Rapid DNA technologies at the crime scene
‘CSI’ fiction matching reality
Mapes, A.A.
Chapter 6

Rapid DNA Analysis at a Mock Crime Scene

The Impact on Collecting and Analysing DNA Traces

Abstract
Mobile Rapid DNA technologies are currently under development for forensic intelligence purposes and might serve as a promising tool in a criminal investigation. However, the effect on current procedures when implementing such a new and rapid technology at the crime scene is unclear. For this purpose, an experimental observation-based study was designed where 40 certified Scene of Crime Officers performed a mock crime scene investigation, either with or without the opportunity of a mobile Rapid DNA analysis. This study focused on the effect of a Rapid DNA analysis option on the decisions to collect, select and analyse DNA traces. It was found that the presence of a Rapid DNA device significantly impacted the decision to analyse DNA traces. When Rapid DNA analysis is possible, participants analysed significantly more DNA traces. In addition, a great variety of DNA traces were analysed rapidly, including various low copy number DNA traces. Participants showed to lack using some kind of “frame work” in their decision-making process, including a lack of DNA success rate knowledge. This study suggests that evidence-based information on DNA success rates, together with a hierarchical decision model, could improve future crime scene investigation processes.

1This chapter is accepted for publication at the Journal of Forensic Sciences as: Mapes AA, Poot de CJ. Rapid DNA analysis at a mock crime scene - The impact on collecting and analysing DNA traces. This study was designed by both authors. The experiments and analyses were performed by the first author. The article was written by the first author with contributions from the co-author.
6.1 Introduction

Since the beginning of forensic DNA analysis, and the possibility of using a DNA database for matching crime traces to samples of known offenders, only a few studies have experimentally analysed whether DNA helps to solve crimes (1-7). These few studies show that DNA contributes to the criminal investigation in identifying unknown offenders. Currently, technologies are being developed to perform Rapid DNA analysis. With these techniques, DNA analyses might make a more significant contribution to identifying suspects and solving crimes. These technologies can analyse DNA traces within 2 hours, which means that it is possible to obtain identification results of potential offenders whilst the crime scene investigation is still on-going (8-10).

Rapid DNA technology brings about a technology driven change in the practice of the crime scene investigation. The promise of such advancements is that the effectiveness and efficiency in controlling crime and identifying offenders will be improved (11-13). Whether this capability can be reached in practice remains unclear. Although there is much theoretical discussion about the impact of technologies on police work, there are only a few empirical and evidence-based studies on the way in which new technologies are used during police work, and integrated within the police organisation (11-21). A main issue most empirical studies share is that the analyses are based on surveys or previous case data of several cases or crime scenes. Knowledge on the way new technologies are implemented in practice, and comparisons between traditional methods and methods supported by new technologies, are often lacking. More focus is needed on how to incorporate scientific and technological innovations; to increase the value of forensic investigations, and provide new means to solve crimes (22). When promising new tools emerge like Rapid DNA analysis at the crime scene, which could influence the work processes of professionals in the legal system, a thorough ‘real-world’ experimental analysis is essential. The best time to conduct a study concerned with the effects of new technologies on the work processes of professionals is before the technology becomes routine practice (6). In that case, the results of the study can be used to successfully implement the new technology.

In general, new information processing techniques influence and transform the cognitive system, and the operational activities of practitioners in the field (23). When observing the introduction of a new technology into a field of practice, any behavioural changes observed in practitioners help us to understand how activities could be performed in a novel way, what opportunities and risks are involved, and how this process can be further optimised (23, 24).

To understand the influence of new technologies on the behaviour, working methods and the decision processes of Scene of Crime Officers (SoCOs), SoCOs need to be observed during their work in the current situation, without these new devices, and in the new situation, where the new devices can be used. In this way, the consequences of
the new technologies can be measured. This information can be used to develop a thorough implementation plan, including new working methods that can help to maximise the opportunities, and avoid the risks associated with the use of these new technologies.

For instance, Rapid DNA technology allows analysis of samples in 2 hours that could quickly generate intelligence for the criminal investigation and may improve improve crime scene investigative practice. However, SoCOs might focus too much on finding and analysing DNA traces, in order to receive this rapid identification information, at the cost of other relevant traces. It is well known that investigators are prone to seeking confirmation for their theories, and are less focused on falsifying their hypotheses (25-27). Rapid identification techniques can deliver information on alleged perpetrators very quickly, when database matches are interpreted as perpetrator identifications. These quick identifications might also stop SoCOs from completing a further search for relevant traces, because they think they have solved the case. This can lead to missing relevant evidence, to an overvaluation of matching traces, and to an undervaluation of other relevant non-matching traces (28, 29).

Before these technologies can safely be used during crime scene investigations, we need to find out how we can overcome these risks, and seize the opportunities these technologies entail. Consequently, we need to find out more precisely how the availability of these Rapid DNA technologies influences the collection, selection and analysis of DNA traces at a crime scene.

From Crime Scene Trace to Rapid DNA Profile

The DNA investigative process consists of recognising traces, collecting traces for potential further analysis, selecting traces that are the most promising for further analysis, and deciding which traces are most suitable to analyse, either rapidly or in the laboratory. The challenge for any SoCO is to detect and recognise relevant physical traces as evidence in a criminal case, prior to any analysis (30, 31). A previous publication, using data from the same experimental observation study we use for the current research, focused on the detection of available traces. This study showed no influence of the availability of mobile DNA devices on the detection of traces (25). However, it is unclear what happens after SoCOs have recognised and detected DNA traces in their search. According to different scholars in this field, the collection, selection, and decision to analyse traces depends on the context of a case. This context includes: the general observations of the SoCOs, the background information they get before or after they enter the crime scene, their expertise, and the hypotheses set up to evaluate the evidence (32-34). In addition, it is suggested that SoCOs could be guided through this process of selecting evidentiary traces and deciding on analysing DNA samples when working on a case by a four-step decision model comprising of: 1) collecting traces, 2) ranking traces on crime and/or offender relatedness, 3) ranking
traces on success rates and 4) selecting the most promising trace(s) for DNA analysis (35). To our knowledge there is no systematic empirical literature discussing the decision process for selecting and analysing DNA traces.

The aim of this study is to explore how the processes of collecting selecting traces for analysis works in practice, and how this process is influenced by the availability of a Rapid DNA device. For this purpose, a mock crime scene of a violent home robbery was designed. Participating SoCOs were invited to investigate the mock crime scene. The SoCOs either worked under standard conditions in the control group, or had the opportunity to use Rapid DNA analysis in the experimental group. In this way, the effect of a Rapid DNA opportunity at the crime scene on collecting, selecting and analysing DNA traces was examined, and it was explored on which grounds SoCOs decide to select traces for analysis, and on which grounds they decide to analyse traces either rapidly or at the laboratory. By investigating these aspects, knowledge on having a Rapid DNA device at the crime scene is gained. This can be used to develop methods that help SoCOs to be better guided in their future DNA analysis decision process.

