Child sexual abuse material networks on the darkweb: a multi-method approach

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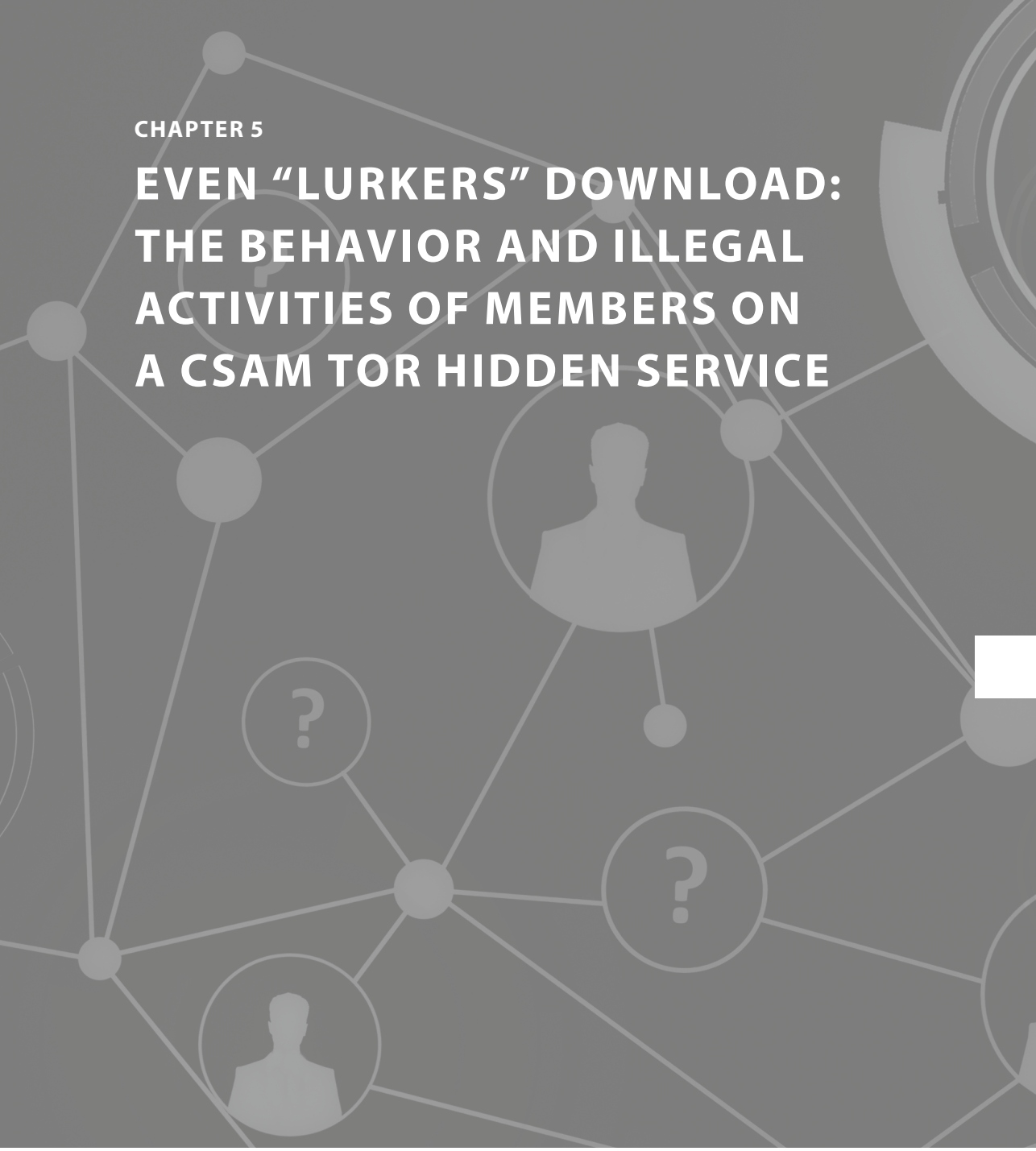
CHAPTER 5

EVEN "LURKERS" DOWNLOAD: THE BEHAVIOR AND ILLEGAL ACTIVITIES OF MEMBERS ON A CSAM TOR HIDDEN SERVICE



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"In loving memory of Special Agent Daniel Alfin, without whom, this research would not have been possible."

