

Analysis of Competing Hypothesis for Investigating Lone Wolf Terrorists

Lisa Kaati

Swedish Defence Research Agency
SE-164 90 Stockholm, Sweden
lisa.kaati@foi.se

Pontus Svenson

Swedish Defence Research Agency
SE-164 90 Stockholm, Sweden
ponsve@foi.se

Abstract—One of the most unpredictable forms of terrorism acts are those committed by a single individual, a so-called "lone wolf terrorist". The most difficult part in detecting a lone wolf is that they can come in any size, shape, and ethnicity and represent any ideology. However, there are some characteristic similarities that many lone wolves share. In this paper we identify three different areas where similarities among lone wolves can be found: the background and their behavior, the radicalization process and the terrorist planning cycle. We use an adoption of the analysis of competing hypotheses method where we introduce the notion of template hypotheses. A template hypotheses aims to capture similarities between different lone wolf cases. The hypotheses are continuously developed and cultivated into more detailed hypotheses that are specific for each individual. We outline how a computer-support tool for investigating lone wolf terrorists using this method could be implemented.

Keywords: lone wolf terrorism, analysis of competing hypotheses

I. INTRODUCTION

One of the most puzzling and unpredictable forms of terrorism are violent acts committed by single individuals, commonly referred to as lone wolves terrorists, which are extremely difficult to detect and to defend against. The definition of a lone wolf terrorist is someone who commits violent acts of terrorism in support of some group, movement, or ideology, but does so alone and not as a part of an organized group. The problem of lone wolf terrorism is growing and is presently a greater threat towards society than organized groups. All major terrorist attacks in the United States (except for the 2001 attacks against World Trade Center, the Pentagon and the White House) were executed by deranged individuals who were sympathetic to a larger cause — from the Oklahoma City bomber Timothy McVeigh to the Washington area sniper John Allen Muhammad. In Europe the situation is similar; several terrorist attacks have been executed by lone wolf terrorists, for example the murder of the Swedish Minister of Foreign Affairs Anna Lindh.

When intelligence services are investigating terrorist organizations and terrorist activities it can be done on a basis of the interception of telephone calls and e-mail. It is also common to infiltrate organizations. However, a lone wolf who plans to commit a terrorist act rarely reveals the details of their plans to anybody. This makes it impossible for the police and

the intelligence community to prevent such terrorist attacks. Recently, it has been observed that the internet is becoming a platform for lone wolves to express their views. The 2010 suicide bomber in Stockholm was for example active on the internet and had a youtube account, a facebook account and searched for a second wife on Islamic web pages. The radicalization process of the Stockholm suicide bomber could possibly have been identified through an analysis of the data that could be found on the internet.

The problem is that it is impossible for analysts to manually search for information and analyze all data concerning radicalization processes of possible lone wolf terrorists. It is equally impossible to produce fully automatic computer tools for this. However, computer-based support tools that aid the analysts in their investigation could enable them to process more data and this investigate more possibilities of radicalization.

In this paper, we use the fact that there are some characteristic similarities that many lone wolves share. We identify three different areas where similarities among lone wolves can be found: the background and their behavior, the radicalization process and the terrorist planning cycle. We present an adaptation of the analysis of competing hypotheses (ACH) method. We use the notion of template hypotheses to capture these similarities and we reason about them using ACH. These template hypotheses are continuously developed and cultivated into more detailed hypotheses that are specific for each individual. The hypotheses are used in a framework for a computer-support that can be used for detection and investigation of lone wolf terrorists.

This paper is outlined as follows. In Section II we define a lone wolf terrorist and describe some of the characteristics regarding their background and behavior that lone wolves share. We also describe the notion of a radicalization process and the terrorist planning cycle, that can be used to detect signs that a lone wolf terrorist is planning a terrorist attack. Section III describe the process of analysis of competing hypothesis (ACH) and the adoption of template hypotheses. Section IV describes a framework that can be used to identify, reason and analyze about possible lone wolf terrorists. Finally, Section V concludes the paper with a discussion and some directions for future work.

II. LONE WOLF TERRORISTS

A lone wolf terrorist is a person that, as the name indicates, operates by themselves without a support organization. We use the same definition of the term lone wolf as [2]:

A lone wolf terrorist is a person who acts on his or her own without orders from or connections to an organization.

