

## **Title**

Management of crime scene units by Quebec police senior managers: insight on forensic knowledge and understanding of key stakeholders

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## **Abstract**

What do policing leaders think and know of forensic science? Beyond crime scene investigators or detectives, how do police senior managers perceive the role, utility and limitations of forensic science? Very few empirical studies have addressed the issue. Forensic scientists should be concerned about the perception that law enforcement senior managers have of their discipline for two reasons. First, strategic and financial decision-makers are obviously key players in the overall administration and provision of forensic science, either as a supervisor, money provider or as a customer. Second, literature has highlighted that other actors involved in forensic science underestimate the scope and possibilities offered by forensic science, hence limiting its exploitation and potential. Following interviews with 18 police senior managers from Quebec (Canada), this study shows that they generally restrict forensic science to a reactive discipline whose role and utility is to identify offenders and support the Court. This understanding of forensic science, like that of many others including a significant share of forensic scientists, differs from the perception of other police activities in modern law enforcement agencies where proactive action is sought. Considering these findings and the growing body of literature which calls for forensic science to connect more tightly with policing and security, we advocate a more extensive education of police leaders regarding the scope of forensic science.

## **Key words**

Forensic science ; Crime scene investigation ; Policing ; Police management; Forensic education and training ; Forensic management

## **Reference**

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## **1. Introduction**

Forensic science daily practice and popular fiction could lead one to believe that the discipline is now within reach of understanding all roles, from crime scene examiners to police senior managers in the field of security and justice. However, as illustrated by recent reports from the United States and Canada, debates, misunderstandings and uncertainties still persist about the nature of crime scene examination, crime scene management and involvement of forensic science in law enforcement activities [1–7]. On the one hand, it is only recently that the literature has deeply analyzed crime scene examiners' skills and attributes as factors to make forensic science and investigations more efficient, knowing the crime scene is where it all begins. On the other hand, confusion about the very nature of forensic science also manifests itself among several actors in the police community. Patrollers, investigators, and crime scene examiners themselves seem to underestimate the potential of forensic science and restrict the investigative work at the crime scene to a mechanical rather than a scientific task [8–14]. But what about strategic and financial decision-makers within law enforcement agencies? It is recognized that they have powers and responsibilities that may influence the quality and use of forensic science [15–17]. Police leaders assign tasks and objectives to crime scene units and crime labs and define the conditions that guide their involvement and standards. They are also in charge of the financial, material and human resources allocation within the organization they lead [18,19]. However, to our knowledge, only a few studies have taken interest in the police managers' perception of forensic science, and they did so in a relatively superficial way [13,14]. Taking Quebec (Canada) as a field of study, this article aims to understand how police senior managers conceive the roles, utility and limits of forensic science.

## **2. Overview of forensic science practices at police level**

Forensic science can contribute in a variety of ways to the investigative process. It is firstly known for its ability to guide investigators in their decision-making. It can support the various stages of the investigative process, from the detection and establishment of an offense, to the identification of a potential perpetrator, and the hypothetical reconstruction of the facts and their unfolding [13,20,21]. Forensic science is also strongly associated with the role of producing, evaluating and presenting tangible evidence to assist the Court decision-making process. By analyzing and interpreting the various traces collected during the investigative process, forensic scientists assemble the clues to answer the questions of the investigators and the courts about a perpetrated crime. This role particularly derives from the ability of forensic science to identify the profile of the source or the single source at the origin of the traces [22–25].

In a recent approach, it was proposed - and in some agencies effectively carried out [26–29] - that the systematic comparison of traces should contribute in the study of crime patterns and serial crimes via forensic intelligence [30–32]. This concept relies on the analogy that similar criminal activities will leave traces that are likely to be – at least partly – similar, while distinct activities will produce distinct traces. Using forensic science in an intelligence perspective is thus useful for supporting decision-making at the strategic, operational and tactical levels of law enforcement agencies [16,28,33–36]. By expanding even more this ability, forensic science becomes useful at a macroscopic level as a tool both for managers and for the development of scientific knowledge. Since traces are, by definition, dependent on the criminal activities at their origin, they can be used in a criminological perspective to create knowledge on “forms of crime, modus operandi, typologies of crime situations and problems” (*Free translation*)

[20, p.143]. Therefore, forensic science can contribute to understanding particular crime systems, criminal trajectories and the evolution of certain offending behaviors, including new criminal trend detection (crime epidemiology), thus becoming an interesting resource for the detection of innovations used by offenders and for resource allocation [37].

However, in parallel, the contribution of forensic science in the investigative process has been described as limited by many researchers over the past decades. Since the mid-1970s, several researchers have emphasized that the exploitation of traces is not a guarantee of success and that a small ratio of criminal cases is solved with the help of forensic science. Several empirical studies have highlighted the minimal role of forensic science in resolving homicide and burglary cases in the United States, England, Australia, France and Quebec. Rather, human sources (witnesses, informants) and police activities (patrol intervention, surveillance) seem to be the factors contributing to the elucidation of homicide cases [38–46]. Although many of these studies are more than a decade old, “the effectiveness of forensic science on solving or preventing crime is [still] unclear and at best modest” [105, p.3], thus remaining a topical issue in the scientific literature [7,15,106,107]. Researchers also found that few traces were collected from crime scenes and that those did not necessarily end up into court. In fact, physical evidence is collected in less than a third of the assault and burglary cases reported to the police [35,47,48]. Moreover, despite the primary role of presenting evidence to the Court associated with forensic science, it seems that only a small proportion of all traces available at incident scenes is presented in court. Many traces therefore remain unexploited in the files [7,47,49,50]. The deployment of forensic intelligence seems also slow to take place in police forces [51].

Therefore, in order to optimize the exploitation of forensic science, it seems highly relevant to understand in depth the perceptions of the actors involved in the field, but even more those of the actors with a strong power of influence. As the former ones begin to be studied [25], little if any research has been made on law enforcement senior managers, even though they are responsible for many decisions related to forensic science units and their activities.

### **3. Police decision-makers influence on forensic science**

Police management can be defined as a set of individual, collective and organizational practices undertaken with the aim of producing useful knowledge to ensure the satisfaction of staff members and the performance of the organization in terms of cohesion and policing [19]. Within the organization they oversee, police senior managers act as strategic planners who define short, medium and long-term goals and objectives in order to meet expectations and needs of members, beneficiaries and other partners of their organization. To do so, they must identify which problems their organization faces and who are the actors involved. These problems may be related to security threats or they may be related to internal conflicts or obsolete and non-functional equipment. Then, they must determine among those issues which ones should be prioritized based on the knowledge or resources available. Finally, police managers formulate, implement and coordinate strategies and activities that seem most appropriate to respond to identified problems [18,52,53]. While modern law enforcement agencies are increasingly moving toward a more proactive approach of addressing offending, disorder and crime, it seems that community policing, problem-oriented policing and intelligence-led policing are gradually becoming the standard way of administering the police - at least in its organizational rhetoric [54–58]. In parallel, police decision-makers also fulfill the functions of managing the organization and distribution of the human,

material and budgetary resources of the police organization. Thus, senior leaders in law enforcement agencies must invest various resources in order to achieve their goals and to allow staff members to fulfill their respective functions. They must also do so within financial and legislative constraints, political pressures and public expectations [19,59,60].

Because of the various roles held by police senior managers within law enforcement agencies, we can easily understand how they may influence the use and provision of forensic science and how their perceptions on this discipline is decisive for traces exploitation. Police chiefs and mid-level managers (eg. sergeants) have the power to assign tasks to the crime scene unit and crime lab and to define the procedures that guide their involvement [15]. They are also responsible for purchasing tools and devices that may contribute to crime scene examiners' and forensic scientists' work. In charge of human resources, police managers must furthermore decide how many staff is required in crime scene units, what kind of qualified person will be hired as crime scene examiners, who will receive training, or which standards and indicators will be used to assess employees' and units' performances. As a result, police decision-makers at various levels of the hierarchy should be considered as part of a group of (mainly non-scientific) actors, if not key-ones, directly involved in forensic optimization, alongside investigators, judges and prosecutors, or intelligence analysts [17]. It is important to note that their advisers in this field are mainly, if not exclusively, their own hierarchical qualified employees, on which they have no technical or scientific grasp.