Abstract
Knowledge about online child sexual exploitation (CSE) offenders mostly remains limited to offender populations known by the criminal justice system. Because of its hidden and anonymous nature, knowledge on those offenders active on the Darkweb is especially scarce. For the current study, researchers had access to a unique dataset of member communication on a Darkweb CSE website, as well as members' virtual movements (or clicks) across the side, regardless of being verbally active or not. This offered a unique opportunity to establish behavioral patterns of members who were unaware that they were being observed. This paper summarizes the results of a descriptive analysis of the growth of member count, the frequency with which members were online, and detailed member behavior such as their activity on certain sub-forums and their downloading activity. Main findings include that although only 3.4% of the members were communicatively active, the vast majority of 93.6% of members downloaded CSE material. Results indicate that regardless of being verbally active, most members do engage with the site's content, and thus, effectively impact the CSE community. This has important implications for law enforcement practice, which will be discussed.

5.1 Introduction

The distribution of online child sexual exploitation (CSE) material is a serious crime, with severe societal consequences. Combining this with the increased opportunities, accessibility and anonymity of the internet, it is only logical that online CSE has attracted increased attention from researchers from various disciplines in recent years. Examples from psychological research include studies exploring differences between online and contact offenders (e.g. Babchishin et al., 2015; Owens et al., 2016), the risk that online offenders commit additional crimes against children (past, present, or future), including contact offences and the production of CSE material (e.g. Seto & Eke, 2005; Seto & Eke, 2015), and the evaluation of treatment approaches (e.g. Seto & Ahmed, 2014). From a criminological perspective, several studies have aimed to classify online CSE offenders based on type of and motivation for offending (e.g. Lanning, 2010; Merdian et al., 2013; Shelton et al., 2016). What characterizes many of these prior studies is the fact that they were conducted on offender populations known by the criminal justice system or by healthcare professionals. Much less is known about those offenders that remain active in online CSE communities for longer periods of time but may not (yet) be caught.

Rather than focusing on individual offenders, their motivation and risk, or aiming to uncover the more hidden groups of offenders, another strand of research focuses on the platforms and networks facilitating online CSE offending instead. For example, Steel (2009) quantified and described the nature of CSE material exchanged on a peer-to-peer platform by analyzing CSE-related querying and traffic on those platforms. Other studies focused on the social and interpersonal aspects of offenders who gather and communicate online, the normalizing aspect of child abuse, and pro-offending attitudes (O'Halloran & Quayle, 2010; Prichard et al., 2011). Studies in these areas conclude that the lack of reinforcement of social norms leads to a feeling of freedom to break these norms within online CSE communication spaces (Rimer, 2017). Finally, Canadian researchers took a strict network perspective with CSE websites as the unit of analysis, considering the online CSE network as a large virtual community connected through hyperlinks (Westlake & Bouchard, 2016). They identified certain "key-player websites" based on content severity and connectivity to other CSE websites, and determined that their removal would result in a loss of network capital (Westlake et al., 2011). From an evolutionary point of view, Westlake and colleagues further suggested that popular, central, and larger websites are the most persisting and have the greatest chances of survival (Westlake & Bouchard, 2015); however acknowledging websites still demonstrate a vulnerability to attack strategies that can cause disruption and network fragmentation (Joffres et al., 2011).

An underlying factor that characterizes most of these studies is the fact that they were conducted on Clearnet platforms. Much less is known about the more hidden groups of offenders active on the Darkweb, the encrypted part of the internet that exists at hidden levels outside of the observable internet and that is only accessible through specific software (the best known example being TOR). Much of the CSE offending on the Darkweb takes place on websites called "hidden services" that are only accessible via the TOR network, and structurally consist of layers of forums and sub-forums. Research on CSE offender behavior would benefit from additional insight regarding the manner in which the Darkweb's anonymous infrastructure facilitates increased trafficking and secure downloading of CSE material.

