groups. Insights into the information obtained and the information integrated in the scenarios will show which information is obtained and is integrated in the scenarios. Information received from rapid analyses of certain traces will now be elaborated on.

Table 4 shows whether or not participants received identification information about the bloodstain on the bathroom door and whether or not they wrote the correct interpretation of the trace in their scenario. Most of the participants in the control group (15/20) did not mention the trace at all in their scenario. The same goes for the RI group. Nine out of 20 participants did not receive information and did not mention the trace, four of them did receive information but did not mention it in their scenario and five participants did receive information and also wrote a correct interpretation in their scenario.

Part of the decision tree made for the blood on the bathroom door is shown in Figure 3. The figure shows that the trace is mostly analyzed when participants thought the offender might have left the trace. Examples of quotes given by the participants about the bloodstain are "it's probably from the victim, but marked by the offender" or "I have no reason to think it is a trace left by the offender." Three of four participants in the RI group who thought they found an offender trace, analyzed it in the mobile lab and received identification information did not give an explanation in their scenario. One participant decided not to collect the trace at all but did give a correct interpretation in his scenario.

Table 5 shows the numbers for the latex gloves found in the bedroom. A little bit more than half of the participants in the control group (12/20) did not give an explanation for the gloves, whereas the same number of participants in the RI group (12/20) received identification information and did give an explanation for the gloves. An analysis of the qualitative data showed that most of the participants believed the gloves to be from the offender. All participants from the RI group who thought the offender left them decided to analyze the trace in the mobile lab. Six of them did not give an explanation for the gloves in their scenario. Most of the participants in the control group also thought the offender left his gloves and decided to send the gloves to the regular lab. However, only half of them gave an explanation for the gloves.

Table 6 shows the numbers for the bloodstain on the water tap in the bathroom. Most of the participants of both groups did not find the bloodstain at all. Only six participants in the control group and four in the RI group found the trace. Two of the four participants in the RI group decided to analyze it in the mobile lab and received identification information. The other two decided not to analyze the trace for RI and also did not mention the trace in their scenario. Three of the six participants in the control group gave a correct explanation of the bloodstain in their scenario without

TABLE 4 Bloodstain bathroom door. Information received and interpretation in scenario

	Condition		
Bloodstain bathroom door	**Control**	**Rapid ID**	**Total**
No information + not in scenario	15	9	24
No information + correct in scenario	5	2	7
Information + not in scenario	X	4	4
Information + multiple explanations in scenario	X	2	2
Information + correct in scenario	X	3	3
Total	20	20	40