Literature has already highlighted that police actors at the lower end of the police hierarchy seem to have difficulty in identifying the roles and scope of forensic science itself. But what about members of the upper hierarchy of law enforcement agencies? To our knowledge, not only has this question found very little interest among researchers, but studies on police managers' perception of forensic science have only been conducted in Europe. The differences in culture and practice between this region of the world and North America concerning forensic science make it difficult, in principle, to generalize the findings [4,6,7,61]. Taking Quebec as a field of study, this article aims to fill this void on knowledge through interviews with strategic and financial senior decision-makers in law enforcement agencies.

#### **4. Material and Methods**

In Quebec, municipal law enforcement agencies and the provincial law enforcement agency have missions that are defined by the *Loi sur la Police* (Police law). There are six levels of police services defined by the population size of the municipality and its geographic location. The complexity of policing, investigations, emergency measures and support services increase according to the service level assigned to the police force [62,63]. For example, "a [municipal police force] of level 1 can control a peaceful crowd whereas [police forces] of service levels 5 and 6 will have to control crowds showing high risk of agitation, uncontrolled behavior or riot." [63]. For the present study, level 2 and higher police forces were selected as potential research fields as they are required to have a crime scene unit under the *Loi sur la Police*. These units, called *Service d'Identification Judiciaire* in French, are almost exclusively composed of police officers who investigate incident scenes, develop and collect physical, chemical, biological and digital traces as well as compare and identify some of these traces (eg. fingerprints, shoemarks). Within the 24 identified law enforcement agencies, the selection of candidates had to be consistent with the limited accessibility to the research field. Indeed, not only is the police environment known to be difficult to access by researchers, but the decision-making sphere of police organizations

has several significant responsibilities and little free time. Thus, study subjects were recruited via opportunity sampling. This method involved taking advantage of the opportunities offered to us to select the sample of interest and access the research environment [64–66]. In this case, the support of the *École nationale de police du Québec*<sup>1</sup> (ENPQ) greatly facilitated the identification of candidates as it took care of initial contact with police senior managers of various law enforcement agencies in Quebec. Those interested in participating in this study were then asked to contact us to arrange an interview.

In total, 18 police senior managers from 18 different police organizations were interviewed between February 2017 and July 2017<sup>2</sup>. Eleven police chiefs, four deputy directors, one chief inspector and two captains of the investigation section participated in this study. All participants were between 44 and 62 years old and had between 23 and 40 years of experience in the police service. Twelve participants had mainly worked in the investigation division over the course of their careers, being investigators themselves in the past. Four other decision-makers had evolved in the gendarmerie division, acting within patrol teams. The two remaining subjects did not specify their career path. Finally, among the 18 respondents, 17 had at least one certificate in police management. As the latter is not mandatory to perform police managers duties, the last respondent was in the process of completing his training to obtain a diploma. Thus, all the police leaders interviewed had a strong experience in police work and a university education in the field of public administration. It should be noted that police management training in Quebec does not include any courses dedicated to forensic science.

To answer the research question of this paper, the semi-directive interview was chosen as the appropriate data collection method. This type of interview is of particular interest to understanding values, beliefs and norms specific to a given culture. By focusing on the concerns of the interviewee, the semi-directive interview allows a great freedom as to the topics discussed, facilitating the discovery of knowledge that would have risked being ignored with a closed data collection method. It provides the opportunity to obtain details of the personal opinions, experiences, motivations, and roles with which the subjects identify. Moreover, semi-directive interviews provide access to an indispensable resource in understanding the social reality of the subjects of study: language. It can be very useful because it defines how the subjects interviewed conceive the themes of the research and their importance [64,67,68].

During these interviews, which were all conducted by the first author, four discussion themes were fixed in order to understand the perception of forensic science by police officers in Quebec and their practices in the management of crime scene units. First, the subjects of study were invited to talk about their career paths within law enforcement agencies, so we could identify the social sub-groups to which they belonged in the police services and to evaluate the relationship they had with crime scene units throughout their careers. Then, participants were invited to share their expectations of forensic science, the utility and the limits that they associate with the discipline and their knowledge of the subject. Finally, they were invited to describe current practices in the management of crime scene units and their relationships with partner organizations involved in the use of forensic science (e.g. who may influence their decision making?). To avoid confusion in interviews and because the exploitation of digital traces

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<sup>1</sup> The *École nationale de police du Québec* is the institution in charge of all the police trainings in the province of Quebec. See <http://www.enpq.qc.ca/>.

<sup>2</sup> This research was conducted after obtaining an ethics certification from the *Comité d'éthique de la recherche en arts et en sciences (CÉRAS)* of the University of Montreal (*n°CERAS-2016-17-209-D*).

remains, for the moment, isolated in the current distribution of forensic expertise, the present study was limited to physical, chemical and biological traces. The present reflection on perceptions of police senior managers could however extend to digital traces in future research as digital traces are increasingly integrated into a holistic conception of forensic science [69–71].

To interpret the subjects' responses, it seems necessary to analyze verbatim interviews in a way that assigns codes to recurring elements. To do so, each interview was first analyzed vertically via *QDA Miner*. Descriptive codes and *In Vivo* codes, corresponding to labels applied by the researcher and labels from the respondent's own vocabulary, respectively, were associated with short passages to summarize statements that seem essential to understanding the perceptions of those police decision-makers interviewed. Subsequently, by horizontally analyzing all interviews, recurring first-level codes and similar codes were grouped into larger typologies to target certain trends in the responses of the study subjects [72]. In fact, even if the interviewees seemed very diverse and they address themes sometimes distinct, "[it is possible] to find in each of them models that will have profound similarities." (*Free Translation*) [67, p.235]. This second-level coding exercise makes it possible to attribute more meaning to respondents' comments and to highlight elements specific to the culture to which they belong.

## 5. Results

### 5.1 Roles attributed to forensic science

For the police senior managers interviewed, crime scene units are deemed to be support units for criminal investigations. They therefore tend to associate forensic science to a reactive (i.e. on request) and somewhat auxiliary process initiated by the commission of crimes and other types of incidents requiring investigation (e.g car accidents). Police senior managers assign various roles to forensic science that, in one way or another, emphasize the contribution of the discipline to the investigative process. According to all participants, the main role of forensic science is to consolidate and strengthen the evidence files presented to the Court.

*[Forensic scientists], they really are people who are there to make a proof that will be beyond doubt, well framed, and that will be able to close all the doors that the defense lawyers open could bring. (Subject 12, Free Translation)*

*Once it is proven that there are no other possible outcomes than the crime scene examiner's conclusion, it is there that one says that you really have a tremendous strong proof. [...] But if you just have witnesses, well, the defense lawyers will undermine the credibility of the witnesses. While scientific evidence [...] is very hard to undo. The judge and the juries will come to a fairly obvious conclusion. [...] It gives confidence in the outcome of a procedure. It gives confidence to the investigators who will tell [the prosecutors]: 'look, I am convinced that this is it.' [...] It is important, and it gives confidence to the courts, it gives confidence to the investigators. (Subject 11, Free Translation)*

*I have never seen hesitation regarding the use of crime scene units. Because forensic science provides evidence that is unchallengeable in court, it's the best piece of evidence. Testimonials may vary and may be contradicted, [but] DNA or palmar evidence and it is over. [...] I had the chance to work on bikers' files, and when we found DNA... You know, to convict someone of murder, if you do not have a material evidence... (long silence suggesting that such an attempt may be unsuccessful). But with*

*forensic evidence, it is possible. Police officers are aware of this fact, that this is the king of evidence beyond any doubt. (Subject 13, Free Translation)*

Police decision-makers interviewed believe that forensic science gives investigators and prosecutors confidence in the outcome of legal proceedings. With Court seeming more and more demanding in terms of the evidence required, according to many subjects, forensic science would offer prosecutors elements difficult to challenge by defense lawyers. In the final stages of the investigation process, forensic science also seems useful to support the claims of the investigators by corroborating other so-called traditional evidence such as testimony, confession and surveillance. According to 3 senior managers interviewed, forensic evidence also offers investigators the opportunity to confront suspects during interrogations.