6.1.1 Hypotheses and Assumptions

The aim of the study is to examine the processes of collecting and selecting traces for analysis in practice, and to explore how this process is influenced by the availability of a Rapid DNA device.

In comparison with SoCOs in the control condition, it is expected that SoCOs who have the opportunity to use a Rapid DNA analysis device will shift their focus towards DNA traces during crime scene investigation, which will result in:

1. collecting more DNA traces
2. selecting more DNA traces for analysis

In the decision process of selecting DNA traces for analysis we expect SoCOs in general to:

1. use some kind of framework to select and analyse traces through considering the crime scene and/or the perpetrator/victims relatedness of the trace.
2. take into account the type of DNA traces (blood, saliva, contact or interdisciplinary) and their DNA success rates as factors in the triage process when making a decision for DNA analysis, either rapid or at the laboratory.
6.2 Materials & Methods

The observation study was set up as a joint research study to analyse the effect of bringing mobile identification techniques to the crime scene. This article focuses on part of the data collected for this study. The study was conducted at a mock crime scene in a ‘crime house’ that allows video and audio recording (Figure 1). Using a mock crime scene made it possible to build the exact same crime scene for each participant. This way, the influence of the independent measure (the presence or absence of a rapid DNA device) could be measured under the same conditions. The data collection required a staff of 4 persons and was a joint effort by the whole team of the overall project.

For each individual SoCO, the study started with a briefing in which the study, and a short account of the discovered crime were explained. Next, the participant was sent to the crime scene to conduct the investigation. In this process, a member of the research team, who posed as a trainee SoCO, accompanied the participant. The trainee’s role was to gain information on decision processes made at the crime scene by the participant. Each participant was instructed to search the crime scene and secure traces, in the same way as they would do in a real investigation. They had to decide which traces they wanted to secure, which traces they wanted to be analysed, and which traces they would like to keep in storage.

To measure the effects of having a Rapid DNA analysis opportunity on the selection and investigation of traces, participants were distributed over two conditions: the Rapid DNA group, who had the opportunity to analyse traces rapidly at the mobile laboratory containing a Rapid DNA analysis device, and the control group who conducted the crime scene investigation as they would normally do.

Finishing up the investigation, the SoCOs were asked to write down their scenario about what had happened, and all the analysed traces were discussed explicitly.

After the mock crime scene investigation, the SoCOs had to perform a thought experiment. During this experiment the SoCOs in the Rapid DNA group were asked to explain what they would have done with the traces they collected at the mock crime scene if they had worked under standard conditions, and SoCOs in the control group were asked what they would have done with the collected traces if they had a Rapid DNA analysis option.

\[\text{Figure 1. Crime house}\]

\[\text{1 The set up of this experiment has been previously partly described in an article that focused on the impact of rapid information on creating scenarios (25).}\]
Finally, the SoCOs had to fill out a questionnaire on DNA success rates and the study ended with an interview on the experience and performance of the experiment.

### 6.2.1 Experimental Set-up

**Mock crime scene scenario - a violent home robbery**

The case we used for this study was based on a combination of real home robbery cases. In the scenario used the victim (no criminal record) was attacked at night whilst coming home from the pub by 2 perpetrators wearing gloves and face protection. Earlier that night the victim’s father (criminal record for, amongst other things, dealing of drugs) came by and gave him (the victim) a substantial sum of money and a small safe containing a package. The victim decided to hide the package and money in a ‘safer place’. One perpetrator molested the victim and tied him up while the other perpetrator searched the house for the money and drugs. While molesting the victim, perpetrator 1 got hurt and left a blood trace on the tap and in the sink in the bathroom. The victim’s neighbour heard noises, and after shouting to the victim she decided to call the emergency services. The perpetrators fled the scene, where perpetrator 2 threw away his balaclava in a garbage can outside. The neighbour saw one perpetrator fleeing after which she went out to the crime scene, at the same time the police arrived.

**Traces**

In this study we consider a ‘trace’ as “all types of traces, swabs and items collected from the crime scene, victim, witness or perpetrator for scientific analysis and/or potential use as evidence” (36). For DNA analysis such a trace can also be latent and either swabbed immediately at the crime scene or later, when the item can be taken from the scene.

The interior of the crime scene was furnished and decorated as if a 29-year-old male was living there. To create the crime scene and obtain the most realistic traces the scenario was actually played in the crime house, by three actors. The crime scene was set up in exactly the same way for each participating SoCO. The scenario led to 31 actual crime scene-related DNA traces that were either victim related or traces that were handled, touched or left by the offenders:

- **Outside**: door keys [1], door knob [2], garbage can handles [3], balaclava [4].
- **Hallway**: blood on bathroom door [5], drugs in a bag [6].
- **Bedroom**: 3 blood swipes [7-9], small piece of duct tape for mouth [10], large piece of duct tape for hands [11], roll of tape [12], 2 latex gloves [13, 14], zip tie [15], safe with key [16], and digit wheel [17], wallet [18], handles drawer [19].
- **Bathroom**: bloodstain on the tap [20], blood in the sink [21].
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• Bathroom: bloodstain on the tap [20], blood in the sink [21].
• Living room/kitchen: money in a can [22], toolbox [thrown on the floor by offender] [23], broken kitchen shelf [24], money box with key in cupboard [25], cupboard handle [26], 2 speaker fronts torn off [27, 28], drawer handles [29].
• From the victim [collected by a colleague in the hospital]: nail dirt [30], clothes [31].

There were also 15 additional non crime scene-related DNA items intentionally placed on every mock crime scene:

• Bedroom: earring in the bed [1].
• Living room: 2 empty beer bottles on the counter [2, 3], pair of sun glasses [4], blood on dishcloth [5], empty can [6] and 2 water bottles [7, 8] in the waste bin, mobile phone [9], laptop [10].
• Outside: 4 cigarette ends [11-14], breath mark on the bedroom window [15].

Experimental conditions

To examine the effect of a Rapid DNA analysis opportunity on the collection, selection and analysis of DNA traces, two experimental conditions were conducted:

1. Rapid DNA - SoCOs in the Rapid DNA group had the opportunity to make use of Rapid DNA analysis through the presence of a mobile DNA lab.
2. Control - SoCOs in the control group performed their crime scene work under standard conditions.

Mobile laboratory

In the Rapid DNA condition a mobile laboratory was present at the crime scene to perform Rapid DNA analysis. When the SoCOs decided to perform Rapid DNA analysis on a trace, the trace was immediately handed over to the mobile laboratory. The mobile DNA lab worker received the traces for Rapid analysis, performed the tests, and handed back the results to the SoCOs.