The very limited research previously conducted on Darkweb CSE offending (e.g. Fonhof et al., 2018; Van der Bruggen & Blokland, 2021), is based on the communication occurring on the public areas of Darkweb CSE websites, and thus solely covers members that are communicatively active and visible on the site. Hardly anything is known about the so-called "lurkers", those members of online communities that observe but do not actively participate (in the form of posting messages within the public environments of the website). It is this group that contains the truly hidden CSE offenders on the Darkweb.

For the current study however, the researchers had access to a unique and unprecedented dataset of a CSE TOR hidden service. This dataset not only archived member communication exchanged during the entire time the site was online, but also captured all member movements (or clicks) behind the screen/keyboard for a specific and shorter timeframe of interest. Therefore, activity such as clicking on internal and external links, regardless of members being communicatively active or not, was available for analysis. This offered a unique opportunity to establish behavioral patterns of members who were unaware that they were being observed and therefore showed their natural behavior. This paper summarizes the results of a descriptive analysis of the proportion of members that were not verbally active, the frequency with which they were online, on which sub-forums they were most active, and their attempts to download CSE material. The aim of the current paper is to describe and compare members' movement and activity (clicks), offering greater insight into behavioral characteristics of the "average" member on CSE hidden service communities on TOR. The results suggest that in addition to those members who visibly communicate, the vast majority of lurkers are also active and motivated members who (attempt to) download CSE material. Thus, the current study provides a more comprehensive picture of CSE offending behavior on the Darkweb.

5.1.1 Darkweb CSE hidden services and lurking

The ability to freely access relatively unique and new CSE material in large quantities and the desire to be part of a community of like-minded others in relative anonymity, has recently led to large numbers of online CSE offenders relocating to the Darkweb (Finklea, 2017; Van der Bruggen & Blokland, 2021). Darkweb CSE hidden services, also called forums, are similar to forums on the Clearnet, with their homepage typically listing a number of sub-forums, under which members can navigate to and submit messages or referrals to a multitude of sexually abusive material depicting children. These messages result in threads that can evolve into long-running discussions between countless members. Sub-forums often refer to environments where hyperlinks to content of a certain sexual interest (i.e. age and/or gender of the depicted children, the severity of the material, or the type of sexual act) should be placed. Threads in such sub-forums involve communication and negotiation about the exchange of the CSE material, and extensive discussions about members' sexual preferences, fantasies, and experiences. However, popular sub-forums also provide locations where members can access information about the hidden service's rules and regulations, (technical) safety, and law enforcement operations and evasion techniques, which offer education and guidance among members. Darkweb CSE hidden services often have a hierarchical order: members have a certain status assigned to them (such as regular mem-

ber, moderator, or administrator), depending on their activity, popularity or formal responsibility. It is not uncommon for members with a higher status to have access to certain restricted or hidden sections of the forum, for example consisting of "administrator-only" information or more unique and/or newly produced CSE material (Bartlett, 2014; Van der Bruggen & Blokland, 2021).

After having registered with a nickname and password to gain access to the hidden service, not all members portray the same level of activity. Some members are significantly more active within the community, communicate regularly about topics relevant to the forum's continuity and may even have a role in the technical development and management (with or without a formal status). More commonly, members may be more or less active, but their communication centers on certain topics related to their sexual experiences and fantasies and the exchange of CSE material. Finally, there are those members that "solely" use the website to browse around seeking access to and potentially obtaining CSE content, yet who do not communicate or contribute material. This final group is often characterized as "lurkers". Although this sub-group of members may not actively contribute to the community with regards to the uploading of CSE material or communication with others (such as explicitly encouraging others to offend against children and produce new material), these so-called "lurkers" actively read the postings and their mere presence on the site creates and facilitates the demand for more CSE material.

Although to date there is no research on lurking on CSE hidden serives specifically, previous academic research has been conducted on lurking on other online platforms and social media communities. From this research, it is evident that lurking is very normal internet behavior, with lurkers constituting a significant proportion of approximately 90% of all users active on the platforms studied (Gong et al., 2015; Mousavi et al., 2017; Nonnecke & Preece, 2000; Tagarelli & Interdonato, 2013). This suggests that not paying attention to these users could lead to a misinterpretation of the overall population and their behavior (Gong et al., 2015).