*Forensic evidence is very factual. So, when you come in for interrogation, and you come up with things like that, it hits hard. [...] In fact, sometimes we will keep them and keep that to "break" the suspect. You will start the interview with the common links, then you will work a little on his criminal record. And when you feel that it does not open so much, well you will arrive with very precise facts: "You spoke on such date with such person for such period of time. We have your fingerprints in this place, we have witnesses" or "you told me something in your interrogation and the crime scene revealed something else" and it's very factual. (Subject 7, Free Translation)*

The study of the language used during the interviews also tends to support the finding that the main role attributed to forensic science is one of presenting evidence to the Court. Indeed, although 16 respondents use the term "traces" and eight use the term "clue", they do not seem to make a distinction between these terms. In any case, they refer to the term "evidence" when it comes to forensic science. All respondents also referred to fingerprints and DNA throughout their responses. Even though they particularly refer to blood traces when it comes to DNA, seven respondents also noted the interest of biological secretions and epithelial cells (eg. under the victim's nails) as sources of DNA. Footmarks and shoemarks (8 subjects), tire and break marks (5 subjects) and tool marks (4 subjects) were also mentioned during interviews but less frequently. Traces of flammable liquids, fibers or paint marks were only mentioned by three police managers during the interviews.

Additionally, 14 of the interviewees also perceived forensic science as an important part of the investigative process, assigning it the role of guiding investigations and identifying perpetrators of crimes committed. It represents a major element of the investigation since it provides leads and answers to investigators throughout the judicial process.

*[Forensic science] serves us, you know... The ultimate goal is to be able to identify the perpetrators of crimes. It is to solve crimes, to have better results in our investigations. This is a little bit the purpose of forensic science for me. It's about being able to really identify who the authors are. To give ourselves more chances, to use superior technologies rather than just a visual survey of the crime scene. This is going to improve our evidence that we can have now, ensure that we will be able to convict the right people and that the people who have committed crimes are found guilty. (Subject 9, Free Translation) At the criminal investigation level, we work on cases where we are called immediately after a crime and where we must go to the scene, we must meet witnesses, take care of the victims to have their versions, etc. But, what is most important in these cases is the crime scene. So, [forensic science] is often what leads us to find our suspect or at least corroborate versions that we will have had by other means to confirm the identification of our suspect. (Subject 8, Free Translation)*

*We are looking for who is the author [...]; Who was there? If we did not have forensic science, if we did not have crime scene units... It is one more element to help us discover the perpetrators of the crimes. (Subject 1, Free Translation)*

Forensic science thus appears to be a complementary and powerful resource to the work of investigators based on the police managers interviewed, which has the potential to be used not only in court, but also at the beginning of the investigative process. According to these 14 police decision-makers, crime scene units can contribute to the advancement of investigations by identifying suspects who could not be identified by other so-called conventional investigation methods. Two subjects also pointed out that traces can help clear potential suspects and focus police efforts on the right individuals. In addition, eight of the 18 managers interviewed highlighted the role of forensic science in solving serial crime since traces have the potential to link criminal events by identifying a common perpetrator of serial crimes. Traces can thus link similar cases that would not likely have caught the attention of the investigators in the first place. Interestingly, the role of forensic science in detecting serial crime is less considered than in solving it.

*If there is a [DNA] hit, it will come back to us. I often receive a bulletin where there are 12 investigation files in 12 police forces with the same DNA hit. Although, we do not know who the offender is. But, if he is later identified in a case in another city, we can now accuse him in all the other cases. (Subject 13, Free Translation)*

*[...] That does not mean [the offender] is in the DNA databank. But when you find blood, you find other things, you feed the DNA databank of the forensic laboratory. Often, when you get a DNA match, there are other crimes that come out that the laboratory has kept. Then, they are able to tell us "you should make a quick phone call to your colleagues in [another city], they could perhaps have information on your boy". (Subject 10, Free Translation)*

*If I have a high number [of break-ins] in a short time, my analyst will raise a flag and tell me that we have started having break-ins in this area and that we have a high frequency. Yeah? Ok. There, I advise the officers that I want my guy [from the crime scene unit] to be systematically called on each of the scenes to once again maximize my research for potential suspects. And maybe he's going to do 4-5 where he will not find anything, but the 5th he's going to find something that will allow me to solve all the ones before. At some point, we must stop the bleeding. (Subject 6, Free Translation)*

Despite almost half of the interviewees associating forensic science to the resolution of serial crimes, decision-makers generally do not attribute the discipline with a proactive role for detecting serial crimes within their jurisdiction, let alone on a bigger scale. Indeed, if some police senior managers ask their crime scene officers to intervene more frequently and systematically on different cases where links are anticipated – i.e. when those cases could be connected to the work of a serial offender –, their primary belief is first and foremost built on other types of perception, information and intelligence provided by criminal analysts on circumstantial, temporal and digital data. Indeed, the identification of offenders still seems to be almost the exclusive contribution of forensic science to the investigation, with a quite reactive position.

However, three interviewees attributed to forensic science a proactive role similar to the concepts on which forensic intelligence is based. They suggested that forensic science may be useful in identifying a particular *modus operandi*, in detecting a criminal series, in discovering new techniques used by



offenders and in acquiring knowledge on offenders' habits. Nevertheless, it should be noted that this extension of the role of forensic science was only very briefly mentioned by a few subjects, rather a result of a reflection consistent with the ongoing conversation than an entrenched perception.

*We are looking for who committed the crime, what is the modus operandi, how did it go? Forensic science can be used to prevent crimes if we discover new ways of doing things, new techniques. (Subject 1, Free Translation)*

*[Forensic science] has an important place at the level of [...] knowledge. It solves the investigation, but at the same time it can help us in the future to predict how crimes are committed. So, that deepens our knowledge. And we know that [...] evidence-based policing is becoming more and more important. [But] we have not been [into this use of forensic science] yet, we have used it strictly ... at the level of specific research. In my opinion. I think there would still be something to do in a development component with that. (Subject 5, Free Translation)*

5.2 At some point, there are similarities to be made between all these crimes. You can go with the modus operandi. It does not give you who did it, but it can target a criminal organization that did it or [tell you] that a signature in that kind of way [begins to appear]. (Subject 11, Free Translation)*The utility and limitations of forensic science*

In theory, crime scene units can fulfill several functions regarding investigation and security. But these are not necessarily fulfilled in the daily practice of those units [15,59]. It is therefore necessary to distinguish the roles associated with forensic science from its real contribution to police work. All police senior managers we met agreed on the importance of forensic science in modern investigative processes. Two subjects even described the discipline as the "cornerstone" of the investigation because of the "added value" it brings to a file. In the same vein, the interviews conducted tend to show that Quebec police senior managers firmly believe in the ability of forensic science to produce reliable and indisputable evidence. Overall, they do not seem to consider that forensic science has particular limitations or weaknesses.

*What is the limit of forensic science? I wonder if I can say something, because I have the impression that over the years, it improves all the time. [...] Sometimes we think, where is the limit? I have trouble answering negatively to this question, I have a lot of trouble. (Subject 8, Free Translation)*

However, the contribution of forensic science to the daily work of police officers in smaller municipal organizations is considered modest by four respondents. In fact, two police managers interviewed believe that they would not likely need a permanent crime scene unit because of the low volume of crime committed in the territory in which they operate.