Boxes

With this study we wanted to find out: on what grounds the SoCOs collect specific traces, why they think these traces could be important for the investigation, and what follow-up steps they want to take with regards to those traces. To gain insight into these aspects, SoCOs had to explain their decisions and place the trace in one of the following boxes:

• Storage - no direct follow-up on the trace, but collected for possible future analysis
• Police Laboratory - trace will be analysed in the police laboratory at the police department (not suitable for DNA)
• Forensic Laboratory - trace will be sent to the Forensic Laboratory for analysis
• Rapid DNA analysis - trace is immediately handed over to the mobile laboratory for Rapid DNA analysis

These boxes were present outside the crime scene where the SoCOs could create their working space. The Rapid DNA analysis box was only present when the participant was assigned to the Rapid DNA condition.

**CSI-trainee**

The trainee was introduced to the SoCO as a Forensic Science student who wants to learn about crime scene investigation and will join the SoCO at the crime scene. The purpose of the trainee was to understand the actions and decisions of the SoCOs and also to assist the SoCO in their administration during the investigation. The trainee did not influence the SoCOs in their work or decisions. Most SoCOs are used to having an intern at the crime scene.

**Police officer**

At the crime scene a police officer was present, played by another member of the research team. She guarded the crime scene while the SoCO performed the investigation; this is standard procedure in the Netherlands. Any questions or requests concerning the crime scene investigation could be asked to the police officer, as she was in direct contact with the SoCO in the hospital, the tactical officer involved in this case and the mobile laboratory worker.

**Participants**

A total of 40 certified SoCOs participated in this study and were evenly distributed over the two experimental conditions, thereby correcting for possible background variables like age, gender, education level and years of experience. The control group consisted of 16 males and 4 females with a mean age of 44 years (st.dev = 10.7) and a mean of 9 years (st.dev = 6.8) experience in crime scene investigation. The Rapid DNA group consisted of 17 males and 3 females with a mean age of 42 years (st.dev = 10.3) and a mean of 9 years (st.dev = 9.9) experience in crime scene investigation.

**6.2.2 Procedure and Data Collection**

Every participant followed a strict routine to collect data in the experimental study. Figure 2 illustrates this process and is further outlined in the following paragraphs.
1) Prior to mock CSI
Before attending the mock crime scene all participants were first welcomed and briefed by one of the researchers. Participants had to sign an informed consent form about using the results and it was made clear to the participants that this study was not a test and that their performance would not be measured. It was shared that the purpose of this study was to learn and understand the decisions that SoCOs make during an investigation. The participants were asked to operate and proceed through the investigation just like they would normally do at an actual crime scene, and they were told that the investigation would take approximately 2 to 3 hours. To understand the decisions made on securing and analysing traces it was explained that each collected trace had to be placed directly in one of the four present boxes and the role of the CSI trainee and the police officer was also established.

In addition, the Rapid DNA group received information on the option of Rapid DNA analysis. It was explained that participants could immediately decide to analyse traces rapidly at the crime scene at any desired moment by using the mobile Rapid DNA device present in the mobile laboratory. It was made clear that the participants were the decision-makers for analysing the trace. The lab worker would only handle/swab the trace, insert the swab in the system, and hand back the results. Participants were told that there was no minimum or maximum number of traces that could be analysed at once and that the technique was non-destructive in this experiment. The DNA traces were first fictitiously analysed with an indicative DNA test, given a negative result to mean there was not enough DNA to generate a profile, and was handed back after 5 minutes. With a positive result, where enough DNA to generate a profile was present, the trace was analysed with the Rapid DNA technology. In that case, the results and the trace would be handed back after 30 minutes.

When there were no further questions about the set-up, the study started and the first information segment about the crime scene was given through the ‘emergency call centre’.

2) During mock CSI
When entering the mock crime scene, the real-life experiment started and the participants performed their crime scene investigation. During the investigation the participants were observed, and data was collected on the collection, selection, and analysis decisions of the handled traces through the observation of the participant and the interaction with the trainee. When finishing up the investigation the participants were asked to write down their scenario of what happened, and any additional data that was collected.
3) After mock CSI

After finishing the mock crime scene investigation, data was collected through four steps - mostly through direct interaction with the researcher. Initially, the boxes in which the participants assigned the traces during the study were placed on the table. The participants were asked to explain the considerations underlying their decisions to deal with traces in a specific way. They also had to explain the possible function of the traces in the subsequent investigation process.

Then secondly, participants were asked to participate in a ‘thought experiment’, where they had to deal with a ‘what-if’ situation. For this experiment, all traces that were collected by the participants were in the middle of the table, and the participants were asked to reassign them into the different boxes again (storage, Police Lab, Forensic Lab, and, if applicable, Rapid DNA analysis).

- Participants in the control group now performed the study as if they had a Rapid DNA device at hand. The Rapid DNA device was explained in the exact same way as was done for the Rapid DNA group during the briefing of the mock crime scene investigation. Based on this additional information the ‘Rapid DNA analysis’ box was added on the table and the participants were asked to reassign the traces as if they performed the mock crime scene investigation with a mobile laboratory at hand.
Figure 2. Experimental Procedure and Data Collection

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In the third step of the post mock CSI procedure, the participants conducted a DNA success rate study. Laboratory DNA success rates are important data to allow decisions to be made on the analysis of a DNA trace. To test the knowledge of the participants on this aspect, participants had to fill out a questionnaire on DNA success rates. The participants had to assess the DNA success rates, the expected chance of obtaining a DNA profile suitable for comparison, of all traces they collected and sampled during their investigation. They had to rate these chances on a 7-point Likert scale, whose endpoints were anchored with 1 as extremely low and 7 as extremely high.

Finally, a post experimental interview was conducted where participants were asked about the way they experienced the mock crime scene investigation, their performance, and the Rapid DNA technology was discussed.

6.3 Results

Firstly, a quantitative analysis was performed to examine the influence of a Rapid DNA analysis option on the collection of traces and the selection of traces for analysis. The software SPSS (37) was used for statistical analyses. After this, a qualitative analysis was utilised to examine the decision process for selecting DNA traces for analysis. Finally, the perspective of SoCOs regarding the DNA success rates was explored to examine DNA success rate knowledge.

6.3.1 DNA Traces Collected During Real-life Experiment

In total, 63 different types of DNA traces were collected by at least one of the SoCOs, whereas our scenario led to a total of 31 crime related and 15 non-crime related DNA traces. This means that the SoCOs identified 17 additional items or samples as DNA traces that we did not consider as crime related or were intentionally placed at the crime scene. These traces were, based on our scenario, non-crime related traces.

