Experience says it all! Or not..?

Situation awareness on the fire ground

L. Bomhof

Supervisors
Dr.ir. P.W. de Vries
Prof.dr. J.H. Kerstholt
28th of August, 2017

UNIVERSITY OF TWENTE.

Master thesis

Experience says it all! Or not..?
Situation awareness on the fire ground

Student
Lisan Bomhof

Master psychology: Conflict, Risk and Safety
Faculty behavorial, management and social sciences
University of Twente
First supervisor: Dr.ir. P.W. de Vries
Second supervisor: Prof.dr. J.H. Kerstholt
Enschede, The Netherlands
28th of August, 2017

UNIVERSITY OF TWENTE.

Acknowledgements

After an intensive period of eight months, it is finally time to write the last part of my thesis, the acknowledgements. Being able to do my thesis research and to take part in the pilot study *Situationele commandovoering* of the Fire Service Academy of the Netherlands was an amazing opportunity. I have learned and grown a lot, both on personal and academic level. Even though writing this thesis is an individual process, I could not have done it without the help others.

First of all I would like to thank Hans Hazebroek en Thijs Geertsema of the Fire Service Academy of the Netherlands. Thank you for giving me the opportunity to do my thesis research during the pilot and trusting me to do it well. Thijs, thank you for learning me to own my research, thank you for your (sometimes overwhelming) enthusiasm and never ending curiosity. And thank you Hans for guiding me in the process of setting boundaries and to focus on one topic. Even though I would have loved to research it all. I can honestly say that without your support and help, my research and thesis would not have been the way it is right now. I would also like thank Fred Vorenkamp for allowing me to do my research during the training weeks. And thank you Sabine Kok for (unintentionally) helping me through the first days of my research in Weeze. During my internship I was not the only intern at the Fire Service Academy. I want to thank all the other inters for everything, all the fun we had and we could always rely on each other for motivation and support. A special thanks to Jitske and Amber, for having so much trust in my thesis that you guys came to celebrate my graduation one month early.

I also want to thank Edgar Graham from the University of Gloucestershire. You have helped me a lot in the beginning of my research. Thank you for giving me access to FireMind and for helping me to understand it. And of course I want to thank my supervisors Peter de Vries and José Kerstholt. Thank you for your critical view and feedback during the process of writing my thesis.

And at last, but certainly not at least, I want to thank my family. Thank you mom and dad for making it possible for me to go to the university and study whatever I wanted. Thank you Gienke for reading my thesis and your endless comments, it surely helped to improve my thesis. And a thousand thanks to my dear Sven, for being the best support I could have ever wished for!

Abstract (ENG)

This research was conducted to examine the association between experience and situation awareness (SA) of duty officers in the fire service of the Netherlands. For SA perception, comprehension and projecting the near future are important. Experience is researched in several ways, like the number of years of experience, training, incident experience, full-time or retained duty officers and subjective experience.

Several hypothesis and research questions were proposed. One of the expectations was that SA would be higher when a firefighter has a higher number of years of employment (experience). This does not seem to be true. However, more years of experience do lead to a better comprehension of the fire and its environment. Apparently believing that you have more experience with specific, similar or large incidents is associated with a better comprehension of the intervention and environment of the incident. A remarkable finding was that training did not lead to a better understanding of a real fire or the projection of the future status of the fire. No difference in SA or bias was found between full-time and retained duty officers.

A striking finding was that in this research duty officers who were not active as a firefighter or crew commander, seemed to have a greater tendency to reject information as false even if true and a greater tendency to zoom in, compared to duty officers who were still active as a firefighter or crew commander. The results confirmed the critical aspect about bias tendencies of firefighters. Displayed bias tendencies may well be only appropriate for the particular situation it is measured in. Investigation of bias tendencies would seem critical to understand the factors that influences these tendencies and if these tendencies are consistent over time and place.

This research can be a big steppingstone for future research about experience on the fire ground. It showed that just the number of years of experience is not sufficient for professions with high risk, low frequency incidents. Subjective incident experience seems to be a better indicator for experience of duty officers of the fire service in the Netherlands. Also the way the fire service organises their training should be evaluated when looking at its contribution to situation awareness. To answer the main research question: a small percentage of the variance in situation awareness can be explained by difference in experience. There is a relation between situation awareness and experience of the fire service, it all depends on how you define experience.

Abstract (NL)

Dit onderzoek is uitgevoerd om de relatie tussen ervaring en omgevingsbewustzijn (situation awareness (SA)) bij officieren van dienst (OVD) bij de brandweer te onderzoeken. Bij omgevingsbewustzijn spelen perceptie, begrip en het voorspellen van de nabije toekomst een belangrijke rol. Ervaring is op verschillende manieren gemeten, het aantal jaren ervaring, training, de ervaring met incidenten, ervaring als beroeps of vrijwillige officier van dienst en het gevoel van ervaring hebben.

Verschillende hypotheses en onderzoeksvragen waren opgesteld. Één van de verwachtingen was dat SA hoger zal zijn voor OVDs met meer jaren ervaring. Dit bleek niet zo te zijn. Echter, meer jaren ervaring verhogen wel het begrijpen van de brand en de omgeving van het incident. Het gevoel hebben van ervaring met specifieke, soortgelijk en grote incidenten kan geassocieerd worden met een beter begrip van interventie en de omgeving van het incident. Een opvallende bevinding is dat de training niet bijdraagt aan een beter begrip van een brand en de voorspelling van de nabije toekomst. Er is geen verschil in SA gevonden tussen beroeps en vrijwillige OVDs.

Een ander opvallende bevinding was dat in dit onderzoek de OVDs die niet meer actief als manschap of bevelvoeder zijn, een sterkere neiging lijken te hebben to het verwerpen van informatie als niet waar, terwijl deze wel waar is. Ook lijken zij meer de neiging te hebben tot in zoomen op een incident, dit in vergelijking tot OVDs die nog wel actief zijn als manschap en bevelvoerder. Dit resultaat bevestigd het cruciale aspect van de bias van brandweerpersoneel. De vertoonde bias zou zomaar alleen van toepassing kunnen zijn op de situatie waarin het gemeten is. Meer onderzoek naar bias is nodig om te begrijpen welke factoren van invloed zijn op de bias en of de bias consistent is in tijd en plaats.

Dit onderzoek kan een mijlpaal zijn voor vervolg onderzoek over ervaring van brandweerpersoneel. Het laat zien dat enkel de jaren van ervaring niet toereikend is voor beroepen met hoog risico en lage frequentie incidenten. Subjectieve incident ervaring lijkt een betere indicator te zijn voor brandweer OVDs uit Nederland. Ook de manier waarop de brandweer traint moet geëvalueerd worden, wanneer het gaat om de bijdrage aan de ontwikkeling van SA. Om antwoord te geven op de hoofdvraag: een klein percentage van de variantie in omgevingsbewustzijn kan verklaard worden door ervaring. Er is een relatie tussen omgevingsbewustzijn en ervaring, het is echter afhankelijk van hoe je ervaring definieert.

Definitions*/translations in Dutch**

Fire appliance = in general, a fire appliance is manned by six persons. Four firefighters, one driver/pump operator and one crew commander*
= een (zespersoons) tankautospuit**

Firefighter = a crew firefighter*
= manschap**

Crew commander = commander in charge of the fire appliance, which consists of four firefighters and one driver/pump operator*
= bevelvoerder (BV)**

(junior) Duty Officer = the person initially responsible for incident command and control*
= officier van dienst (OVD)**

Senior Duty Officer = the single agency disciplinary leader of the fire service and sounding board for the duty officer*
= hoofd officier van dienst(HOVD)**

Hazmat (hazardous material) scientific advisors = adviseur gevaarlijke stoffen (AGS)**

Fire service = the entire organization in charge of preventing and fighting fires*
= de Brandweer als gehele organisatie**

→ in regard to experience = the (entire) employment at the Fire service (full-time/retained)*
= gehele loopbaan bij de Brandweer (zowel beroeps als vrijwillig)**

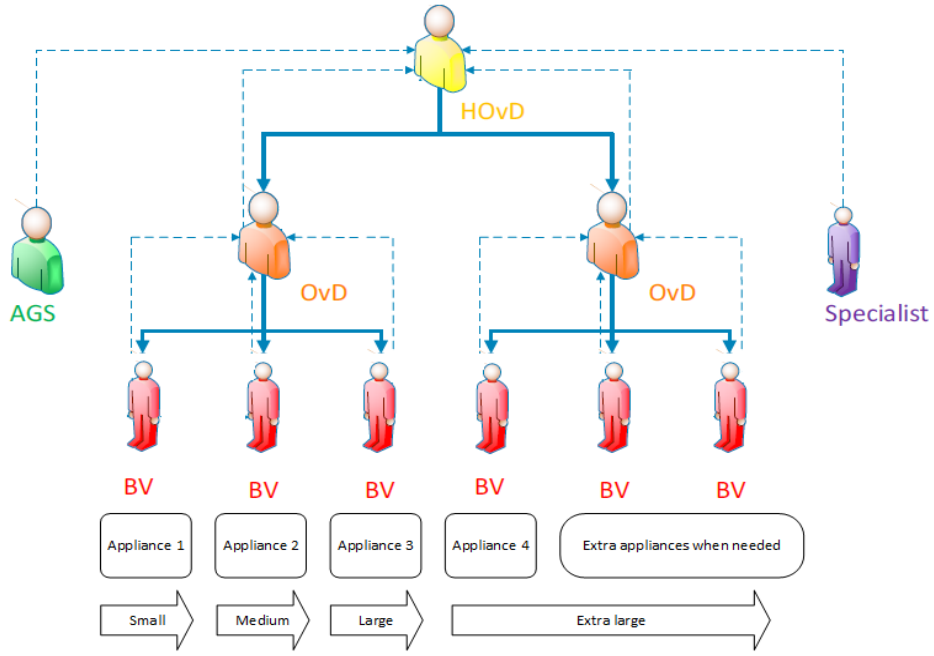

Figure 1. Basic hierarchic mobilisation model (Geertsema, Hazebroek & Groenendaal, 2015). Small/medium/etc. is the size of the incident.

Introduction

At 14:26 o'clock on January 5th 2011 the staff of Chemie-pack, a chemical company, at Moerdijk called the emergency services because there was a fire in the outdoor storage area of chemicals. It started with a small fire and the staff of Chemie-pack tried to extinguish the fire, but they failed and some containers started to leak chemicals. The fire spread fast and more containers melted and leaked more flammable liquids. Two fire appliances and a duty officer were initially mobilised. Black smoke was visible from a distance and while driving to Chemie-pack the duty fire officer requested more fire appliances (IOOV, 2011). The duty officer was the first to arrive at Chemie-pack and he felt overwhelmed seeing the huge fire and getting all the information from the staff of Chemie-pack. It was his main task to gain a complete overview of the incident. An employee pointed out to the duty officer that some containers near the fire contained acetone. At 14:36 the first fire appliance arrived at Chemie-pack and between 14:43 and 14:52 six other fire appliances arrived. The duty officer ordered to cool the containers with acetone and to prevent the fire of spreading. Even though the surface of the fire was already more than 6500 square meters, he did not order an elaborative exploration of the area (Omroep Brabant, 2011). More fire appliances, specialised appliances, duty officers, senior duty officers, hazmat (hazardous material) scientific advisors, company commanders, mayors, police, medical staff and other services were mobilised (as well on-site as off-site). In no time 120 fire fighters were working at the site of the incident. Around 17:00 the fire spread to a neighbouring storage/warehouse. Due to the smoke highways needed to be closed, the railway system in the region was shut down and in several towns in the region civilians were warned to stay inside and keep all doors and windows closed (Omroep Brabant, 2011). In the evening an employee of Chemie-pack warned the Fire Service about the huge amount of chemicals in a warehouse at the front of the estate of Chemie-pack. Due to this new information, a new plan of action needed to be made. At 00:15, after a long and complicated fire fighting day, the fire was under control.

This unique and major incident received a lot of attention, both from the media as from the fire service and researchers. After the initial euphoria about extinguishing the fire, criticism took over. Was the fire service up to their task? Why did they not let the fire burn and extinguish itself? Why did they use water instead of foam? And there were questions about the environment, the public health and the permits of Chemie-pack (Omroep Brabant, 2011). A manager of Chemie-pack even blamed the fire service for the fact that the company burned down, because they used water instead of foam to extinguish the fire (NRC, 2012).

Different investigations were concluded and the regions *Midden- en West-Brabant* and *Zuid-Holland-Zuid* expressed their need for an objectively and value free observation about the way the fire service had handled the incident. The *Nederlandse Vereniging voor Brandweerzorg en Rampenbestrijding* (NVBR) (Dutch Association for Firefighting and Disaster management) organised a *Leerarena Moerdijk* (a learning arena) to improve the learning capabilities of the fire service, and to answer the important question 'what would you tell your colleagues if they were mobilised for such an incident tomorrow?' (NVBR, 2011). During the learning arena they focused on the dispatch system, the system of calling on additional services or resources, leadership and coordination, technique and tactics (both for the actual fire fighting operation as well as for handling the impact of the fire), and the information exchange during the initial fire-fighting. For leadership and coordination, technique and tactics and the information exchange, questions as "What kind of incident is it? Can I deal with it? Do I know enough or do we need to obtain more facts? What is my goal and what will I do?" are important to ask yourself as a duty officer. The fire at Chemie-pack showed how important it is to be aware of the situation you are in and to stay aware of the changing situation during the incident. An action plan needs to be adjusted continuously during the deployment. (Developing) situation awareness (SA) became one of the key points of focus in that arena (NVBR, 2011).

One of the reasons why SA is important for duty officers is because they have to deal with ill-structured problems, uncertain, dynamic environments, shifting, ill-defined, or competing goals, action/feedback loops, time stress, high stakes and multiple players (Zsambok, 1997). On top of that major incidents, like Chemie-pack, are high risk and low frequency events. When making decisions during these major and unique incidents, it seems natural to trust experience. That is why Naturalistic Decision Making focuses on the way people use their experience to make decisions in their natural environments (Zsambok, 1997). Situation awareness is also one of the key points of focus in Naturalistic Decision Making (Endlsey, 1997; (Klein, Calderwood & Clinton-Cirocco, 1986). That is why the main question in this current research is;

> *What is the effect of experience on Situation Awareness (of duty officers of the fire service from the Netherlands)?*

First Naturalistic Decision Making (NDM) will be examined, followed by the theoretical approach of Situation Awareness (SA). After that the FADCM model will be

explained, this is the decision-making model duty officers in de Netherlands use in operational condition. Next the relationship, similarities and differences between NDM, SA and FADCM will be examined. Finally the variable 'experience' will be analysed, how should experience be defined and how should it be measured?

Naturalistic Decision making

In 1989 the term Naturalistic Decision Making (NDM) appeared for the first time during a conference for researchers who had stepped out of the traditional decision research paradigms (Zsambok, 1997). In the eighties and nineties these researchers studied how experienced people actually make decisions in their natural environments. The group that was researched consisted mostly of incident commanders (Groenendaal, Helsloot & Brugghemans, 2014). The short definition of NDM is the way people use their experience to make decisions in field setting.

