

# Linguistic Analysis of Lone Offender Manifestos

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**Abstract**—The Internet and social media allow people to spread their views rapidly to a large group of people. While the right to freely express one’s ideas and views is a cornerstone in a democratic society, in some cases the Internet can serve as a breeding ground for violent extremism and terrorism. Hence, in order to protect democracy, effective techniques of Internet surveillance are needed. Previous research has shown that there is a connection between word use and psychological states. The text analysis tool Linguistic Inquiry and Word Count (LIWC) counts words in psychologically meaningful categories. Based on the relative frequency of words from the different categories, conclusions can be drawn about the author of for instance a blog text. In this work, we have explored the characteristics of written communication produced by ten different lone offenders prior to their engagement in targeted violence. We found eight possible indicators of the drives and emotions that preceded their attacks.

## I. INTRODUCTION

While most people use the Internet and social media for harmless interactions, communication and for finding information, it is also used as a propaganda tool by proponents of violent extremism and terrorism. It has been shown that the Internet has played a role in many terrorist attacks, such as in the 2009 Fort Hood shootings, the 2008 Mumbai attacks, and the 2004 Madrid bombings, as well as in various terrorist plots, including amongst the Netherlands’ Hofstad Group, and Colleen La Rose (Jihad Jane) and others plotting to murder the Swedish cartoonist, Lars Vilks [1]. When it comes to lone actors (or actors that engage in terror with little assistance from others), the role of the Internet is even more important, since all kinds of information that might be important for planning a terror attack can be found online, hence there is no longer any need for accomplices [2]. Lone actors are doubtlessly a serious threat against the security of the society. Three of the worst terrorist attacks in the history of the US (the 9/11 attacks not included) were conducted by lone actors or at least actors with little assistance from others [3]. Since many lone actors signal their upcoming attack [4] before it takes place, analyzing and understanding potential signals in written communication (e.g. manifestos) is important for countering and preventing terrorist attacks conducted by lone actors.

Warning behaviors are defined in [5] as any behavior that “precedes an act of targeted violence, is related to it, and may, in certain cases, predict it”. There are eight different warning behaviors described in [5] namely (i) pathway warning behavior, (ii) fixation warning behavior, (iii) identification warning behavior, (iv) novel aggression warning behavior, (v) energy

burst warning behavior, (vi) leakage warning behavior, (vii) last resort warning behavior and (viii) directly communicated threat warning behavior. Warning behaviors can be viewed as indicators of increasing or accelerating risk of committing targeted violence.

Some of these warning behaviors have already been identified as potentially observable in social media [6]. In this work we focus on the *leakage warning behavior* that we hereafter will refer to as leakage. Leakage is the communication to a third party of an intent to do harm to a target, it usually infers a preoccupation with the target and may signal the research, planning and/or implementation of an attack. Data suggest that leakage commonly occurs in cases of targeted violence, ranging from school shootings to attacks on public figures. Leakage can be intentional or unintentional, with a range of different motives: need for excitement, a desire to frighten, attention-seeking, or fear and anxiety about the impending act. Sometimes, leakage is a result of the subject’s desire to memorialize their deed following their death or incarceration.

In this work we have identified a number of indicators that are present in written texts (i.e. leakage warning behavior) authored by lone offenders prior to their engagement in violent attacks. The linguistic indicators can be identified using automatic text analysis, and they can be seen as indicators for the warning behavior leakage. The linguistic indicators are not related to the meaning of the texts, instead we are using the text analysis tool Linguistic Inquiry and Word Count (LIWC) [7] to connect words to psychologically meaningful categories. The results shows that some categories are used significantly differently by lone actors in their communication compared to a baseline of how people express themselves on blogs. The identified categories, or linguistic indicators, seems to be inline with previous research on terrorism and behavior.

### A. Outline

The rest of this paper is structured as follows. In Section II we describe how text analysis can be used to identify indicators of extremism and some work that is related to ours. Section III describes the method we have used in this work. We also provide a description on how the eight different LIWC-categories that we consider related to previous research. This section also contains short description of our subjects and the texts we have used in our analysis. Section IV contains the results of our tests - both on when considering the subjects as group and for each subject individually. Section V provides a

discussion of the results. Finally, the paper is concluded and some directions for future work is presented in Section VI.