*I think I would probably not even need [a crime scene unit]. I could take a service agreement, for example, with another municipal police force or the provincial police and have them serve me. [...] I do not think there is a significant volume [of crimes]. When I ask questions to managers, they answer "yes! they have work, they have work!" But that's not the perception I have. [...] Do I have a false impression? I cannot wait to see the answers in the report I requested. (Subject 12, Free Translation)*

Instead, they may seek assistance from a higher-level organization when necessary (eg. Sûreté du Québec), as they can do already when no crime scene examiner from their own organization is available.

Two other leaders from municipal police organizations perceived forensic science as particularly useful in the investigation of major crimes (eg. homicide).

*[When crime scene examiners are requested], it's on crime scenes that, I'll tell you, but I do not want you to tell them, all in all, are quite minor. [...] It's still quite limited I would say, it remains pretty succinct as activity. [...] We agree that they are level 2 of service. As I told you, I have nothing against ... But it's not THE big crime scene. It's not complex, in fact, from what I know, from what I did as an investigator. You do not have 4 crime scenes at a time, you have no murder investigations, multiple murders. (Subject 10, Free Translation)*

Therefore, since the types of crimes these police organizations respond to are mostly property crimes (level 2 police services are not allowed to handle complex homicide investigations), these two police decision-makers seem to associate the work of their crime scene units and the crime scene investigation of “less serious” crimes to a rather simplistic task whose utility is limited compared to the investigation of homicide scenes. Additional findings showed that police managers admitted to not having tight relationships with forensic laboratories or forensic research institutions, or to not having dedicated assessment protocols and standards to evaluate the performance of their crime scene units. These findings were extracted from the interviews but cannot be exposed here in details.

## **6. Discussion**

### ***6.1 Underestimating the potential of forensic science***

According to our results, it seems that the perception of forensic science is fairly consistent among the police senior managers interviewed. They tend to view the discipline as the science of identification [73]. They seem to focus almost exclusively on the ability of traces to identify crime perpetrators, thereby giving particular attention to human traces with high identification potential such as fingerprints and DNA. Quebec police decision-makers also seem to associate forensic science with a discipline specifically dedicated to the criminal investigative process. The attention given to the added value of forensic science and to its ability to solidify an evidence file, as well as the repeated use of the term “evidence” as a central component of the vocabulary of police senior leaders interviewed reveals the one-dimensional purpose which seems to be associated with forensic science: its contribution to the criminal justice system. Indeed, a piece of forensic evidence is considered an integrated element by a court to arrive at establishing the course of events. By definition, it has a limited function and utility, whereas a trace (or a clue) should be recognized as an element carrying information on the source and activity at its origin, thus opening the possibilities for its use [28,74]. Furthermore, by only associating forensic science to the investigative process and to the judicial process, Quebec police managers generally seem to limit forensic science to a reactive approach, where it comes into play only on request after the commission of a crime, the police intervention, or the detection of a crime series by other actors. They thus seem little informed about the demonstrated usefulness of traces in a proactive perspective that goes beyond the investigation of singular cases, and in the knowledge acquisition on volume crimes [20,32,35,75]. Interestingly, despite their focus on the criminal justice system and the repeated use of the term “evidence”, police managers seem to generally overlook the challenges associated with forensic evidence interpretation and evaluation. In fact, only one interviewee discussed such aspects of forensic science.

These results therefore tend to confirm the scientific literature and to emphasize that the situation observed is not unique to Quebec: police managers as well as some other practitioners and researchers do not perceive the full potential of traces in a holistic approach [13,14,61]. Indeed, by concentrating their attention mainly, if not exclusively, on the ability of forensic science to serve justice and to reveal an offender's identity, police senior managers tend to restrict forensic science to a set of scientific disciplines used in a laboratory context, without a clear understanding and a real reflection of its potential within a broad security context [7,28,76,77,108]. Restricting the role of forensic science to that of identification of the source of a trace limits the discipline to an application that does not exploit all available information that can be obtained by analyzing traces. The police managers interviewed would thus benefit from being better informed about the potential of forensic science to support policing and security, particularly since it has been raised several times in the recent scientific literature (see section 2).

Indeed, some members of the forensic community highlighted the relevance to rethink the dominant conception of the discipline and its use in order to maximize its usefulness as well as to strengthen its connection to policing. In contradiction with the rather restricted and isolated perception of forensic science expressed by the senior police managers interviewed, it is proposed to return to the scientific foundations of the discipline and its design by the early 20th century pioneers, such as Archibald Reiss or August Vollmer [7,28]. These pioneers defined forensic science as a science in its own right, studying crime in its broad conception via its resulting traces, while supporting both the judicial system and law enforcement agencies. This holistic conception of the discipline does not seem to be shared by police senior managers according to our results. More recently, Roux and colleagues (2015) pointed out that forensic science should focus on the trace and its potential contribution to security and policing rather than on the specialisation of laboratory techniques and the mere presentation of evidence to the Courts. Forensic science should be extended to a proactive role of detection and resolution of problems faced by law enforcement agencies and other actors in the field of security in order to maximize the widespread underutilization of traces. These problems here refer to criminal activities which, by their frequency or their gravity, will threaten the social order and the security of the community [34,78]. The scientific literature is also increasingly recognizing that traces can be exploited from a proactive perspective of operational and strategic intelligence, by participating in the definition of problems and objectives, in the resource prioritisation and allocation, as well as in the development of standards and strategies regarding crime prevention [16,79–81]. It thus could be of interest for police senior managers to be made aware of this redesigned conception of forensic science and its associated challenges.

Furthermore, although the police decision-makers interviewed demonstrated a surprising knowledge of a variety of types of physical and chemical traces, they tended to mainly focus their efforts on fingerprints and DNA, arguably because of their role in the identification of offenders that they associate above all with forensic science and crime scene units. Supporting this focus, some have also set up "judicial patrollers" in their organization, who are police officers trained specifically for the collection of fingermarks and blood traces when a crime scene examiner cannot attend a crime scene [82]. However, since forensic science should not be restricted to the search for two or three types of traces, police leaders would benefit from using their knowledge of the diversity of traces in the development of their forensic strategies [28,83,84]. The need for a broader view is also supported by the

fact that offenders are increasingly aware and cautious about the material traces they can generate during their criminal activities and are adapting their methods to avoid leaving traces [20,29].

Thus, law enforcement agencies would benefit from "[the] overall scanning of the relevant dimensions [because it] makes it more difficult for criminals who can hardly control their behavior to avoid the transfer of the different types of traces, which can inform on various aspects of their profile and method." (*Free Translation*) [36, p.303]. Moreover, the tendency to focus on a low diversity of traces, which seems to emerge from the police senior managers' interviews, is consistent with a lack of knowledge of the concept of forensic intelligence, which again goes beyond the Quebec police environment [29,51,61,85]. The scientific literature tends to emphasize the usefulness of several types of traces in acquiring knowledge about various criminal phenomena, particularly volume and serial crimes, such as firearm marks on projectiles and cartridges [86], shoemarks [87], drugs chemical profiles [88–90], fire residues [91], fraudulent identity documents [92] and digital traces (eg. image, online data, mobile data) [69,70]<sup>3</sup>.

Finally, what mostly testifies to the lack of knowledge of the police senior managers interviewed regarding the potential of forensic science in a broad security context is their reactive perception of the discipline. Such a perception seems in fact out of phase with recent policing models used by law enforcement agencies. The primary concern of police organizations is to provide security and maintain order. Modern police forces have therefore different needs and objectives from those of the justice system frequently referred to by the interviewees [31,93]. Indeed, community policing, problem-oriented policing and intelligence-led policing all focus on crime prevention, crime reduction and crime disruption rather than crime response, while police forces are increasingly using information and intelligence analysis in various spheres of police work, whether it is investigation or strategies planning. As the identification of problems and the selection of priorities relies on the information available to law enforcement agencies, many types of intelligence sources (eg. OSINT, HUMINT, MASINT, SIGINT, IMINT<sup>4</sup>) are already used for this purpose [53–55,57,58]. But this raises the following question: why are material traces or forensic data not used as a vector of information in the strategic and operational planning of police forces (called FORINT by some authors [94,95])? Police managers, well aware of proactive policing models, could then connect forensic science with such models.