There are three major problem when detecting and identifying lone wolves. The first problem is that they do not need to communicate with others or include others in the planning or execution of their plots. The second problem is that they come from a variety of backgrounds and have a wide range of motivations. Some lone wolves are politically motivated, others are religiously motivated, some are mentally unstable and some are a little bit of everything. A lone wolf terrorist may identify or sympathize with extremist movements, but they are not a part of these movements. The third problem with lone wolves is that it is difficult to differentiate between those who intend to commit an actual crime and those who simply have radical beliefs but keep within the law.

A. Background and Behavior

Many lone wolves share characteristic similarities regarding their background and their behavior. Lone wolves are for example often interested in exploring extremist media on the Internet. It is also common that they publish their own manifestos on the Internet. An example of a lone wolf terrorist who used the internet is the anti-abortion activist Scott Roeder. Scott Roeder shot and killed the physician George Tiller 2009 in Kansas. Tiller was a well known doctor and he was one of the few doctors in the United States that performed late abortions. Before the attack, Scott Roeder wrote a column on an abortion critical web page where he expressed his views against abortion and especially against Tillers work. Another example of a lone wolf that was using internet to express his views is James Von Brunn also known as the Holocaust Museum shooter. Von Brunn was involved in a shooting that killed a security guard at the United States Holocaust Museum in 2009. Von Brunn was an anti-semitic white supremacist and he was in charge of an anti-Semitic website where he was able to express his views.

Other characteristic behavior for lone wolves is that they often have social problems and had a difficult childhood. A military connection is also common among lone wolf terrorists. Some lone wolves where refused to do military service for example Jared Loughner who shot a congresswomen in Arizona 2011. Others joined the military, like James Von Brunn who served in the United States Navy for fourteen years.

B. Radicalization Processes

A radicalization process is when an individual becomes more revolutionary, militant or extremist, While there is a lot of research on how individuals become radicalized in groups,

much less is known about how individual lone wolves become radicalized.

If we assume that a radicalization process develops over a period of time, there is a possibility to identify a pattern that is similar for all radicalization processes. This is done in [7] where an analysis of three famous American lone wolf terrorists is described. For the analyzed lone wolves, the author is able to establish similar patterns of psychology and development along a common timeline.

Apart from the patterns identified in [7], there are several other markers and indicators for a radicalization process. Examples are isolation, recent conversion to Islam, decision to travel abroad to countries involved in conflict for training and changes in personal behavior.

This pattern of behavior can be used to identify future lone wolf terrorists' radicalization activity and potentially enable law enforcement to prevent tragedies caused by lone wolf terrorists.

There are several external events that might influence and effect a radicalization process. For example an election, a royal wedding, a natural disaster, or an armed conflict could all serve as triggers that cause a potential lone-wolf terrorist to cross the border-line and commit an attack.

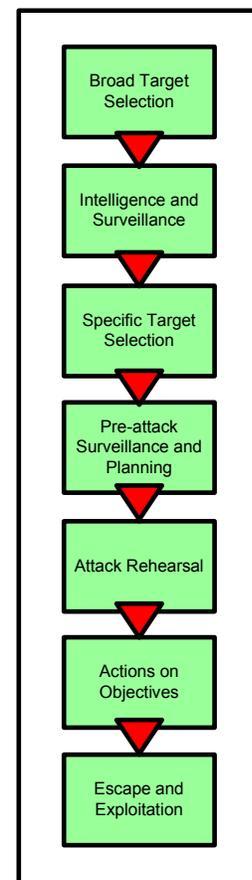


Figure 1. Terrorist planning cycle.

C. Terrorist Planning Cycle

To conduct a successful terrorist attack, a great amount of skills are necessary. For a lone wolf obtaining the necessary skills for an attack is a problem. This is one of the reasons why lone wolves rarely are suicide bombers — such an attack is much too complicated and involves too much preparation. One tool that can be useful when analyzing whether or not a lone wolf intends to commit an actual crime is the terrorist planning cycle. The terrorist planning cycle can be used to detect different phases that a lone wolf terrorist has to go through when planning an attack. It is not likely to identify all phases in the terrorist cycle but it can be useful for detecting signs of planning for an attack. Note that the terrorist planning cycle is used here as a tool for analyzing information about possible terrorists. This does not mean that the terrorist is aware of the terrorist planning cycle or follows it rigorously. However, the cycle contains phases that are needed in order to conduct a successful attack, and can thus be used as an heuristic aid in investigating possible terrorists.

The terrorist planning cycle consists of seven phases [9] as illustrated in Figure 1. Phase one is called the Broad target selection. In this phase information about possible targets are collected from a variety of different sources. Information can be open source and general information such as stories from newspapers and blueprints. In phase two information about the targets is gathered. This phase can be short or it can be conducted over a period of several years.