## II. LINGUISTIC INDICATORS

Research [8] [9] has shown that it is possible to connect word use to psychological constructs such as personality, drives, cognition and emotion. The text analysis tool Linguistic Inquiry and Word Count (LIWC) [7] sorts words in psychologically meaningful categories. By counting the relative frequencies of words in a text and divide words into different meaningful categories it is possible to create a profile of the person who wrote it. The profile describes how much the person uses words from the different LIWC categories (in percent).

LIWC was developed by James W. Pennebaker at the University of Texas and has been evaluated and tested in a number of different studies [9], [10]. The dictionaries are currently translated to more than twelve different languages. The text analysis module in LIWC checks each word contained in a document against an internal dictionary of more than 6400 words and word stems. Approximately 80 categories are available (grammatical, emotional, contents, etc) and for each category the percentage of the total words in the document is reported in the results [11].

There has been many different studies done with LIWC. Some examples are [12] where the language of suicidal and non-suicidal poets are investigated and [13] where the language that is used when people are lying is studied. In [14] linguistic markers of depression in English and Spanish forums are studied, and it is noted that depressed discussants use less positive emotions and less first person plural but significantly more 1st person singular pronouns. Another study using LIWC is done in [11], where the focus is on how four psychological dimensions of language (emotional positivity, cognitive processing, social orientation and psychological distancing) change before and after the September 11 attacks. The results show that in the short run, the participants (bloggers) expressed more negative emotions, were more cognitively and socially engaged and were more psychologically distant in their daily writings. Within 2 weeks, the participants mood and social referencing returned to baseline, but there was still an increase in distancing and their level of cognitive analysis was significantly lower than it had been before September 11.

LIWC can serve as a way to gain indirect information about subjects who will not directly provide information about

them selves. In 2007 Pennebaker did a study on al Qaeda communications that is described in [10]. The study included 58 texts by Osama bin Laden and Ayman al-Zawahiri (bin Laden's second in command). Pennebaker noticed that Osama bin Laden's use of first-person pronouns (I, me, my, mine) remained fairly constant over several years while al-Zawahiri used such words more and more often. An explanation for the increase that was provided by Pennbaker is that al-Zawahri was having greater insecurity, feelings of threat, and perhaps a shift in his relationship with bin Laden. Other findings from the same study include includes that al Qaida texts are more emotional than other extremist groups.

We will use LIWC to indicators of leakage - a behavior that has been suggested to proceed an act of target violence. Our subjects are lone offenders that have conducted targeted violence after communicating through a manifesto or some other form of written communication. A more detailed description of our subjects can be found in Section III.

## III. METHOD

In this section we will describe the method we have used in the study. The study includes subjects who

- 1 Alone, or with minimal help from others have perpetrated a violent act with the intent caused severe (fatal) personal damage, and
- 2 prior to perpetrating this act, have stated their points of view in written communication that has subsequently been made public, either by themselves or by police investigations.

We have identified eight different LIWC-categories that we consider to be in line with "a terrorist mind", as it is described in the literature. Some of our subjects would not be considered as "terrorists" but since they did not have a clear goal behind their actions but we still believe that some of the traits that has been found common among terrorists could also be found among lone offenders in general. Examples of common traits of terrorists are according to [15] low cognitive flexibility and low tolerance for ambiguity, a trait that we hypothesize can be reflected in an high use of words in the category "certainty". Additionally, an "extraordinary need for identity, glory, or vengeance; or a drive for expression of intrinsic aggressivity", is also considered common among terrorists [15], something that we believe can be reflected in language as elevated frequencies of power-words and anger-words. The eight LIWC categories that we have focused on are: the use of big words, the use of third person plural, positive and negative emotions, anger, the use of words related to friends, certainty and power. The LIWC categories are listed in Table I. The table also contains some examples of English words from each category. How each category in LIWC relates to lone offenders drives and emotions that might preceded their attacks is described below.