During the NDM conference in 1989 researchers also identified the key task and factors that affect real-world decisions. They are ill-structured problems, uncertain, dynamic environments, shifting, ill-defined, or competing goals, action/feedback loops, time stress, high stakes and multiple players (Zsambok, 1997). Other markers for NDM research are the participants (experienced decision makers), the purpose of the research (discovering how experienced people actually make decisions in dynamic environments) and locus of interest within the decision episode (not just the option selection process, but also in situation awareness) (Zsambok, 1997). Considering these four markers Zsambok (p. 5, 1997) gave a more elaborate definition;

'The study of NDM asks how experienced people, working as individuals or groups in dynamic, uncertain and often fast paced environments, identify and assess their situation, make decisions and take actions whose consequences are meaningful to them and to the larger organization in which they operate.'

This definition with its markers emphasizes a complex and uncertain situation where decision makers cannot rely on routine thinking. But a great deal of real-world decision making involves (a sort of) routine thinking (Zsambok, 1997). Thinking of Chemie-pack at Moerdijk again, it was an incident were different scenario's piled up to a unique and major incident that nobody had experienced before (Omroep Brabant, 2011). With the continiously changing situation, the approach needed to be changed and adjusted at the same pace. Some researches choose to model both the simple and the complex decision making. For example Rasmussen (1983) who distinguished two levels of routine performance, called skill-based

and rule-based. Other examples of NDM models are explanation-based decision making (Pennington & Hastie, 1988) and intuitive (system 1) versus analytical (system 2) decision making (Kahneman & Klein, 2009), and so on. These are models that try to understand how (experienced) people actually make decisions in their natural environments or in simulated environments that preserve key aspects of natural environments (Groenendaal, Helsloot & Brugghemans, 2014; Groenendaal, 2015; Kahneman & Klein 2009). NDM does not mandate field studies as the only methodology. A laboratory study can be a simulated environment that preserves key aspects of natural environments (Zsambok, 1997). Within the military and aviation sciences also various NDM models have been developed which describe steps for successful decision making under stress. In one of the models regarding incident command and control for fire fighters, Burke (1997) integrated two main components into a model; deciding and acting. In order to decide, commanders need information about resources, safety and risk. In order to act, commanders need to communicate, control and evaluate and this can lead to new information in the decision process (Burke, 1997; Groenendaal, 2015).

The NDM approach relies on improving the decision maker's understanding of the condition under which the decisions have to be made (Drillings & Serfaty, 1997). A topic that gained a spotlight position due to this NDM approach and research is situation awareness (SA). Zsambok (1997) gives a few examples of studies that have integrated SA: Keampf and Orasanu conclude that SA is important and needs to be supported in decision aids and training. Smith and Marshall are attempting to build a ‘naturalistic decisions aid’ that involves SA. Waag and Bell describe one of their studies to better understand SA in fighter pilots and to design better training programs.

Situation Awareness (SA)

One of the reasons why SA gained a spotlight position in the NDM approach is because research indicates that experts rely on situation recognition and pattern matching to memory structures to rapidly make decision in realistic conditions (Endsley, 1997; Klein, Calderwood & Clinton-Cirocco, 1986). A driving factor for making decisions is the framework of the current situation, a person’s SA. It is necessary to understand the construct of SA to understand its impact on decision making (Endsley, 1997).

Situation awareness (SA) is a term that has been used widely with several definitions. SA can be seen as a product, emphasising the perceptual and cognitive processes that are used to build and maintain SA, or as a process, emphasising on the resultant mental model of the situation compared to the situation as it really is. The distinction in the definition is based on

the measurement of SA, rather than the concept of SA. The most widely used definition of SA is from Endsley (1995a); the perception of elements in the environment within a volume of time and space (SA level 1), the comprehension of their meaning (SA level 2) and the projection of their status in the near future (SA level 3). This definition focuses on knowledge, based on the gathering and interpretation of the given information. Endsley (1995a) emphasises how important SA is for effective real-world decision making. SA does not simply involve gathering information to build a good understanding of the situation, it also requires an appropriate selection of the gathered information (Catherwood, Sallis, Edgar, Medley & Brookes, 2012; Gasaway, 2007; Klein, Calderwood & Clinton-Cirocco, 1987). When making a selection the commander analyses the situation, gives meaning to what is seen and the projection of its status in the near future (Endsley, 1995a). The selection, accepting or rejecting, of information can be described as the 'filter' or 'scope' that is applied, also known as 'bias' (Catherwood et al., 2012). According to Catherwood et al. (2012) there are two independent aspects of analysing information in the decision making process;

(1) SA can be defined as knowledge or defined as how well the individual discriminates true from false information
(2) the tendency to accept or reject information as true (the bias)

Heightening situational awareness is being explored as the most critical factor in maintaining the safety of participants in high risk, low frequency events. In order for commander to evolve their SA, it must be understood within the culture of the fire-fighting service (Dow, Garis & Thomas, 2013). SA in the fire-fighting context is a dynamic process that is characterized by fluidity, rapidly changing circumstances, peril, and high stress (Gasaway, 2007). SA has been described as;

> *…being aware of everything that's happening and could happen during your arrival on scene, initial and ongoing size-up, operational period and overhaul and rehab period* (Dubé, 2008).

This research will follow Endsley's (1995a) definition of SA with the three levels of SA, combined with Dubés (2008) definition of SA in the fire-fighting context. Groenendaal (2015) developed a model that also places SA in the fire-fighting context, namely FADCM. FADCM stands for: Factfinding (receiving and gathering of information), Analysis (analysing the problem), Decision making, Communication (issues to order) and Monitoring (monitoring

the implementation of the issued order). The model shows a lot of overlap with the model of SA in dynamic decision-making of Endsley (Figure 2).

FADCM

Groenendaal (2015) developed a model that connects recognition primed decision making (RPD), image theory and explanation based decision making (Lipshitz, Klein, Orasanu & Salas, 2001) with the jargon of incident command.

RPD explains how experienced decision makers are able to make effective decisions under time-pressure and uncertainty (Klein, Calderwood & Clinton-Cirocco, 1986; Gasaway, 2007; Klein, Calderwood & Clinton-Cirocco, 2010). Effective decision-making in fire and rescue operations clearly requires a good selection of information (Arendtsen et al., in press). The cognitive processes involving processing information and selecting information may be driven by prior experience or memory about a situation. Klein, Calderwood and Clinton-Cirocco, (2010) reported that these memories or experience influence the RPD processes. RPD is evident when prior experience influence choices and decisions (Gasaway, 2007; Klein, Calderwood & Clinton-Cirocco, 2010). Commanders make their decisions based on their intuition, gut feelings and just knowing what to do (Gasaway, 2007). Only when time permits, experienced decision-makers intentionally imagine the course of action, to see if it will work, and to look for unintended consequences that might be unacceptable (Lipshitz et al., 2001).

The image theory assumes that a decision maker bases decisions on values, personal principles and strategies (Groenendaal, Helsloot & Brugghemans, 2014). The personal values and principles reflect his belief of how the world should be, how things should be done and how people should behave. This influences his goal. A goal can be concrete, preventing the fire to spread to neighbouring buildings, or a goal can be abstract, being a good firefighter. The decision maker chooses a strategy to reach this goal while being loyal to his values and principles (Groenendaal, 2015).

Explanation-based decision making assumes that decisions are based on a narrative (story or causal representation) the decision maker makes of the available facts (Pennington & Hastie, 1993a; Pennington & Hastie, 1993b). Decision making involves matching the ‘constructed stories’ and ‘constructed choice’ sets (Pennington & Hastie, 1993b). The decision maker chooses the story that best explains all available evidence and the story that seems the most coherent (Groenendaal, 2015).

The FADCM model tries to take into account the way in which people make decisions in their daily working lives, which is mostly not based on a rational process of decision making, but on intuition for example. In this research we will only look at the first two steps of FADCM for commander on the fire ground. The first step of FADCM is Factfinding. In this step the commander is receiving and gathering information and selecting what is relevant and what is not. Different core insights are involved in this process; situation awareness, attention and working memory and spatial distance. Changing in spatial distance can improve SA because there is a difference in perception when being close or further away from the incident (Groenendaal, 2015). Examining attention and working memory involves zooming in or out. Under pressure incident commanders tend to zoom in, using only a few details, or zoom out, using a wide span of details on a superficial level, while making decisions (Arendtsen et al., in press). The zooming in or out can be called the bias of SA. There are many reasons for zooming in or out, but one main factor is the natural processing limitation of the human brain. The brain can only hold a limited number of details (working memory) and may overload under pressure, which can lead to errors in decision making (Klein, Calderwood & Clinton-Cirocco, 2010; Useem, Cook, Sutton, 2005). Experience can prevent these errors (Gasaway, 2007; Klein, Calderwood & Clinton-Cirocco, 2010) but it can also lead to a narrower focus on selected information or overlook information if the experience does not fit the current circumstances (Perry, Wiggins, Childs & Fogarty, 2009).

During the second step of FADCM, Analysis, the incident commander must assess (their perception of) the situation. The incident commander has to analyse the problem and its significance for the present and the near future (Cohen, Freeman & Wolf, 1996). System 1 and System 2, two modes of thought as presented by Kahneman and Klein (2009), time pressure and task load are important in this step. System 1 is based on intuitive decision making, a decision is based on recognition (mentioned before as RPD). This is what we mostly do, but we also make decisions based on reason (System 2). System 2 kicks in when System 1 fails or when the situation is not immediately recognised (Kahneman & Klein, 2009). Where System 1 one is our initial and intuitive way of decision making, System 2 requires more effort and time (Groenendaal, 2015).

The sense of time pressure during incidents prevents frontline workers from making decision based on both systems. Better decisions can be made when System 2 is used as a validation tool for System 1 (Kahneman & Klein, 2009). The ability to use System 2 is also influenced by task load. As mentioned before, our brain can only handle so many things at once. When duty officers are subject to heavy cognitive load, like performing complex tasks

or multiple tasks at the same time, there is less cognitive capacity to consciously analyse the situation (Catherwood et al., 2012; Groenendaal, 2015). It implicates that duty officers should concentrate on the most critical task and should call for backup for other tasks to be carried out (Groenendaal, 2015).

In this research the focus is on SA in relation to the process of decision-making, not on the decisions that are being made. Because of this, only the first two steps, factfinding and analyses, of FADCM will be researched. Fact finding starts with the perception of the situation, taking into account the capacity of your working memory. Changing the spatial distance every now and then can improve SA, because there is a difference in perception when being close or further away from the incident. The second step, analyses, contains System 1 and System 2, time pressure and workload. After collecting information the incident commander gives meaning to the information to select what is important and what is not. Part of this selection is intuitive and part is based on reason. Time pressure and task load can determine whether System 2 is used as a validation tool for System 1.

Looking more critical at the FADCM model and the three levels of SA, it would make sense to place level 1 SA in Factfinding and level 2 and 3 in Analysis (Figure 2). Factfinding is about receiving and gathering of information which includes the perception of elements in the current situation (level 1 SA). Making an analysis of the information includes comprehension of the current situation (level 2 SA) and projection of future status (level 3 SA). Following these steps leads to making a decision (Endsley, 1995b; Endsley, 1997).

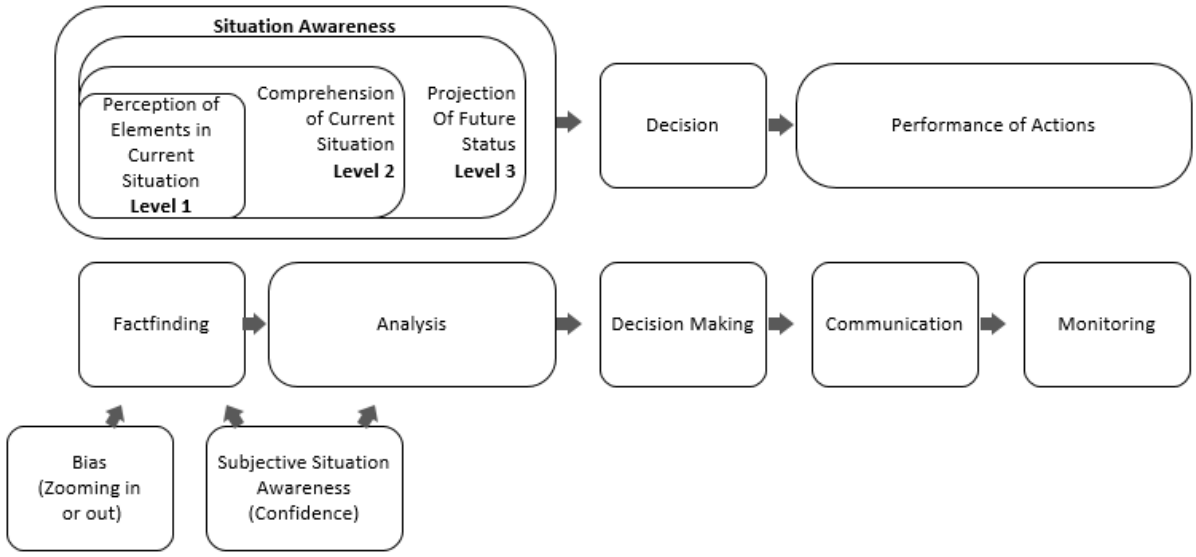

Figure 2. Top part: the model of situation awareness in dynamic decision making of Endsley (1995b), and bottom part: the FADCM model of Groenendaal (2015) combined and adjusted to current study.

Experience

Looking at the definition of NDM again, NDM researches how experienced people identify and assess their situation (Zsambok, 1997). But what should be the definition of experience? When searching for a definition of experience, the most common definition is: that what you know, because you have experienced it (translated from Encyclo). The command of fire forces is a complex and difficult skill, and experience is a difficult concept to understand. Having to make decisions for unique and major incidents is difficult, because the decision on hand reflects a high level of complexity and uncertainty, it is under time pressure and often there is no single (or none at all) correct answer (Serfaty, MacMillan, Entin & Entin, 1997). According to RPD, using their previous experience, decision makers frame the current situation and match it to previous situations, experience and training (Drillings & Serfaty, 1997; Endsley, 1997). When there is a good match, the course of actions becomes clear. If there is a poor match, the commander must acquire additional information. A good match provides knowledge of the relevant elements, a means to understand the meaning of these elements and a mechanism for projecting the elements on future states and understanding its dynamics (Endsley, 1997). Drillings and Serfaty (1997) also state that the quality of the match also provides a measure of the commander's confidence in the decision.

When looking at the relationship between experience and SA, Catherwood et al. (2012) defined SA as accumulating information to build good understanding of the situation and requiring appropriate selection from the range of information on offer, either from the external environment or the internal knowledge base of the decision maker. While comparing untrained students and firefighters they found that untrained student's SA was significantly lower than that of firefighters. The mean SA score of full-time firefighters was higher than the SA score of retained firefighters, but the difference was not significant. Also the number of years of experience for both groups was not significantly related to SA. These results confirm the expectation that firefighters' experience is linked to better SA, but that the years of experience is not significantly related to SA, possibly due to a ceiling effect (Catherwood et al., 2012). This leads to the following hypotheses:

> *H1: Situation awareness will be higher when a firefighter has a higher number of years of employment (experience).*

A distinction will be made between the total number of years of employment for the fire service and the number of years of employment as a duty officer.

H2: Situation awareness will be higher for full-time duty officers than for retained duty officers.