Phase three consists of selecting a specific target and during phase four the surveillance and actual planning is intensified.

In phase five rehearsals of the operation is conducted to improve the odds of success. Phase six is the stage of the operation where the odds favor a successful attack. Phase seven is called the Escape and Exploitation phase. Since exploitation is one objective of the operation it is important that the operation is properly publicized. Escape plans are usually well rehearsed and executed except for operations involving suicide attacks.

III. ANALYSIS OF COMPETING HYPOTHESES

When a possible lone wolf terrorist is identified we want to pose hypotheses regarding them and their behavior. To be able to do this we use a well known analysis method called analysis of competing hypotheses (ACH) [6], [8]. The method is used to evaluate multiple competing hypotheses for data that is observed and it is grounded in basic insights from cognitive psychology and decision analysis. Since the method is thorough it is suitable for controversial issues when an analyst wants to achieve traceability and the ability to show what he/she considered when arriving at their judgement.

ACH is an eight step procedure [1] that consists of the following steps.

1. Brainstorm possible hypotheses with other analysts. Consider the possibility that an opponent is trying to deceive you. Keep the number of hypotheses manageable.

2. Make a list of significant evidence for and against each hypothesis. Note the absence as well as presence of evidence.
3. Prepare a matrix with hypotheses across the top and evidence down the side. Analyze the "diagnosticity" of the evidence by marking which items are most helpful in judging the relative likelihood of alternative hypotheses.
4. Delete evidence and arguments that have no diagnostic value. Save all items in a separate list as a record of information that you have considered to obtain traceability. If others disagree with your assessment, they can be provided with this separate list.
5. Draw tentative conclusions about the relative likelihood of each hypothesis. Proceed by trying to disprove hypotheses rather than prove them. The hypotheses that are least likely are the ones that most time should be spent on since the one that is most likely is usually the one with the least evidence against it, not the one with the most evidence for it.
6. Analyze how sensitive your conclusion is to a few critical pieces of evidence. Consider the consequences for your analysis if that critical piece of evidence were wrong, misleading, or subject to a different interpretation.
7. Report your conclusions by discussing the relative likelihood of all the alternative hypotheses
8. Identify things in your report that the policymaker should look for that would alter your appraisal of the situation. Specify what it would take for you to change your mind.

A. Template Hypotheses Generation

The ACH method is used to generate a set of template hypotheses (or patterns) describing different behaviors that are related to lone wolf terrorism. The template hypotheses are created by experienced analysts. The analysts create the hypotheses with support from the available literature in the field and previous experience. When creating these hypotheses several issues need to be considered. The hypotheses are general since their function is to be used as templates. We use the identified characteristic similarities that many lone wolves share regarding their background and their behavior, the radicalization process and the terrorist planning cycle.

Figure 2 shows a simplified example of two template hypotheses. One of them is a hypothesis regarding characteristic lone wolf's background and behavior. The other is a hypothesis for an ongoing terrorist attack according to the terrorist planning cycle. The idea is to use these hypotheses as templates and continuously develop and cultivate them into more detailed hypotheses that are specific for each individual. The templates are only used in their general form initially. As soon as the analyst gain more knowledge about each possible lone wolf the hypotheses are cultivated and refined to suit each specific case.

The idea is that the analyst choose a set of suitable template hypotheses from a library of template hypotheses that are created using the three areas where there exists characteristic similarities for many lone wolves. As soon as more informa-

	Lone wolf background and behaviour
Military connection	
Manifesto	
Active in organizations	
Job	
Interest in extremist media	
Drug problem	
Difficulties when growing up	

	Lone wolf terrorist attack
Collection of material	
Screening of target	
Surveillance	
Practice	
Explosives	
Weapon	
Escape plan	

Figure 2. Two simplified examples to illustrate template hypothesis. The hypotheses are at the top and the evidence down the side. The left matrix is a hypotheses regarding the characteristics in background and behavior of lone wolf terrorists. The right matrix illustrates a hypotheses regarding a terrorist attack.

tion is acquired about each individual the template hypotheses are developed into more specified hypotheses.

IV. FRAMEWORK

In this section we present a framework that can be used to help analysts to identify and analyze possible lone wolf terrorists. When a possible lone wolf terrorist is identified a set of template hypotheses from a library is chosen. These hypotheses are continuously developed and cultivated into more detailed hypothesis specific for each individual. Then a process consisting of collecting information that confirm or refute the hypotheses is started. The process may continue for a long time period. The hypotheses and the information regarding them are continuously analyzed by a human analyst.