Participants in the control group collected, on average, 25 different types of DNA traces (st.dev = 5.2), and the Rapid DNA group 22 (st.dev = 4.3). We performed an independent sample t-test and found no differences between the two groups in collecting DNA traces in general ($t(38) = 1.58, p = 0.122$).
From these 63 different types of DNA traces, 39 were selected for DNA analysis by at least one SoCO. In our further data analyses, we only focus on the traces that were collected and analysed at least once. Figure 3 shows these 39 DNA traces and the results that were given back to the SoCOs when tested with a Rapid DNA device. These 39 DNA traces were further classified into 4 categories: blood (n=7), saliva (n=9), contact (n=18) and interdisciplinary (n=5) traces as shown in Table 1. Interdisciplinary traces are traces that can be sampled for multiple analyses on the same spot, for instance analysing possible fingerprints on a piece of tape or swabbing the prints on the tape for DNA analysis.

Most of these collected and analysed DNA traces concerned the intentional crime related traces as based on our scenario. In addition, the non-crime related DNA traces towel, coffee cup, breakfast knife and plate, were also collected and analysed at least once by a SoCO.

Figure 3 shows that 64% (25/39) of the collected and analysed traces were in fact crime related and 84% of those crime related traces were also offender related (21/25).

Figure 3. Rapid Analysis Results of all DNA Traces that were sent in at least once for Analysis either at the Laboratory or Rapidly
Table 1. The Analysed DNA Traces were Classified in 4 Categories (based on the trace type)

<table>
<thead>
<tr>
<th>Trace Type Category</th>
<th>Trace Items / Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood (n=7)</td>
<td>Blood tap, blood sink, blood door, blood swipes (1-3) and blood on dishcloth</td>
</tr>
<tr>
<td>Saliva (n=9)</td>
<td>Balaclava, beer bottles (1 &amp; 2), glass, coffee cup and cigarette ends (1-4)</td>
</tr>
<tr>
<td>Contact (n=18)</td>
<td>Latex gloves (1 &amp; 2), key and wheel of safe, door key, door knob, tool box, cupboard handle, key of money box, nail dirt, drawer handles (bedroom and living room), zip tie, sun glasses, towel, breakfast knife and plate, and earing</td>
</tr>
<tr>
<td>Interdisciplinary (n=5)</td>
<td>Tape for mouth (ends of tape), tape for hands, roll of tape and speaker fronts (1 &amp; 2)</td>
</tr>
</tbody>
</table>

Concerning the 39 collected traces that were analysed at least once; there was again no difference in the total number of DNA traces collected when performing an independent sample t-test and (Table 2). However, Table 2 indicates that participants in the control group collected significantly more blood traces ($t(38) = 2.09, p = 0.043$) compared to the participants in the Rapid DNA group. When studying these blood type traces in more detail, the difference in collecting the blood on the dishcloth stands out. This trace was collected by 9 participants in the control group but by only 1 participant in the Rapid DNA group. For the other blood traces there were no systematic differences between the groups.

Table 2. Mean Number of DNA Traces Collected with (st.dev), by Participants in the Rapid DNA Group (N=20) and the Control group (N=20)
The p-value shows the results of an independent t-test

<table>
<thead>
<tr>
<th>Trace Type</th>
<th>Rapid DNA group</th>
<th>Control group</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood (n=7)</td>
<td>4 (1.7)</td>
<td>5 (0.8)</td>
<td>0.043*, $t(38) = 2.09$</td>
</tr>
<tr>
<td>Saliva (n=9)</td>
<td>7 (1.4)</td>
<td>7 (1.8)</td>
<td>0.770, $t(38) = 0.30$</td>
</tr>
<tr>
<td>Contact (n=18)</td>
<td>6 (2.5)</td>
<td>7 (2.1)</td>
<td>0.631, $t(38) = 0.49$</td>
</tr>
<tr>
<td>Interdisciplinary (n=5)</td>
<td>4 (1.0)</td>
<td>3 (0.9)</td>
<td>0.505, $t(38) = -0.67$</td>
</tr>
<tr>
<td>Overall (N=39)</td>
<td>21</td>
<td>22</td>
<td>0.358, $t(38) = 0.93$</td>
</tr>
</tbody>
</table>

* Significant difference between numbers of traces collected in the Rapid DNA condition and in the control condition.

6.3.2 Collected vs. Analysed DNA Traces in General

Whilst conducting this study, the question was raised as to whether the number of traces analysed is dependent on the number of traces collected by the participants. To test such a relationship a Pearson’s r correlation coefficient test was performed. There was only one opportunity for trace collection in this study: during the real-life experiment. A positive correlation was found within the control group between the number of DNA
traces collected and the number of DNA traces analysed, $r = 0.561$, $n = 20$, $p = 0.005$. Within the Rapid DNA group such a correlation was not observed.

### 6.3.3 DNA Traces Selected for Analysis

**Real-life experiment**

During the real-life experiment the participants in the Rapid DNA group analysed, on average, significantly more DNA traces than the participants in the control group ($t(38) = -2.89$, $p = 0.006$). In the control group the participants decided to analyse, on average, 8 DNA traces (st.dev = 3.4) at the laboratory. The participants in the Rapid DNA group decided to analyse, on average, a total of 12 DNA traces (st.dev = 4.6), of which 9 were with the Rapid DNA device and 3 at the laboratory (Table 3 & Figure 4, bar 1 & 2). When considering these analysed traces in more detail, Table 3 further shows that the Rapid DNA group analysed significantly more blood, saliva, and contact traces when compared to the control group. On average, the participants in the Rapid DNA group showed a similar pattern of deciding to analyse samples with the mobile Rapid DNA device as the participants in the control group decided for analysis at the laboratory. However, the participants in the Rapid DNA group chose to analyse on average 1 extra sample in each trace category at the laboratory.

When studying the analysed traces on trace type level, it is observed that for the traces in the blood category the participants in the Rapid DNA group decided to analyse more often the traces *blood on the door*, *blood in the sink* and additional *blood swipes*. In the saliva category, more *cigarette ends* and *beer bottles* were analysed in the Rapid DNA group. Within the contact category, especially more *ininfrequently collected trace samples* were analysed in the Rapid DNA group. In addition, the traces *door keys* and *wheel of safe lock* were solely analysed in this rapid condition. Participants of the

<table>
<thead>
<tr>
<th>Trace Type</th>
<th>Rapid DNA Group</th>
<th>Control Group</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rapid</td>
<td>Lab</td>
<td>Analysis (tot.)</td>
</tr>
<tr>
<td>Blood (n=7)</td>
<td>2 (1.7)</td>
<td>1 (1.3)</td>
<td>3 (1.7)</td>
</tr>
<tr>
<td>Saliva (n=9)</td>
<td>2 (2.0)</td>
<td>1 (1.5)</td>
<td>3 (2.1)</td>
</tr>
<tr>
<td>Contact (n=18)</td>
<td>3 (2.4)</td>
<td>1 (0.8)</td>
<td>4 (2.0)</td>
</tr>
<tr>
<td>Interdisciplinary (n=5)</td>
<td>2 (1.7)</td>
<td>1 (1.2)</td>
<td>2 (1.4)</td>
</tr>
<tr>
<td>Overall (N=39)</td>
<td>9 (5.4)</td>
<td>31 (3.3)</td>
<td>12 (4.6)</td>
</tr>
</tbody>
</table>

*Due to rounding off the numbers do not add up.