Historically, lurkers were negatively seen as "free-riders" benefiting from the contributions of the community without offering anything in return, arguably because online platforms are dependent on collaboratively generated content by their users. However, more recently lurkers have been categorized as harmless, curious and passive participators (Cranefield et al., 2015; Tagarelli & Interdonato, 2013). Through their presence and browsing activity, the forum's posts and threads receive increased numbers of views, so even indirectly lurkers facilitate the content to reach a larger audience. Moreover, lurkers may have good reasons to stay silent, such as not feeling the need to post, privacy and safety concerns, poor system usability, user friendliness, and improving their understanding of the community etiquette before starting to par-

ticipate (Preece et al., 2004). In fact, in some cases lurking may even be beneficial, as some forms of active communication may be deemed negative and undesirable, and it may even harm the community (Lutz & Hoffmann, 2017; Tagarelli & Interdonato, 2013). Furthermore, lurkers may be active participators in other, more restrictive/private areas of the site or on entirely different sites, such as on a separate personal message systems or on other but similar online platforms. Lurkers may, therefore, still have important ties with influential fellow members or with the larger network (Cranefield et al., 2015; Tagarelli & Interdonato, 2013). Along these lines, Cranefield et al. (2015) discussed "follower-feeders", the online followers and offline leaders, or invisible members who only communicate privately with influential and trusted others and who play a brokering role in transferring knowledge between contexts within the broader ecosystem. Finally, lurkers may ultimately break their silence at some point, for example, to share information or to update other users about their personal life (Gong et al., 2015).

From an emotional perspective, rather than viewed as unimportant or harmless users, lurkers are individuals with interests and consume the content related to those topics that interest them (Gong et al., 2015). Observing what other members do resembles a process of vicarious learning about the community and topic of interest, and it affects attitudes and future behavior (Bozkurt et al., 2020; Mousavi et al., 2017). The cognitive and emotional investment made in their online presence, as well as their feelings of belongingness to the community may be as significant as for active users (Lutz & Hoffmann, 2017; Mousavi et al., 2017). To this point, research conducted on online brand communities revealed that lurkers were just as valuable members as their more active posting counterparts, and similarly derived their social identity from their membership of the online community (Mousavi et al., 2017).

Taken together, aside from the exchange of CSE material, a main interest of a CSE hidden service is to have public influence (Van der Bruggen & Blokland, 2021), and lurkers create just that, which means that they are of value without being active posters. Where previous research on online communities has mainly focused on observable acts of communication and content creation, future research would benefit from more incorporation of hidden concepts such as motivation and intent (Bozkurt et al., 2020; Lutz & Hoffmann, 2017; Mousavi et al., 2017). Such concepts could be inferred by members' movements within the online communities under consideration (for example, time spent online, numbers of pages visited, and downloaded content) and their activities in the broader and external online and offline ecosystem (Mousavi et al., 2017).

5.2 Methods

5.2.1 Data and sample

The data used for the current study were extracted from a Darkweb CSE hidden service, which was only available to members via the TOR network. The areas in which discussions took place and content was shared were divided into forum and sub-forum environments, predominantly focusing on victim gender (boys versus girls), and severity of content (hardcore versus softcore CSE material). Additionally, there were environments for certain sexual acts and fetishes, and administration-related security and information environments. During the timeframe when data were collected for analysis, this hidden service amassed activity in 13 forums and 55 sub-forums, within which members could create and title their own threads for discussions and the exchange of CSE material. Members who posted visual material typically provided a thread title and a preview image associated with the depicted content that could be downloaded with the embedded hyperlink. By clicking the link, the downloading member would then be referred to an external hosting website where the content could be downloaded. The overall site would be considered an "open board", as registered members were not required to contribute themselves in order to gain access to the CSE material. Finally, this hidden service was online for a period of less than a year, which can be considered a relatively short period of time compared to other CSE hidden services. However, because this hidden service had the largest number of members and activity at the time, there was no shortage of data for extensive analyses.

