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PAPER

PSYCHIATRY & BEHAVIORAL SCIENCE

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Lone Actor Terrorist Attack Planning and Preparation: A Data-Driven Analysis*,†

ABSTRACT: This article provides an in-depth assessment of lone actor terrorists' attack planning and preparation. A codebook of 198 variables related to different aspects of pre-attack behavior is applied to a sample of 55 lone actor terrorists. Data were drawn from open-source materials and complemented where possible with primary sources. Most lone actors are not highly lethal or surreptitious attackers. They are generally poor at maintaining operational security, leak their motivations and capabilities in numerous ways, and generally do so months and even years before an attack. Moreover, the "loneness" thought to define this type of terrorism is generally absent; most lone actors uphold social ties that are crucial to their adoption and maintenance of the motivation and capability to commit terrorist violence. The results offer concrete input for those working to detect and prevent this form of terrorism and argue for a re-evaluation of the "lone actor" concept.

KEYWORDS: forensic science, lone actor terrorism, pre-attack behavior, attack planning and preparation, terrorism, threat assessment, leakage behavior, early-warning indicators

Groups perpetrate the vast majority of terrorist violence (1). Yet in recent years, counterterrorism practitioners and academics have paid increasing attention to lone actor extremism (2,3). Attacks such as those carried out by Anders Breivik in 2011 (77 fatalities) and Omar Mateen in 2016 (49 fatalities), as well as a rise in lone actor violence overall, raised the specter of a new dimension to the international terrorist threat (4,5). Without ties to larger groups and the communication signals that entails, preemptively detecting lone actor terrorists is perceived as a particular challenge by law enforcement and intelligence agencies (6–10). Based in part on unique primary sources, this article provides a detailed analysis of 55 lone actors' attack planning and preparation in Europe and North America in the 1986–2015 period, including specific attention for temporal aspects. The results help expand the burgeoning literature on lone actor threat assessment (11–13) and offer concrete input for those working to detect and prevent this form of terrorism.

On a definitional note, this article purposefully avoids using the term "lone wolf" because it is sensationalist rather than descriptive, hampering a dispassionate assessment of the phenomenon (14). Moreover, as later paragraphs will illustrate, the term's connotations of a singular, stealthy, and deadly attacker poorly describe the reality. For most of the individuals described in this study, the "lone wolf" moniker is simply not applicable and its use may perpetuate myths about these individuals' capabilities and modalities of attack planning and preparation that can hamper effective detection and interdiction efforts. Prototypical "lone wolves" such as Anders Breivik and Unabomber Ted Kaczynski are exceptional in terms of their social isolation and terrorist capabilities, rather than representative of a broader typology of terrorism.

Existing Research on Lone Actor Terrorists' Pre-Attack Behavior

Much has changed since Hamm wrote that lone actor terrorism was a "neglected field of research" (15). Data-driven studies have provided substantive insights into the background and characteristics of lone actor extremists (16–19). Some recent publications have focused specifically on lone actors' target selection preferences (20–23). But, "[t]here is not yet a distinct theme within the literature on lone actor terrorism that focuses specifically on attack preparation" (21). This does not mean, however, that previous work has not generated any insights into this aspect of the lone actor phenomenon. Lone actor extremist violence is generally described as the result of forethought and planning, with at least some form of preparatory conduct being observed (1,18,24). The attacks and their preparation tend to be relatively unsophisticated, owing to *inter alia* the smaller pool of resources and relevant skills that individuals have at their disposal (6,25,26). Firearms appear to be the weapon of choice, closely followed by the use of explosives (1,24,27–31). Reflecting their preference for easily obtainable and pragmatic types of weaponry, lone actors appear increasingly drawn to vehicular attacks, especially so in the Israeli context (30,32–34).

The relatively low sophistication of lone actor extremist attacks is also apparent in their choice of targets. People are the most commonly selected target, with civilians or the general

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public much more likely to be attacked than government officials or politicians, who are generally better protected (1,18,27,31,32,35). Lone actors appear to select targets early in the pre-attack process, shortly after grievance formation (21). The lower rate of attack completion (36) and lethality of lone actor attacks compared to group-based attacks (0.62 deaths per incident vs. circa 1.60 deaths per incident, respectively) may be another indicator of the former's general tendency to execute simple, straightforward operations (1). However, research has shown that context is key. Phillips highlights that lone actors in the United States are significantly more lethal in their attacks, and this may be due to the easier availability of firearms (37). In Europe, Breivik proved a very lethal terrorist who murdered 77 people. Moreover, some lone actors have shown an interest in using nuclear, chemical, biological, or radiological weapons of mass destruction, as well as suicide attacks (25,32,38,39).

These findings provide a general picture of lone actor attack planning and preparation but lack depth of detail. Especially for the purposes of detection and prevention, a finer-grained understanding of the various dimensions of lone actor preparatory behavior is essential (40). Before this article attempts to fill in some of these blanks, it is worthwhile to briefly review the literature on *group-based* terrorism pre-attack behavior to assess whether it can offer insights by proxy.