*Significant difference between the numbers of traces analysed in the rapid condition (Analysis total) and in the control condition (Lab).
The p-value shows the results of an independent (N=20) and the Control Group (N=20) often the traces in the blood category the participants in the Rapid DNA group decided to analyse more. When studying the analysed traces on trace type level, it is observed that for the traces sample in each trace category at the laboratory. However, the participants in the Rapid DNA group chose to analyse on average 1 extra device as the participants in the control group decided for analysis at the laboratory. showed a similar pattern of deciding to analyse samples with the mobile Rapid DNA compared to the control group. On average, the participants in the Rapid DNA group analysed significantly more blood, saliva, and contact traces when

Rapid DNA group who decided to analyse these discussed traces, mostly decided to analyse them with the mobile Rapid DNA device. The two groups showed no overall difference in their decisions concerning the traces in the interdisciplinary category. However, it was noted that only the participants of the Rapid DNA group decided to analyse the speaker traces, and always with rapid analysis. Finally, participants in the control group and the Rapid DNA group did not differ from each other concerning the need to analyse most of the traces left or handled by the perpetrator including blood tap, balaclava, gloves, zip tie, keys for money box, tape for mouth, tape for hands and roll of tape. These traces were discovered and analysed by most of the participants, except for the blood on the tap, which was only discovered by 9 of the 40 participants and analysed by 8 of them. This was interesting because this trace could only lead to the second offender. Again, the Rapid DNA group decided to analyse most of these important perpetrator-related traces rapidly.

Thought experiment
During the thought experiment, the control group had a Rapid DNA option, whereas the Rapid DNA group lost this option and had to process the traces under standard conditions. The decisions the participants made on the analysis of traces during the thought experiment showed the same trends as observed during the real-life experiment. Participants in the Rapid DNA group now decided to analyse on average 9 DNA traces, whereas participants in the control group chose to analyse 12 DNA traces of which 10 with the Rapid DNA device and 2 at the laboratory (Figure 4). Although this difference is not significant ($t(38) = 2.008$, $p = 0.052$) the p-value, together with the
results shown in Figure 4, indicate there is reason to suggest a similar trend of deciding to analyse DNA traces when Rapid DNA is at hand, as was observed in the real-life experiment.

**Real-life experiment vs. thought experiment**

Each participant actually performed two experiments when deciding on DNA analysis in this study. They made decisions in a standard procedure condition as well as in a Rapid DNA option condition. The Rapid DNA option was given to them either during the real-life experiment or during the thought experiment. A more valuable analysis, therefore, is combing the DNA analysis decisions of both experiments and conducting a mixed-design ANOVA, where the availability of the Rapid DNA option is a between-group as well as a within-group variable. The results show a strong significant interaction regarding the total number of DNA traces analysed depending on the availability of the Rapid DNA device (Figure 5). Both during the real-life experiment as well as during the thought experiment, participants analysed more DNA traces when they could use a Rapid DNA analysis device. This means that the total analysis of DNA traces, with and without Rapid DNA option, was significantly different for participants in the control and Rapid DNA group \(F(1,38) = 25.57, p < 0.001\). Both in the Rapid DNA group and in the control group, participants analysed significantly more DNA traces when Rapid DNA was an option compared to a standard protocol condition.

![Figure 5. Mean Number of DNA Traces Analysed by Participants in the Control and Rapid DNA Group during the Real-life and Thought Experiment Showing a Significant Interaction Effect (mixed-design ANOVA p < 0.001)](image)
6.3.4 Qualitative Analysis - Decision Process to Select DNA Traces for Analysis or Storage

To explore the reasons underlying the decisions of the participants to select DNA traces for analysis or to keep them in storage, we gathered qualitative data through intensively discussing the traces participants collected and analysed during the ‘real-life’ experiment of performing the mock CSI (Figure 2) after the experiment was finished. For this purpose, these decisions were manually analysed, taking the following most often mentioned factors into consideration: ‘crime relatedness’, ‘perpetrator relatedness’, ‘victim relatedness’, ‘DNA success rates’, ‘multidisciplinary research required’, ‘additional information concerning the case required’, ‘important trace’, ‘less important trace, others more valuable’, ‘scenario testing / reconstruction’, ‘because it is an option’, ‘no rush’, and ‘depending on capacity’.

Reasons to analyse DNA traces

Table 4 shows the qualitative results of the aforementioned reasons underlying the decision to analyse a DNA trace. In general, either with or without the option of Rapid DNA analysis, the main reason to analyse a trace was because it was considered perpetrator related. This was often mentioned by the participants as: “This is a perpetrator trace” or “This is an important trace and could lead to the perpetrator”. Especially for the blood traces, victim relatedness (87%) appeared to be correlated with perpetrator relatedness (83%) as a reason to rapidly analyse the specific trace: “The victim was hurt, but maybe the perpetrator got wounded too and left the blood trace”. The next main reason for rapid analysis of blood traces, mentioned in 30% of the cases, was simply because it was possible: “If there is the opportunity of rapid analysis, why not use it?” For saliva (11%), contact (13%) and interdisciplinary (7%) traces this reason was mentioned far less.

Table 4. Reasons Mentioned by the Participants in a given Category to Select and Analyse a DNA Trace (in percentages).