In the year 2016 the Fire Service Academy of the Netherlands registered all large incidents (defined conform fire-fighting jargon; four or more fire appliances mobilised for the incident). Scanning that database shows that there is a big difference in number of incidents between regions. A duty officer in Amsterdam could have gained more experience with incidents in the year 2016 than a duty officer in, for example, Friesland. But there is also a difference in type of incidents. In rural areas there are more, for example, fires in stables on farms and in urban areas there are more incidents regarding to housing or offices. It could be concluded that for duty officers number of years of experience does not completely cover the definition of experience and that it is worth to research a more comprehensive definition of experience. This leads to the following hypothesis:

H3: Situation awareness will be higher when a duty officer has more incident experience.

Looking at incident experience, a distinction between fives types of experience will be made. The first type was training of incidents. The second type of experience was experience of actual incidents as duty officer. The third type of experience was specific incident experience compatible to the given scenario (SIE). The fourth type of experience was similar (compared to the given scenario) incident experience (SGE). The fifth and last type of experience was experience with large incidents (4 fire appliances or more) (ELI).

Catherwood et al. (2012) also conducted a more realistic study with fire-fighting personnel. The results for SA were the same and they confirm that simply acquiring knowledge does not necessarily lead to effective decision making and the lack of knowledge does not necessarily explain tendencies towards errors. The results also showed an overall tendency towards a negative bias, but the three groups (full-time, retained and students) did not differ in level of bias scores (Catherwood et al., 2012). A negative bias is a tendency to accept information as true even when actually false. The more negative the score the greater the tendency to accept information. Number of years of experience were also not significantly related to level of bias scores. However, further analysis did show that most firefighters showed a negative bias and that there was a significant difference between the positive bias group (n = 15) and the negative bias group (n = 29) (Catherwood et al., 2012). This leads to the following hypotheses:

H4: The bias score will be (more) negative when a firefighter has a higher number of years of employment (experience).

A (more) negative bias means a greater tendency to accept information as true even if false. distinction will be made between the total number of years of employment for the fire service and the number of years of employment as a duty officer.

H5: The bias score will be (more) negative when a duty officer has more incident experience.

Also for this hypothesis the distinction between five types of experience will be made: training, actual experience, SIE, SGE and ELI.

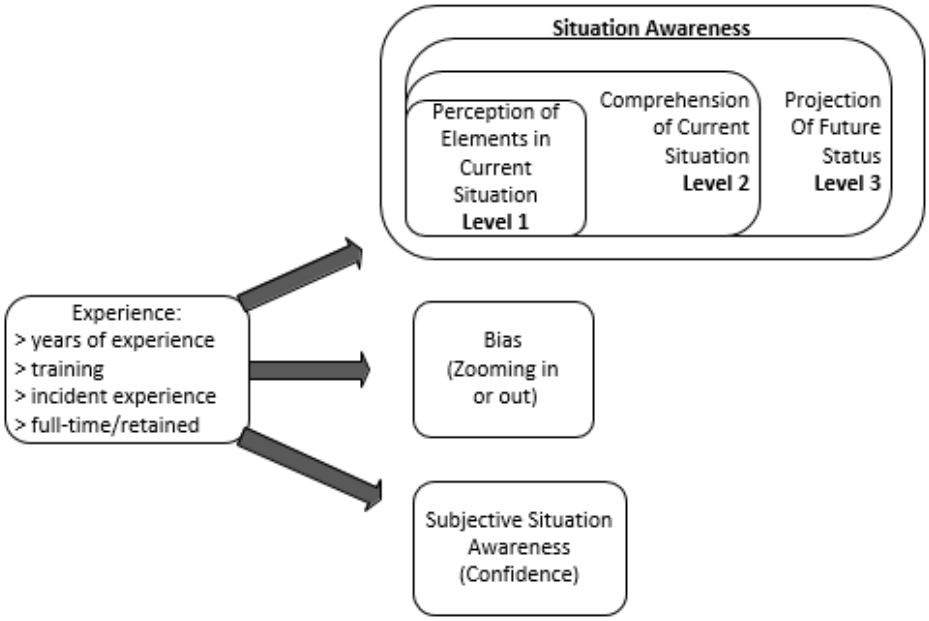

Figure 3. Research model: exploring the relation between experience and SA, bias and SSA.

Additional research questions

The link between SA and the decision making process is multidimensional. Firstly it forms the basis for decision making. An additional research question concerning SA is:

R1: Is there a difference in situation awareness between duty officers who were also still active as firefighters or crew commanders and duty officers who were not?

In the Netherlands a duty officer can stay active as firefighter or crew commander. The duty of firefighters and crew commanders is to deal with the core of the incident, most of the time a fire. Their focus is to extinguish or contain the fire, it is their job to zoom in on the incident.

It is a duty officers job to also zoom out and see the incident and the situation around it. It will be interesting to see if a difference in SA will be found.

The link between SA and the decision-making process secondly also impacts the types of processes used for decision making (Endsley, 1997). The way a person characterizes a situation, zooming in or out, can determine the decision process used to solve a problem. This bias has an influence on Factfinding and can influence SA (Arendsten et al, in press). During Analysis the commander matches the current situation to an experienced situation. The quality of this match influences the confidence of that decision (Drillings & Serfaty, 1997). Two additional research question were formed concerning bias:

R2: Is there a difference in bias between full-time and retained duty officers?

This research question is based on the fact that full-time officers experience more incidents, quantitatively wise. The 'myth' in the fire service is that there is a difference between full-time and retained duty officers.

R3: Will the bias score for duty officers who were also still active as firefighters or crew commanders be higher and positive (above 0) than duty officers who were not?

Expected is that still being active as a firefighter or crew commander, and needing to zoom in while performing that duty, will influence the bias negatively when performing as duty officer.

When looking at the quality of the match of situations (Drillings & Serfaty, 1997) an incident commander must be able to reflect on his SA (Arendtsen et al., in press). Perceived situation awareness, in this research called subjective situation awareness (SSA) is an individual's conscious awareness of their own actual SA and the ability to reflect on how good or how bad their actual SA is. The correlation between measures of SA and SSA varies; as described in Endsley (2000) Endsley and Rodgers found that SA and SSA scores were not correlated in an aircraft cockpit display evaluation study, however when dividing SSA into understanding and attention, and in another research Endsley reports a significant correlation with SA comprehension. A reason for the variation in correlation between SSA and SA could be that the cognitive processes to build SA were not all part of our conscious awareness and this can influence our perception when asked to rate our confidence about SA (on a scale from guess to certain) (Edgar, Catherwood, Sallis, Brookes & Medley, 2012; Edgar, Catherwood, Baker, Sallis, Bertels, Edgar, Driton, Buckle, Goodwin & Whelan, in press). Decision making and performance can be moderated by how good or bad an individual believes their SA is, no

matter how good or bad their SA actually is (Endsley, 1993). This leads to the following research questions:

R4: Is there a difference in subjective situation awareness when a firefighter has less or more number of years of employment (experience)?

A distinction will be made between the total number of years of employment for the fire service and the number of years of employment as a duty officer.

R5: Is there a difference in subjective situation awareness when a duty officer has more incident experience?

Also for this hypothesis the distinction between five types of experience will be made: training, actual experience, SIE, SGE and ELI.

R6: Is there is a difference in subjective situation awareness between full-time or retained duty officers?

This research question is based on the fact that full-time officers experience more incidents, quantitatively wise. The 'myth' in the fire service is that there is a difference between full-time and retained duty officers.

Methods

Participants and design

The participants were 51 duty officers of the Fire Service of the Netherlands. These 51 participants were selected through cluster sampling. Four regions of the Netherlands, Drenthe, Gelderland-Zuid, Haaglanden and Kennemerland joined a pilot study of the Fire Service Academy of the Netherlands. Between the regions there is a difference in number of incidents and the sort of incidents, Drenthe and Gelderland-zuid are more rural regions and Haaglanden en Kennemerland are more urban regions. During the pilot study the implementation of a situational command system for duty officers will be evaluated and adjusted if necessary (for more information see *Situationele commandovoering bij de brandweer*, a rapport of the Fire Service Academy of the Netherlands). All participants of the pilot study followed a one week training at Trainings Base Weeze. There were five weeks in total in 2017, week two, four, seven, ten and fourteen of the calendar year. All participants of this training week and thereby the pilot study have participated in this research, that took place on the Tuesday morning during the training week.

In Table 1 an overview has been given of the participants. All participants were male, the average age was 47.5 years (M=47.49, SD=7.45) and varied between 32 and 59 years of age. The average of total number of years of employment at the fire service was 24 years (M=24.33, SD=8.91) and varied between 7 and 41 years of experience. The full-time duty officers (86.3%, n=44) had an average of 8 years of experience as a duty officer (M=8.30, SD=6.17) and varied between 0 (less than 12 months) and 26 years. 42 of them were still active full-time duty officers, one has quit as full-time duty officer and one has switched from full-time duty officers to retained duty officer. The retained duty officers (19.6%, n=10) had an average of 6 years of experience as a duty officer (M=6.00, SD=6.29) and varied between 1 and 21 years. Eight of them were still active as retained duty officers, one has switched from retained duty officer to full-time duty officer and one was retained and full-time duty officer at the same time, he quit as retained duty officer but is still active as full-time duty officer.

Table 1.
Overview (n=51).

Week	Drenthe	Gelderland Zuid	Haaglanden	Kennemerland	Total
1	2 (18.2%)	2 (18.2%)	4 (36.4%)	3 (27.3%)	11 (21.6%)
2	2 (20%)	2 (20%)	4 (40%)	2 (20%)	10 (19.6%)
3	1 (14.3%)	1 (14.3%)	3 (42.9%)	2 (28.6%)	7 (13.7%)
4	2 (16.7%)	2 (16.7%)	5 (41.7%)	3 (25%)	12 (23.5%)
5	3 (27.5%)	4 (36.4%)	0	4 (36.4%)	11 (21.6%)
Total	10 (19.6%)	11 (21.6%)	16 (31.4%)	14 (27.5%)	51 (100%

Education level	Mavo	Havo	MBO	HBO	WO
	2 (3.9%)	2 (3.9%)	20 (39.2%)	24 (47.1%)	3(5.9%)

Education level Fire Department	Manschap A (Crew)	Manschap B (Crew)	Crew Commander
No	0 (0%)	7 (13.7%)	3 (5.9%)
Yes	51 (100%	44 (86.3%)	48 (94.1%)

	Duty Officer	Senior duty officer	Master of crisis & disaster management / Master of public management
No	0 (0%)	46 (90.2%)	47 (92.2%
Yes	51 (100%)	5 (9.8%)	4 (7.8%)

Has fulfilled this function (still active)		Total	Full-time	Retained
	Firefighter	45 (9)	21 (4)	28 (5)
	Crew commander	44 (13)	21 (5)	25 (8)
	Duty officer	51 (50)	44 (42)	10 (8)

Note: some participants were both full-time and retained firefighters/crew commanders/duty officers. That is why the total number is not the sum of full-time and retained.

All participants were provided with the same incident scenario and SA, bias and SSA were obtained in regard to the presented information, via the QASA method. The QASA technique requires true-false decisions about statements concerning a situation that were either true or false.

Materials and procedure

The research was conducted through a presentation of FireMind (answers on paper) and a survey on an online-platform, qualtrics.com. FireMind is a new tool for training fire and rescue service decision-making and measuring SA. It is developed (and still being fine-tuned) in cooperation between Scientific and Research Centre for Fire Protection National Research Institute of Poland, Fire Services of Denmark, Gloucestershire Fire and Rescue Service, Institute for Physical Safety /Fire Service Academy of the Netherlands, Provincial Centre for Education & Training: Fire and Rescue Training Centre of Belgium and the University of Gloucestershire; Centre for Research in Applied Cognition, Knowledge, Learning & Emotion (Arendtsen et al., in press). Beforehand a protocol (Appendix A) was developed to make sure every group would get the same information and what measure should be taken if any threat for validity or reliability should occur. The scenario for FireMind and its probes were extensively checked and adjusted before it was used in this research. Before the participants participated, they were informed about what they were going to do in a preliminary briefing about FireMind, they would see a scenario and would have to answer questions about that scenario, some question were time limited. Afterwards they would have to fill in a survey for background information (Appendix B). They were informed that anonymity was guaranteed, that they could withdraw at every single moment during the research with no further explanation, that it is not a test and they will not be judged on their results and they were asked not to talk about the research with their colleagues who will participate in the research in one of the following training weeks.

The participant started with FireMind, a PowerPoint presentation presented to all participants at once. The task content, format and probe question were designed with guidance and input on the content and format from senior experienced firefighter staff who were not involved as participants. The PowerPoint (FireMind) consisted out of slides and video-segments representing a fire in a furniture company in a small city on the countryside. Several fire appliances and the duty officer were mobilised. The first slide is a sound fragment of contact between the emergency service and the owner of the furniture company. The following slide showed information of the mobilised fire service resources and a sound

fragment of contact between the emergency service and the crew commander of the first responding fire appliance. The third slide showed an aerial view of the neighbourhood and incident location. After these three slides the first set of ten probe statements was presented, with a warning in advance that the time limit for answering was ten seconds. The probe statements were as "requests for clarification from the emergency service". An example is: The owner of the company mentions the street name. The participants had to answer, on paper, with true or false. The probe statement was followed with the question of level of certainty on a 4-point scale (unsure to sure) of their answer on the probe statement.

The next slide showed a short movie where the commander of the first responding fire appliance briefs the duty officer (the participant) about the incident, followed by a series of nine rapidly presented images, providing a collage of views of the incident. Then the second set of probe statements, followed with the question of level of certainty, had to be answered. After this set, two open ended questions were asked: What kind of analysis do you make? and How do you think the incident will develop in the next fifteen minutes? For answering these two questions there was a time limitation of four minutes. The answers on the probe statements were used to measure SA level 1, the answers on the open questions were used to measure SA level 2 and SA level 3. Following the question was a series of five rapidly presented images, providing a collage of views of the incident and one slide with a short film about the developing incident, including helicopter view images with an heat camera followed by a series of four rapidly presented images (Figure 3), providing a collage of views of the incident. Than the third set of probe statements, the questions of level of certainty and the two open ended questions had to be answered. The probe statement about the picture (Figure 4) is: The firefighter near the facade was wearing respiratory protection. At last one slide with a short movie with a news item about the incident was shown, followed by the fourth set probe statements and questions of level of certainty.

Figure 4. A picture shown in FireMind. Reprinted from FireMind. Copyright by FireMind. All rights reserved.

After FireMind the participants moved to a laptop room, same set up every week, where they filled in the survey for background information. When everybody was finished with the survey, participants left the research classroom. The survey with background questions is a survey on an online-platform, qualtrics.com. The background questions were about gender; age; region of employment; years of experience as a firefighter, crew commander and duty officer (full-time and retained), other functions within the fire department, education level, experience with different sizes of incidents, and randomly 36 constructs were shown, fourteen constructs about specific incident experience compatible to the given scenario, fourteen constructs about experience with a similar (on certain levels) incident compared to the given scenario, and eight constructs about experience with big incidents (four fire appliances or more). The constructs were answered on a seven point Likert-scale where only the extremes were appointed with totally disagree and totally agree.