A. Identification

Possible lone wolf terrorists are identified by an analyst using traditional Internet searches, automatic search or by other means such as suggestions from the public. A possible lone wolf terrorist is someone that are suspected of going through a radicalization process or that express extreme views.

B. Hypotheses selection

A set of hypotheses are selected from a library of template hypotheses. These hypotheses are created by experienced analysts and stored in a library of hypotheses. The hypotheses

are quite general but specifically made for analyzing persons that might be likely to commit some kind of terrorist act or are planning to commit such an attack.

Each lone wolf terrorist candidate is connected to a set of hypotheses. The hypotheses are then developed and cultivated when more information and knowledge about the specific person is gained.

C. Collection

Information regarding the persons under observation is collected continuously. The information comes from a variety of heterogenous sources such as twitter, Facebook, weblogs, police reports, intelligence reports, tips and web forums. Some of the information can be collected automatically while other is gathered manually.

D. Analysis

Relevant information is linked by the analyst to hypotheses that it supports. As the analyst learn more about each individual the hypothesis are broken down into more specific statements until the statements become observable actions called indicators.

During the entire process, the ability to trace and show what the analysts considered when arriving at their judgement is present. The different hypotheses are used to aid judgment

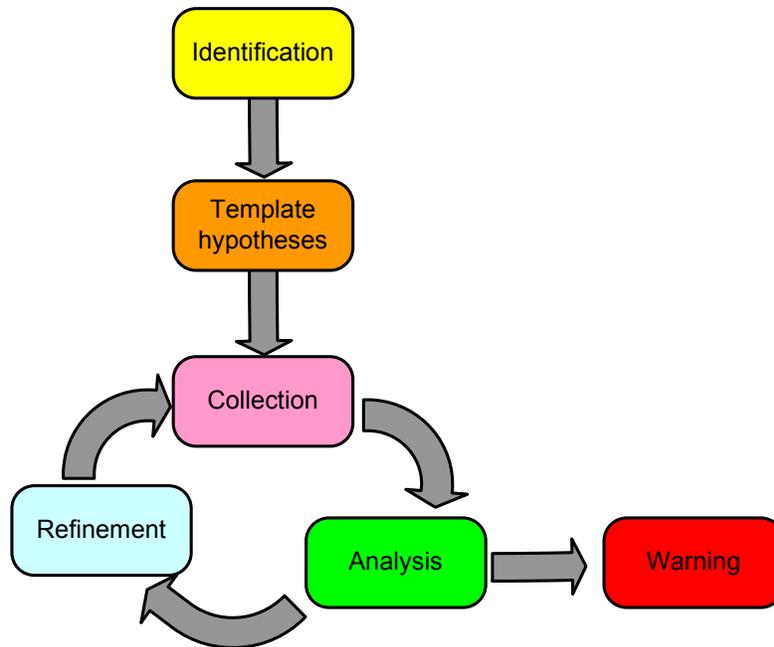


Figure 3. Mode of operation for the framework.

and help an analyst overcome some of the cognitive limitations that make prescient intelligence analysis extremely difficult to achieve.

When there is enough evidence that supports one or more of the hypotheses, the tool warns the analyst so that appropriate action can be taken.

V. DISCUSSION AND FUTURE WORK

In this paper, we briefly discussed the problem of investigating lone wolf terrorists using an adaptation of the analysis of competing hypotheses (ACH) method. We use template hypotheses to capture known characteristics of lone wolves. These template hypotheses then used as basis for analyzing possible lone wolves since they are continuously developed and cultivated into more detailed hypotheses that are specific for each individual.

The hypotheses are used in a framework for a computer-support that can be used for detection and investigation of lone wolf terrorists. We plan to integrate support for this in the Impactorium information fusion platform [4] for intelligence analysis developed by FOI.

For future work it would be interesting to implement the system and test if analysts finds it useful as tool for detecting and analyzing possible lone wolf terrorists. It would also be interesting to develop more methods for analyzing and predicting radicalization processes. If we assume that a radicalization process is chronological pattern with markers and observable indicators we can focus on predictive models for radicalization. One way to do this is to use methods from statistical relational learning (SRL) [5], to predict how likely it is that an individual will commit a terror act.

In [3] statistical relational learning is applied to a database of criminal and terrorist activity to predict attributes and event outcomes. These methods could be useful to predict outcomes of radicalization processes of possible lone wolves as well.

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