Insights From the Literature on Group-Based Terrorism

There is a small but growing literature that seeks to use knowledge of terrorist groups' modus operandi as the basis for "early warning indicators" that can then be incorporated in threat assessment work (41,42). Analyzing international and domestic terrorism in the United States between 1980 and 2004, Smith et al. (43) found that, on average, terrorist incidents are preceded by 2.3 activities that authorities register. Hamm's case study design concludes that even skilled terrorists leave clues to their violent intentions, either through poor criminal tradecraft or a desire to attain fame and notoriety (44). The potential to disrupt terrorist plots through such clues is not merely a theoretical possibility: Strom et al. (45) claim that over 80 percent of foiled terrorist attacks on American targets between 1999 and 2009 were initially discovered by law enforcement or the general public.

Acquiring a more detailed understanding of lone actors' attack planning and preparation is thus not merely an academic exercise, but one with the potential to concretely assist counterterrorism policy makers and practitioners. Such work is by no means straightforward, however. Tallying the number of "precursor acts" for 476 terrorist incidents in the United States, Smith et al. (36) found that cells or groups engaged in three times as many preparatory behaviors as lone actors. This underlines the importance of developing a detailed appreciation of how such attacks are planned and prepared, to maximize the chances of detecting and preempting them.

Assessing potential indicators of terrorist motivation or capability also requires an appreciation for contextual factors, both large and small. Suspects' ideological convictions are one relevant element in this regard, but research has also pointed, for instance, to the influence of socio-geography on terrorists' targeting and weapon selection preferences (46,47). More generally, terrorism seldom occurs in isolation from broader societal, economic, and (geo) political developments (48–50). Knowledge of the background against which a terrorist threat emerges can be crucial for correctly assessing the intentions and threats posed by individuals or groups of interest. A final relevant insight to draw from the literature on group-based terrorism emphasizes the importance of looking at capability as well as motivation. Only when the stated intent to use violence is associated with the means and preparations necessary to carry it out, does an actual risk of violence emerge (51).

Analytical Approach

To acquire a detailed understanding of lone actor attack planning and preparation, a codebook was developed that recorded both qualitative and quantitative data. This section briefly outlines the analytical approach, which underpinned the development of the codebook, before the modalities of data collection and coding are discussed.

One of the aims of the project from which the present research stems was to address a few of the limitations of prior risk factor or indicator-based analyses of terrorist events. Principally, that stable indicator-based "profiles" remain elusive as indicators appear to change between cohorts (52), that the number of indicators has continued to increase to the point of outstripping the number of subjects with what seems like marginal gains in understanding (53), and that the rationale behind selecting certain indicators over others has often been left to the reader to figure out (54). To tackle some of these issues, a risk analysis framework was developed, which drew from criminological research to identify the key categories of causal mechanisms and processes which characterize each phase of the lone actor extremist event and try to dispel some of the conceptual fuzziness surrounding key constructs (e.g., motivation).

An in-depth discussion of the framework and its development is beyond the scope of this study but is available elsewhere (55). With regard to attack preparation and planning, two related processes were identified as key to this phase of the event, meaning that disrupting either of these processes would disrupt the event altogether: *the emergence (and maintenance) of the motivation to act* and *the perception of the capability to act (successfully)*. Indicators that made up the codebook were inferred to be visible "flags," symptoms or markers of these key processes likely to be detectable by stakeholders, but with the understanding that in another time or place the specific markers (e.g., weapon type) may appear different, though their function (e.g., capability acquisition) remained.

The presence of both indicators of intent and capability was seen as a key way for overcoming the problem of false positives. While relatively many people might issue threats, especially online, and thus appear to have the motivation to commit an attack, an actual threat does not occur unless that motivation is matched to at least a rudimentary level of capability. Our analytical approach does not claim to be able to remove the false-positive problem when conducting threat assessment work, yet by matching a theoretically nuanced understanding of motivation and capability with a fine-grained empirical analysis, we aim to provide counterterrorism practitioners and others working in the realm of threat assessment with concrete guidance in this endeavor.

Motivation is understood here as an individual's goal-directed attention toward planning, preparing, and ultimately committing an act of terrorist violence. The motivation to harm or kill others and/or cause damage to property is commonly seen as the result of a complex process in which a variety of factors play a role (56,57). Within the aforementioned risk analysis framework, the emergence of motivation is understood as a situational process; in other words, motivation is not a stable individual characteristic,

but rather the outcome of the interaction between the person and the frictions present in his or her environment (58). The origin of these frictions can be more or less proximal, ranging from events such as the military interventions in Iraq and Afghanistan but also leader-follower interactions or personal historical events (59).