1) *Use of big words:* Big words are all words longer than six letters. Previous research [16] states that a high percentage of big words correlates negatively with emotionality and correlates positively with psychological distancing or detachment. Distancing and detachment are characteristics according to [15] that have been identified among terrorists.

TABLE I. A SUBSET OF THE LIWC 2015 CATEGORIES AND SOME EXAMPLE WORDS.

Psychological process	Example
<b>Language variables</b>	
Sixltr (words with more than six letters)	
<b>Personal pronouns</b>	
3rd person plural	they, their, them
<b>Expression of Emotions</b>	
Positive Emotions	happy, pretty, good
Negative Emotions	hate, worthless, enemy, hurt
Anger	hate, kill, pissed, annoyed
<b>Social processes</b>	
Friends	buddy, neighbor
<b>Cognitive processes</b>	
Certainty	always, never
<b>Drives</b>	
Power	superior, bully

TABLE II. BASELINE FOR THE USE OF WORDS FROM EACH CATEGORY IN PERCENT.

	Blogs	Expressive	Novels articles	Natural speech	Ny Times	Twitter	Grand Mean	Mean SDs
<b>Language variables</b>								
Sixltr	14.38	13.62	16.30	10.42	23.58	15.31	15.60	3.76
<b>Personal pronouns</b>								
3rd person plural	0.68	0.57	0.92	0.65	0.68	0.47	0.66	0.60
<b>Expression of Emotions</b>								
Positive	3.66	2.57	2.67	5.31	2.32	5.48	3.67	1.63
Negative	2.06	2.12	2.08	1.19	1.45	2.14	1.84	1.09
Anger	0.68	0.49	0.51	0.36	0.47	0.75	0.54	0.59
<b>Social processes</b>								
Friends	0.40	0.55	0.25	0.37	0.18	0.43	0.36	0.40
<b>Cognitive processes</b>								
Certainty	1.56	1.51	1.45	1.38	0.76	1.43	1.35	0.70
<b>Drives</b>								
Power	2.07	2.02	2.46	1.72	3.62	2.17	2.35	1.12

2) *The use of personal pronouns*: The use of pronouns in natural language has been examined in various studies, where they have been linked to different aspects of personality and emotion [16]. A frequent use of third person plural (they, them etc) in a group suggests that the group is defining itself to a large degree by the existence of an oppositional group [10]. It is a strong indicator of the kind of negative identification with an outgroup something that MacCauley and Moskaleiko consider [17] a precursor of terrorism. As Pennebaker and Chung point out: wars, prejudice, and discrimination are based on the psychological distinction between "us" and "them" [18]. The use of third person plural pronouns in analysis of online groups such as American Nazis and animal rights groups has been proven to be the best single predictor of extremism as rated by independent judges [10].

3) *Expressions of emotion*: Positive emotion words (happy, pretty, good) are used to describe positive events, while negative emotion words (hate, worthless, enemy) are used to describe negative events. A high degree of emotion words while describing an event also seems to correlate with a high degree of immersion in whatever event one is describing [8]. These categories can be used to assess the emotionality in a text and information can also be found in how the frequencies of positive and negative emotion words relate to each other. In an analysis of al Qaida-texts, Pennebaker and Chung [10] found them to be relatively high in emotion compared to other texts and also that the relation between positive and negative emotion differed from what is usually found in natural conversation. While natural conversation contains almost twice as many positive than negative emotion words, the al Qaida-texts had a much higher relative degree of negative emotion words, mostly anger words.

4) *Social Processes - friends*: The social processes section in LIWC gathers words that reference other people. In [16] it is said that people who use a high level of social words are more outgoing and more socially connected with others. If low level of social words is used, the opposite might be true. An observation made by [4] is that lone actor terrorists are more likely to be socially isolated, something that is also noticed by [19] who states that the prevalence of social isolation is much higher among lone actor terrorists compared to group based terrorists. A sign of social isolation could be a low level use of words from the category friends.