<table>
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</thead>
<tbody>
<tr>
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<td>Lab (n=15)</td>
<td>53</td>
<td>73</td>
<td>0</td>
<td>7</td>
<td>7</td>
<td>7</td>
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<td>0</td>
<td>0</td>
<td>40</td>
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<td>0</td>
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<td>Lab (n=23)</td>
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<td>13</td>
<td>4</td>
<td>9</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Cont.</td>
<td>Lab (n=23)</td>
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<td>74</td>
<td>0</td>
<td>9</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Saliva</td>
<td>Rapid</td>
<td>Lab (n=5)</td>
<td>80</td>
<td>20</td>
<td>20</td>
<td>40</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>20</td>
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<td>0</td>
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<tr>
<td></td>
<td>Rapid</td>
<td>Lab (n=28)</td>
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<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Contact</td>
<td>Rapid</td>
<td>Lab (n=12)</td>
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<td>42</td>
<td>0</td>
<td>8</td>
<td>25</td>
<td>17</td>
<td>8</td>
<td>17</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>8</td>
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<tr>
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<td>Lab (n=54)</td>
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<td>26</td>
<td>0</td>
<td>17</td>
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<td>13</td>
<td>0</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Cont.</td>
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<td>18</td>
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<td>0</td>
<td>25</td>
<td>0</td>
<td>10</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Inter-</td>
<td>Rapid</td>
<td>Lab (n=17)</td>
<td>18</td>
<td>6</td>
<td>94</td>
<td>12</td>
<td>6</td>
<td>29</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>12</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>disciplinary</td>
<td>Rapid</td>
<td>Lab (n=28)</td>
<td>64</td>
<td>0</td>
<td>25</td>
<td>7</td>
<td>11</td>
<td>7</td>
<td>18</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Cont.</td>
<td>Lab (n=45)</td>
<td>69</td>
<td>53</td>
<td>76</td>
<td>16</td>
<td>11</td>
<td>0</td>
<td>16</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>
To analyse traces at the laboratory, the participants in the Rapid DNA group also stated perpetrator relatedness as a reason to analyse blood (53%), saliva (80%) and contact traces (25%). The main arguments mentioned not to analyse those types of traces rapidly, but at the laboratory, were the victim relatedness of the blood (73%), saliva (20%) and contact traces (42%), often in combination with considering those traces to be of less importance and therefore ‘no rush’ for rapid analysis, for instance: “The perpetrator could also be wounded, but I think the trace is left by the victim. No rapid analysis because it is probably the victim’s, you do not need to know this fast.” or “I consider this trace of not enough priority for rapid analysis. I do want the trace to be analysed but with regular laboratory analysis is fine.”

The main reason for the interdisciplinary traces to go for laboratory analysis and not rapid analysis was because they considered these traces to have multidisciplinary analysis options (mentioned in 94% of these cases) and therefore should be analysed at the laboratory: “It is a multidisciplinary trace, possible for DNA, fingerprint, ‘souche’ and fibre analysis. This needs to be analysed under optimal circumstances and therefore analysed at the laboratory and not rapidly.” Although more than half of the analysed interdisciplinary traces (28/45) still went for rapid analysis in the Rapid DNA group; the multidisciplinary nature of these traces was then only specified in 7 of those 28 (25%) cases. Again perpetrator relatedness was of highest importance to decide for rapid analysis of those interdisciplinary traces.

In general DNA success rates were not taken into account as often as was expected, it was only mentioned in 14 % of the cases when deciding for DNA analysis on a trace. For instance: “For Rapid analysis because I think this is a perpetrator related trace, and I know that latex gloves show very good DNA results”. DNA success rates were mostly mentioned for traces in the contact (26%) and blood (22%) categories and were hardly ever mentioned in the saliva (4%) category. However, when it was considered it was merely used as a reason to analyse the trace.

**Reasons to keep the DNA traces in storages**
Success rates were rarely stated as a reason not to analyse a trace. For participants both in the Rapid DNA as well as the control group the main reason to decide not to analyse a trace and keep it in storage as a reserve was because more information about the criminal case was desirable (Table 5). Even though perpetrator relatedness was again often specified, it was mainly mentioned to wait for the statement of the victim before deciding to analyse the trace, for instance: “Based on the traces at the crime scene there is a story of what could have happened on the scene. However, you need to be careful in making conclusions, more options could be possible, this depends on the statement of the victim.” However, the necessity for additional information concerning the case was also mentioned a few times when the participants still decided to analyse the trace (Table
4). The main reason not to wait for additional information was again perpetrator relatedness of the trace.

When deciding not to analyse a trace, but keep the trace in storage, the victim relatedness of the trace was an important reason. Stored traces were considered more often as ‘less important’ than traces that actually went for analysis: “For the time being I consider this a victim related trace, I know that the victim is wounded but I don’t know if the perpetrator got wounded. I have other more important perpetrator related traces for analysis.” Especially for the interdisciplinary traces participants also often discussed the capacity as a reason not to analyse the trace at this moment: “Not all collected traces can be analysed, you always have to make choices”.

Lastly, it was observed that for saliva traces collected from drinking items an additional reason was considered, namely the hypothesis that the perpetrator and the victim were acquaintances of each other. This was merely mentioned as a reason not to analyse saliva traces, for instance: “There were 2 beer bottles on the counter. It could be that the victim invited a friend over for a beer. It could also be that this friend decided to rob him. There are different scenarios for the beer bottles, we have to wait for the statement of the victim”.

Table 5. Reasons Mentioned by the Participants in a given Category to keep a DNA Trace in Storage (in percentages).

The numbers represent in what percentage of the decisions made in a specific category the underlying reason was mentioned. For example: the reason ‘more info is necessary’ was mentioned in 26% of the blood traces that were decided to keep in storage in the Rapid DNA group (n= 19).

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</tr>
</thead>
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<td>Blood</td>
<td>Rapid (n=19)</td>
<td>42</td>
<td>26</td>
<td>53</td>
<td>11</td>
<td>5</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td>Cont. (n=32)</td>
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<td>28</td>
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<td></td>
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<td>72</td>
<td>39</td>
<td>44</td>
<td>50</td>
<td>0</td>
<td>28</td>
</tr>
</tbody>
</table>

6.3.5 DNA Success Rates

The participants assessed the expected DNA success rate of obtaining a profile of their collected DNA traces on a 7-point Likert scale. This scale was further categorised to: 1-2 = low, 3-5 = moderate, and 6-7 = high chance of obtaining a profile. The expected success rates for obtaining a DNA profile, as rated by the participants, were then compared to the actual DNA success rates (38). There were no differences between the control and the Rapid DNA group in rating success chances of their collected traces. Therefore, the ratings on success chances of the DNA traces from both groups could be
Figure 7. Expected DNA success rates to obtain a profile versus the actual success rates (38), ranked from highest to lowest actual success rates.

The actual success rate scale shows the probability of obtaining (any kind of) DNA profile or no profile. The expected success rate scale shows the percentage of participants rating the trace on a 7-point Likert scale, we consider 1-2 as low, 3-5 as moderate and 6-7 as high.

taken together for further analysis. The rated success chances were compared to actual success rates (38), these actual success rates were unknown to the SoCOs during this study.

Figure 7 shows that for the more successful traces (blood, cigarette ends, balaclava and drinking items) the majority of the participants were able to correctly rate the success chance of these traces. However, with the less successful traces, (latex gloves, glasses, keys, zip tie and tape) rating success chances became more difficult. For instance, the zip tie was rated by 25% of the participants as highly successful and in 56% as

\[\text{High/*profile obtained} \quad \text{Moderate} \quad \text{Low/*no profile obtained}\]

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2 A comparable study on DNA success rates was performed with NYPD SoCOs (40)
moderately successful in obtaining a profile, whereas the actual success rate is only 15%. The perspective of SoCOs on obtaining profiles for these traces appears to be much higher than is actually the case. This could clarify why Rapid DNA analysis was also often used for contact and interdisciplinary traces.