The authors had access to two separate datasets for analysis. Dataset 1 contained registration-, member-, and communication-related data (public posts as well as private messages) from August 2014 to March 2015. In other words, this included the written communication data regarding the entire 8-month period that the hidden service was online. This sample consisted of a total of 417,438 members.[1] Dataset 2 included all members' movements (or clicks) and activity within a specific two-week timeframe in early 2015 (specifically between February 20 and March 4, 2015), during which time the hidden service was monitored by a federal law enforcement agency. This sample consisted of a total of 97,178 members who logged in at least once during this two-week timeframe. In total, approximately one million logins were captured.

5.2.2 Design

The main aim of the current study was to determine and describe all forum activity

1 Because an individual could register with multiple accounts, the researchers acknowledge that this number is an approximation, as there is no way to know how many unique individuals this number represents.

from the CSE hidden service data available, including that of members that were not verbally active via public posts. This was operationalized by the term "behavior flow", defined by the authors as the way in which members traverse and interact with the website. More specifically, behavior flow is used to define the logged/captured clicks of a member, visiting various internal or external hyperlinks during a single session on the website. This can, but does not necessarily, include verbal communication by means of making a post, as well as all (usually hidden) forum behavior extending beyond what is visible on the site. Examples of this hidden behavior include actively navigating to a certain forum, trying to gain access to a certain sub-forum, or (making the attempt) to download a file.[2]

Three dependent variables were measured: 1) the average time spent on the hidden service, 2) the frequency of visiting, and 3) the activities undertaken during a visit (sub-forum visits and (attempted) downloads). An activity was recorded when a member clicked on an internal link to a certain sub-forum or on an external link to the CSE material in an attempt to download it to his or her personal computer. For the current descriptive analysis, univariate descriptions with measures of central tendency were used.

5.3 Results

5.3.1 Basic analyses: Dataset 1

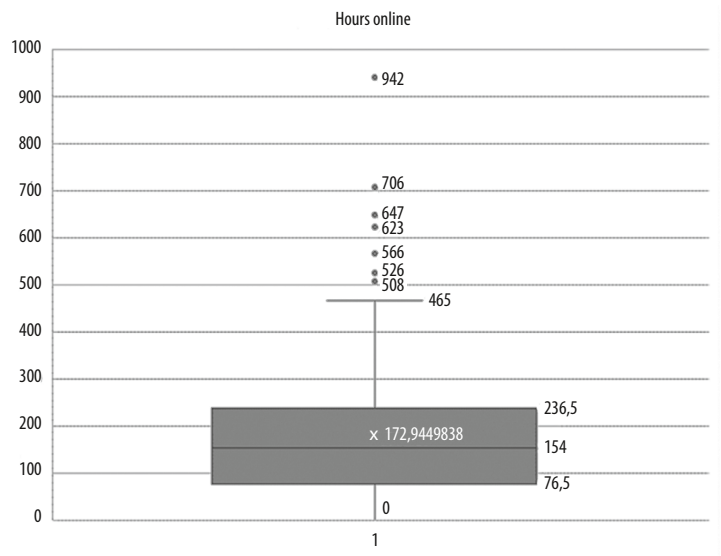
In order to illustrate member behavior and describe the "average" member, a number of basic descriptive analyses were conducted. To do so, initially the first dataset (registration-, member-, and communication data from all registered members regarding the total 8-month period that the hidden service was online) was used. In order to assess the hidden service's development and growth, an evaluation of the start of membership (using members' first logon time on the website) was conducted. The results illustrate that only the administrator registered on the hidden service in early August 2014. However, on the first day that the website became publicly available, an additional 321 members registered with a member profile. Within the first week, a total of 6,968 profiles were registered.