5) *Cognitive processes - certainty*: As stated earlier, certainty words are likely to be used more by a person who

is cognitively rigid and prone to simplification of complex matters, something that also applies to most terrorists [20]. Elevated levels of certainty have also been said to predict a tendency of risk-taking [21]. If this is correct, it is a very important observation with regards to assessing potentially threatening communication.

6) *Drives - power*: Frequent use of words such as words such as "leader", "follower", "superior", "demand", or "weak" may indicate that a person is driven by a need for power. Power oriented people are concerned with questions of status and who is in control and who is not [16].

In a study of the language of terrorist groups [22], it is noted that violent terrorist groups express more power motives than others. These effects were observed in the language of violent terrorist groups even before their engagement in terrorist acts. Also, in [23] it is noted that power motive words increase among leaders in times before war. The texts analyzed in the present work are also written in a time that can be regarded as preceding the subjects' own personal wars, something that can explain their high usage of power words.

#### A. Analysis

The texts written by our subjects were analyzed with LIWC and statistical tests were performed on the output in order to assess to what extent they differ from blog texts, both on group and individual level. First, one sample t-tests were conducted for the means of each of the categories in order to establish to what extent our sample of lone offender texts differs from a larger sample of online material (baseline blog text). Second, a number of t- tests were conducted on each individual in the sample to create individual profiles with respect to the degree of difference from the baseline blog text. The results of the analysis is presented in Section IV.

The base rates of word usage as described in [24] shows how language varies across settings. The figures are based on a number of different samples divided into six different classes: blogs, experimentally derived emotional writing, English language novels written 1660 and 2008, transcripts of natural speech from multiple contexts, all kinds of NY times articles from the first half of 2014, and Twitter posts from the public profiles found in the Analyze Words webpage. More information about the base rates can be found in [24]. As objects of comparison we have chosen blogs, since we believe that they representative to texts that can be found

TABLE III. STATISTICS ON THE SUBJECTS TEXTS.

Name	Number of words	Publication year	Age when writing
Nidal Malik Hasan	3555	2008	38
James von Brunn	47178	1999	79
Anders Behring Breivik	807712	2011	32
Dylan Roof	2446	2015	21
Elliot Rodger	108206	2014	22
Christopher Dorner	11489	2013	34
Jim David Adkisson	1056	2008	58
Ted Kaczynski	34719	1995	52
Lucas Helder	3296	2002	21
Andrew Joseph Stack III	3236	2010	54

online. Expressive is also a category that could be interesting to compare our texts with but since the expressive texts were produced during an experiment and the sample of texts is small compared to the blogs, we have chosen not to compare our results with the expressive category. Another reason for not comparing our results with the expressive category is that we think that the texts in the expressive category is not representative to texts that can be found online. The baseline for all categories are presented in Table II

### B. Lone actors

One of the challenges with lone actors, as compared to terrorist groups, is that they do not need to communicate with others. This makes it much harder for intelligence services and authorities to intercept communication, something that could help them to identify and captivate potential terrorists. Yet, many lone actors cannot resist the temptation to let others know about their extremist beliefs or even their plans to commit violent attacks [3]. In many cases lone actors write manifestos that they publish online or send in emails. In this work we use publicly available communication or manifestos from lone actors. No single ideology can be defined among the included lone actors - instead their ideologies and motivations are widely spread. All texts that we use in this analysis are originally written on English, even if all subjects did not have English as their mother tongue. The texts comes from 10 different lone actors. Even though this is a small number, we believe that some initial conclusions can be drawn, to serve as guidelines for larger studies. We have not included school shooters in our analysis. Table III shows the subjects, the number of words in the texts and and some statistics regarding the age of our subjects when the text was written and what year the text was published. Some additional information about the subjects and the texts that we have included are described below.

- **Nidal Malik Hasan** Hasan killed and injured more than thirteen soldiers in a shooting at Fort Hood in Texas 2009. Before the attack, Hasan had been in contact via e-mail with Anwar al-Awlaki, an American Islamic extremist. We have used Hasan's part of the email conversation that was released by the FBI as part of the their investigation into the handling of intelligence in the Fort Hood shooting [25].
- **James von Brunn** Von Brunn was a white Supremacist and Holocaust denier, who shot and killed a security guard in an attack on the United States Holocaust Memorial Museum in 2009. Von Brunn hosted a racist, anti-Semitic, web site and wrote a book titled "Tob Shebbe Goyim Harog!", translated

as "Kill the Best Gentiles". We have used the book [26] in our analysis.