Research instruments

Dependent variables

Situation awareness (SA) is measured through FireMind, a tool that measures level 1 of SA (the perception of elements in the environment within a volume of time and space). Two open ended question were added to measure level 2 (the comprehension of the meaning of the elements) and 3 (the projection of the element's status in the near future) of SA. The true/false responses to the probes of FireMind (SA level 1) will be analysed with the Quantative Analysis of Situation Awareness (QASA). QASA includes separate measures of actual SA, subjective SA and the bias (Edgar et al., in press). Bias is a measure of information acceptance and not a measure of criterion point, because bias and information use do not need to be the same. Someone can accept information, but not use it to build SA (Edgar et al., in press). A' (actual SA) and B" (bias) were calculated with the formulae described by Edgar et al .(in press), who describe the formulae by Stanislaw and Todorov (1999): H = 'Hit' rate, F = 'False alarm' rate, Max(H,F) = Either H or F, whichever is greater.

$$A' = 0.5 + \left(sign(H - F) \frac{(H - F)^2 + |H - F|}{4\max(H,F) - 4HF} \right)$$

$$B'' = sign(H - F) \frac{H(1 - H) - F(1 - F)}{H(1 - H) + F(1 - F)}$$

Table 2.
Interpretations of the SA, bias, and confidence scores provided by the QASA tool. Reprinted from (Edgar et al., in press). All rights reserved.

Score	(Actual) Situation Awareness (SA) - A'	Bias - B''	Subjective SA (Confidence)
Positive (max +100)	Good SA. Can tell true information from false: higher score is better.	'Strict' bias. Tendency to reject information as false even if true. The higher the score the greater the tendency to reject information as false. More zoomed-in.	Indicates a *belief* that the responses given are correct, suggesting a belief that SA is good. A higher score represents greater confidence.
Zero	No SA – guessing?	No bias towards accepting or rejecting information. A 'neutral' attitude.	Neither high nor low confidence.
Negative (max -100)	Misguided. Believes false information is true and *vice versa.* More negative is worse.	'Lax' bias. Tendency to accept information as true even if false. The more negative the score the greater the tendency to accept information. More zoomed-out.	Indicates a *belief* that the responses given are wrong, suggesting a belief that SA is poor.

Table 2 shows the interpretation of the actual SA, bias and SSA provided by the QASA tool. For ease of interpretation the QASA tool applies a logarithmic transformation to the bias (Edgar et al., in press).

This provides measures of level 1 SA and the bias applied by the participant (the tendency to accept or reject information as true). After every true-false statement the participant is asked to rate their certainty level of that answer, this will provide their SSA. For both level 2 SA and level 3 SA an open question will measure their meaning given to the information and the projection to the near future. The answers will be scored according to the summary of characteristics of fire safety (Figure 5). The duty officers have learned to approach a fire with these five interrelated disciplines. The first discipline is fire characteristics, like fire growth and fire effects like smoke. The second discipline is building characteristics, for example the compartments of a building and the fire suppression systems. The third discipline is human characteristics, human behaviour prior and during a fire. The

fourth discipline is intervention characteristics, the response of the fire service. The last discipline is environmental characteristics, like the geographic location and the surroundings (Hagen & Witloks, 2014). Level 2 and 3 of SA will be analysed and scored using Atlas.ti.

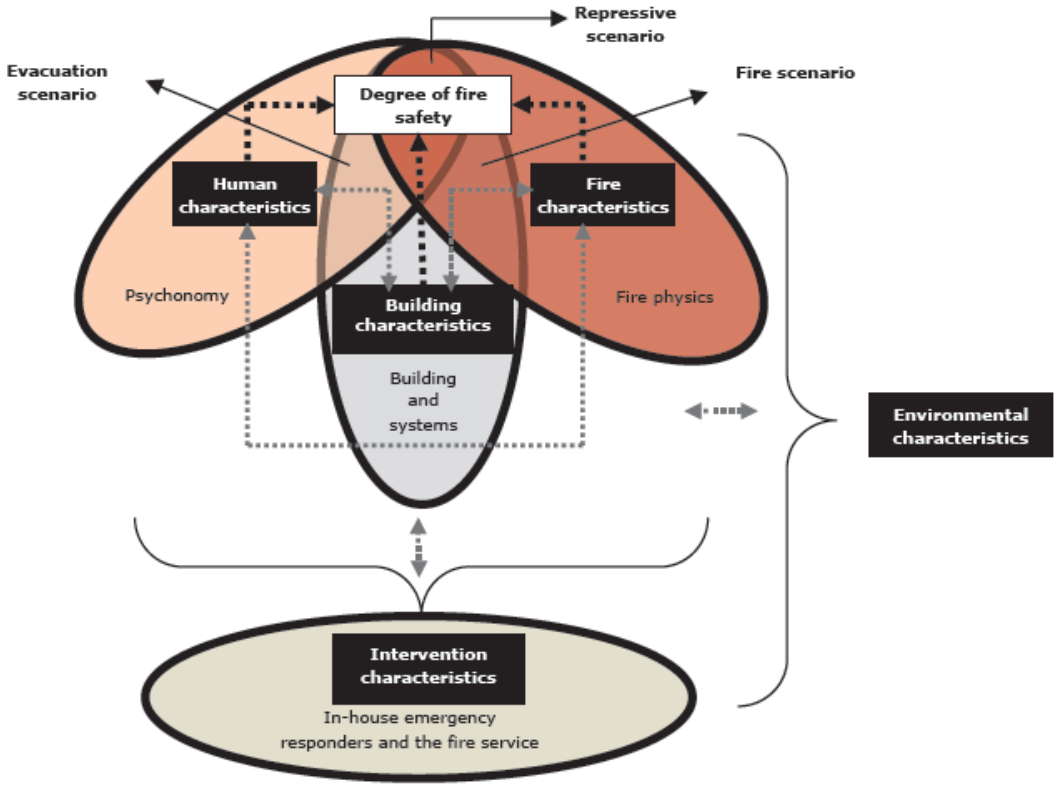

Figure 5. The summary of characteristics of safety. Reprinted from The Basis for Fire Safety, 2014. Copyright 2014 by Institute of Physical Safety the Netherlands. All rights reserved.

Another dependent variable in this research is experience. Experience is measured in years of employment (full-time and retained**)**. The number of years of experience is divided up in the functions firefighter, crew commander and duty officer, to prevent misinterpretation of the years of experience (11 years might be 2 years as crew firefighter, 5 year as crew commander and 4 as duty officer or 11 years as duty officer). Experience will also be measured on training experience and actual experience with different sizes of incidents and different kind of incidents for the year 2016.

The duty officer also rates his or her experience on 36 constructs, the constructs were answered on a seven point Likert-scale where only the extremes were appointed with totally disagree and totally agree. Fourteen constructs about specific incident experience compatible to the given scenario (SIE). The construct SIE is computed out of the sum of the scores of the fourteen items and is reliable and internal consistent with a Cronbach's alpha coefficient

of 0.723. Another fourteen constructs about experience with a similar (on certain levels) incident compared to the given scenario (SGE). The construct SGE is computed out of the mean scores of the fourteen items and is reliable and internal consistent with a Cronbach's alpha coefficient of 0.733. And there were eight constructs about experience with big incidents (four fire appliances or more) (ELI). The Cronbach's alpha coefficient for this construct, based on eight items, was 0.498. Even after factor analysis and deleting items the Cronbach's alpha coefficient, based on five items, would not become higher than 0.665. The construct of experience with large incidents (ELI) is computed out of the mean scores of the eight items and its reliability and internal consistency is low.

Independent variables

Since this was a descriptive research, and not an experimental research, there were no independent variables.

Control variables

It is plausible that knowledge and experience affect each other and that they both influence situation awareness. Knowledge is measured on level of education. Also the region of employment was recorded, between the regions there is a difference in number of incidents and the sort of incidents. These two questions were asked to examine if the effects found were not due to these variables.

Other variables

In addition to the dependent and the independent variables also other variables were questioned in the survey. The other variables were gender; age, full-time or retained, other functions within the fire department (other functions can influence the way a duty officer looks at an incident).

Selecting probes in FireMind

An issue with probe generation is whether probes should be framed positively or negatively. Edgar et al. (in press) always uses positively-framed probes, this fits with the theoretical background to the approach of accepting or rejecting information. Because of that probe P14 (de brand is nog niet overgeslagen) and probe P29 (in 1 loods van Borgo is nog geen brand) were removed, they were negatively framed.

The percentage of correct responses to each probe was then calculated. If participants were just guessing, the percent correct should have been approximately 50%. If the percentage of correct answers dropped below this there may have been a problem with the

probe. This distinguished a difficult probe (where one might expect the percent correct to be around 50%) from a poor probe.

Probe P8 (de haven wordt bedreigd door rook); 41.2 % answered the probe correctly with true, 58.8% answered the probe incorrectly with false. After checking the probe with two experts the conclusion was to remove the probe, because its interpretation is ambiguous. Does the term 'harbour' only reflect the waterways or does it extend to the surrounding buildings?

Probe P11 (Er zijn 3 tankautospuiten ingezet); 23.5% answered the probe correctly with false, 76.5% answered the probe incorrectly with true. With this probe it was important that participants made the distinction between the fire appliances being alarmed and the fire appliances actually being on scene and being deployed. Two fire appliances were deployed and the third was only alarmed, not on scene yet. The information about the third appliance is given in a short film (with subtitles) where the duty officer is briefed about the incident. One of the participants who answered the probe correctly even wrote down the note that the third fire appliance was only alarmed. Since it is important for the duty officer to know which fire appliances are on scene or still on their way, the conclusion was to keep the probe.

Probe P27 (Warmtebeeld geeft hitte met verschillende kleuren aan); 35.3% answered the probe correctly with true, 64.7% answered the probe incorrectly with false. After checking the probe with two experts the conclusion was to remove the probe, because its interpretation is ambiguous. The heat image camera can provide images in different colours, but the given images were only blue and black. Since black is not a real colour, the probe can be interpreted both ways.

Probe P30 (De container aan de loading dock is van Borgo); 41.2% answered the probe correctly with false, 58.8% answered the probe incorrectly with true. The trailer on the loading dock is form Bobo lifestyle not Borgo. After checking the probe with two experts the conclusion was to keep the probe, because even though it is a small difference, it is important for a duty officer to know that kind of trailer it is, what is inside of it and if and how it is going to influence the tactic or approach of the incident.

Results

At the end of this paragraph a concluding summary of the results will be given.

Overall view:

In Table 3 an overview has been given of the SA, bias and SSA scores. When checking for outliers and ensuring the assumption of normality, SSA and bias violated this assumption.

One participant had scored -6 for SSA, while all the other participants scored 31 or higher. The score of -6 of SSA was deleted, because it is lower than the mean minus three times the standard deviation. Two distinct groups in bias were identified from inspection of the data. Following the research of Catherwood et al. (2012), the two groups were classified using the measured bias score to define a 'positive-bias' (n = 13) and a 'negative-bias' (n = 38) group. After dividing the bias in the two groups, the assumption of normality was not violated anymore (Appendix C).

Table 3.
Overview SA, Bias and SSA (n=51).

Raw data	N	Mean	SD	Min	Max
SA	51	73.06	11.16	49	93
Bias	51	-31.59	59.33	-100	90
SSA	51	65.96	19.00	-6	98
Recalculated	N	Mean	SD	Min	Max
Positive bias	13	62.38	13.04	51	90
Negative bias	38	-63.74	23.17	-100	-19
SSA	50	67.40	16.15	31	98

Testing the hypotheses

For some hypotheses Pearson product-moment correlation coefficient or Spearman's Rho correlations were performed (Appendix D, E, F, G, H). For all correlations a preliminary analyses was performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. This was done by checking the skewness and kurtosis values, the Kolmogorov-Smirnov, inspecting the histogram, boxplot, detrended normal Q-Q plots, and residuals scatterplot.

H1: Situation awareness will be higher when a firefighter has more number of years of experience.

The average of total number of years of employment at the fire service is 24.3 years (M=24.33, SD=8.91) and varied between 7 and 41 years. There was no correlation found between SA level 1 and the total number of yours of experience in the fire service. There was a small, positive correlation between the SA level 2 fire as well as environment characteristics and total number of years of experience in the fire service. For SA level 3 building characteristic there was a small, negative correlation with total years of experience in the fire service. Also an one-way between groups analysis of variance was conducted to explore the impact of total years of employment for the fire service on SA level 1. Participants were

divided into three groups according to total years of employment for the fire service (Group 1: 20 years or less; Group 2: 21 to 29 years; Group 3: 30 years and above). An one-way between groups analysis of variance revealed no difference at the $p < .05$ level in SA level 1 scores for the three groups: F (2,48) = 0.48, p = .622. A Kruskal-Wallis Test revealed no difference in SA levels across the three different total number of years of experience groups. In summary, there is no correlation between years of experience and the perception of elements in the current situation, SA level 1. High levels of SA level 2, a better comprehension of the current situation, for fire and environment characteristics were associated with a high number of total years of experience in the fire service. A negative association was found between the number of total years of experience in the fire service and SA level 3 building characteristics, projection of future status of the building.

Looking at years of experience as a duty officer , the average of number of years of experience is 8.2 years (M=8.20, SD=6.37) and varied between less than 12 months and 26 years. There were no correlations between any SA and the number of years of experience as a duty officer. After dividing the participants into three groups (Group 1: 4 years or less; Group 2: 5 to 10 years; Group 3: 11 years and above) an one-way between groups analysis of variance was conducted to explore the impact of number of years of employment as a duty officer on SA level 1. There was no difference at the p < .05 level in SA level 1 scores for the three groups: F (2,48) = 0.25, p = .778. A Kruskal-Wallis Test revealed no difference in SA levels across the three different total number of years of experience groups, except for SA level 3 intervention characteristics (Gp1, n = 18: <= 4 years, Gp2, n = 16: 5-10 years, Gp3, n = 17: 11+ years), $\chi^2(2, n = 51) = 6.61$, p = .037. The middle years of experience group (5-10 years) recorded a higher median score (MD = 8.00) than the other two years of experience groups, which recorded median values of 4.50 for group 1 and 4.00 for group 3. In summary, no correlations where found between SA and number of years of experience as a duty officer, except for a difference in median scores in projection of the future status of intervention characteristics for the group with five to ten years of experience as a duty officer.

H2: Situation awareness will be higher for full-time duty officers than for retained duty officers.

An independent-samples t-test was conducted to compare SA level 1 scores for full-time and retained duty officers. There was no significant difference in scores for retained (M = 70, SD = 12.24) and full-time duty officers ((M = 73.80, SD = 10.91; t (49) = -0.97, p = .339, two-tailed). The magnitude of the difference in the means (mean difference = -3.81, 95%

CI: -11.72 to 4.11) was very small (eta squared = .02). For SA level 2 intervention characteristics also an independent-samples t-test was conducted to compare SA level 2 intervention characteristics for full-time and retained duty officers. There was no significant difference in scores for retained (*M* = 1.8, *SD* = 1.23) and full-time duty officers ((*M* = 2.98, *SD* = 2.01; *t* (49) = -1.77, *p* = .084, two-tailed). The magnitude of the difference in the means (mean difference = -1.18, 95% *CI*: -2.51 to 0.16) was very small (eta squared = .06). For the other SA level 2 characteristics and all five of the SA level 3 characteristics a Mann-Whitney U Test was executed. The Mann-Whitney U Test revealed no significant difference in SA level 2 and 3 characteristic levels of retained and full-time officers. In summary, no difference in SA was found between full-time duty officers and retained duty officers.