## 6.2 The need for more extensive forensic science education

Several non-exclusive hypotheses can be advanced to try to determine why police decision-makers perceive forensic science in the way they seem to. Although police culture and social interactions within the police forces may be promising avenues, it seems first and foremost that the underestimation of the potential of forensic science is due to a lack of education of strategic and financial decision-makers in this field. The results of our study point to a need for basic and/or continuing education for Quebec police managers on how forensic science can be fully utilized in the policing and security context. Despite their longstanding experience, some subjects themselves admitted their limited knowledge of

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<sup>3</sup> However, as digital traces were willingly excluded from this research project (see Methodology), we cannot speculate on the conception of the utility of these traces by the interviewed decision-makers.

<sup>4</sup> Open Source Intelligence, Human Intelligence, Measurements and Signature Intelligence, Signals Intelligence, Imagery Intelligence

forensic science and their absence of training in forensic management in the training they had. As an interviewee pointed out:

*We, the managers, have no training in forensic science. We are not aware of this in our schooling, there is no forensic science 101 course<sup>5</sup>. The officers do not have any forensic training either. (Subject 10, Free Translation).*

Far from putting their skills in question, this need instead underlines the complexity of the management of crime scene units that police leaders currently face in the exercise of their duties.

A quick review of training offered in police management in Quebec confirms these statements and reveals the lack of courses dedicated to forensic science, its foundations and administration. For some interviewees, their last course linked to forensic science is a basic and limited training that dates from the time when they studied at the police academy to become police officers, which naturally puts forward the technical component of the discipline. Since the police senior managers interviewed had an average of 32 years of service in police forces, this means that their last theoretical training in forensic science goes back more than 30 years. Therefore, it is in some way understandable that they are not very sensitive to the recent concepts and issues of forensic science. Having little contact with the community of forensic scientists, be it forensic laboratories or forensic research institutions, we can hypothesize that police leaders maintain their knowledge through occasional exchanges with crime scene examiners and the media coverage of forensic science.

This study thus suggests that basic and/or continuing training dedicated to the various roles of forensic science and to the possibilities offered by the discipline should be developed to supplement the knowledge of police decision-makers, and to maximize the scope of their reflections on this subject. It seems necessary that they be made aware of the usefulness of forensic science in the proactive fight against crimes, particularly volume crimes, and the management of policing [16]. They would also be better equipped to evaluate the work and contribution of their units and the provision of forensic services, for which they are stakeholders. Moreover, police senior managers need to be aware of the limits of forensic science to avoid developing unrealistic expectations based on fictitious notions, in particular of analysis deadlines, of device detection limits and of the scope of interpretation of results [96,97].

At the moment, police managers interviewed do not seem to consider any particular limitations or weaknesses in forensic science. However, the scientific literature has repeatedly shown the discipline's limited contribution to investigations while questioning its ability to provide valid clues to the court over the past 20 years, particularly in North America. Successively, the Daubert/Merrel Dow hearing, the National Research Council of the United States, the Center for Forensic Science & Medicine of the University of Toronto, and more recently the President's Council of Advisors on Science and Technology have all questioned the empirical validity of some of the disciplines and comparison methods used in forensic science. Many practices in place have also been described as non-rigorous, while a lack of peer review for many identification methods has been noted. These reports called for an academic investment in support of the practice and denounced the culture of isolation of the various scientific disciplines that can compose forensic science [4–6,98,99]. Cases of miscarriage of justice also point to

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<sup>5</sup> Referring to an introduction course in forensic science, a « *Forensic for dummies* » course.

the fact that forensic science and the justice system can not claim perfection [100], but also, raise the question of how to strengthen this field when critical forensic decisions during investigations are left to decidedly not-scientific actors [47]. Interestingly, the police senior managers interviewed did not talk about those issues, concerns and criticisms of forensic science, leaving the feeling that they are out of reach or disconnected from these debates. In our opinion, it is the duty of both forensic scientists and police decision-makers to build a dialogue about such challenges.

Police senior managers aware of these limits would be more inclined to question themselves about their own knowledge of forensic science but also their colleagues and subordinates such as investigators, crime scene examiners and forensic scientists about the discipline and its assistance for their cases at hand. This questioning of forensic science would be crucial to the undermining of the dominant conception of a forensic science essentially used to present irrefutable evidence to the court. Indeed, police decision-makers would appear as legitimate key-actors to participate to the present change of paradigm in forensic science [7,35,61,75,101].

A training dedicated to forensic science for police senior managers could take several forms, such as a periodic seminar on forensic intelligence as the one proposed to the European police managers in 2012 [61], a continued education as offered annually by the School of Criminal Justice of the University of Lausanne, bringing together forensic scientists, crime intelligence analysts and police managers since 2012 [102], or a capability 'showcase' or display session with practical examples and scene/case related results to discuss. The *École nationale de police du Québec* (ENPQ), which oversees the various police education and training programs in Quebec, including those in police management, should thus look to add some training dealing with the usefulness of forensic science to the various courses in police management offered in the province. Since the development of forensic training and of forensic intelligence in Quebec cannot be done without a sustained cooperation between universities and police organizations, this research also calls for a strong collaboration between police decision-makers and the scientific and academic communities. In addition to developing forensic science use and practices, the latter could contribute to reinforce the knowledge of law enforcement agencies' managers [36,89,103–105].

As a last word, the above findings cannot be generalized to the context of other Canadian provinces or of other countries, moreover of inquisitorial culture. They may be related to particular reasons in the location of the study or particular implications for the surveyed organizations. However, consulting the available literature, we do not for the moment identify specific reasons why such a perception from police leaders would be exclusive to Quebec. Further studies are underway in Europe to determine whether the situation is specific to Quebec and, if so, how to explain the differences in other contexts.

## **7. Conclusion**

Although it is acknowledged that police senior managers play a key role in the use, provision and development of forensic science, there is still a lack of empirical knowledge in the perceptions and understanding of these actors regarding the discipline [17,33,81,106]. This article thus sought to enlighten the understanding of forensic science and its management by strategic and financial senior managers of the police forces from Quebec via semi-directed interviews. Overall, the results suggest that

police leaders share a narrow view of forensic science and its potential. Police senior managers conceive forensic science as a discipline specifically dedicated to a single investigative process and to building infallible evidence for the Court, confining it to restrictive reactive roles. They have a strong propensity to associate forensic science with its ability to identify the single sources at the origins of traces, thereby mainly concentrating their attention on fingerprints and DNA. Most Quebec police senior managers overlooked the added value associated with the collection and analysis of a diversity of traces while almost all interviewees ignored the utility of forensic science in the detection of recurring crime problems and the acquisition of knowledge on offenders' activities, particularly on volume and serial crimes, the daily routine of policing [20,32,35,75]. While traces can be exploited in a proactive perspective for operational and strategic intelligence [16,79–81], this research identifies a need for a more extensive education among police senior managers regarding the usefulness of forensic science to policing and police administration. This will help them recognize forensic science as a discipline that can guide decision-making at the operational and strategic levels [16, 51]. It is thus suggested to develop a basic and/or continuing training dedicated to police decision-makers in this field, with the collaboration of forensic laboratories and research institutions.

Our results also highlight that Quebec police managers have a very positive appreciation of forensic science, they have a certain degree of technical knowledge regarding the discipline and they remain aware of the great diversity of traces. Hence, this research suggests that with proper forensic science training, police senior managers could have a leading role in supporting and extending the use of forensic science for criminal intelligence and more generally policing.