- **Anders Behring Breivik** Before his attack in Norway 2011, Breivik wrote a Manifesto called "2083: A European Declaration of Independence" [27] that he distributed to approximately 8000 people via email. The email addresses he used were mainly collected through Facebook during 2009 and 2010 [28]. We have used the manifesto in our analysis.
- **Dylan Roof** Roof is an American suspected of perpetrating the June 17, 2015 Charleston church shooting, where nine persons where killed. Roof published a manifesto on a website [29], stating his views towards for instance black people. We have used the manifesto in our analysis.
- **Elliot Rodger** Rodger was an American who killed six people and injured fourteen others near the campus of University of California, Santa Barbara, before committing suicide. Before his attack Rodger uploaded a video on YouTube where he outlined details of his upcoming attack and his motives. He also e-mailed a manifesto to a dozen acquaintances and family members, a document titled "My Twisted World" [30] that describes his childhood, family conflicts, frustration over not being able to find a girlfriend, his hatred of women, his contempt for racial minorities and interracial couples, and his plans for what he described as retribution. We have used the manifesto in our analysis.
- **Christopher Dorner** On February 3, 2013, Dorner was involved in a series of shootings that killed four people and wounded three others. A manifesto posted on Facebook, which police say was written by Dorner, declared "unconventional and asymmetric warfare" upon the Los Angeles Police Department (LAPD), their families, and their associates, unless the LAPD admitted publicly he was fired in retaliation for reporting excessive force. We have used the manifesto [31] in our analysis.
- **Jim David Adkisson** On July 27, 2008, Adkisson conducted a politically motivated fatal shooting at the Tennessee Valley Unitarian Universalist Church in Knoxville, Tennessee, United States. Adkisson fired a shotgun at members of the congregation during a youth performance of a musical, killing two people and wounding seven others. Adkisson left a handwritten manifesto [32] in his car. We have used a transcript of the manifesto in our analysis.
- **Lucas Helder** Helder was a college student from Pine Island, Minnesota, who planned to plant pipe bombs in mailboxes across the United States in order to create a smiley face shape on the United States map. We have used the letter Helder sent to the student newspaper The Badger Herald in our analysis [33].
- **Ted Kaczynski** Kaczynski, also known as the "Unabomber", is an American that was engaged in a nationwide bombing campaign between 1978 and 1995. Kaczynski wrote the text *Industrial Society and*

*Its Future* (also called the "Unabomber Manifesto"), that was published in 1995 and that also led to his conviction. We have used the *Industrial Society and Its Future* in our analysis.

- **Andrew Joseph Stack III** Stack was responsible for the 2010 Austin suicide attack that occurred on February 18, 2010. Stack deliberately crashed his single-engine Piper Dakota light aircraft into an office complex in Austin, Texas, United States. Before the crash, Stack had posted a suicide note/manifesto on his business website [34]. We have used that manifesto in our analysis.

#### IV. RESULTS

The results when running LIWC on the identified categories are shown in Table IV. The results are given in percent together with the mean and the standard deviation.

When running one sample t-tests on the group, we yielded significant results for all examined categories when we compared our subject texts to a sample of blog texts from LiveJournal.com and Blogs.com (N = 714,000), the analyzed texts had significantly lower frequencies of positive emotion and friends and significantly higher frequencies of negative emotion, anger, power, certainty, third person plural and big words. The results from using one sample t-tests is presented in Table V.