Moreover, the relative role of frictions may change over time. The factors that sparked an interest in violence are not necessarily the same ones that sustain the motivation to act through to the end of the event (60,61). It is precisely because motivation is a situational process that it is so sensitive to time and place and, once emerged, needs to be sustained, which brings us to the second, key process associated with attack preparation and planning. For motivation to be sustained beyond the initial perception of a temptation or provocation, a person has to perceive that they have the capability to carry out the action successfully. Without some sense that something is doable, most people will not be able to sustain the drive to action.

In the context of terrorist action, the acquisition of weapons and explosives is central to the development of capability, but this aspect of planning and preparatory behavior also has a cognitive dimension. For example, lone actor extremists need a basic level of technical proficiency and experience if weapons are to be used with some measure of effectiveness. Substantial numbers of (would-be) terrorists actually lack such skills (62). Hence, attempts to gain relevant knowledge and experience, for instance, through attending firearms courses or traveling abroad to participate in paramilitary training, could be important observable indicators of capability acquisition and (by extension) motivation maintenance and thus potential intervention points. Interrupt one or the other, and the event is disrupted.

Furthermore, the acquisition of capability also means overcoming innate moral barriers to harming and killing others, which may be accomplished through the internalization of extremist ideology or the viewing of materials that produce a desensitization to extreme violence (63). Research suggests that this state may be harder for lone actors to achieve than for extremists operating in groups, thus justifying an analytical view of capability acquisition that extends beyond a focus on weaponry and other material aspect of offense commission (17,64).

Hence, analytical attention to the acquisition and maintenance of the material and cognitive capability to carry out acts of violence also focuses attention on the role of social ties and external assistance. Although the term "lone actor" implies a high or even complete degree of autonomy, these individuals are in actuality seldom completely isolated (65). Contacts with other people, whether in "real life" or the online domain, can be crucial to the emergence and maintenance of both motivation and capability (66). Lone actors frequently seek some form of legitimization for the use violence from people they see as authority figures and might approach others to gain their (sometimes unwitting) help with the acquisition of the means or skills necessary to carry out an attack (18).

As stated, motivation and capability are understood as conceptually connected, whereby motivation may drive actions geared toward acquiring capability, while, reflexively, the actor's perception of their own capability to realize their intent successfully may impact whether their motivation is sustained over time. Because emergence of motivation and acquisition of capability are both temporal processes, indicators related to *time* especially were given pride of place in the study's codebook. Arguably, acts of political violence are rarely completely spontaneous. Most occur at the end of some lengthy process, even if the length of time elapsed between the earliest desire to commit an attack and its actual execution varies widely (36,43,67). This means that the study of lone actor attack planning and preparation should, where possible, also capture *when* behaviors occurred and what the duration of the various activities was.

Methodology

Coding Lone Actor Attack Planning and Preparation

Data on each of the 55 cases were first entered into a specially made Excel sheet to visualize the chronological progression of the various aspects of lone actors' pre-attack behavior and to provide qualitative information on this process. Second, this information was analyzed using a codebook based on the one that Gill et al. (18) used in their study of 119 lone actor terrorists. The codebook was tailored and expanded to focus specifically on attack planning and preparation in as much detail as possible, using insights from the broader literature on (lone actor) terrorist attack planning and the authors' previous work on this topic to do so.

The final version of the codebook contained 198 variables, all of which were linked to either the emergence and maintenance of motivation or the acquisition of the capability to commit an act of terrorist violence, as well as the temporal indicators associated with these processes. Its development followed an iterative process, whereby the qualitative information captured in the Excel sheet could lead to the inclusion of new variables as aspects of lone actors' pre-attack behavior materialized that were not expected a-priori. Naturally, any new or amended variables were applied retrospectively to all cases in the dataset. This approach ensured that the authors were not limited in their analysis to pre-existing notions about lone actor attack planning and preparation.

A straightforward coding scheme was used, consisting of "yes," "no," "unknown" or "does not apply." For those variables that captured temporal information, time was measured in months. For instance, when a certain event occurred 2 days prior to arrest, this was noted as "2/[total days in that month]." The first author was responsible for the coding task. Four research assistants provided help by gathering (additional) information on nine of the 55 cases, which the first author then incorporated into the codebook. No formal inter-rater reliability test was conducted, as the coding itself remained the first author's responsibility, who manually checked the data provided against the sources listed to assess its accuracy and whether it was coded in line with his own assessment of the case.

It should be noted that the availability and the accuracy of the information, particularly with regard to temporal aspects, was often less than ideal. In the best cases, the sources provided data that were precise down to the day. More frequently, sources would mention that a particular activity occurred "approximately a month before the attack," or that it took place "between 6 and 12 months" prior to the event. As a rule, whenever a period of time was provided, the earliest likely date was used. Whenever the available data conflicted, two steps were taken. First, the majority opinion was ascertained: which interpretation was published most frequently? Second, the quality and impartiality of the sources were scrutinized to judge their relative value. For instance, findings based on long-term investigative reporting were judged more reliable than short newspaper excerpts printed anonymously.