#### **8. Declaration of Interest**

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

## References

- [1] F. Crispino, Nature and place of crime scene management within forensic sciences, *Sci. Justice*. 48 (2008) 24–28. doi:10.1016/j.scijus.2007.09.009.
- [2] O. Delémont, S. Tanner, Vers une intégration des connaissances : dialogue épistémologique entre science forensique et criminologie, *Rev. Int. Criminol. Police Tech. Sci.* 68 (2015) 354–364.
- [3] P. Margot, Forensic science on trial - What is the law of the land?, *Aust. J. Forensic Sci.* 43 (2011) 89–103. doi:10.1080/00450618.2011.555418.
- [4] NAS, Strengthening forensic science in the United States: a path forward, National Research Council of the National Academies, National Academies Press, Washington, D.C, 2009.
- [5] M.S. Pollanen, M.J. Bowes, S.L. VanLaerhoven, J. Wallace, *Forensic Science in Canada*, University of Toronto, Toronto, 2012.
- [6] President’s Council of Advisors on, Science and Technology, *Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods*, Executive Office of the President, États-Unis, 2016.
- [7] C. Roux, F. Crispino, O. Ribaux, From Forensics to Forensic Science, *Curr. Issues Crim. Justice*. 24 (2012) 7–24.
- [8] J.G. Fraser, Not science...not support: forensic solutions to investigative problems, *Sci. Justice*. 40 (2000) 127–130. doi:10.1016/S1355-0306(00)71958-7.
- [9] R. Julian, S. Kelty, J. Robertson, “Get it right the first time”: Critical Issues at the Crime Scene, 24 (2012) 15.
- [10] R. Julian, S.F. Kelty, Forensic science as “risky business”: identifying key risk factors in the forensic process from crime scene to court, *J. Criminol. Res. Policy Pract.* 1 (2015) 195–206. doi:10.1108/JCRPP-09-2015-0044.
- [11] S.F. Kelty, R. Julian, J. Robertson, Professionalism in Crime Scene Examination: The Seven Key Attributes of Top Crime Scene Examiners, *Forensic Sci. Policy Manag. Int. J.* 2 (2011) 175–186. doi:10.1080/19409044.2012.693572.
- [12] A. Ludwig, J. Fraser, R. Williams, Crime Scene Examiners and Volume Crime Investigations: An Empirical Study of Perception and Practice, *Forensic Sci. Policy Manag. Int. J.* 3 (2012) 53–61. doi:10.1080/19409044.2012.728680.
- [13] N. Tilley, A. Ford, *Forensic science and crime investigation*, Home Office, Police Research Group, London, 1996.
- [14] R. Williams, *The management of crime scene examination in relation to the investigation of burglary and vehicle crime*, Home Office, London, 2004.
- [15] S. Bitzer, N. Albertini, E. Lock, O. Ribaux, O. Delémont, Utility of the clue — From assessing the investigative contribution of forensic science to supporting the decision to use traces, *Sci. Justice*. 55 (2015) 509–513. doi:10.1016/j.scijus.2015.05.005.
- [16] O. Guéniat, In Vestige @ and Police Management?, *Polic. J. Policy Pract.* (2017) 12. doi:10.1093/police/pax044.
- [17] Q. Rossy, O. Ribaux, A collaborative approach for incorporating forensic case data into crime investigation using criminal intelligence analysis and visualisation, *Sci. Justice*. 54 (2014) 146–153. doi:10.1016/j.scijus.2013.09.004.
- [18] P. Aepli, O. Ribaux, E. Summerfield, *Decision Making in Policing: Operations and Management*, 1st ed., EPFL Press, Lausanne, 2011.
- [19] R.R. Roberg, J.L. Kuykendall, K. Novak, *Police Management*, 3rd ed., Roxbury Publishing Company, Los Angeles, 2002.
- [20] S. Baechler, Science forensique et innovations criminelles : opportunité méthodologique ou jeu du chat et de la souris ?, in: D. Décary-Héту, M. Bérubé (Eds.), *Délinquance Innov.*, Les Presses de l’Université de Montréal, 2018: pp. 139–158.



- [21] S.S. Kind, Crime investigation and the criminal trial: a three chapter paradigm of evidence, *J. Forensic Sci. Soc.* 34 (1994) 155–164. doi:10.1016/S0015-7368(94)72908-X.
- [22] S. Bitzer, Factors leading to the involvement of Forensic Advisors in the Belgian criminal justice system, *Forensic Sci. Int.* 285 (2018) 181–188. doi:10.1016/j.forsciint.2018.02.007.
- [23] S. Bitzer, L. Heudt, A. Barret, L. George, K. Van Dijk, F. Gason, B. Renard, The introduction of forensic advisors in Belgium and their role in the criminal justice system, *Sci. Justice.* (2017). doi:10.1016/j.scijus.2017.11.002.
- [24] G. Jackson, S. Jones, G. Booth, C. Champod, I.W. Evett, The nature of forensic science opinion—a possible framework to guide thinking and practice in investigation and in court proceedings, *Sci. Justice.* 46 (2006) 33–44.
- [25] C. Kruse, *The Social Life of Forensic Evidence*, University of California Press, Oakland, CA, 2015. <https://www.ucpress.edu/book/9780520288393/the-social-life-of-forensic-evidence> (accessed October 21, 2018).
- [26] S. Ioset, P. Esseiva, O. Ribaux, C. Weyermann, F. Anglada, S. Locicero, P. Hayoz, I. Baer, L. Gasté, A.L. Terrettaz-Zufferey, C. Delaporte, P. Margot, Establishment of an operational system for drug profiling: a Swiss experience, *Bull. Narc.* 57 (2005) 121–147.
- [27] T. Resnikoff, O. Ribaux, A. Baylon, M. Jendly, Q. Rossy, The polymorphism of crime scene investigation: An exploratory analysis of the influence of crime and forensic intelligence on decisions made by crime scene examiners, *Forensic Sci. Int.* 257 (2015) 425–434. doi:10.1016/j.forsciint.2015.10.022.
- [28] O. Ribaux, *Police scientifique: Le renseignement par la trace*, PPUR Presses polytechniques, Lausanne, 2014.
- [29] O. Ribaux, S.J. Walsh, P. Margot, The contribution of forensic science to crime analysis and investigation: Forensic intelligence, *Forensic Sci. Int.* 156 (2006) 171–181. doi:10.1016/j.forsciint.2004.12.028.
- [30] O. Ribaux, A. Baylon, E. Lock, O. Delémont, C. Roux, C. Zingg, P. Margot, Intelligence-led crime scene processing. Part II: Intelligence and crime scene examination, *Forensic Sci. Int.* 199 (2010) 63–71. doi:10.1016/j.forsciint.2010.03.011.
- [31] O. Ribaux, A. Baylon, C. Roux, O. Delémont, E. Lock, C. Zingg, P. Margot, Intelligence-led crime scene processing. Part I: Forensic intelligence, *Forensic Sci. Int.* 195 (2010) 10–16. doi:10.1016/j.forsciint.2009.10.027.
- [32] O. Ribaux, B. Talbot Wright, Expanding forensic science through forensic intelligence, *Sci. Justice.* 54 (2014) 494–501. doi:10.1016/j.scijus.2014.05.001.
- [33] C. Bell, Concepts and possibilities in forensic intelligence, *Forensic Sci. Int.* 162 (2006) 38–43. doi:10.1016/j.forsciint.2006.06.030.
- [34] M. Cusson, O. Ribaux, Vers une méthode commune à la police scientifique et à la criminologie, *Rev. Int. Criminol. Police Tech. Sci.* 68 (2015) 266–283.
- [35] O. Ribaux, F. Crispino, O. Delémont, C. Roux, The progressive opening of forensic science toward criminological concerns, *Secur. J.* 29 (2016) 543–560. doi:10.1057/sj.2015.29.
- [36] O. Ribaux, P. Margot, La trace matérielle, vecteur d’information au service du renseignement, in: *Traité Sécurité Intérieure*, Éditions Hurtubise, Montréal, 2007: pp. 300–321.
- [37] Q. Rossy, D. Décary-Héту, O. Delémont, M. Mulone, *The Routledge International Handbook of Forensic Intelligence and Criminology*, Routledge, Abingdon, UK, 2017.
- [38] D. Baskin, I. Sommers, The influence of forensic evidence on the case outcomes of homicide incidents, *J. Crim. Justice.* 38 (2010) 1141–1149. doi:10.1016/j.jcrimjus.2010.09.002. [39] M. Briody, T. Prenzler, D.N.A. Databases and Property Crime: A False Promise?, *Aust. J. Forensic Sci.* 37 (2005) 73–86. doi:10.1080/00450610509410617.
- [40] J.-P. Brodeur, L’enquête criminelle, *Criminologie.* 38 (2005) 39. doi:10.7202/012661ar.
- [41] T. Coupe, M. Griffiths, *Solving Residential Burglary*, Home Office, Police Research Group, London, 1996.