Instead of looking at the subjects as a group (as in Table V) we can compare each individual with the baseline of the sample of blogs. To do this, we performed a t-test between each subject text and the baseline blog texts. The mean for a subject's text is calculated by dividing the number of words used from each category with the total number of words in the subject's text. We use the Poisson distribution built on the assumption that the words from each category are randomly distributed. As been noted in [35] it can be justified to adopt the Poisson distribution for describing the number of occurrences of a certain word in documents of fixed length when the independent assumption of each word occurrence holds in an approximate sense. When the Poisson distribution is applied, the standard deviation is the square root of the mean. The result for each individual is presented in Table VI. The symbols used in the table is described in Table VII.

#### V. DISCUSSION

As can be seen in the results each category has a significant difference for all the examined categories when we compared our subject texts to the baseline blog texts. The use of big words are significantly higher for all our subjects compared to the use of big words in the baseline blog texts. Fig. 1 shows the average use of big words in the different subject texts. As can be noted, the average percentage of big words is much higher than in the baseline blog texts. Especially Brevik and Kaczynski used a high percentage of big words in their texts. It would be interesting to analyze the manifestos of these two in detail to gain a deeper understanding in their use of big words and how it correlates to psychological distancing or detachment.

The use of third person plural is also significantly higher in the subject texts, except in Helder's letter. Frequent use of

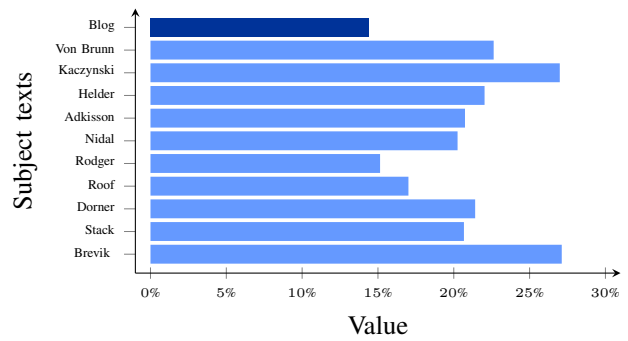


Fig. 1. Average use of big words for the different texts.

third person plural is already identified as a predictor of the kind of extremism that precedes terrorism. Fig. 2 show the usage of pronouns (first person singular, first person plural and third person plural) in the subject texts. First person singular pronouns includes words like *I*, *me* and *mine* while first person plural pronouns includes words such as *we* and *ours*. As can be noted, Adkisson had a particular frequent use of third person plural. Rodger on the other hand used many words describing first person singular. Something that would be interesting to investigate further would be the relation and use of pronouns among the subjects.

Among our subjects, the rate of negative emotion words was actually higher than the rate of positive emotion words in almost all cases. This supports the notion that a sense of persistent grievance is behind the kind of violent attacks considered in the present work. Our subjects use significantly less positive emotion words and significantly more negative emotion words compared to the baseline blogs. Anger, a subcategory of negative emotion, is also used significantly more than in the baseline blog texts. Adkisson and Nidal are the subjects that uses the highest level of negative emotion and anger in their writing.

Figure 3 shows the level of emotions for the texts that we have analyzed. As can be noted, the level of negative emotions compared to positive emotions are higher than what can be expected in a natural conversation something that was also noted in [10] in the analysis of al Qaida-texts.

In the analyzed texts, words from the category "friends" are used significantly less than in the control texts. This is true for all subjects except Dorner. Comparing the use of friends-words of our subjects with the baseline texts it can be noted that the mean of our subjects usage is less than half compared to the blog category.

The results shows that our subjects use more certainty words and more power words than what is used in the baseline blog texts. Certainty words are used significantly more among six of the subjects. Power words indicates that a person is driven by a need for power. All subjects except Roof used significantly more power words than the baseline blog texts. Fig. 4 illustrates the use of friends words, certainty words and power words for each individual. As can be noted, words from the "friend" category are used sparsely in all our subject texts.

A manual analysis of the subjects and the subjects texts are out of the scope for this work but it would be interesting to

TABLE IV. THE RESULT OF LIWC ON THE IDENTIFIED CATEGORIES FROM THE SUBJECTS TEXTS IN PERCENT.