Case Selection and Data Collection

As it represents the most complete and detailed dataset of lone actor terrorists currently available, the 119 cases included in the 2014 study by Gill et al. formed the foundation of this study. Because of the particularly detailed nature of the codebook used for the examination of lone actor attack planning and preparation and the attempt to gain primary sources based information on at least a part of the sample, it was not possible to assess all 119 cases within the time available. Instead, the cases in the Gill et al. dataset were ranked according to how rich information was on the planning and preparatory phase of the event, which yielded an initial list of 43 individuals for which sufficient information was thought to be available. Two Canadian, one American, one Danish and eight Dutch cases were later added as they also appeared to offer the requisite level of detail on pre-attack behavior. In total, therefore, this article presents findings based on 55 cases of lone actor extremists (see Table S1).

The relative scarcity of lone actor extremist attacks and the difficulties associated with gaining access to privileged information, such as police files, make open-source information especially valuable. Yet, the accuracy and level of detail found in media-based publications can be a matter of concern (68–70). The authors would have preferred to utilize primary sources for the entire sample. Police files in particular can offer a level of detail and reliability usually not found in the public record. Unfortunately, requests for access to such sources proved unfeasible for legal reasons except in regard to five of the eight cases drawn from the Netherlands. In addition to the Dutch police files, the first author also conducted semi-structured interviews with Dutch police investigators and public prosecutors who worked on those five cases. To address the lack of similar access for the other 50 cases, the authors utilized biographies, autobiographical materials, and sentencing documents for all the other cases wherever possible (71–74).

The results presented in this article cover a cross-section of the lone actor threat as it occurred in Europe and North America over the 1978–2015 period, encompassing individuals driven by ideological convictions labeled as Islamist (38%), right-wing extremist (29%), anti-abortion (15%), antigovernment (5%), single-issue (4%), animal rights activism (2%), and "unclear"(7%). Of these individuals, 74% carried out an attack, which in 13% of the cases failed during its execution for a variety of reasons. The remainder were arrested while in advanced stages of attack planning and preparation. As most of the 55 cases predate 2011, the sample has little to say directly about the recent lone actor threat emanating from returning "foreign fighters," those citizens of Western countries who left to join Islamist terrorist groups in Syria and Iraq (75). This is one area where future research could make a substantial contribution to extant insights.

The designation lone actor extremist remains a subjective one. There is an ongoing debate on what constitutes a lone actor terrorist (26,76,77). A distinction can be made in the literature between definitions that focus on individual terrorists operating completely autonomously of extremist groups or networks (24), those that operate autonomously but do or did participate in such groups (18), and isolated dyads or even triads of individuals that operate jointly but lack ties to a larger extremist organization or movement (78,79). This article selected cases predominantly from the first of these categories and included cases from the second only when the attack itself appeared to be planned, prepared, and perpetrated by one particular individual. Dyads and triads were ruled out, because as soon as two or three people conspire to commit acts of terrorist violence, group dynamics come into effect that by definition rule out the lone actor label (65,80).

Some readers may look at the finding that most of the sample turned out to have social ties to other radicals, extremist, or terrorists and question why these individuals were included for analysis in the first place. It is therefore important to emphasize that this study builds upon a dataset of individuals *commonly seen* as lone actors and that the results which problematize this designation followed from the subsequent analysis. While case selection is likely to remain a topic of debate, the authors assert that the findings discussed below offer insights into lone actor attack planning and preparation that significantly add to the academic debate on this topic while simultaneously providing actionable information for counterterrorism practitioners.

Results and Discussion

The following discussion is organized into eight sections corresponding to broad categories of relevant factors. These are (i) lone actors' personal background, (ii) the social context in which they operated, (iii) attack planning and (iv) attack preparation, (v) operational security, (vi) so-called "leakage behavior," (vii) postpreparation activities, and (viii) any relevant-related activities. Rather than discussing all of the codebook's variables, the discussion is limited to those the authors deem to be most relevant. Finally, a Gantt chart is presented that visualizes the temporal aspects of lone actor attack planning and preparation. To provide an indication of the data quality per variable, the percentage of cases for which no information could be found is provided as the percentage "unknown." For an at-a-glance overview of the findings, see Table S2.

Personal Background

There is considerable consensus among academics that terrorism is not chiefly the outcome of mental health issues, personality profiles, or specific character traits, which is not to say such elements cannot play a role in bringing about involvement in this form of violence (81,82). Congruent with a focus on motivation emergence and capability, data collection on lone actors' personal backgrounds paid particular attention to prior involvement in crime and militancy. Most interestingly, 46% of our sample had a history of violent behavior, including domestic abuse and stabbing attacks (13% unknown). This is consistent with prior research suggesting that aggressiveness is often associated with increased likelihood of involvement in criminal violence (83) and recalls Della Porta's finding that prior experience of using violence for political means was a consistent background factor among the Italian terrorists of the 1970s and 1980s (84). Within a broader lone actor threat assessment framework, a history of violence is likely to be a reliable indicator of potential to carry out an attack, given that, across problem domains, one of the most reliable predictors of future violence is past violent behavior (41,85).