H3: Situation awareness will be higher when a duty officer has more incident experience.

A distinction between fives types of incident experience were made. The first type was training. There was no correlation found between SA level 1 and training. For SA level 2 different small, negative correlations were found with different types of training (Appendix E). For SA level 3 there was only a small negative correlation between fire characteristic and training large incidents (Appendix F). Overall, training has no association with perception of the elements, SA level 1, and training is negatively associated with comprehension of the current situation and projection of the future status of the fire.

The second type of experience was experience of actual incidents as duty officer. Only one correlation was found with SA level 1 and a fire in a building of (isolated) steel, a medium, negative correlation. Multiple statistically significant correlations with SA level 2 were found (Appendix E). For SA level 3 there were four statistically significant correlations (Appendix F). A negative association was found between experience of actual fires in a building of (isolated) steel as duty officer is and perception of elements, SA level 1. Looking at the five characteristics, a better comprehension of fire characteristics is associated with more experience with a fire in a building of (isolated) steel. The projection of the future status of the fire is negatively associated with experience with a fire in a storage/warehouse and more experience with a fire in a furniture of factory store. The comprehension of the building characteristics is negatively associated with experience of large incidents and experience with a fire in a storage/warehouse with a pointy roof. More experience with fires in a storage/warehouse with overhead doors is associated with a better projection of the future

status of the building. The comprehension of human characteristics is negatively associated with experience with large incidents, as well as a fire in a storage warehouse with or without a pointy roof. The experience with large incidents is also associated with the comprehension of the intervention characteristics, with more experience associated with better comprehension. Also more experience with a fire in a storage/warehouse and experience with fire near a port or waterway were associated with a better comprehension of the intervention. The projection of the future status of human as well as intervention characteristics is associated with more experience with incidents with two platoons or more. Experience with incidents with two platoons or more and more experience with fire in a storage/warehouse were associated with a better comprehension of the environment characteristics.

The third type of experience was specific incident experience compatible to the given scenario (SIE). There was no correlation found between SA level 1 and SIE. There was a medium, positive correlation between SA level 2 as well as SA level 3 intervention characteristics and SIE, and a small, positive correlation between SA level 2 environment characteristics and SIE. There was also a small, positive correlation between SA level 3 building characteristics and SIE. In summary, more specific incident experience compatible to the given scenario is associated with better comprehension of intervention and environment characteristics and also with a better projection of the future status of the building and the intervention.

The fourth type of experience was similar (compared to the given scenario)incident experience (SGE). There was a small, negative correlation between SA level 1 and SGE. There was a medium, positive correlation between SA level 2 intervention as well as environment characteristics and SGE. There was also a medium, positive correlation between SA level 3 building characteristics and SGE, and a small, negative correlation between SA level 3 human characteristics and SGE. Perception of elements is negatively associated with experience with similar incidents. More similar (compared to the given scenario)incident experience is associated with a better comprehension of the intervention and environment characteristics. It is also associated with a better projection of the future status of the building, but negatively associated with comprehension of the human characteristics.

The fifth and last type of experience was experience with large incidents (four fire appliances or more) (ELI). There was no correlation found between SA level 1 and ELI. There was a medium, positive correlation between SA level 2 intervention as well as environment characteristics and ELI. And there was a medium, positive correlation between SA level 3 intervention characteristics and ELI. In summary, more experience with large

incidents is associated with a better comprehension of the intervention and environment characteristics and a better projection of the future status of the intervention.

H4: The bias score will be (more) negative when a firefighter has a higher number of years of experience.

For both groups (positive-bias and negative-bias) no correlation was found with the total number of years of experience in the fire service. No correlation was found between the positive-bias and the number of years of experience as a duty officer. There was a medium, positive correlation between negative-bias and the number of years of experience as a duty officer. More years of experience as a duty officer is associated with a greater tendency to accept information as true even if false.

H5: The bias score will be (more) negative when a duty officer has more incident experience.

The first type of incident experience was training. No correlations were found between bias and training (Appendix G, H). For the second type, experience of actual incidents, a medium, positive correlation between positive-bias and large incidents was found. More experience with large incidents if associated with a greater tendency to reject information as false even if true. For the negative-bias group there was a medium positive correlation with completely burning down of a building, with high levels of negative-bias associated with more actual experience with completely burning down of a building. More experience with completely burning down of a building is associated with a greater tendency to accept information as true even if false.

The third type of experience was specific incident experience compatible to the given scenario (SIE). There was a strong negative correlation between the positive-bias and SIE. Specific incident experience is negatively associated with a more neutral attitude with a low tendency to reject information as false even if true. No correlation was found between negative-bias and SIE.

No correlations were found between bias and the fourth type of experience, similar (compared to the given scenario) incident experience (SGE), and bias and the fifth type of experience, experience with large incidents (four fire appliances or more) (ELI).

Additional research questions

R1: Is there a difference in situation awareness between duty officers who were also still active as firefighters or crew commanders and duty officers who were not?

The average, standard deviation and minimum and maximum scores of SA level 1 per group are shown in Table 4. An independent-samples t-test showed that there was no significant difference in scores for duty officers still being active (M = 72.63, SD = 14.42) and not being active as a firefighter ((M = 73.06, SD = 10.05; t (38) = 0.101, p = .920, two-tailed). For SA level 2 an independent-samples t-test showed also no significant difference in scores for duty officers still being active (M = 3.13, SD = 1.81) and not being active as firefighter ((M = 2.31, SD = 1.69; t (38) = -1.199, p = .238, two-tailed). For SA level 2 environment characteristics a Mann-Whitney U Test revealed a significant difference in scores for duty officers still being active (MD = 1.50, SD = 1.49) and not being active as firefighter (MD = 3.00, SD = 2.28), U = 65, z = -2.170, p = .015, r = .002. For the other 3 characteristics of SA level 2 the Mann-Whitney U revealed no significant difference in SA level 2 levels of between duty officers still being active and not being active as firefighter. For SA level 3 also an independent-samples t-test was conducted to compare SA level 3 intervention as well as environment characteristics and for the other three characteristics of SA level 3 a Mann-Whitney U Test was conducted. There was no significant difference in scores for level 3 SA for duty officers still being active or not being active as firefighter.

Table 4.
SA level 1 scores.

	N	Mean	SD	Min	Max
Active as Firefighter					
No	32	73.06	10.054	52	89
Yes	8	72.63	14.422	51	91
	N	Mean	SD	Min	Max
Active as Crew Commander					
No	30	73.40	10.575	52	93
Yes	13	73.79	12.202	51	91

An independent-samples t-test showed no significant difference in scores for SA level 1 for still being active (M = 74.69, SD = 12.20) and not being active as crew commander (M = 73.40, SD = 10.58; t (41) = -0.351, p = .727, two-tailed). Also an independent-samples t-test was conducted to compare SA level 2 intervention characteristics and there was no significant difference in scores for duty officers still being active (M = 3.08, SD = 1.85) and

not being active as crew commander *(M* = 2.43, *SD* = 1.72; *t* (41) = -1.104, *p* = .276, two-tailed). For SA level 2 a Mann-Whitney U Test revealed a significant difference in SA level 2 environment characteristics levels of duty officers still being active (*MD* = 2.00, *SD* = 2.30) and not being active as crew commander (*MD* = 3.50 *SD* = 2.17), *U* = 108, *z* = -2.342, *p* = .009, *r* = .000. For the other 3 characteristics of SA level 2 the Mann-Whitney U revealed no significant difference in SA level 2 levels of retained and full-time officers. For SA level 3 the independent-samples t-test s and Mann-Whitney U Tests revealed no significant difference of duty officers still being active and not being active as crew commander. In summary, in this research a difference is found between duty officers who were still active as a firefighter or crew commander and duty officers who were not. The difference, based in median scores, is that duty officers who were still active as a firefighter or crew commander have a lower comprehension of environment characteristics compared to duty officers who were not active as a firefighter or crew commander.

R2: Is there a difference in bias between full-time and retained duty officers?

The assumption of normality was violated for both positive-bias and negative-bias. A Mann-Whitney U Test could not be performed for positive-bias, because the groups were too small (retained *n* = 1 *MD* = 51, *SD* = not applicable, and full-time *n* = 12, *MD* = 61.50, *SD* = 13.14). A Mann-Whitney U Test revealed no significant difference in negative-bias levels of retained (*MD* = -76.00, *SD* = 29.95) and full-time duty officers (*MD* = -71.00, *SD* = 21.20), *U* = 123, *z* = -0.258, *p* = .807, *r* = .006.

R3: Will the bias score for duty officers who were also still active as firefighters or crew commanders be higher and positive (above 0) than duty officers who were not?

An independent-samples t-test revealed no significant difference in positive-bias scores for still being active (*M* = 57.00, *SD* = 8.12) and not being active as a firefighter (*M* = 68.71, *SD* = 14.06; *t* (9) = 1.507, *p* = .166). A Mann-Whitney U Test revealed no significant difference in negative-bias levels for still being active (*MD* = -73.50, *SD* = 28.15) and not being active as a firefighter (*MD* = -67.00, *SD* = 21.62), *U* = 49, *z* = -0.063, *p* = .482, *r* = .013. A Mann-Whitney U Test revealed no significant difference in negative-bias levels for still being active (*MD* = -73.50, *SD* = 23.76) and not being active as crew commander (*MD* = -74.00, *SD* = 20.78), *U* = 82, *z* = -0.610, *p* = .278, *r* = .007. An independent-samples t-test revealed a significant difference in positive-bias scores for still being active (*M* = 55.80,

SD = 7.53) and not being active as a crew commander (*M* = 71.67, *SD* = 12.80; *t* (9) = 2.430, *p* = .038). So duty officers who were not active as a firefighter or crew commander, have a greater tendency to reject information as false even if true, compared to duty officers who were still active as a firefighter or crew commander.

R4: Is there a difference in subjective situation awareness when a firefighter has less or more number of years of employment (experience)?

No correlation was found between SSA score and the number of years of experience. Also after dividing the participants into three groups according to total number of years of employment for the fire service or number of years of employment as a duty officer, the one-way between groups analyses of variance revealed no difference at the $p < .05$ level in SSA scores for the three groups of total number of years: F (2,47) = 0.21, p = .600, or the three groups of number of years as duty officer: F (2,47) = 0.690, p = .507.

R5: Is there a difference in subjective situation awareness when duty officer has more incident experience?

No correlations were found between SSA and the five types of experience.

R6: Is there is a difference in subjective situation awareness between full-time or retained duty officers?

An independent-samples t-test was conducted to compare SSA for full-time and retained duty officers. There was no significant difference in scores for retained (*M* = 67.11, *SD* = 12.63) and full-time duty officers ((*M* = 67.46, *SD* = 16.95; *t* (48) = -0.059, *p* = .953, two-tailed).

Additional analyses

Stepwise multiple regression

Several different correlations were found between experience and SA. A multiple regression will provide information about how well experience is able to predict SA and the relative contribution of each type of experience to SA. Preliminary analyses (like Durban-Watson) were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity. The stepwise multiple regression considered all types of experience plus the region of employment and level of education. For SA level 1 experience with a fire in a building of (isolated steel) was entered at Step 1, explaining 12.5% of the variance. After entry of experience with a fire in a storage/warehouse with overhead

doors at Step 2 the total variance explained by the model as a whole was only 18.0%, F (2, 34) = 4.95, p = .013. Fire in a storage/warehouse explained an additional 10.0% of the variance in SA level 1, R squared change = .10, F change (1,34)= 4.39, p = .044. The recorded beta values are shown in Table 4.

For SA level 2 fire, human and building characteristics no variables were entered into the equation. Only actual experience with large incidents was entered, explaining 12.3% of the variance in SA level 2 intervention characteristics, F (1, 35) = 4.92, p = .033. For SA level 2 environment characteristics only SGE was entered, explaining 16.7% of the variance, F (1, 35) = 7.03, p = .012. The recorded beta values are shown in Table 4. For SA level 3 intervention characteristics only ELI was entered, explaining 16.1% of the variance, F (1, 35) = 6.73, p = .014 with a beta value of 0.402. And for SA level 3 building characteristics, the control variable level of education was entered, explaining 21.9% of the variance, F (1, 35) = 9.81, p = .004 with a beta value of 0.468. A correlation test was conducted, there was a medium, positive correlation between the two variables, r = 0.468, n = 51, p < .001. This indicates that a higher level of education was associated with a higher SA level 3 building characteristics, a better projection of the future status of the building.

The stepwise multiple regression entered no, one or two variables that would explain the variance in SA. This shows that experience explains only a small part of the variance of SA between the duty officers.

Table 5.
Stepwise multiple regression

	Beta	*p*
SA level 1		
Fire in a building of (isolated steel)	-0.582	.004
Fire in a storage/warehouse with overhead doors	0.390	.044
SA level 2		
Intervention characteristics		
Actual experience large incident	0.351	.033
Environment characteristics		
SGE	0.409	.012
SA level 3		
Building characteristics		
Level of education	0.468	0.04
Intervention characteristics		
ELI	0.402	.014

Summary of the results

From the analyses it could be stated that the first hypothesis is partly confirmed. There is no association between years of experience as a duty officer and SA. There is also no association between years of experience and the perception of the current situation. Only for fire and environment characteristics, more total years of experience in the fire service seemed to lead to a better comprehension of the fire and its environment. And total years of experience in the fire service is negatively associated with the projection of the future status of the building.

The second hypothesis is not confirmed. No difference in SA was found between full-time duty officers and retained duty officers.

The third hypothesis is partly confirmed. The associations found between experience and SA were positive as well as negative (Appendix E,F). Remarkable is that training has no positive association with perception of the elements, and more training seemed to lead to less comprehension of the current situation and projection of the future status of the fire. Also remarkable is that all associations for SIE, SGE and ELI with comprehension of the intervention and environment in the incident were positive. SIE, SGE and ELI were measured with survey questions about how they think or feel about their experience. Apparently feeling that you have more experience, with specific, similar and large incidents, associates with a better comprehension of the intervention and environment of the incident.

The fourth hypothesis is confirmed for the number of years of experience as a duty officer. More years of experience as a duty officer is associated with a greater tendency to accept information as true even if false.

The fifth hypothesis is not confirmed. More incident experience with actual large incidents and specific incident experience compatible to the given scenario seemed to lead to a more neutral attitude with a low tendency to reject information as false even if true. Only having more experience with completely burning down of a building seemed to lead to a greater tendency to accept information as true even if false.

The additional research shows that in this research a difference is found between duty officers who were still active as a firefighter or crew commander and duty officers who were not. The difference, based in median scores, is that duty officers who were still active as a firefighter or crew commander have a lower comprehension of environment characteristics compared to duty officers who were not active as a firefighter or crew commander. There is no difference in bias or SSA between full-time duty officers and retained duty officers and there is no association between experience and SSA. Remarkable is that the bias score for duty officers who were also still active as firefighter or crew commander is only lower,

compared to duty officers who were not active as firefighter or crew commander, in the positive-bias group. Not as expected, duty officers who were not active as a firefighter or crew commander, have a greater tendency to reject information as false even if true and a greater to zoom in, compared to duty officers who were still active as a firefighter or crew commander. And at last, that a higher level of education seemed to be associated with a better projection of the future status of the building.