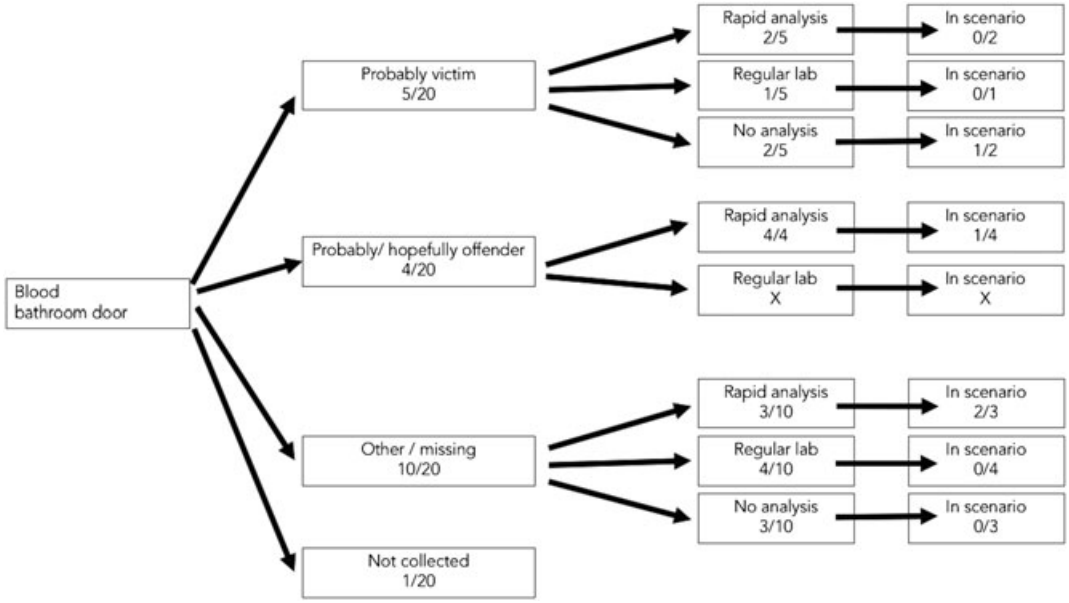

FIGURE 3 Decision tree based on the decisions made about bloodstain on the bathroom door

TABLE 5 Latex gloves. Information received and interpretation in scenario

	Condition		
Latex gloves	Control	Rapid ID	Total
No information + not in scenario	12	2	14
No information + correct in scenario	8	0	8
Information + not in scenario	X	6	6
Information + correct in scenario	X	12	12
Total	20	20	40

TABLE 6 Bloodstain water tap. Information received and interpretation in scenario

	Condition		
	Control	Rapid ID	Total
No information + not in scenario	16	18	34
No information + incorrect in scenario	1	0	1
No information + correct in scenario	3	0	3
Information + multiple explanations in scenario	X	1	1
Information + correct in scenario	X	1	1
Total	20	20	40

receiving identification information. They mentioned that the offender got injured and washed his hands. The RI group, however, was also able to conclude that two offenders might have committed the crime, as the trace provided identification information of the second offender. The participants of the control group did not know that another person left the trace. One participant of the control group thought it was blood left by the victim and decided not to collect the trace. The data also shows that the trace was analyzed when participants thought the offender left it. A reason of a participant not to analyze it with RI technologies was "I already have enough information."

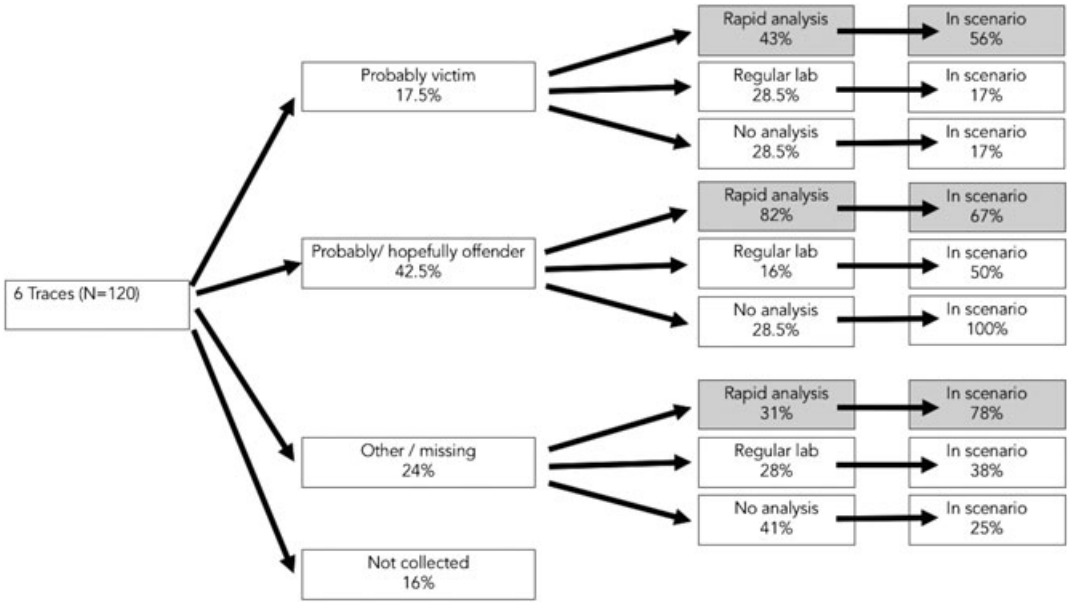

FIGURE 4 Decision tree with decisions made about six traces that provided identification information