Social Context

Lone actor extremists are frequently seen as individuals who live an isolated existence and plan, prepare, and execute their acts of violence by themselves. The presumed isolation of lone actors in particular is thought to be one of the reasons why they pose a special challenge to police and intelligence agencies

(7,86). It is therefore notable that 62% of our sample turned out to have contacts with clearly radical, extremist, or terrorist (87,88) individuals (9% unknown). Moreover, 33% socialized with individuals who could be designated as leaders or authority figures within radical, extremist, or terrorist groups (16% unknown). Finally, 31% were recognized members or participants in radical, extremist, or terrorist groups at some point in their lives (4% unknown). Although their peers oftentimes described these individuals as on the fringes of these group, even marginal or passive participation in radical, extremist, or terrorist groups can have significant influences on the adoption and maintenance of the motive to commit acts of extremist violence.

As social learning theory, research on social identity, and research on the situational nature of criminal motivation shows (89,90), to hear others state that the use of violence is both effective and acceptable can be a powerful way of overcoming the societal stigma associated with such behavior and natural instinct not to perform such activities. The effect is increased when "role models" are present who through their own (past) use of violence can demonstrate that violence is a course of action worthy of emulation for reasons of efficacy or status. Indeed, identification with such violent role models, the warrior mentality to which they appeal and the weapons, paraphernalia, and clothing that are a part of it, has been highlighted as an important potential warning sign for impending violence (64). Participation in groups that condone or even actively support the use of force can thus contribute to overcoming moral barriers to the use of violence (91).

That the broader "radical milieu" matters, is given further emphasis by the finding that 78% of our sample were exposed to external sources of encouragement or justification for the use of violence (9% unknown) (92). These took the shape of ideological materials found both on and offline, as well as violent "role models" such as leading jihadist militants or infamous murderers of abortion providers accessed through those same media. Although such materials do not require any direct interaction to be found and consumed, these findings do underline that lone actors draw inspiration and emulation from the wider radical environment of which they were a part. In short, our findings suggest that social settings supportive of radicalism, extremism, or terrorism play an important role part in the commission of extremist events, even for those thought of as "lone" actors.

Our sample was primarily alone in the sense that, in the vast majority of cases, the ultimate decision to carry-through with an act of terrorist violence was theirs alone. In only two cases was there outside pressure or guidance to carry out an attack (93). A minority of lone actors were, however, found to have been the recipient of assistance during planning (16%) and preparation (29%) stages (11% and 7% unknown, respectively). Such outside help ranged from assistance with selecting targets or the provision of a postattack hideout, to guidance on creating explosives and other weapons. In short, while the majority of our lone actor extremists carried out their violent act alone, social ties played an important role in the emergence of motivation to commit violence and, in some cases, during the planning and preparation of these attacks.

Attack Planning

Activities in this category are focused on target selection and the elaboration of plans of attack, rather than on more practical necessities such as constructing explosives, which we have labeled attack preparation. A successful planning phase leaves (would-be) terrorists with a clear (albeit often implicit, rather than formally recorded) road map of the actions that need to be undertaken to carry out their attack (42).

For 71% of the lone actors studied, the (intended) attack was the result of at least a rudimentary planning process (11% unknown). Only 11% of these individuals decided to engage in violence spontaneously (for instance, upon spotting a suitable target of opportunity). When planning an attack, 36% of lone actors considered multiple targets (33% unknown). In a majority of cases, the planned and actual targets overlapped, providing another indication that lone actor extremist violence is generally premeditated rather than spontaneous. Owing the relatively "old" nature of the sample, the use of the Internet to acquire information on potential targets could only be confirmed in 11% of the cases (44% unknown). However, "real-life" target reconnaissance was conducted by 38% of the individuals in the sample (29% unknown).

We found that 60% of the individuals studied were influenced by one or more constraints during the target selection process (33% unknown). The majority of lone actor extremists weighed the pros and cons of the targets available to them. Constraints included target accessibility and degree of protection, but in some cases also encompassed distinctly personal factors, such as the likeliness that friends or family would be caught up in the attack. Research has indicated that the incidence of mental health problems is considerably higher among lone actor extremists than the general public and particularly pronounced when compared to group-based terrorists (16,94,95). Our findings support existing research which cautions that such findings should not be seen as providing a causal explanation for involvement in terrorism, as they suggest that such pathologies do not rule out the ability to engage in at least basic planning and cost-benefit analysis (1,18).