	Brevik	Stack	Dorner	Roof	Rodger	Nidal	Adkisson	Helder	Kaczynski	Von Brunn	Mean	SD
Sixltr	27.12	20.67	21.41	17.01	15.14	20.25	20.74	22.03	26.99	22.63	21.40	3.74
3rd person plural	1.10	1.64	0.88	2.00	1.06	1.52	2.75	0.91	1.64	0.91	1.44	0.60
Positive emotion	2.16	2.32	2.89	2.29	3.30	3.54	2.65	3.22	2.85	2.23	2.74	0.49
Negative emotion	2.36	2.56	2.34	2.70	2.62	3.77	5.40	2.58	2.62	2.25	2.92	0.97
Anger	1.10	0.80	1.03	1.06	0.98	1.77	3.31	0.49	0.71	1.35	1.26	0.80
Friend	0.15	0.12	0.37	0.08	0.47	0.17	0.00	0.12	0.09	0.10	0.17	0.14
Certainty	1.45	2.13	2.25	2.09	2.00	1.27	1.89	2.31	1.67	1.36	1.84	0.38
Power	4.19	4.14	4.55	2.70	2.29	3.40	3.88	3.34	4.40	4.52	3.74	0.78

TABLE V. ONE SAMPLE T-TESTS COMPARING MEAN VALUES OF RELEVANT LIWC-CATEGORIES IN ALL SUBJECT TEXTS TO THE BASELINE BLOG TEXTS.

Category	N	Mean	SD	t(9)	p	CI
<b>Language variables</b>						
Sixltr	10	21.40	3.75	5.92	.000	4.34, 9.70
<b>Personal pronouns</b>						
3rd person plural	10	1.44	.60	4.00	.003	.33, 1.19
<b>Expression of Emotions</b>						
Positive	10	2.74	.49	-5.89	.000	-1.27, -.56
Negative	10	2.92	.97	2.81	.000	.17, 1.55
Anger	10	1.26	0.80	2.29	.048	.01, 1.15
<b>Social processes</b>						
Friends	10	0.17	0.14	-5.16	.001	-.34, -.13
<b>Cognitive processes</b>						
Certainty	10	1.84	0.38	2.35	.044	.01, .55
<b>Drives</b>						
Power	10	3.74	0.78	6.73	.000	1.11, 2.23

TABLE VI. SIGNIFICANCE TEST FOR SUBJECT TEXTS COMPARED WITH THE BASELINE BLOG TEXTS.

	Brevik Blog	Stack Blog	Dorner Blog	Roof Blog	Rodger Blog	Nidal Blog	Adkisson Blog	Helder Blog	Kaczynski Blog	Von Brunn Blog
Sixltr	*	**	**	****	**	**	**	**	*	*
3rd Person	**	***	*****	**	**	**	**	-	**	**
Positive	*	**	**	***	**	-	-	-	**	**
Negative	**	-	-	-	**	**	**	-	**	*****
Anger	**	-	***	-	**	**	**	-	-	**
Friend	*	***	-	**	*****	*****	*	**	**	**
Certainty	**	*****	**	-	**	-	-	*****	-	***
Power	*	**	**	-	**	**	*****	**	**	**

TABLE VII. SYMBOLS USED IN THE STATISTICAL SIGNIFICANCE TESTS IN TABLE VI.

Significance	p-value
*	$p = 0$
**	$0 < p < 0.000001$
***	$0.01 < p < 0.001$
****	$0.001 < p < 0.01$
*****	$0.01 < p < 0.05$
-	$p > 0.05$

investigate the results in more detail and to gain understanding of the differences and similarities among the subjects. A summary of our results suggests that there are eight linguistic indicators that can be used when analyzing and assessing written communication by possible lone offenders. The linguistic indicators are: a lower frequency of words related to positive emotions and friends and a higher frequencies of words related to negative emotion, anger, power, certainty, third person plural and big words.