Discussion

The main research question was: *What is the effect of experience on Situation Awareness (of duty officers of the fire service from the Netherlands)?*Five hypothesis and six additional research questions about situation awareness, bias and subjective situation awareness were proposed. Situation awareness was divided into three levels: the perception of elements in the environment within a volume of time and space (level 1), the comprehension of their meaning (level 2), and the projection of their status in the near future(level 3).

Discussion of the results, limitations and implications

Situation Awareness

Decision makers match previous experience to the current situation. A good match contributes to the three levels of SA and provides knowledge of relevant elements. Starting with years of experience, Catherwood et al. (2012) stated that their results confirmed that firefighters' experience is linked to better SA, but that it is not significantly related. The results from this research did not confirm this. More years of experience seemed not lead to a better perception of elements (SA level 1), and on top of that the results show that more years of experience were not linked to a better perception of elements and a less suited projection of the future status of the building. More years of experience in the fire service do lead to a better comprehension of the fire and its environment. Which makes sense. The more years of experience, the more fires you have seen and the better you will understand the meaning of a fire and its environment. Overall, more research should be done to see if years of experience is actually linked to SA.

Catherwood et al. (2012) also found that the mean SA score for full-time firefighters was higher than the SA score of retained firefighters, but the difference was not significant. The mean SA score for full-time duty officers in this research was slightly higher than the SA score of retained duty officers. Nevertheless, it can be stated that there is no difference in

perception, comprehension or projection of future status of SA between full-time duty officers and retained duty officers.

Looking at the five types of experience, results showed that training did not lead to a better perception of the elements. Training even seemed to lead to a lower comprehension of the current situation and a lower projection of the future status of the fire. This is remarkable, training did not lead to a better understanding of a real fire or the projection of the future status of the fire. Is it the training that does not truly cover the characteristics of a real fire, or does it even undermine the characteristics of a real fire? More research should be done to see if the training (in the Netherlands) might lead to a lower comprehension of the current situation and a lower projection of the future status of the fire and what can or should be changed about the training to change and improve this link with SA.

Also striking is that all associations for specific incident experience compatible to the given scenario(SIE), similar (compared to the given scenario) incident experience (SGE) and experience with large incidents (4 fire appliances or more) (ELI) with comprehension of the intervention and environment of the incident were positive. SIE, SGE and ELI were measured with survey questions about how they think or feel about their experience. Apparently believing that you have more experience, with specific, similar and large incidents, associated with a better comprehension of the intervention and environment of the incident. There was a difference between years of experience, the number of incident experience and the subjective experience of the duty officer and its association with SA. These results showed that it is crucial, for future research, to make a clear definition of experience and that for decision makers who deal with high risk and low frequency events, years of experience do not cover the entire concept of experience.

Bias

Catherwood et al. (2012) reports that most firefighters showed a negative bias (the tendency to accept information as true even if false) and that there was a significant difference between the negative bias and positive bias group. The results of this research partially confirmed this. Most firefighters showed a negative bias, but no significant difference could be found between the groups. Possibly due to the low number of participants. However, contrary to the non-significant results of Catherwood et al. (2012), more years of experience as a duty officers seemed to lead to a greater tendency to accept information as true even if false. The same goes for having more experience with completely burning down of a building. But more experience with large incidents and incidents compared to the scenario seemed to lead to a more neutral attitude with a low tendency to reject information as false even if true.

A striking finding was that in this research duty officers who were not active as a firefighter or crew commander, seem to have a greater tendency to reject information as false even if true and a greater tendency to zoom in, compared to duty officers who were still active as a firefighter or crew commander. Noteworthy is that this is based on the median scores of the bias scores in the two groups. As firefighter or crew commander it is their job/duty to focus on the fire and to zoom in, the duty officer has to be able to zoom in, but most certainly zoom out. Maybe, still being active as a firefighter or crew commander while being a duty officer gives a clearer distinction between the mean focus of the different tasks per roll. It is interesting to investigate if this tendency is really there and why duty officers, who were not active (anymore) as a firefighter or crew commander show the tendency to zoom in on the fire.

The results confirmed the critical aspect about bias tendencies of firefighters. Displayed bias tendencies may well be only appropriate for the particular situation it is measured in. Investigation of bias tendencies would seem critical to understand the factors that influences these tendencies and if these tendencies are consistent over time and place.

Subjective Situation Awareness

In the decision making process the decision maker matches the current situation to an experienced situations. The quality of this match influences the confidence the decision maker has in the decision (s)he makes. Subjective situation awareness had no relation with experience in this research. The results did confirm that there was no difference in subjective situation awareness between full-time or retained duty officers, or between duty officers who were also still active as firefighters or crew commanders and duty officers who were not.

Other limitations and implications

An important limitation of this study was the small sample of duty officers. Even though all the participants of the training weeks of the pilot participated in the study, the sample size was 51 duty officers. This was a limitation, especially for researching differences between groups. This researched cannot be generalized to the duty officer population of the Netherlands. The participants work in four (out of the twenty-five) different regions and they applied to join the pilot study. This means that there is no random selection and the research might be biased. Also the retained duty officers were underrepresented, compared to the population of duty officers in the Netherlands.

Another important observation that should be made is that FireMind is still in development. The basis is well founded, but this was the first time it was used for research in

the Netherlands. There was also only one Dutch scenario. More research will have to be done with this scenario and other Dutch scenario's to confirm validity.

During the training week, where this research was conducted, also a knowledge test was taken by the participants. Results of this test showed that 55.09% of the questions about the summary of characteristics of safety were answered correctly. More than half of the questions about fire and human characteristics were answered correctly, but less than half of the questions about building, environment and intervention characteristics were answered correctly. Taking these results into account, could it be knowledge about the characteristics that contributed to the variance in situation awareness between duty officers? Investigation of the link between knowledge about the characteristics and situation awareness seems critical to develop a more complete model with factors that affect situation awareness. On a further note, the association between level of education and the projection of the future status of the building is interesting to research further. Is there a link between level of education and situation awareness and what is its effect?

This research can be a big steppingstone for future research about experience on the fire ground. It showed that just the number of years of experience is not sufficient for professions with high risk, low frequency incidents. Subjective incident experience seems to be a better indicator for experience of duty officers of the fire service in the Netherlands. Also the way the fire service organises their training should be evaluated when looking at its contribution to situation awareness. To answer the main research question: a small percentage of the variance in situation awareness can be explained by difference in experience. There is a relation between situation awareness and experience of the fire service, it all depends on how you define experience.

References

Arendtsen, B., Baker, S., Bertels, M., Brookes, D., Catherwood, D., Christiansen, K., Cuypers, W., Edgar, G.E., Krawczynska, S., Maes, V., Sallis, G., Stegienko, K., Thoelen, F., Van Craubex, G., Vastmans, J., Vorenkamp, F., Weewer, R. & Wenarski, G. (in press). FireMind: Trialling a new Tool for Training Fire and Rescue Service Decision-making.

Burke, E. (1997). Competents in Command: Recent R&D in the London Fire Brigade. *Journal of Managerial Psychology , 12* (4), 261-279.

Catherwood, D., Sallis, G., Edgar, G., & Medley, Q. (2011). Scoping and bias in the fireground: a new approach to understanding fireground 'situation awareness'. *Fire* , 27-9.

Catherwood, D., Edgar, G., Sallis, G., Medley, A., & Brookes, D. (2012). Fire alarm or false alarm?!: Situation awareness and decision-making "bias" of firefighters in training exercises. *International Journal of Emergency Services , 1* (2), 135-158.

Cohen, M.S., Freeman, J.T. , & Wolf, S. (1996). Meta-cognition in time stressed decision making: recognizing, critiquing and correcting. *Human Factors, 38*, 206-219.

Dow, M., Garis, L., & Thomas, L. (2013). Reframing Situational Awarness within the Fire Service Culture. University of the Fraser Valley.

Drillings, M., & Serfaty, D. (1997). Naturalistic Decision Making in Command and Control. In C. Zsambok, G. Klein, C. Zsambok, & G. Klein (Red.), *Naturalistic Decision Making* (pp. 71-80). Mawhaw, Ney Jersey: Lawrence Erlbaum Associates, Publishers.

Dubé, R. (2008). *Situational Awareness Ensures a Safe Operation.* Retrieved at november 5th, 2016, from http://www.firefighternation.com/article/firefighter-safety-and-health/situation-awarenss-ensures-safe-operation

Edgar, G., Catherwood, D., Sallis, G., Brookes, D., & Medley, A. (2012). "I always know what's going on." Assessing the Relationship between Perceived and Actual Situation Awareness accros Different Scenarios. World Academy of Science, Engineering and Technology 71.

Edgar, G.K., Catherwood, D., Baker, S., Sallis, G., Bertels, M., Edgar, H.E., Driton, N., Buckle, S., Goodwin, C. & Whelan, A.. (in press). QASA: Modelling and Measuring Situation Awareness using Signal Detection Theory.

Endsley, M. (1995a). Towards a Theory of Sitation Awarennes in Dynamic Systems. *Human Factors: the journal of the human factors and ergonomics society , 37* (1), 32-64.

Endsley, M. (1995b). Measurement of Situation Awareness in Dynamic Systems. *Human Factors: the journal of the human factors and ergonomics society , 37* (1), 65-84.

Endsley, M. (1997). The Role of Situation Awareness in Naturalistic Decision Making. In C. Zsambok, G. Klein, C. Zsambok, & G. Klein (Red.), *Naturalistic Decision Making* (pp. 269-284). Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers.

Geertsema, T.P., Hazebroek, J.C., & Groenendaal, J. (2015). *Situationele commandovoering bij de brandweer. Deelrapport commandotype*. Arnhem: Brandweeracademie.

Gasaway, R. (2007). Making Intuitive Decisions Under Stress: Understanding Fireground Incident Command Decision-making. International Fire Service Journal of *Leadership and Management. , 1* (1), 8-18.

Groenendaal, J., Helsloot, I., & Brugghemans, B. (2014). Het benutten van onderzoek naar Naturalistic Decision Makind (NDM). *Management & Organisatie* (4), 5-23.

Groenendaal, J. (2015). *Frontline Command.* Den Haag: Boom Uitgevers: Eleven International Publishing.

Hagen, R., & Witloks, L. (2014). *The Basis for Fire Safety.* (First edition ed.). Arnhem: Instituut Fysieke Veiligheid.

IOOV. (2011). *Brand Chemie-Pack Moerdijk.* Den Haag: Minesterie van Veiligheid en Justitie.

Kahneman, D., & Klein, G. (2009). Conditions for intuitive expertise: a failor to disagree. *American Psychologist , 64* (6), 515-526.

Klein, G., Calderwood, R., & Clinton-Cirocco, A. (1986). Rapid Decision Making on the Fire Ground. *In the proceedings of the Human Factors and Ergonomics Society Annual Meeting. 30*, (pp. (6), 576-580).

Klein, G., Calderwood, R., & Clinton-Cirocco, A. (2010). Rapid Decision Making on the Fire Ground: The Original Study Plus a Postscript. *Journal of Cognitive Engineering and Decision Making , 4* (3), 186-209.

Lipshitz, R., Klein, G., Orasanu, J., & Salas, E. (2001). Focus Article: Taking stock of Naturalistic Decision Making. *Journal of Behavioral Decision Making , 14* (5), 331-352.

NVBR. (2011). *Leerarena Moerdijk.* Nederlandse Vereniging voor Brandweerzorg en Rampenbestrijding.

NRC (2012). Retrieved at december 16th, 2016, from https://www.nrc.nl/nieuws/2012/10/25/chemie-pack-alles-was-oke-de-brandweer-faalde-12568826-a312667

Omroep Brabant (2011). Retrieved at december 16th, 2016, from http://www.omroepbrabant.nl/?news/160263692/Reacties+op+onderzoek+brand+Chemie-Pack+Vernietigend+en+schokkend.aspx

Pennington, N., & Hastie, R. (1993a). Explaning the evidence: Tests of the story model for juror decision making. *Journal of Personality and Social Psychology , 62* (2), 189-206.

Pennington, N., & Hastie, R. (1993b). Reasoning in explanation-based decision making. *Cognition , 49*, 123-63.

Pennington, N., & Hastie, R. (1988). Explanation-based decision making: effects of memory structure on judgement. *Journal of Experimental Psychology: Learning, Memory, and Cognition , 14* (3), 521-533.

Perry, N., Wiggins, M., Childs, M., & Fogarty, G. (2009). Decision Support For Competent and Expert Firefighters. *Conference Proceedings of the 8th Industrial and Organisational Psychology Conference.*, (pp. 101-105).

Rasmussen, J. (1983). Skills, rules and knowledge; signals, signs, and symbols, and other distinctions in human performance models. *Systems, Man and Cubernetics, IEEE Transactions* (3), 257-266.

Serfaty, D., MacMillan, J., Entin, E., & Entin, E. (1997). The Decision-Making Expertise of Battle Commanders. In C. Zsambok, & G. Klein (Red.), *Naturalistic Decision Making* (pp. 233-246). Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers.

Useem, M., Cook, J., & Sutton, L. (2005). Developing Leaders for Decision Making Under Stress: Wildland Firefighters in the South Canyon Fire and Its Aftermath. *Academy of Management Learning & Education , 4* (4), 461-485.

Zsambok, C. E. (1997). Naturalistic Decisoin Making. Where Are We Now? In C. Zsambok, K. G., C. Zsambok, & G. Klein (Red.), *Naturalistic Decision Making* (pp. 3-16). Mahwah, Ney Jersey: Lawrence Erlbaum Associates, Publishers.

Appendix

Appendix A: protocol for measurement, developed beforehand (in Dutch)

Validiteit + maatregel

Bedreigers van validiteit	**Maatregel**
Statistische validiteit; is het verband statistisch significant?	
Steekproefomvang	Alle deelnemers van de trainingsweek van de pilot doen mee (n = 60)
Lage betrouwbaarheid	
Interne validiteit; is er geen schijnverband?	
History	Alle deelnemers volgen hetzelfde lesprogramma, meet moment is elke keer op de dinsdag.
Rijping	Geen effect, er is 1 meetmoment.
Testeffecten	Er is geen voormeting, deelnemers hebben FireMind nog niet eerder ingevuld Vragen over ervaring volgen na FireMind.
Instrumentatie	Interactie met selectie; er kan sprake zijn van een plafondeffect, naar verwachting zitten de meeste deelnemers aan de top van schaal als het aan komt op jaren ervaring. Ervaring wordt daarom op meerdere manieren gemeten; jaren, aantal incidenten en met constructen.
Selectie	Alle deelnemers van de pilot doen mee Deelnemers pilot zijn niet a select.
Uitval	Uitval is mogelijk door het niet deelnemen aan de trainingsweek, in principe doen alle aanwezige deelnemers van de pilot mee aan het onderzoek.
Onvoldoende scheiding tussen groepen	Deelnemers worden geïnstrueerd latere deelnemers niet over het onderzoek te vertellen.
Waargenomen verschil tussen groepen	Alle deelnemers van de pilot/trainingsweek doen mee aan het onderzoek en het onderzoek vindt elke keer plaats volgens het meetprotocol, er is geen verschil tussen de groepen.
Regressie naar het gemiddelde	Er is geen sprake van matching of blocking.
Externe validiteit; geldt het resultaat ook buiten de onderzochte groep?	
Interactie van testeffecten en interventie	Er is geen voormeting, deelnemers hebben FireMind nog niet eerder ingevuld Vragen over ervaring volgen na FireMind.
Interactie van selectie en interventie	De groep is samengesteld op basis van de deelnemers aan de trainingsweek van de pilot. Hierdoor zullen de resultaten niet klakkeloos te generaliseren zijn.