- [42] P.W. Greenwood, J. Petersilia, *The Criminal Investigation process volume I : Summary and Policy implications*, US Department of Justice, National Institute of Justice, Santa Monica (CA), 1975.
- [43] T. McEwen, W. Regoeczi, *Forensic Evidence in Homicide Investigations and Prosecutions*, J. Forensic Sci. 60 (2015) 1188–1198. doi:10.1111/1556-4029.12787.
- [44] L. Mucchielli, *L'élucidation des homicides : de l'enchantement technologique à l'analyse du travail des enquêteurs de police judiciaire*, *Déviance Société*. 30 (2006) 91–119. doi:10.3917/ds.301.0091.
- [45] C.F. Wellford, J.M. Cronin, *An Analysis of Variables Affecting the Clearance of Homicides: A Mutistate Study*, Justice Research and Statistics Association, Washington, DC, 1999.
- [46] J.H. White, D. Lester, M. Gentile, J. Rosenbleeth, *The utilization of forensic science and criminal profiling for capturing serial killers*, *Forensic Sci. Int.* 209 (2011) 160–165. doi:10.1016/j.forsciint.2011.01.022.
- [47] J.E. Laurin, *Remapping the path forward: toward a systemic view of forensic science reform and oversight*, *Tex. Law Rev.* 91 (2012) 1051–1118.
- [48] J. Peterson, I. Sommers, D. Baskin, D. Johnson, *The role and impact of forensic evidence in the criminal justice process*, (2009).
- [49] J. Robertson, *Forensic science, an enabler or dis-enabler for criminal investigation?*, *Aust. J. Forensic Sci.* 44 (2012) 83–91. doi:10.1080/00450618.2011.595736.
- [50] K. Strom, M.J. Hickman, *Unanalyzed evidence in law-enforcement agencies: A national examination of forensic processing in police departments*, *Criminol. Public Policy*. 9 (2010) 381–404.
- [51] T. Raymond, R. Julian, *Forensic intelligence in policing: organisational and cultural change*, *Aust. J. Forensic Sci.* 47 (2015) 371–385. doi:10.1080/00450618.2015.1052759.
- [52] R.G. Lynch, *The police manager*, Holbrook Press, Boston, 1975.
- [53] P. Wouters, M. Pattyn, *Définir des priorités en matière de criminalité*, in: *Traité Sécurité Intérieure*, Éditions Hurtubise, Montréal, 2007: pp. 322–334.
- [54] J.-P. Brodeur, *Les visages de la police: pratiques et perceptions*, Les Presses de l'Université de Montréal, Montréal, 2003.
- [55] *Conseil des académies canadiennes, Le maintien de l'ordre au Canada au XXIe siècle : Une nouvelle police pour de nouveaux défis: Le comité d'experts sur l'avenir des modèles canadiens de maintien de l'ordre*, Conseil des académies canadiennes, Canada, 2014.
- [56] *National Academies of Sciences, Engineering, and Medicine, Proactive Policing: Effects on Crime and Communities*, The National Academies Press, Washington, D.C., 2017. doi:10.17226/24928.
- [57] *Police Executive Research Forum, Future Trends in Policing*, Office of Community Oriented Policing Services., Washington, D.C, 2014.
- [58] N. Tilley, *Modern approaches to policing: community, problem-oriented and intelligence-led*, in: T. Newburn (Ed.), *Handb. Polic.*, 2e ed., Routledge, 2008: pp. 373–403.
- [59] S. Baechler, D. Cartier, P. Schucany, O. Guéniat, *Les interventions de la police scientifique suite à des cambriolages: quelle est la perception des lésés et y a-t-il lieu de s'en soucier?*, *Rev. Int. Criminol. Police Tech. Sci.* 68 (2015) 228–247.
- [60] N.H. Stamper, *Removing Managerial Barriers to Effective Police Leadership: A Study of Executive Leadership and Executive Management in Big-city Police Departments*, Police Executive Research Forum, Washington, D.C, 1992.
- [61] F. Crispino, Q. Rossy, O. Ribaux, C. Roux, *Education and training in forensic intelligence: a new challenge*, *Aust. J. Forensic Sci.* 47 (2015) 49–60.
- [62] M. Cusson, M.-È. Diotte, *Les organismes de sécurité intérieure au Québec: Une classification.*, in: *Traité Sécurité Intérieure*, Éditions Hurtubise, Montréal, 2007: pp. 89–97.

- [63] Ministère de la Sécurité publique du Québec, Six niveaux de service des corps de police au Québec - Ministère de la Sécurité publique, Sécurité Publique Qué. (2014). <https://www.securitepublique.gouv.qc.ca/police/quebec/services-de-police/desserte-policier/six-niveaux-service.html> (accessed March 7, 2018).
- [64] R. Legard, J. Keegan, W. Kit, In-depth Interviews, in: J. Ritchie, J. Lewis (Eds.), *Qual. Res. Pract. Guide Soc. Sci. Stud. Res.*, Sage Publications, London ; Thousand Oaks, Calif, 2003: pp. 138–169.
- [65] G. Pruvost, Enquêter sur les policiers: Entre devoir de réserve, héroïsation et accès au monde privé, *Terrain*. (2007) 131–148. doi:10.4000/terrain.5059.
- [66] R. Sollund, Obstacles and possibilities in police research, *Outl. Crit. Pract. Stud.* 7 (2005) 43–64.
- [67] G. Michelat, Sur l'utilisation de l'entretien non directif en sociologie, *Rev. Fr. Sociol.* 16 (1975) 229–247. doi:10.2307/3321036.
- [68] R.S. Weiss, *Learning From Strangers: The Art and Method of Qualitative Interview Studies*, Simon and Schuster, New York, 1995.
- [69] E. Casey, *Handbook of Digital Forensics and Investigation*, Academic Press, Burlington, MA, 2010. doi:10.1016/C2009-0-01683-3.
- [70] M. Pollitt, E. Casey, D.-O. Jaquet-Chiffelle, P. Gladyshev, *A Framework for Harmonizing Forensic Science Practices and Digital/Multimedia Evidence*, Organization of Scientific Area Committees for Forensic Science, Lausanne, 2018. doi:10.29325/OSAC.TS.0002.
- [71] O. Ribaux, *Transformations criminalistiques. Quelques éléments.*, (2018). [https://oraprdnt.uqtr.quebec.ca/pls/public/docs/GSC4215/O0000377761\\_180215\\_RIBAUX\\_Transformations\\_criminalistiques.pdf](https://oraprdnt.uqtr.quebec.ca/pls/public/docs/GSC4215/O0000377761_180215_RIBAUX_Transformations_criminalistiques.pdf) (accessed April 10, 2018).
- [72] M.B. Miles, A.M. Huberman, J. Saldana, *Qualitative Data Analysis, A Methods Sourcebook*, 3rd ed., SAGE, California, US, 2014.
- [73] P.L. Kirk, The Ontogeny of Criminalistics, *J. Crim. Law Criminol. Police Sci.* 54 (1963) 235–238. doi:10.2307/1141173.
- [74] P. Margot, Traçologie: la trace, vecteur fondamental de la police scientifique, *Rev. Int. Criminol. Police Tech. Sci.* 67 (2014) 72–97.
- [75] C. Roux, B. Talbot-Wright, J. Robertson, F. Crispino, O. Ribaux, The end of the (forensic science) world as we know it? The example of trace evidence, *Philos. Trans. R. Soc. B Biol. Sci.* 370 (2015) 20140260. doi:10.1098/rstb.2014.0260.
- [76] F. Crispino, O. Ribaux, M. Houck, P. Margot, Forensic science – A true science?, *Aust. J. Forensic Sci.* 43 (2011) 157–176. doi:10.1080/00450618.2011.555416.
- [77] S.F. Kelty, R. Julian, A. Ross, Dismantling the Justice Silos: avoiding the pitfalls and reaping the benefits of information-sharing between forensic science, medicine and law, *Forensic Sci. Int.* 230 (2013) 8–15. doi:10.1016/j.forsciint.2012.10.032.
- [78] H. Goldstein, *Problem-oriented Policing*, McGraw-Hill, United States, 1990.
- [79] E. Bruenisholz, S. Prakash, A. Ross, M. Morelato, T. O'Malley, M.A. Raymond, O. Ribaux, C.P. Roux, S. Walsh, *The Intelligent Use of Forensic Data: An Introduction to the Principles*, *Forensic Sci. Policy Manag. Int. J.* 7 (2016) 21–29. doi:10.1080/19409044.2015.1084405.
- [80] L. Grossrieder, O. Ribaux, *Towards Forensic Whistleblowing? From Traces to Intelligence*, *Polic. J. Policy Pract.* (2017) 14. doi:10.1093/police/pax039.
- [81] O. Ribaux, C. Roux, F. Crispino, Expressing the value of forensic science in policing, *Aust. J. Forensic Sci.* 49 (2017) 489–501. doi:10.1080/00450618.2016.1229816.
- [82] V. Mousseau, *Le management des services d'identité judiciaire : Pratiques et perceptions des dirigeants policiers du Québec en matière de criminalistique*, Mémoire de Maîtrise, Université de Montréal, 2018.
- [83] S. Bitzer, P. Margot, O. Delémont, Is Forensic Science Worth It?, *Polic. J. Policy Pract.* (2017) 9. doi:10.1093/police/pax058.