The decision to initiate attack planning was preceded by a clearly identifiable "trigger event" in 44% of the cases (22% unknown). This finding echoes research on the role of "cognitive openings," such as personal setbacks or seeing others successfully use violence, in bringing about involvement in radical or extremist groups (96). It suggests that the intention to commit violence or the belief that violence is justified is unlikely to be enough on their own to initiate the attack process. This is consistent with the view, long held in criminology, that propensity (belief in the legitimacy of violence; i.e., radicalization) and motivation to commit an act of violence are distinct concepts in the analysis of violence and that this distinction is a crucial one, inasmuch as preventing propensity acquisition and disrupting motivation emergence and maintenance require very different kinds of interventions (97).

Attack Preparation

Attack preparation relates to all those activities that must be undertaken to make an act of terrorist violence possible in a practical sense. This primarily concerns the acquisition or, as was often the case with regard to explosives, the construction of weapons. Preparation can also entail gathering the necessary funds or soliciting outside support, for instance, to acquire the necessary bomb-making skills.

Firearms were the weapon most frequently chosen by the lone actor extremists studied (62%), followed by attempts to construct explosive devices (44%; 2% and 4% unknown, respectively). Interestingly, attempts to make or acquire firearms and explosives were less frequently accompanied by activities aimed at

learning to utilize such weapons effectively. At 15% (7% unknown), relatively few lone actors had a background of (para) military training; only 35% of the individuals studied took firearms training and only 33% practiced shooting by themselves. These findings must be qualified by the fact that data on firearms training and shooting practice were unavailable in 29% and 33% of the cases, respectively. Still, this suggests that limited weapons-related expertise may account for the relatively lower lethality of lone actor attacks compared to group-based acts of violence. These findings support the notion of lone actors as, *on the whole* preferring, or being forced to adopt through their limited resources or know-how, relatively unsophisticated modes of attack (25).

Several aspects of the preparatory process are interesting precisely because they occurred infrequently. In only 13% of the cases studied did the individuals take steps to secure finances additional to existing sources of income (29% unknown). This once again underlines the relatively unsophisticated and consequently inexpensive nature of most lone actor extremist attacks. The data also show the unpopularity of incendiary devices, such as Molotov cocktails, which were present in only 13% of cases (2% unknown). While simple to construct, their relatively limited ability to (directly) inflict deadly physical harm may diminish their appeal. Most notably, only 11% of lone actors acquired a remote location specifically to conduct their preparatory activities (6% unknown). Lone actors' predisposition toward conducting preparatory activities at or close to their place of residence forms another potential point of detection and intervention, as bomb-making activities in particular have the potential to be noticed by other citizens (98).

We also considered whether weapons were acquired specifically for the (intended) attack. While 71% of explosives were created with violent intent in mind (4% unknown), only 47% of firearms were procured specifically for the purpose of an attack (13% unknown). Some individuals were simply fascinated by such weapons (99), used them for hunting or recreational shooting, while others had employed them for criminal acts unrelated to terrorism. While the acquisition of explosives is likely to be a sign of an impending attack, the procurement of firearms and other weapons may not be necessarily similarly revealing. This is particularly the case in countries where acquiring such weapons can be easily and legally achieved.

Operational Security and Leakage Behavior

Operational security includes behaviors that lone actors deliberately engage in to minimize their chances of detection while planning or preparing an attack. Leakage behavior, as defined by Meloy and O'Toole, refers to the behavior of (would-be) lone actors who intentionally or unintentionally divulge their motivation or capability to commit acts of violence, thus providing opportunities for early detection and intervention (100).

By far, the most surprising finding was the infrequency with which lone actors took operational security precautions. Only 26% took measures to maintain plot secrecy (18% unknown). The lack of often straightforward operational security procedures is surprising, given the degree of amateurism betrayed by such lapses. For instance, only 6% of the lone actors implemented data protection measures (7% unknown), leaving incriminating evidence such as bomb-making manuals in plain sight for the authorities. Likewise, only 24% of the individuals studied tried to hide weapons, explosives, or the precursor components necessary for the latter's construction (0% unknown). Most lone actors simply stored such materials in their place of residence.

It may be argued that the disregard for operational security stems from an intent to die during the attack itself. Such a desire for "martyrdom" would obviate the need to prevent the discovery of evidence during postattack investigation. Operational security measures, however, are just as important, if not more so, to prevent discovery by the authorities or general public during preparatory conduct. Utter disregard for the personal consequences of carrying out an act of terrorism means little if the attack is pre-empted. From the perspective of lone actor terrorists, operational security is thus crucial regardless of whether the aim was to survive the attack or perish during its execution.

With regard to leakage behavior, a striking 86% of lone actors communicated their radical or extremist convictions to others, be that family members, friends, colleagues, or strangers online (7% unknown). Of course, a much larger number of people will make such threats than those who actually follow through on them. From a threat assessment perspective, it is perhaps more interesting that 58% of the sample gave others the idea that they were involved in suspicious and potentially violent activities (7% unknown). A third of lone actors communicated a desire to commit an (as of yet) unspecified attack, for instance, by stating online that they "wanted to kill someone" (11% unknown). Moreover, 26% went so far as to divulge specific intentions, for example, that they were planning to kill a particular individual (7% unknown). A specific desire to cause harm was expressed offline in the majority of cases (71% vs. 29%), whereas unspecific desires to cause harm were shared online as much as offline (50%).