Further examination of the registered profiles revealed that only a small minority, 3.4%, of all members were verbally active at some point during the 8-month period that the site was online (14,088 of 417,438 members); the remaining 96.6% did not post

2 Researchers are using the term "attempted download" because it represents a member clicking on a hyperlink to attempt to download a file. Given the data available to researchers, there was no way to confirm whether the download was completed or not, or if the file associated with the link was still available at the time of the click.

any message on the public areas of the site.[3] On average, members were online for 7.8 hours in total, with a variation of 0 to 942 hours. An important reason for this great variation in total logon time is the fact that this distribution included several outliers of members who were online for over 500 hours, with the administrator being online the longest (942 hours).[4] On the contrary, there was a larger number of members who were only online briefly. More than half of all members (55%, or 225,969 members) were online for a total of less than 1 hour during the total 8-month timeframe the hidden service was online. In order to gain more insight into the distribution, the median was calculated (Figure 5.1). This analysis revealed that 416,992 members (or 99% of the member population) were online less than the median time of 154 hours. Finally, just under 6% of members were not only online for less than 1 hour, but apparently only registered on the website and went offline shortly after that and never came back. A noted caveat to this finding is the possibility that some of these members may have registered right before the site was shut down, and therefore did not have the chance to come back online.

Figure 5.1 Boxplot of median time online in hours



3 Members may however have been active in the non-public areas of the hidden service (such as private or hidden areas, or via personal messages). These areas were not taken into account in this analysis.

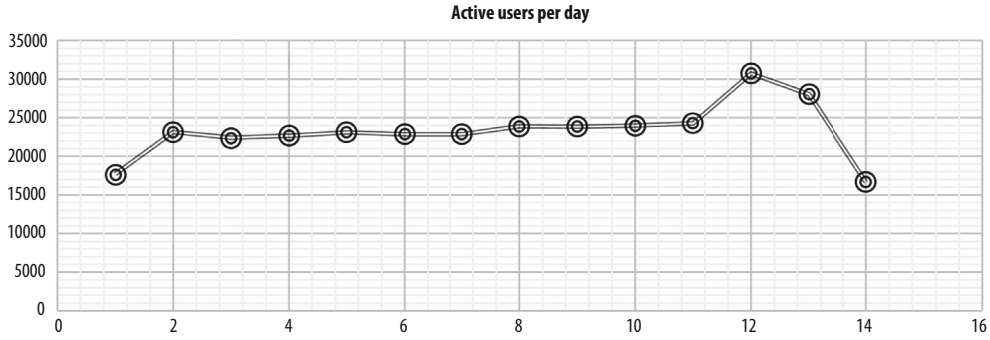
4 Being online means that a member was logged on to the website for the number of hours stated in this paper. This does not necessarily mean that a member has shown activity (in the form of posting content) within this timeframe.

In order to calculate the timeframe during which members were online, the period between when a member created his profile ("create profile") and the last time a member was online ("last seen online") was measured. Findings indicate that the "average" member was active on the CSE site for a duration of 2-3 months (84 days), with a total logon time of 10-12 hours. This is equivalent to approximately 0.13 hours per day, or just under 1 hour a week. There were also some noted outliers of members who were online very frequently.

5.3.2 Behavior flow analyses: Dataset 2

In order to demonstrate in more detail how members interact within the CSE hidden service, the second dataset with logged/captured clicks of a registered member (behavior flow) on the site was analyzed. Therefore, the following results refer to the limited two-week timeframe in which a total of 97,178 members engaged in any activity on the site. Figure 5.2 illustrates the number of active members per day within the two-week timeframe.

Figure 5.2 Scatterplot of the count of active members per day within the two-week timeframe



Members were divided into two categories:

1. Registered members, who were present on the hidden service more than once, who visited various forums and sub-forums, and who had at least one download (attempt). This comprised a total of 90,943 members (93.6%).
2. Registered members, who were present on the hidden service more than once, who visited various forums and sub-forums, but did not (attempt to) download. This comprised a total of 6,235 members (6.4%).

5.3.2.1 Members' sub-forum activity and surfing behavior

Because most members had no verbal activity on the site, their behavior flow was the only data available. Therefore, these members' activity within the 55 sub-forums was mapped.