6.4 Discussion

This mock crime scene study showed overall that Rapid DNA analysis did not influence the collection of traces, resulted in a higher throughput of traces for DNA analysis, and also led to faster identification of the suspect. In general, it can be concluded that a criminal case might be solved more quickly when introducing this Rapid DNA technology.

Overall, the control group and the Rapid DNA group collected the same number of DNA traces and similar kinds of DNA traces. This indicates that there is no influence on the process of detecting relevant physical traces with the potential use of a Rapid DNA technology. This was also acknowledged in a previous publication on this mock crime scene scenario where it was argued that the SoCOs were not directed in their search to detect traces by these new technologies (25), which is a reassuring finding. It suggests that the possibility of Rapid DNA analysis does not lead to either missing important DNA traces or focusing too much on finding DNA traces. For instance, although few SoCOs collected the incriminating blood trace on the tap in the bathroom (7 times in total), there was no difference between the Rapid DNA and the control group in this respect. However, when categorising on trace type level (blood, saliva, contact, interdisciplinary) it was found that the control group collected significantly more blood traces compared to the Rapid DNA group. This difference can possibly be explained by the fact that more SoCOs detected and collected the blood on the dishcloth in the control group (9 times) compared to the Rapid DNA group (1 time). Because this difference was only observed with one trace, that was considered an old and not crime related trace, it is difficult to explain these differences. On the one hand this could indicate an influence of Rapid DNA analysis on missing DNA traces, or on the other hand, it might be that the participants in the Rapid DNA group are more focused on crime related traces and can therefore better discriminate between crime related and non-crime related traces. However, the higher number of blood traces collected by the control group did not result in more analysis of blood traces. In fact, the Rapid DNA group analysed significantly more blood samples.

The decision to analyse a DNA trace appeared to be independent of the number of DNA traces collected, when Rapid DNA analysis was an option. Within the control group, however, a positive correlation was observed between the number of traces collected and the number of traces analysed. Again, this indicates an effect of Rapid DNA
analysis; with Rapid DNA at hand more analyses are performed, independent of the number of traces collected.

Overall, the Rapid DNA group analysed significantly more DNA traces than the control group during the real-life experiment. A reason for this might be that the results of one piece of evidence could influence the interpretation of another piece of evidence, in such a way that the second piece of evidence is evaluated in the same manner as the first piece of evidence (39). When Rapid DNA is at hand results could be obtained more quickly, and thus might lead to a form of confirmation bias on a second piece of evidence. Another phenomenon that could lead to a form of confirmation bias is the urge to believe and confirm that the offender left the trace when immediate DNA analysis led to a rapid database hit.

Another explanation for the higher number of traces analysed when Rapid DNA is an option could be that the Rapid DNA group can focus directly on identifying a suspect as well as reconstructing a crime scene; they can have immediate feedback on the traces, and might be more inclined to also analyse expected victim related traces. Thus, considering analysis both for the source as well as for reconstruction purposes. In the control group, on the other hand, participants are not able to receive fast feedback and therefore prioritise identifying the unknown perpetrator. Focusing on reconstruction comes in a later stage.

Interestingly, the same trend for deciding to analyse traces was observed during the thought experiment, even though the control participants did not receive the rapid result in this experiment. A significant interaction of total DNA traces analysed was found, caused by the availability (either in the real life experiment or in the thought experiment) of a Rapid DNA analysis device. Both in the rapid as well as the control group, participants analysed more DNA traces with a Rapid DNA option than without this option, during both the real-life experiment and the thought experiment. This strongly indicates that having the option for Rapid DNA analysis on the crime scene results in analysing more DNA traces, irrespective of immediately receiving the results or not.

When taking into account the fact that the traces were analysed just as often within the control as the Rapid DNA group during the real-life experiment, at least one perpetrator would be identified. However, in addition the Rapid DNA group analysed many more DNA traces. This was not to test a possible scenario of two perpetrators; 10% of the participants in the control group mentioned the possibility of two perpetrators in their scenario and this was only in 5% of the Rapid DNA group (see also (29)). In particular, more victims related traces were analysed in the Rapid DNA group, suggesting that with Rapid DNA analysis at hand, SoCOs are also focusing on reconstruction; finding out what happened vs. finding out who is the suspect. Without the rapid option the SoCOs might feel more restricted in analysing DNA traces, because they remain ignorant of the results of these analyses and therefore focus more on identifying the perpetrator in the first stage of the analysis procedure.
In the Netherlands there is a maximum capacity of DNA traces that can be sent to the laboratory for analysis. This restriction could have influenced the decision-making process of the participants in the control condition who had to work with standard protocols. Furthermore, this analysis restriction could also have influenced the Rapid DNA condition. In this case participants might have been inclined to analyse more DNA traces because, due to the Rapid DNA option, they believed to have more capacity for analysis. Restrictions for analysis were not specified or corrected in the experimental study and could therefore have influenced the results, which might be a limitation of the set-up.

Overall, the main reason not to analyse a trace, and to keep it stored, was to wait for the statement of the victim and to gain more information on traces. Although it was often mentioned that more information was desirable, many traces in the Rapid DNA condition were still analysed, this was especially found for traces in the saliva group. Possibly SoCOs decided to use rapid analysis not because they considered it immediately necessary but because it is available with this ‘new and exciting’ technology, but it is also possible that they used this technique because it can promptly lead to new investigative information. The time factor therefore plays a different role in the two conditions. Participants in the control group have to wait days, weeks or even months for DNA results. Therefore, waiting a (few) days on the statement of the victim is less significant in their DNA trace prioritisation and selection process compared to participants in the rapid group who can receive DNA results within 30 minutes. All participants collected, selected and analysed at least the balaclava trace or the glove trace, resulting in identifying one perpetrator. In this case, it could have saved a lot of time and money when the participants were waiting to complete any additional analysis until the statements of the victim and the identified suspect. However, it is obviously difficult to anticipate strategically on information opportunities that occur during the subsequent information process. SoCOs have to make decisions in light of the criminal case by weighing the best options for analysing traces. Obtaining rapid feedback on the analysed traces can guide the decision-making process of the SoCO for further analysis of traces but can also affect the progress of the entire criminal investigation. To ensure that SoCOs make strategic and well thought out decisions in this new process with Rapid DNA, it is important to assist them in their trace prioritisation and selection process.