Almost half of all lone actors (49%) came in contact with the authorities during the planning and preparation phase (7% unknown). This does not mean that the police or intelligence agencies were necessarily aware of their extremist convictions or terrorist intent, however. Frequently, the individuals in our sample had a criminal record for transgressions unrelated to ideologically driven violence. More telling in terms of leakage behavior, 27% of lone actors were suspected of involvement in terrorism, *while* they were engaged in planning and preparatory activities (11% unknown). In other words, just under one-third of lone actors studied were already on the authorities' radar as potential terrorist threats.

Lone actors' generally poor operational security and their frequent tendency to engage in leakage behavior are both promising findings for detection and prevention purposes. Most of these individuals are not highly lethal and stealthy operatives. Inexperience, carelessness, and a desire for infamy render many vulnerable to drawing the attention of the authorities or other citizens. The obverse, however, is that those who *do* invest in operational security and avoid leakage behavior, such as Anders Breivik and Ted Kaczynski, are among the most dangerous lone actor terrorists. Thus, while the majority of lone actors present an essentially detectable and preventable threat, the most dangerous of them may be the hardest to find.

PostPreparation Phase

Research on the preparatory behavior of group-based terrorists has indicated that the completion of this phase might be marked by a sudden drop in activity (43). A postpreparation phase characterized by an absence of activity could function as a crucial final warning indicator, signaling that an attack is imminent and requiring immediate intervention by security forces. In 47% of

the cases, there was nothing to suggest that the finalization of attack planning and preparation led to a period of relative calm followed by the attack itself. For the remaining individuals, there was either no relevant data available or the question did not apply because they were apprehended before they could finish attack planning and preparation. The relatively poor data quality for this variable means that no definitive conclusion can be reached on whether a distinct "post-preparation phase" can form a part of lone actors' pre-attack behavior.

Related Activities

The last category in the codebook was designed to address a qualitative question: did the individual in question engage in any "related activities" that could strengthen suspicion regarding their motivation or capability to plan and prepare an attack? Such related activities are themselves not illegal or directly linked to preparation for violence but might provide a glimpse of an individual's worldview or an inkling of his or her social networks that can then function as a valuable piece in the threat assessment puzzle. Related activities were found in 53% of cases and fell into two broad categories (9% unknown). The most frequently noted related activity was involvement in right-wing extremist groups or movements, followed by involvement in (the radical fringe of) the anti-abortion movement in the United States. Interestingly, jihadist lone actors appear less likely to be or have been involved in groups that share their ideological beliefs.

Temporal Aspects of Attack Planning and Preparation

The Gantt chart in Fig. 1 shows the average duration of the various activities associated with the lone actor attack planning and preparation process for which more than one data point was available. With time given in months, it provides an overview of when activities began and how long they lasted, relative to the (intended) act of violence or the perpetrators' arrest, marked as "0 hour" in the chart. Because data on the duration of attack planning and preparation activities were not always available and frequently of undetermined accuracy, the chart should be treated as suggestive. Nevertheless, it provides insights into the temporal dimension of lone actors' pre-attack behavior that can hopefully be of both academic and practical relevance.

Most striking is that, on the whole, the various aspects related to attack planning and preparation begin months and even years before the actual attack or the suspect's apprehension. This once again suggests that lone actor extremists are on the whole not prone to strike on a whim but do so following a lengthy period in which their activities and leakage behavior renders them vulnerable to being found out and pre-empted. Of course, there can be stark differences between individual cases. But looking at Fig. 1 as representing the "average" build-up to a lone actor extremist event, several other points deserve to be raised.

With regard to the sequence of events, it appears that involvement in nonradical and subsequently radical milieus tends to occur first. Leakage behavior then follows suit, beginning with the espousal of convictions before moving on to intent. It is only after leakage has begun that most forms of preparatory conduct can be found. It seems that many lone actors develop a desire to do something and begin amassing the necessary means before that "something" is given particular thought. Alternatively, lone actor extremists may match intention to capability rather than the other way around. In other words, perception of capability may prove even more central to the emergence of motivation than our analytical framework already accounts for. Firearms and (para) military training appear as outliers because these findings are strongly associated with those few lone actors who have a military background.

While planning-related activities such as target selection take place closest to the attack itself, and frequently after attack preparation has begun, the development of the intent to use such violence occurs significantly earlier. This makes sense, as the emergence and maintenance of intent are crucial to the ability to prepare, and particularly to carry-through with, an actual attack. In those cases where pre-attack behavior is shielded through operational security measures, these tend to begin alongside

FIG. 1—*Duration of attack planning and preparation activities (from intended or executed attack; in months).*

preparatory activities. Again, this is logical, as the acquisition of violent means is the most revealing (and frequently illegal) step toward realizing a terrorist attack.