These examples show no large difference between the explanations given in the scenarios of the control group and the RI group. Receiving identification information does not seem to influence the interpretation of the crime scene. Figure 4 shows a decision tree with decisions made by participants of the RI group for six crime-related traces that could provide identification information. It shows that traces were mostly analyzed in the mobile lab when participants thought the offender left the trace. One participant said: "The trace can also be from the offender, that justifies the decision to use the rapid identification." The information is not always interpreted and included in the scenarios. Identification information is mostly integrated in the scenarios when the results matched the expectations of the participants.

12 | "OTHER EXPLANATIONS"

Besides the number of correct elements, the numbers of written interpretations that are different from the correct scenario are analyzed as well. The "different" interpretations can be all kinds of hypotheses that are not part of the truthful scenario. Examples of different statements are that only one person committed the offence, that the offender smoked cigarettes outside or that the offender was in possession of the keys of the victim. Although eight participants from the RI group wrote about a smoking offender in their scenario, only three of them analyzed the cigarette butts. Three participants in the control group were triggered by the earring they found in the bed of the victim and described a scenario in which a woman was involved. Only one participant in the experimental group described a scenario in which a woman was involved who gave the keys to the actual offender. The participant did not analyze the earring but did get informed about the gender of other offender related traces. The mean numbers of written parts that do not correspond with the ground truth are shown in Table 7. The number of other elements written by the control

TABLE 7 Mean number and standard deviation of "other elements" mentioned in the scenarios of the control and experimental group

	Control group	Rapid ID
Number of other elements	2.4 (SD = 1.9)	1.5 (SD = 1.1)

group differs significantly from the number written by the RI group ($t(38) = 2.455$, $p < .05$) which means that the scenarios of the RI group consist of less other statements.

13 | DISCUSSION

Rapid identification information received during the crime scene investigation does appear to help with constructing more accurate scenarios. Although the results of the present study show no large differences between the scenarios of the control group and the RI group, the RI group has a higher percentage of correct interpretations of the traces in their scenarios compared with the control group and the RI scenarios contain less other explanations. Receiving identification information during the investigation helps constructing a more accurate scenario. Identification information resulting from the analyses, however, is not always integrated in the scenarios. CSIs are not used to writing scenarios in their daily practice, which could have caused the lack of factual information from the analyses in some of the scenarios. The data suggests that information is primarily integrated if the results are in line with the expectations of the CSIs. This implies that CSIs are primarily attentive to confirming information, and possibly prone to confirmation bias (Nickerson, 1998). Also, CSIs in general have the tendency to look for offender-related traces or objects. They seem to use existing patterns of offender behavior to determine which traces may be left by the offender. For example, the gloves found in the bedroom were often interpreted as left by the offender as this is common offender behavior.

During the interviews, the CSIs raised the possibility of using the technologies to discriminate between traces and adjust their scenarios; however, they did not appear to use the technologies in that way. The results show that CSIs use the technology for almost 60% of their collected traces. However, instead of discriminating between traces and making a reconstruction of the crime, they mainly analyzed traces they believed to be from the offender. This might sound logical as police investigations are about finding the perpetrator, but it also entails risks. A trace might be unjustly interpreted as an offender trace, or a trace might be unjustly considered unimportant because the investigator thinks the victim has left it. The interpretation of the bloodstain on the water tap is an example. Two of the four participants in the RI group decided not to analyze the trace for RI because they did not expect the trace to be from the offender. They missed information about the involvement of a second offender. One participant in the control group did not even collect the trace for the same reason. Here as well, the CSIs show a tendency to look for confirmation rather than falsification (Nickerson, 1998). Some CSIs also stated that they had enough information and stopped analyzing traces for RI after they received a match with the same person multiple times. In general, it seems that CSIs want to find the answer on the "who did it" question instead of reconstructing the event. This is in line with findings of Baber and Butler (2012) who found that experienced CSIs are looking for evidence.