Among all 97,178 members within the two-week timeframe analyzed, a total of 21,967,663 individual logged activities of behavior flow (or unique clicks) was measured (see also Table 5.1). Results indicated that each member made an average of 226 clicks during their time on the site. From this total number of clicks, the percentage of clicks per sub-forum was calculated, and the number of unique members located within those sub-forums was documented. These results are displayed in Table 5.1. The sub-forum "Girls Hardcore" had the highest volume of logged activity, with a total of 73,468 visits from unique forum members[5], and 29.3% of the total volume of logged forum activity. The top five sub-forums with the highest volume of behavior flow (excluding sub-forums with identical titles) were: Girls Hardcore, Girls, Preteen Girl, Jailbait Girl, Family – Incest.

Table 5.1 Total number of logged clicks and members in the various sub-forums (*N* = 55)

Sub-Forum	Total number of logged clicks	Logged clicks: % of total	Total number of unique members
6 (Girls HC)*	6,439,786	29.31%	73,468
16 (Girls)	3,223,791	14.68%	57,846
56 (Girls)	2,030,077	9.24%	36,473
10 (Girls HC)	1,417,450	6.45%	47,980
41 (Preteen – Girl)	1,090,865	4.97%	44,332
40 (Jailbait – Girl)	927,187	4.22%	38,413
17 (Girls SC/NN)	832,041	3.79%	30,828
26 (Family Play Pen – Incest)	791,721	3.60%	34,214
8 (Girls)	702,891	3.20%	33,069
19 (Girls SC/NN)	610,794	2.78%	24,308
33 (Vintage)	403,194	1.84%	13,952
7 (Boys HC)	388,001	1.77%	20,201
25 (Toddlers)	363,373	1.65%	16,096
23 (Request)	317,855	1.45%	29,871
22 (General Discussion)	315,688	1.44%	24,507
45 (Zoo)	193,070	0.88%	16,515
34 (Voyeur)	182,769	0.83%	14,213
31 (Peeing)	157,458	0.72%	10,000
30 (Bondage)	126,210	0.57%	12,651
51 (Español)	114,568	0.52%	7,575

5 By unique forum members, the researchers refer to the fact that this number does not include double visits. Again, because an individual could register with multiple accounts, the researchers acknowledge that it is unclear how many unique individuals in real life this number represents.

Sub-Forum	Total number of logged clicks	Logged clicks: % of total	Total number of unique members
32 (Artwork)	92,514	0.42%	7,353
11 (Boys HC)	87,517	0.40%	10,650
52 (Deutsch)	82,593	0.38%	5,426
38 (Chubby)	79,460	0.36%	9,008
24 (Panties, nylons, spandex)	77,588	0.35%	8,115
58 (Русский – Russian)	72,870	0.33%	5,522
37 (Non-fiction)	64,262	0.29%	7,130
53 (Português)	60,151	0.27%	3,706
5 (Boys)	55,977	0.25%	8,604
43 (Preteen – Boy)	55,610	0.25%	7,128
55 (The INDEXES)	55,088	0.25%	11,540
49 (Trash Pen)	54,916	0.25%	11,921
35 (Scat)	50,550	0.23%	5,656
67 (Français)	46,853	0.21%	3,097
57 (Boys)	44,783	0.20%	7,605
28 (How to)	42,124	0.19%	8,416
42 (Jailbait – Boy)	40,978	0.19%	5,601
50 (Italiano)	34,581	0.16%	2,938
21(Playpen information and rules)	32,051	0.15%	6,934
27 (Feet)	31,558	0.14%	3,696
46 (Security & Technology discussion)	30,848	0.14%	4,005
18 (Boys SC/NN)	30,825	0.14%	3,441
29 (Spanking)	29,653	0.13%	4,850
54 (Nederlands)	21,628	0.10%	2,561
36 (Fiction)	18,172	0.08%	4,200
71 (Polski)	16,522	0.08%	2,052
9 (Boys)	12,583	0.06%	3,420
20 (Boys SC/NN)	11,827	0.05%	2,102
39 (Administration)	1,784	0.01%	15
44 (PP members Torchat information exchange. (read only))	1,561	0.01%	402
73 (Pre-Release)	465	0.00%	9
68 (Girls)	434	0.00%	11
60 (Tools, Guides, and Discussion)	393	0.00%	8
66 (Discussion and Rules)	75	0.00%	9
72 (Applications)	71	0.00%	12

Sub-Forum	Total number of logged clicks	Logged clicks: % of total	Total number of unique members
Total	21,967,663	100.00%	

* Some sub-forums had identical titles. As these sub-forums are located on different environments of the site and as they have their own content, they have their own ID number and they are considered different sub-forums in this table.