Interactie van situatie en interventie	Simulatie: in een ‘afgesloten’ lokaal scenario op scherm eigen scherm met toets schermen tussen computers/deelnemers tijdsdruk door beperkte antwoordtijd vaste plattegrond voor indeling tafels

Constructvaliditeit; betrouwbaarheid, operationalisatie (inhoud, criterium, construct)	
Antwoordtendenties	Constructen moeten beoordeeld worden op een 7-punts Likert schaal, waarbij alleen bij de uiterste waarden een betekenis wordt gegeven.
Sociale wenselijkheid	De deelnemers worden van te voren kort en globaal ingelicht over wat ze gaan doen; een scenario met vragen erover en een algemene vragenlijst, het daadwerkelijk doel (relatie SA en ervaring) van het onderzoek krijgen ze pas na afloop te horen.
Respondentrollen	De antwoorden worden anoniem verwerkt, het is geen toets of beoordeling en de deelnemers weten het daadwerkelijke doel van het onderzoek niet van te voren.
Effecten onderzoeker in interactie met respondent	Meetprotocol: van te voren is vastgelegd wat er aan de deelnemers wordt verteld

Betrouwbaarheid + maatregel

Bedreigers van betrouwbaarheid	**Maatregel**
Uitleg vooraf > beïnvloeding focus door vragen inhoud	Vragen vooraf mogen gaan over het programma, niet over de inhoud
Uitleg ELO > door verschil in pijlen kunnen stukken overgeslagen worden	Uitleg vooraf, briefje bij laptop over verschil pijlen
Geen internet	Andere locatie Papierversie
Laptop functioneert niet	Reserve laptop Wachten totdat iemand anders klaar is en dan maken Papierversie
Wifi functioneert niet	PowerPoint presentatie met alle vragen FireMind getimed Antwoorden op papier
Construct ervaring	De constructen worden gerandomiseerd
Vragen worden overgeslagen (= missing data)	Online: force response Papier: van te voren benadrukken dat ze alles moeten beantwoorden

- **Betrouwbaarheid:** is er precies, nauwkeurig gemeten

Opzet

Standaard scenario

Aankomst op maandag, de dag voor het eerste meetmoment:

- Leslokaal bekijken
- Indeling bepalen en plattegrond maken
- Tafelschermen uittesten
- Verlengsnoeren bepalen
- Laptops checken
- Wifi instellen
- Link naar qualtrics klaar zetten
- Internet testen

Dinsdag meetmoment:

- Leslokaal inrichten naar plattegrond
- Laptops opstarten

Presentatie

- Voorstellen + korte uitleg onderzoek
  - Lisan Bomhof
  - Student Conflict, risico en veiligheid, een psychologie master aan de Universiteit Twente
  - Afstudeerstage Brandweeracademie
  - Meelopen met de pilot
  - Onderzoek bij de deelnemende OVD's pilot
  - Onderzoek van belang voor mijn afstuderen, maar ook voor de pilot
- FireMind
  - Meet omgevingsbewustzijn
  - Jullie krijgen een scenario te zien met vragen daarover
  - Sommige vragen zijn tijdsgebonden, dit wordt voor aanvang van die vragen genoemd.
  - Aparte vragenlijst met algemene vragen erachteraan
- Algemene vragenlijst
  - Alles zo waarheidsgetrouw invullen en als je het niet exact weet, dan bij benadering.
  - De link staat in de map Onderzoek op het bureaublad
- Laatste dingen
  - De resultaten worden voor mijn onderzoek anoniem verwerkt. Er wordt wel om je deelnemersnummer gevraagd, maar dat is voor de pilot en het terug koppelen van de resultaten.
  - Graag alleen op je eigen scherm kijken, afkijken heeft geen zin want het is geen beoordeling!
  - Het is geen beoordeling, er is geen goed of fout, puur jouw ervaring
  - Vragen voor nu over programma, niet over de inhoud!
  - Nabespreking: achteraf mogen vragen gesteld worden als iedereen klaar is: vragen over de inhoud
- Verzoekje
  - Vertel je collega's die nog op training komen NIET over het onderzoek! Dit beïnvloed de resultaten.
  - Bij voorbaat dank!

- Achteraf: mijn onderzoek
    - De relatie tussen ervaring en omgevingsbewustzijn bij officieren van dienst van de brandweer in Nederland
        - Ervaring in jaren
        - Ervaring in incidenten
        - Ervaring in verschillende functies
        - Ervaring in opleidingen/bijscholingen
    - Je eigen omgevingsbewustzijn met een paar weken op de mail!
    - Contact: lisan.bomhof@ifv.nl / commandovoering@ifv.nl

Alternatieve scenario's
Geen internet of slecht internet

- vastgesteld op maandag tijdens diner > contact locatie of verbetering mogelijk is
- vastgesteld maandagavond na 20.00 uur of geen verbetering mogelijk > verhuizen naar hoofdgebouw en daar de locatie voorbereiden
- vastgesteld dinsdagochtend bij aanvang onderzoek > papierenversie

→ Op meetmoment 1 waren er problemen met het internet bij aanvang van het onderzoek. Het onderzoek heeft toen op de dinsdagavond plaatsgevonden. Er is gebruik gemaakt van de papierenversie. Op de andere meetmomenten is alles volgens protocol verlopen.

Plattegronden (foto's)
Leslokaal 1 - Firemind

Leslokaal 2 -
Afname algemene vragenlijst

Appendix B: Survey for background information

Algemene vragen
U bent een..
- man
- vrouw

Wat is uw leeftijd?

Bij welke veiligheidsregio bent u werkzaam?
- Drenthe
- Gelderland Zuid
- Kennemerland
- Haaglanden

Dienstjaren en functies
Welke repressieve functie(s) oefent u op dit moment uit of heeft u in het verleden uitgeoefend? Graag startjaar en eindjaar invullen, open laten wanneer niet van toepassing.

	Beroeps - startjaar	Beroeps - eindjaar	Vrijwilliger - startjaar	Vrijwilliger - eindjaar
Manschap Bevelvoerder Officier van Dienst				

Heeft u, naast uw repressieve functie, ook nog (een) andere functie(s)? (meerdere antwoorden mogelijk)
- Manager veiligheid
- Medewerker operationele voorbereiding
- Medewerker opleiden en oefenen oefencoördinator
- Operationeel manager
- Ploegchef
- Specialist operationele voorbereiding
- Specialist opleiden en oefenen
- Strategisch manager
- Tactisch manager
- Geen
- Anders, namelijk.. _____

Opleiding/bijscholing
Wat is uw hoogst voltooide (burger) opleiding? (diploma behaald)
- MAVO
- HAVO
- VWO (atheneum)
- MBO
- HBO
- WO
- PHD
- Anders, namelijk _____

Welke brandweeropleidingen heeft u allemaal voltooid? (diploma behaald) (meerdere antwoorden mogelijk)
- Manschap A (voorheen brandwacht 2e klasse, brandwacht 1e klasse)
- Manschap B (voorheen hoofdbrandwacht)
- Bevelvoerder (voorheen onderbrandmeester, brandmeester)
- Officier van dienst (voorheen adjunct hoofdbrandmeesters)
- Hoofdofficier van dienst (voorheen hoofdbrandmeester)
- Master of crisis & disaster management / Master of crisis & public management

Welke specialismes heeft behaald? (diploma behaald) (meerder antwoorden mogelijk)
- Adviseur gevaarlijke stoffen
- Brandweerduiker
- Centralist meldkamer
- Chauffeur
- Controleur Brandpreventie
- Docent
- Duikploegleider
- Gaspakdrager
- Instructeur
- Medewerker brandpreventie
- Meetplanleider
- Specialist brandpreventie
- Specialist risico's en veiligheid
- Verkenner gevaarlijke stoffer
- Voertuigbediener
- Geen
- Anders, namelijk _____

Heeft u de afgelopen 5 jaar nog **opleidingen** gevolgd? Zo ja, welke?
- Nee
- Ja _____

Hoeveel uur opleiding volgt u gemiddeld per jaar?
- 0 – 10 uur
- 10 – 20 uur
- 20 – 30 uur
- 30 – 40 uur
- 40 – 50 uur
- 50 – 60 uur
- 60 – 70 uur
- 70 – 80 uur
- 80 – 90 uur
- 90 – 100 uur

Heeft u de afgelopen 5 jaar nog **bijscholingen** gevolgd? Zo ja, welke?
- Nee
- Ja _____

Hoeveel uur bijscholing volgt u gemiddeld per jaar?
- 0 – 10 uur
- 10 – 20 uur
- 20 – 30 uur
- 30 – 40 uur
- 40 – 50 uur
- 50 – 60 uur
- 60 – 70 uur
- 70 – 80 uur
- 80 – 90 uur
- 90 – 100 uur

Oefenen
Hoe vaak heeft u de afgelopen jaar de volgende incident(types) geoefend? (als u het niet meer exact weet, dan bij benadering. niet = 0)

	Aantal
Groot incident (brand, HV of OGS) (3 TS'en)	
Zeer groot incident (brand, HV of OGS) (4 TS'en)	
Inzet twee of meer pelotons (brand, HV of OGS) (vanaf 8 TS'en)	
Brand in een opslaggebouw of loods ZONDER gevaarlijke stoffen (m.u.v. asbest)	

Inzet

Hoe vaak heeft u de afgelopen jaar de volgende incident(types) meegemaakt? (als u het niet meer exact weet, dan bij benadering. Niet = 0)

	Aantal
Groot incident (brand, HV of OGS) (3 TS'en)	
Zeer groot incident (brand, HV of OGS) (4 TS'en)	
Inzet twee of meer pelotons (brand, HV of OGS) (vanaf 8 TS'en)	

Per grootschalig incident, over hoeveel TS had u het commando als OVD? (als u het niet meer exact weet, dan bij benadering. Niet = 0)

	Aantal incidenten
2 TS'en	
3 TS'en	
4 TS'en	
5 TS'en	
6 TS'en	
7 TS'en	
8 TS'en	
9 TS'en	
10 TS'en	
Anders, namelijk	

Hoe vaak heeft u de afgelopen jaar incidenten meegemaakt met de volgende factoren; (als u het niet meer exact weet, dan bij benadering. Niet = 0)

	Aantal
Brand in een opslaggebouw of loods	
Brand in een gebouw opgetrokken uit staal of geïsoleerd staal	
Brand in een opslaggebouw of loods met puntdak(en)	
Brand in een meubelfabriek of meubelwinkel	
Brand in een opslaggebouw of loods met overhead deuren	
Een afbrandscenario	
Brand nabij een haven of waterweg	
Brand met een extreme hoeveelheid publiek (groter dan 250)	

Constructen
Voorbeeld:

- Constructen: specifieke incident ervaring: het zijn ervaringen die exact (1 op 1) te projecteren zijn op het voorliggende scenario

Positief	**Negatief**
SIE_09 Wanneer ik een brand in een opslaggebouw of loods opgebouwd uit staal of geïsoleerd staal met puntdak en een grote brandlast herken, neem ik voor mijn gevoel automatisch een besluit.	SIE_01 Ik moet vaak terugvallen op procedures, omdat ik te weinig ervaring heb met opslaggebouwen opgebouwd uit staal of geïsoleerd staal met puntdak en een grote brandlast.
SIE_02 Ik vind dat ik voldoende ervaring heb op het gebied van afbrandscenario's bij een meubelfabriek of meubelwinkel opgebouwd uit staal of geïsoleerd staal met puntdak.	SIE_07 Ik heb een tekort aan ervaring op het gebied van afbrandscenario's bij een meubelfabriek of meubelwinkel opgebouwd uit staal of geïsoleerd staal met puntdak.
SIE_08 Ik neem gemakkelijk besluiten bij brand in opslaggebouwen opgebouwd uit staal of geïsoleerd staal met puntdak en een grote brandlast.	SIE_03 Een gebrek aan ervaring met brand in opslaggebouwen opgebouwd uit staal of geïsoleerd staal met puntdak en een grote brandlast, zorgt er voor dat ik mijn leiderschapsstijl moet aanpassen naar sturend op basis van regels en procedures.
SIE_04 Ik heb voldoende ervaring met branden in een opslaggebouw of loods opgebouwd uit staal of geïsoleerd staal met puntdak, met overhead deuren en een grote brandlast.	SIE_11 Ik heb een tekort aan ervaring met branden in een opslaggebouw of loods opgebouwd uit staal of geïsoleerd staal met puntdak, met overhead deuren en een grote brandlast.
SIE_05 Door het lezen van rapporten heb ik kennis opgedaan over het effect van bluswater nabij een haven of waterweg.	SIE_12 Bij een incident waarbij er een probleem is met bluswater nabij een haven of waterweg val ik terug op procedures om mijn besluit te nemen.
SIE_06 Ik ben vertrouwd met de procedures rondom een extreme hoeveelheid publiek (groter dan 250) bij een brand in 3 grote opslaggebouwen of loodsen opgebouwd uit staal of geïsoleerd staal met puntdak en met grote brandlast.	SIE_13 Wanneer ik een extreme hoeveelheid publiek (groter dan 250) bij een brand in 3 grote opslaggebouwen of loodsen opgebouwd uit staal of geïsoleerd staal met puntdak en met grote brandlast, moet ik mijn leiderschapsstijl moet aanpassen naar sturend op basis van regels en procedures.
SIE_10 Ik heb voldoende ervaring met incidenten waarbij een grote hoeveelheid water wordt gebruikt en een GWT in de haven afgelegd moet worden.	SIE_14 Ik heb een tekort aan ervaring met incidenten waarbij een grote hoeveelheid water wordt gebruikt en een GWT in de haven afgelegd moet worden.

- Constructen: soort gelijke ervaring (kip vs koeienstal): ervaringen waarbij één of meerdere zwaartepunten te projecteren zijn op het voorliggende scenario

Positief	**Negatief**
SGE_01 Oefenen draagt bij aan mijn ervaring met brand in een opslaggebouw of loods met grote brandlast.	SGE_06 Oefenen brengt geen verandering in mijn aanpak bij een brand in een opslaggebouw of loods met grote brandlast.
SGE_02 Ik heb voldoende ervaring op het gebied van branden in betonnen loodsen om effectief op te kunnen treden.	SGE_07 Ik heb een tekort aan ervaring op het gebied van branden in betonnen loodsen om effectief op te kunnen treden.
SGE_03 Wanneer ik een brand in een stalen doos herken, neem ik voor mijn gevoel automatisch een besluit.	SGE_08 Bij een brand in een stalen doos, val ik terug op procedures om mijn besluit te nemen
SGE_09 Ik neem gemakkelijk besluiten bij branden in een autobanden opslaggebouw/loods.	SGE_04 Ik moet vaak terugvallen op procedures, omdat ik te weinig ervaring heb met branden in een autobanden opslaggebouw/loods.
SGE_10 Ik heb voldoende ervaring met een brand in een meubelfabriek.	SGE_05 Als OVD ruk ik vaak uit voor een automaatje in een meubelfabriek.
SGE_11 Ik neem gemakkelijk besluiten bij een afbrandscenario.	SGE_12 Ik moet vaak terugvallen op procedures om besluiten te nemen bij een afbrandscenario.
SGE_13 Ik heb voldoende ervaring met een brand in een opslaggebouw of loods met overhead deuren.	SGE_14 Ik heb een tekort aan ervaring met een brand in een opslaggebouw of loods met overhead deuren.