- [84] C. Weyermann, M. Jendly, Q. Rossy, Explorer les intersections entre la science forensique et la criminologie au travers de la temporalité de trois types d'actions de contrôle social, *Rev. Int. Criminol. Police Tech. Sci.* 68 (2015) 284–298.
- [85] Q. Rossy, S. Ioset, D. Dessimoz, O. Ribaux, Integrating forensic information in a crime intelligence database, *Forensic Sci. Int.* 230 (2013) 137–146. doi:10.1016/j.forsciint.2012.10.010.
- [86] A.A. Braga, G.L. Pierce, Linking Crime Guns: The Impact of Ballistics Imaging Technology on the Productivity of the Boston Police Department's Ballistics Unit, *J. Forensic Sci.* 49 (2004) 1–6. doi:10.1520/JFS2003205.
- [87] O. Ribaux, A. Girod, S.J. Walsh, P. Margot, S. Mizrahi, V. Clivaz, Forensic intelligence and crime analysis, *Law Probab. Risk.* 2 (2003) 47–60. doi:10.1093/lpr/2.1.47.
- [88] K. Dégardin, Y. Roggo, P. Margot, Understanding and fighting the medicine counterfeit market, *J. Pharm. Biomed. Anal.* 87 (2014) 167–175. doi:10.1016/j.jpba.2013.01.009.
- [89] M. Morelato, A. Beavis, M. Tahtouh, O. Ribaux, P. Kirkbride, C. Roux, The use of forensic case data in intelligence-led policing: The example of drug profiling, *Forensic Sci. Int.* 226 (2013) 1–9. doi:10.1016/j.forsciint.2013.01.003.
- [90] M. Ouellet, C. Morselli, Precursors and Prices: Structuring the Quebec Synthetic Drug Market, *J. Drug Issues.* 44 (2014) 37–55. doi:10.1177/0022042613491104.
- [91] E. Bruenisholz, O. Delémont, O. Ribaux, L. Wilson-Wilde, Repetitive deliberate fires: Development and validation of a methodology to detect series, *Forensic Sci. Int.* 277 (2017) 148–160. doi:10.1016/j.forsciint.2017.06.009.
- [92] S. Baechler, P. Margot, Understanding crime and fostering security using forensic science: The example of turning false identity documents into forensic intelligence, *Secur. J.* 29 (2016) 618–639. doi:10.1057/sj.2015.26.
- [93] G.W. Cordner, K.E. Scarborough, *Police Administration*, 7th ed., LexisNexis/Anderson Pub., New Providence, NJ, 2010.
- [94] N. Horne, K. Edmondson, M. Harrison, B. Scott, The applied use of forensic intelligence for community and organised crime, *Aust. J. Forensic Sci.* 47 (2015) 72–82. doi:10.1080/00450618.2014.916755.
- [95] M.M. Houck, F. Crispino, T. McAdam, *The Science of Crime Scenes*, 2nd ed., Academic Press, Waltham, 2017.
- [96] B. Borisova, J. Courvoisier, A. Bécue, L'effet CSI: État de l'art sur un phénomène aux multiples facettes, *Rev. Int. Criminol. Police Tech. Sci.* 69 (2016) 227–246.
- [97] S.A. Cole, G. Porter, The CSI Effect, in: *Routledge Int. Handb. Forensic Intell. Criminol.*, Routledge International Handbooks, Abingdon, UK, 2017: pp. 112–124.
- [98] *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 1993.
- [99] J.L. Mnookin, S.A. Cole, I.E. Dror, B.A. Fisher, The need for a research culture in the forensic sciences, *UCLA Rev.* 58 (2010) 725.
- [100] B.L. Garrett, P.J. Neufeld, Invalid Forensic Science Testimony and Wrongful Convictions, *Va. Law Rev.* 95 (2009) 1–97.
- [101] O. Ribaux, F. Crispino, C. Roux, Forensic intelligence: deregulation or return to the roots of forensic science?, *Aust. J. Forensic Sci.* 47 (2015) 61–71. doi:10.1080/00450618.2014.906656.
- [102] Université de Lausanne, Les cours de formation continue - ESC UNIL, (2018). <https://www.unil.ch/esc/fr/home/menuinst/enseignement/formation-continue/cours-de-formation-continue.html> (accessed April 19, 2018).
- [103] S. Baechler, Do We Need to Know Each Other? Bridging the Gap Between the University and the Professional Field, *Polic. J. Policy Pract.* (2017). doi:10.1093/police/pax091.
- [104] S. Leman-Langlois, F. Lemieux, Renseignement de sécurité et renseignement criminel, in: *Traité Sécurité Intérieure*, Éditions Hurtubise, Montréal, 2007: pp. 335–352.

- [105] O. Ribaux, Reframing Forensic Science and Criminology for Catalyzing Innovation in Policing Practices, *Polic. J. Policy Pract.* (2017). doi:10.1093/police/pax057.
- [106] S. Bitzer, O. Ribaux, N. Albertini, O. Delémont, To analyse a trace or not? Evaluating the decision-making process in the criminal investigation, *Forensic Sci. Int.* 262 (2016) 1–10. doi:10.1016/j.forsciint.2016.02.022.
- [105] C. Roux, O. Ribaux, F. Crispino, Forensic science 2020 – the end of the crossroads?, *Aust. J. Forensic Sci.* (2018) 1–12. doi:10.1080/00450618.2018.1485738.
- [106] A. Ludwig, J. Fraser, Effective use of forensic science in volume crime investigations: Identifying recurring themes in the literature, *Sci. Justice.* 54 (2014) 81–88. doi:10.1016/j.scijus.2013.09.006.
- [107] A. Ludwig, E ‘value’ ating Forensic Science, *Forensic Sci. Policy Manag. Int. J.* 7 (2016) 69–80. doi:10.1080/19409044.2016.1177863.
- [108] D.S. Pietro, B.W. Kammrath, P.R. De Forest, Is forensic science in danger of extinction?, *Sci. Justice.* 59 (2019) 199–202. doi:10.1016/j.scijus.2018.11.003.