With the exception of threats issued to potential targets, which occurs on average some 5.2 months before the (intended) attack, leakage behaviors were found to occur years in advance of the planned act of violence and, in many cases, of the observance of operational security measures. Not only do lone actor extremists communicate their convictions and intentions for violence to others, but they start doing so on average years before they will strike. In other words, the detection and prevention of this form of terrorism do not necessarily depend on last-minute detection of motivation and capability, but can in theory take place at points in time when the individuals in question may still be dissuaded from pursuing violent plans in the first place.

Several activities are best seen as moments in time, rather than processes that occur over days, weeks, or months. These moments are indicated as small bars in the chart. The relative proximity of some of these moments to the execution of the (intended) attack makes them potentially potent signs that the individual in question is coming to the end of his or her planning and preparation activities and may therefore be almost in a position to strike. Particularly relevant from this perspective of proximity are receiving an order to carry out an act of violence (which was found to have occurred in only one case), composing a will or martyrdom video, (attempting to) purchase a ready-made explosive device, hiding evidence, and issuing threats to intended targets.

Conclusion

Most terrorist violence continues to be perpetrated by groups, yet the incidence of lone actor attacks is increasing, a development highlighted by a spate of lone actor terrorist violence in Europe and the United States during 2016 and 2017. Against this backdrop, and in light of the prevalent notion that lone actor extremists pose a threat that is particularly difficult to detect and pre-empt because of their lack of operational ties to co-conspirators, the present article utilized detailed empirical data to provide unique insights into these individuals' pre-attack behavior, including their temporal dimensions. The findings presented here offer law enforcement and security service personnel, as well as operationally oriented behavioral scientists and other consultants, actionable insights that can be used to perform or improve threat assessment procedures.

All policy is built upon assumptions. Should we persist in viewing the lone actor threat as a phenomenon characterized by socially isolated individuals who do not engage in any form of communication, we risk impeding our ability to effectively detect and address this danger. It is precisely the significant degree of social interaction between lone actors and broader radical milieus which re-opens avenues for detection and interdiction that may have been thought closed or unlikely to deliver. Four findings in particular underline the relevance of this study for the detection and prevention of lone actor terrorist violence.

- Lone actors tend to be poor at, or unconcerned with, operational security;
- They engage in leakage behavior that allows others to glimpse their convictions and violent intentions;
- The majority of lone actors do indeed maintain social ties that are crucial to the development of their motivation and capability to commit acts of terrorist violence;
- Temporal analysis indicates that most of the elements that are crucial to the planning and preparation of a lone actor terrorist attack begin months, if not years, beforehand, which suggests that law enforcement and security agencies need not necessarily rely on last-minute indicators of an impending strike but, given sufficient data and a correct analysis of contextual specifics, can engage in the early detection, interruption, and prevention of lone actor violence.

Furthermore, our findings join those of several other authors in challenging key aspects of the lone actor extremist phenomenon as portrayed in some of the academic and popular literature (101–103). Notably, the prevalence and role of social ties in the emergence and maintenance of theses individuals' motivation to act violently altogether problematize the ontological necessity of a discrete "lone actor" analytical category. It seems to us that the lone actor type has been built from exceptions, rather than from the majority of lone actor cases. Norwegian mass-murderer Anders Breivik, for instance, was a highly intelligent, patient, and lethal terrorist, well-aware of the need to maintain operational security and avoid any potential leakage behavior. Yet in these respects he did not represent lone actors in general, but distinguished himself from the ways in which this form of violence usually manifests itself.

Looking to possibilities for future research, we begin by reiterating our analytical stance. As well as sequencing indicators, we would argue that advancing the state-of-the-art, both scientific and practical, in this field requires explicitly tying indicators to meaningful causal mechanisms and processes. Given their inherent instability (markers can be expected to vary across ideological, geographical, and temporal contexts), indicator- (or risk factor) based risk assessment faces limitations that robust analytical models could help address. In addition, it would be worthwhile for future research on lone actor attack planning and preparation to attempt to overcome some of the limitations found in the present study, namely emphasis on pre-2011 cases and the strong empirical reliance on media reporting and other secondary sources.

Terrorist attacks executed by single attackers using relatively unsophisticated means to deadly effect are likely to remain a recurrent feature of the security landscape in Western states for the foreseeable future. Hopefully, this article and the approach to studying this phenomenon that it embodies will serve to inform discussion not only on the ways through which this form of violence can be prevented, disrupted, and mitigated, but also, more fundamentally, with regard to its defining features. Much work still needs to be done before the processes that lead to lone actor violence can be fully understood, but the results presented here can serve as a stepping stone in this process.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Case selection overview.

Table S2. Results overview.