- Constructen: ervaring met grootschalig optreden/commandovoering: ervaring met het commandovoeren over 4 of meer TS'sen tijdens een incident

Positief	**Negatief**
EC_01 Ik heb voldoende ervaring als verantwoordelijke commandovoerder bij een incident waarbij er 4 of meer TS'en zijn ingezet.	EC_03 Een gebrek aan ervaring met incidenten (4TS of meer) zorgt ervoor dat ik de verantwoordelijkheid vaak aan een andere OVD overdraag.
EC_04 Ik heb voldoende ervaring om het commando te voeren over 4 TS'en of meer bij een (zeer) grote brand.	EC_07 Ik heb een tekort aan ervaring om het commando te voeren over 4 TS'en of meer bij een (zeer) grote brand.
EC_06 In mijn regio heb ik regelmatig een incident waarbij ik het commando voer over 4 TS'en of meer.	EC_05 In mijn regio heb ik amper een incident waarbij ik het commando voer over 4 TS'en of meer.
EC_08 Tijdens een grootschalig incident (4 TS of meer) deel ik de verantwoordelijkheid met een HOVD.	EC_02 Tijdens een grootschalig incident (4TS of meer) leg ik de verantwoordelijkheid bij de HOVD neer.

Appendix C: Figures

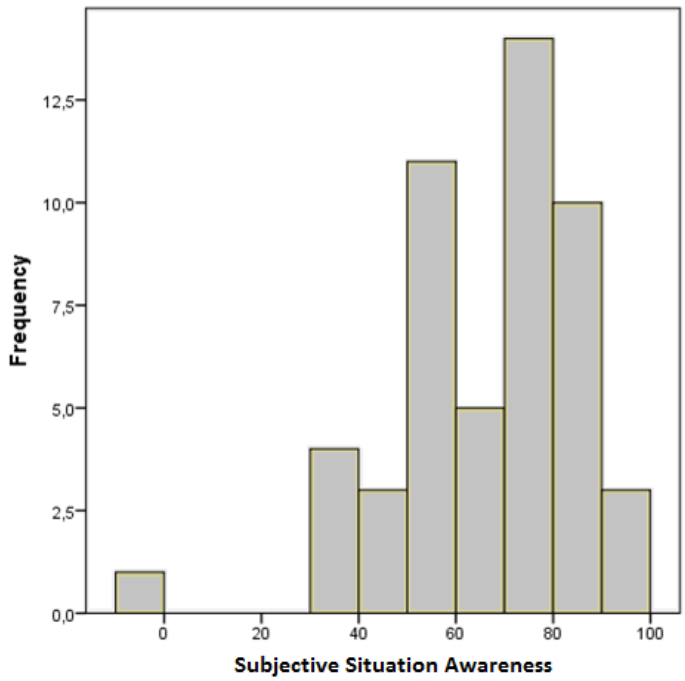

Figure:. A histogram of the SSA scores.

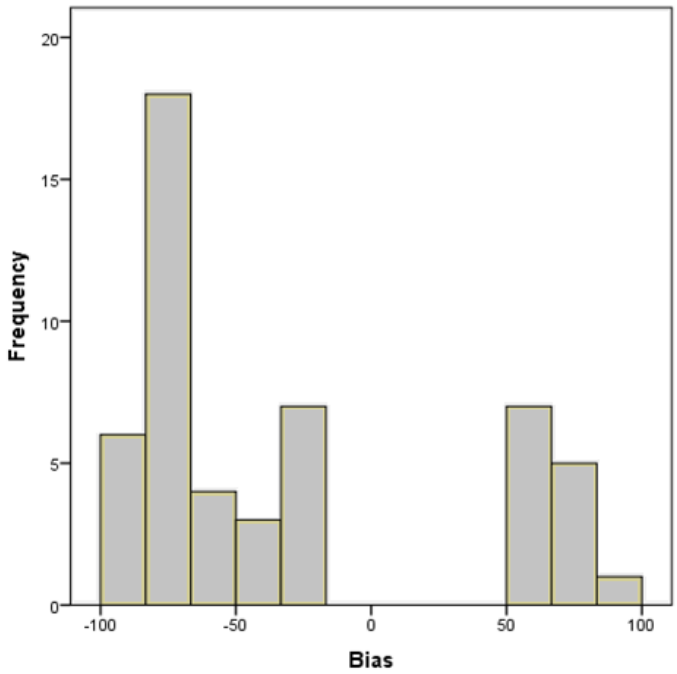

Figure: A histogram of the bias scores.

Appendix D: Table

Table

Correlation (one-tailed)between SA level 1 (n = 51), SSA (n = 50), positive-bias (n = 13), negative-bias (n = 38) and experience.

	SA	SSA	Positive-bias	Negative-bias
Years of experience				
Total years of fire service	*r* = -0.380	*r* = -0.016	*r* =0.398	*r* = -0.152
As duty officer	*r* = -0.102	*r* = 0.111	*r* = -0.193	*r* = 0.337*
Training				
Large incident	*r* = 0.017	*r* = 0.122	*r* = 0.145	*r* = -0.184
Extra large incident	*r* = -0.097	*r* = 0.023	*r* = 0.295	*r* = -0.201
2 platoons or more	*r* = 0.161	*r* = -0.136	*r* = -0.096	*r* = 0.246
A fire in a storage or warehouse (without hazardous substances)	*r* = -0.147	*r* = 0.142	*r* = 0.225	*r* = -0.026
Experience with actual incidents				
Large incident	*r* = 0.221	*r* = 0.180	*r* = 0.447*	*r* = -0.107
Extra large incident	*r* = -0.174	*r* = 0.072	*r* = 0.035	*r* = 0.0174
2 platoons or more	*r* = 0.073	*r* = -0190	*r* = -0.035	*r* = 0.080
Fire in storage/warehouse	*r* = 0.024	*r* = -0.003	*r* = 0.470	*r* = -0.232
Fire in a building of (isolated) steel	*r* = -0.354**	*r* = -0.065	*r* = 0.312	*r* = -0.011
Fire in storage/warehouse with a pointy roof	*r* = 0.050	*r* = -0.216	*r* = 0.158	*r* = -0.042
Fire in a furniture factory or store	*r* = -0.024	*r* = -0.024	*r* = -0.193	*r* = -0.195
Fire in storage/warehouse with overhead doors	*r* = -0.014	*r* = -0.213	*r* = 0.422	*r* = 0.104
Completely burning down of a building	*r* = -0.012	*r* = -0.089	*r* = 0.120	*r* = 0.332*
Fire near port/waterway	*r* = 0.077	*r* = -0.002	*r* = -0.036	*r* = -0.082
Fire with extreme amount of bystanders/audience	*r* = 0.186	*r* = 0.035	*r* = 0.192	*r* = -0.041
SIE	*r* = -0.097	*r* = 0.205	*r* = -0.570*	*r* = 0.023
SGE	*r* = -0.235*	*r* = 0.089	*r* = -0.226	*r* = 0.232
ELI	*r* = -0.053	*r* = 0.120	*r* = -0.291	*r* = 0.080

*Correlation is significant at the 0.05 level (one-tailed).

**Correlation is significant at the 0.01 level (one-tailed).

Appendix E: Table

Table
Pearson correlation (one-tailed)between SA level 2 and experience, n = 51.

	Fire	Building	Human	Intervention	Environment
Years of experience					
Total years of fire service	*r* = 0.252*	*r* = 0.107	*r* = -0.059	*r* = -0.138	*r* = 0.272*
As duty officer	*r* = 0.186	*r* = -0.006	*r* = 0.030	*r* = 0.074	*r* = 0.167
Training					
Large incident	*r* = -0.106	*r* = -0.256*	*r* = -0.009	*r* = -0.275*	*r* = -0.163
Very large incident	*r* = -0.053	*r* = -0.129	*r* = -0.014	*r* = -0.247*	*r* = 0.081
2 platoons or more	*r* = -0.204	*r* = -0.130	*r* = 0.001	*r* = -0.151	*r* = -0.333*
A fire in a storage or warehouse (without hazardous substances)	*r* = 0.023	*r* = -0.202	*r* = -0.232	*r* = 0.209	*r* = 0.200
Experience with actual incidents					
Large incident	*r* = 0.097	*r* = -0.253*	*r* = -0.308*	*r* = 0.351**	*r* = 0.139
Extra large incident	*r* = -0.075	*r* = -0.001	*r* = -0.065	*r* = 0.119	*r* = 0.114
2 platoons or more	*r* = -0.017	*r* = -0.010	*r* = -0.005	*r* = -0.126	*r* = -0.279*
Fire in storage/warehouse	*r* = 0.265*	*r* = -0.169	*r* = -0.245*	*r* = 0.279*	*r* = 0.287*
Fire in a building of (isolated) steel	*r* = 0.287*	*r* = -0.218	*r* = -0.130	*r* = -0.017	*r* = -0.060
Fire in storage/warehouse with a pointy roof	*r* = -0.158	*r* = -0.313*	*r* = -0.294*	*r* = 0.050	*r* = -0.060
Fire in a furniture factory or store	*r* = -0.133	*r* = -0.129	*r* = -0.155	*r* = -0.136	*r* = -0.101
Fire in storage/warehouse with overhead doors	*r* = 0.173	*r* = -0.230	*r* = -0.220	*r* = 0.165	*r* = 0.087
Burning down scenario	*r* = -0.008	*r* = -0.026	*r* = -0.180	*r* = -0.092	*r* = 0.026
Fire near port/waterway	*r* = 0.122	*r* = -0.029	*r* = 0.126	*r* = -0.252*	*r* = -0.164
Fire with extreme amount of bystanders/audience	*r* = 0.044	*r* = -0.149	*r* = -0.060	*r* = 0.085	*r* = -0.158
SIE	*r* = 0.037	*r* = 0.114	*r* = -0.014	*r* = 0.289*	*r* = 0.252*
SGE	*r* = 0.107	*r* = -0.019	*r* = -0.072	*r* = 0.424**	*r* = 0.409**
ELI	*r* = 0.070	*r* = -0.037	*r* = -0.196	*r* = 0.366**	*r* = 0.339**

*Correlation is significant at the 0.05 level (one-tailed).
**Correlation is significant at the 0.01 level (one-tailed).

Appendix F: Table

Table
Pearson correlation (one-tailed)between SA level 3 and experience, n = 51.

	Fire	Building	Human	Intervention	Environment
Years of experience					
Total years of fire service	r = -0.083	r = -0.245*	r = -0.062	r = -0.146	r = -0.148
As duty officer	r = -0.128	r = 0.064	r = -0.105	r = -0.052	r = -0.026
Training					
Large incident	r = -0.249*	r = -0.188	r = -0.007	r = -0.059	r = -0.112
Extra large incident	r = 0.033	r = -0.172	r = 0.117	r = 0.017	r = -0.034
2 platoons or more	r = -0.107	r = -0.180	r = 0.069	r = -0.214	r = -0.058
A fire in a storage or warehouse (without hazardous substances)	r = -0.096	r = -0.065	r = -0.163	r = 0.144	r = 0.135
Experience with actual incidents					
Large incident	r = -0.200	r = 0.126	r = -0.214	r = -0.041	r = 0.056
Extra large incident	r = -0.091	r = 0.059	r = -0.034	r = 0.279*	r = 0.117
2 platoons or more	r = -0.120	r = -0.136	r = 0.276*	r = -0.250*	r = -0.045
Fire in storage/warehouse	r = -0.256*	r = 0.125	r = -0.184	r = -0.010	r = -0.078
Fire in a building of (isolated) steel	r = -0.140	r = 0.183	r = -0.003	r = -0.016	r = -0.146
Fire in storage/warehouse with a pointy roof	r = -0.078	r = 0.214	r = 0.090	r = 0.086	r = 0.033
Fire in a furniture factory or store	r = 0.287*	r = -0.138	r = 0.149	r = -0.015	r = 0.106
Fire in storage/warehouse with overhead doors	r = -0.085	r = 0.263*	r = 0.023	r = -0.019	r = -0.063
Completely burning down of a building	r = -0.172	r = -0.149	r = 0.044	r = -0.112	r = 0.156
Fire near port/waterway	r = 0.202	r = -0.078	r = 0.211	r = -0.100	r = 0.030
Fire with extreme amount of bystanders/audience	r = -0.034	r = 0.028	r = 0.038	r = -0.005	r = 0.046
SIE	r = -0.018	r = 0.256*	r = -0.117	r = 0.330**	r = 0.047
SGE	r = -0.095	r = 0.323*	r = -0.244*	r = 0.190	r = 0.030
ELI	r = -0.128	r = 0.230	r = -0.050	r = 0.402**	r = 0.141

*Correlation is significant at the 0.05 level (one-tailed).
**Correlation is significant at the 0.01 level (one-tailed).

Appendix G: Table

Table

Correlations between positive-bias and training and type of incident experienced as duty officer.

Training	Pearson correlation (one-tailed)
Large incidents	$r = 0.145$, $n = 13$, $p = .319$
Extra large incidents	$r = 0.295$, $n = 13$, $p = .164$
A fire in a storage or warehouse (without hazardous substances)	$r = 0.225$, $n = 13$, $p = .230$
Experience with actual incidents	**Pearson correlation (one-tailed)**
Large incidents	$r = 0.477$*, $n = 13$, $p = .050$
Extra large incidents	$r = -0.126$, $n = 13$, $p = .341$
Fire in storage/warehouse	$r = 0.470$, $n = 13$, $p = .052$
Fire in a building of (isolated) steel	$r = 0.312$, $n = 13$, $p = .150$
Fire in storage/warehouse with a pointy roof	$r = 0.158$, $n = 13$, $p = .303$
Fire in a furniture factory or store	$r = -0.193$, $n = 13$, $p = .263$
Fire in storage/warehouse with overhead doors	$r = 0.422$, $n = 13$, $p = .075$
Completely burning down of a building	$r = 0.549$*, $n = 13$, $p = .026$
Fire with extreme amount of bystanders/audience	$r = 0.192$, $n = 13$, $p = .264$

**Correlation is significant at the 0.05 level (one-tailed).*

Appendix H: Table

Table

Correlations between negative-bias and training and type of incident experienced as duty officer.

Training	Pearson correlation (one-tailed)
Large incidents	r = -0.184, n = 38, p = .134
Extra large incidents	r = -0.201, n = 38, p = .113
2 platoons or more	r = 0.169, n = 38, p = .155
Experience with actual incidents	**Pearson correlation (one-tailed)**
Extra large incidents	r = 0.174, n = 38, p = .148
2 platoons or more	r = 0.155, n = 38, p = .176
Fire in a furniture factory or store	r = -0.192, n = 38, p = .123
Fire in storage/warehouse with overhead doors	r = 0.104, n = 38, p = .266
Completely burning down of a building	r = 0.332*, n = 38, p = .021

**Correlation is significant at the 0.05 level (one-tailed).*