An important question that arises based on the results is how the technologies should be used. One option is to use them for analyses of those traces that the CSI believe to be left behind by the offender, as in the current study. Another option is to use them to discriminate between traces right at the start of an investigation. In this case, a CSI would also have to analyze traces that could have been left by the victim instead of selecting only offender traces. Of course, other factors also influence this decision (e.g., costs and success rates of traces), but it is probably important to be aware of the risks of an offender focus. Future research should focus on the consequences of an offender focus versus a more reconstructive use of the technologies for the entire investigation. Besides the chance of missing important traces, an offender focus could also lead to believing a trace to be from the offender although it actually is not. If an analysis of this trace results in a database-match, this person could be wrongfully accused of the crime and remain the main suspect within the investigation. After all, literature shows that once an idea is formed, people have difficulty changing it (Nickerson, 1998), and several studies have shown that investigators are prone to confirmation bias and belief perseverance and look for confirming evidence of their initial idea (Ask & Granhag, 2005; Rassin, Eerland, & Kuijpers, 2010; Wastell, Weeks, Wearing, & Duncan, 2012). This study showed that CSIs also have the tendency to look for confirmation rather than falsification.

The fact that trace information had no large influence on the interpretation of the scene may be due to the fact that CSIs of the RI group had a hypothetical task. Participants were asked to use the new technologies without knowing exactly how these would work in practice because the technologies are not yet operational. It might have been difficult to think of the optimal way to use them. Also, the fact that, rather than being ambiguous, the mock crime scene was relatively self-evident might have influenced the effects of the information. The identification information mainly confirmed the expectations of the CSIs. A next study should create a more ambiguous scene to investigate the influence of the identification information and the offender focus of the CSIs. Research into the influence of context information on the comparison of traces shows that ambiguous traces can be interpreted differently depending on context information (Dror, Charlton, & Peron, 2006; Dror & Hampikian, 2011; Kassin, Dror, & Kukucka, 2013). Ambiguousness seems to be an important condition when it comes to generating different interpretations and when it comes to using more different sources of information to come to an interpretation, so this should be more well considered applied within the next study on the influence of identification information on the interpretation of the crime scene. However, as this is the first study investigating the influence of trace information we decided to use a less complex crime scene.

The study is conducted within a simulated situation and ideas about what CSIs think and expect are based on what they do and do not mention. This may have had an influence on the outcomes of the study (De Gruijter et al., 2016). A trainee who actively asked clarifying questions was used to overcome this difficulty and after finishing their investigation CSIs claimed that they would have acted the same if it had been a real life case.

This initial study of RI technologies at the crime scene shows that receiving identification information during the investigation results in more accurate scenarios. CSIs in general, however, have rather than reconstructing the event that took place, a "who done it" routine. Their focus is on finding perpetrator traces with the risk of missing important information at the start of the investigation. They seem to use existing patterns of offender behavior. Also, their method shows the tendency to look for confirmation rather than falsification. Rapid identification of suspects can speed up the investigation but also entails the risk of orientating on misleading paths when the relevance is not considered. This could lead, in the worst cases, to the accusation of an innocent person. Future research should investigate the influence of trace information and the different ways to use the technologies with a more ambiguous crime scene. We should understand the influence of receiving identification information in an early phase of the investigation before RI technologies will be adjusted in practice. These studies will contribute to a better understanding of the influence of identification information on the interpretation of the crime scene, and CSIs can be trained how to use the technologies in the real world.

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