## VI. CONCLUSION AND FUTURE WORK

In this work we have shown how computerized text analysis can be used to automatically assess texts written by lone offenders prior to their engagement in violent acts. Given the challenges that the Internet's vast amount of information has brought to the field of threat assessment, a more automated approach to detecting threatening online communication has become a necessity. We believe that this work is a step towards such a development. While computerized text analysis will

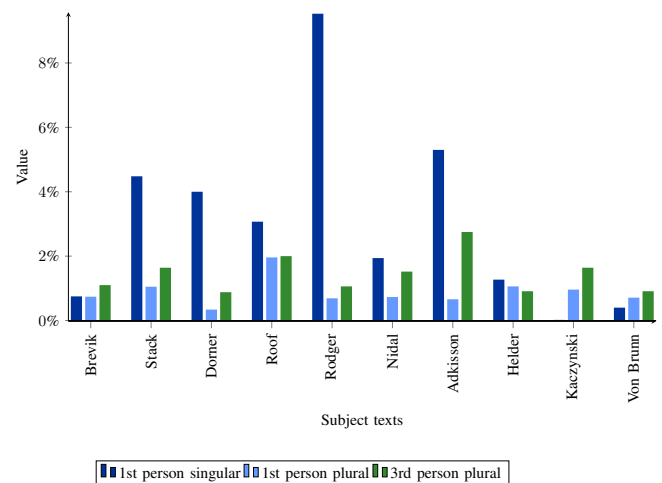


Fig. 2. The use of pronouns.

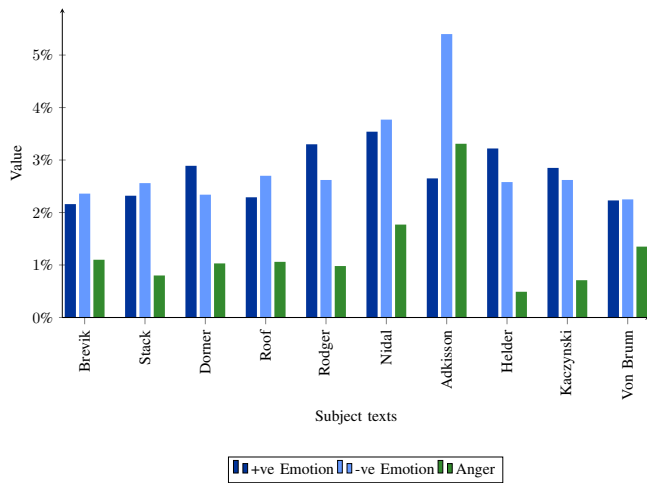


Fig. 3. Expression of emotions.

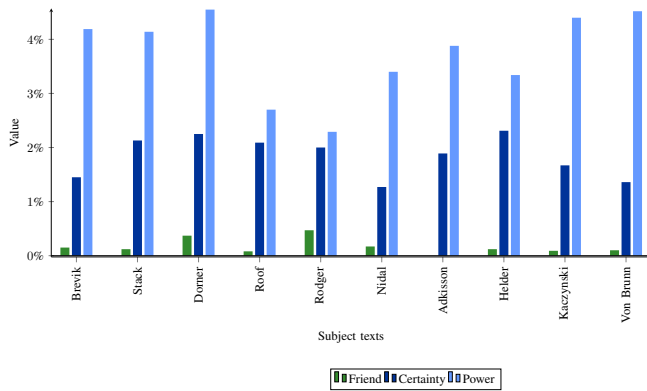


Fig. 4. Social processes, cognitive processes and drives.

most likely serve as a component in the future of threat assessment, it is important to stress that automatic threat assessment can never replace human analysts, it will rather serve as a screening tool, as well as a provider of a complementary view.

Analyzing each manifesto manually as well as compare the differences individually with the baseline is something that would be very interesting and a possible direction for future work. The identified categories could also be tested on written text in the form of "leakage" from for example school shooters.

Another direction for future work includes methods for updating and adjusting dictionaries depending on the domain. One criticism towards LIWC is that the dictionaries are static and does not capture slang, misspellings, and domain specific language. One way to overcome this problem is to use word space models and detect words that are occurring in similar contexts. Word space models can be used to capture the context of words and to find words that are not present in the dictionary but have similar meaning and are used in the same context. There are many different word space models that can be used, for example random indexing [36] and Word2Vec [37]. Using a more generic approach to the LIWC dictionaries could possibly improve the results of the analysis.

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