When looking more into the different types of DNA traces analysed, the participants in the Rapid DNA condition analysed a great variety of DNA traces rapidly, including minimal contact traces and interdisciplinary traces. It was expected that the SoCOs would especially use the Rapid DNA technology for ‘routine’ analysis of blood and saliva type traces, and would also consider success rates to distinguish between traces before deciding to use rapid analysis. The qualitative data revealed that DNA success rates are rarely taken into account before making a decision. In addition, the analysis of the DNA success rates showed that SoCOs are unaware of actual DNA success rates.
Especially for less successful traces, mainly the contact and interdisciplinary trace items, success was rated much higher than the actual success figure. This might explain why various types of traces were analysed with this Rapid DNA technology. This indicates that knowledge on actual evidence-based DNA success rates is necessary information for the decision-making process of Rapid DNA analysis.

In this study, SoCOs were given very little information about the Rapid DNA technology because we wanted to direct them as little as possible and wanted to learn the effects if the police force decided to simply start using this technology. Even though the SoCOs had the opportunity to ask questions during the briefing and the experiment, none of the participants asked about DNA success rates or the sensitivity of the technology.

Not only are current Rapid DNA technologies less sensitive than laboratory DNA technologies, they also lack the opportunity to save part of the sample and therefore analysing a sample with a Rapid DNA technology should be considered destructive. The destructive nature of the technology was not mentioned in this study, which could be considered a limitation; however, SoCOs in the Rapid DNA group rarely decided on further analysis at the laboratory after a negative outcome. A negative outcome could therefore negatively influence their further decisions on analysing the traces. This again shows that knowledge of DNA success rates, especially Rapid DNA success rates, is essential for optimal decisions. It is important to realise that the impact of rapid analysis can differ between types of cases and traces. But also the effect of other rapid identification technologies could influence the Rapid DNA analysis decisions, such as rapid fingerprint analysis. However, we do not expect such technologies to greatly impact the results of this study as DNA and fingerprint analyses are very different. The SoCOs can perform fingerprint analysis themselves, which is standard procedure in current CSI practice, whereas for DNA analysis this is not the case.

Another limitation of this study was that we did this study on a ‘mock’ crime scene. Although we tried to mimic an actual case in this mock field experiment, it is still a fake case and procedures were not completely comparable to real-world practices. However, the SoCOs who participated in this study claimed that even though they performed their investigation on a mock crime scene, it did not influence their behaviour. In addition, the data showed that SoCOs in the experimental and control group acted the same way in deciding for analysis during the real-life and thought experiments, this indicates that performing an actual real-life (mock) CSI yields the same results as conducting a thought experiment. This suggests that, for further research, using less labour-intensive research methods, such as vignette studies and thought experiments could be sufficient.

The objective of Rapid DNA analysis is to quickly identify a suspect and to get a fast lead in an investigation. Therefore, selecting the crime and perpetrator related trace(s) for analysis is essential, whereas analysing victim related traces might have less priority.
at this time. Due to the technology being destructive for the inserted sample, and because the analysis is less sensitive than laboratory options, DNA success rates should then be addressed to better allow a decision to be made regarding Rapid DNA analysis. As such, we expected SoCOs to use some sort of framework to decide for DNA analysis. However, in their decision process crime relatedness was rarely mentioned by the SoCOs in the study; SoCOs often went straight to discussing perpetrator or victim relatedness. Although the question as to whether traces are crime related may be answered in their mind, it is important that they consciously consider the crime relatedness of a trace first, before deciding on the use of a Rapid DNA analysis.

In a previous article (using this mock crime scene), focused on scenario building with rapid identification information, it was found that SoCOs decided to analyse traces much faster, without observing the complete crime scene first when they had the opportunity to use a mobile DNA analysis device (29). The current study shows that many DNA traces were analysed, including traces that were not even crime related. In addition, SoCOs appeared to lack knowledge on DNA success rates, risking the analysis of low template DNA traces and possibly missing vital information for the investigation. A previous study showed that with the current sensitivity of the Rapid DNA technology only a few trace items could be of interest for Rapid DNA analysis (10). Therefore, the four-step decision process for DNA analysis (35), as suggested in the introduction, seems highly necessary and could guide SoCOs in making reasoned decisions for the analysis of DNA traces. The results of this study show that this process, or framework, is rarely used to make a decision on conducting a DNA analysis in general.

With future implementation of Rapid DNA technologies crime scene procedures will need adjusting, because not only the workload of the SoCO will change, but also the decisions for analysing traces.

The worst-case scenario when using Rapid DNA analysis would be linking innocent people to a crime and not pursuing any further analysis. This could occur especially when there are several potential perpetrator related traces and only the trace with the highest success rate proceeds to analysis, resulting in identifying information. For this reason, we suggest a ‘reconsideration step’ in the Rapid DNA procedure, where all traces are to be evaluated with the investigative team and an appointed forensic scientist after the crime scene investigation, allowing a decision to be made regarding further DNA analysis. This might not rule out potential errors or biased decisions, but it could assist in a more thorough decision-making process.

Taking all this together we propose to expand the four-step procedure to a ‘hierarchy of decisions’ for Rapid DNA analysis:

1) Detect and collect all evidentiary traces
2) Rank the traces by crime relatedness
3) Rank the presumed crime related traces by perpetrator relatedness
4) Use the Rapid DNA success rate figure for further selection (Table 1 in Mapes et al., 2016 (10))
5) Select the most promising trace(s) for Rapid DNA analysis
6) Reconsider all collected traces in the light of different crime scenarios with the investigative team after the crime scene investigation
7) Decide for further DNA analysis

We expect this ‘hierarchy of decisions’ to highly contribute to the forensic investigative practice and to benefit the decision-making process for Rapid DNA analysis. We should also keep in mind that analysing traces is not only for the identification and location of a suspect, but also to build a case and to assist the court.

It is time for the forensic community to realise that current practices are in need of change. Designing effective new strategies and guidelines when integrating new and rapid technologies requires an understanding of the field of crime scene practice (23). This article focused mainly on the trace collection and selection process, and SoCOs’ work practices when integrating a Rapid DNA technology. Research towards understanding best practices in crime scene investigation is therefore necessary. In addition, it should be kept in mind that for an optimal technology driven change, cultural (social, organisations, public) and political factors (management, roles, relationship, cost effectiveness) are also important aspects to take into account (11, 17). We hope to encourage the forensic science community to take action in these fields of analysis.

To finish, this study gives an insight into the effects of implementing a new technology within police investigation. We can conclude that an effect of integrating Rapid DNA analysis at the crime scene is observed on the selection and analysis of DNA traces. A ‘hierarchy of decisions’ as suggested could effectively assist the SoCO to make knowledge and evidence-based decisions for analysing a DNA trace at the crime scene, or forward the trace to the laboratory, and will be valuable in future crime scene practice procedures.
6.5 References


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