Researchers further analyzed which sub-forums were visited frequently in combination with each other. To do so, the number of clicks in each sub-forum for each member was calculated. Activities within sub-forums dedicated to various "fetishes" (bondage, chubby, feet, panties-nylons-spandex, peeing, scat, spanking, voyeur, and zoo) were compared with the main categories of "boy-lover" and "girl-lover" environments. Results from these combined sub-forum visits indicate that the majority of 80,111 members (82.4% of the total of members) were mostly active in girl-environments. Moreover, among a smaller number of members that were most active in the boy-environments (2,596 members, 2.7% of the total of members), approximately half (50.2%; or 1,303 members) also frequently visited girl-lover environments. And from the small minority of members who were most active in the fetish-environments (2,283 members, or 2.4% of the total of members), the majority also frequently visited girl-environments. Finally, there were a total of fifteen members active in the administration subforum, six of whom were most active in this particular sub-forum. Apart from their activity in this administrative environment, these members were found to visit the girl-environments most frequently. Four of them were most active within the hardcore environments, and two were most active within the softcore environments of the hidden service.

5.3.2.2 Members' downloading behavior

A final analysis calculated how frequently certain links containing CSE material files for download were accessed by unique members. Within the two-week timeframe analyzed, a total of 7,444,550 unique downloads were attempted among the 97,178 members. This equated to an average of 77 download attempts per member over a two-week period, or just under five download attempts per member per day. Only 6,235 members did not make any download attempt (6.4%).

Further examination of those members who made at least one download attempt (90,943 members), found that on average, these members were active on the website for approximately 3.5 days. Consequently, the 33,439 members who engaged in activity that was above the mean (four days or more), were further explored. Analysis

revealed that only 41 of these 33,439 members did not make any download attempt. Taken together, this means that of the approximately 33,452 members who were active on the website for more than four days, nearly all (99.9%) made at least one download attempt.

5.4 Discussion

The results from an overall descriptive analysis of the first dataset examining the "average" member on a CSE TOR hidden service suggest variation among members. Some members were active for only a short period of time, whereas others logged many hours of forum activity over a longer period of time. This result supports the notion of the existence of a relatively small group of keyplayer forum members (Fonhof et al., 2018), who play an important role in delivering content and moderation, and who are important for the hidden service's existence and survival. Furthermore, the results from the analysis of the first login time on the hidden service demonstrate that the number of members that register during the very early days of the site's existence is limited and that the number of registered members increased quickly from the beginning of September 2014 onwards. This implies that those members that registered in the first week the hidden service became public are potentially interesting and valuable targets for law enforcement. Their familiarity with the new hidden service could indicate that they have relevant ties to the broader CSE network, and that they may fulfill a key role in the site's development.

Moreover, it is noteworthy that only a small percentage (3.4%) of members were verbally active on the hidden service. This is consistent with previous literature on lurking, which emphasizes that lurking is very normal internet behavior that constitutes a significant proportion of approximately 90% of all members active on the platforms (Gong et al., 2015; Mousavi et al., 2017; Nonnecke & Preece, 2000; Tagarelli & Interdonato, 2013). The fact that the percentage of lurkers is even higher in the current datasets is not surprising, as CSE hidden services are dedicated to taboo and illegal content/topics, about which members may be reluctant to speak about openly.

From the analysis of dataset 2 (the narrower two-week timeframe), it became evident that those members who were not verbally active, were still actively engaged with the website's content and purpose, clicking and navigating through the various forums and sub-forums and (attempting to) download CSE material. Overall, 93.6% of forum members attempted to download illegal content. Of those members who were active on the site for at least four days, nearly all (99.9%) attempted to download CSE material. These results stress the need to emphasize that although the 96.6% of lurkers

represents the vast majority of forum members and may not be visibly or communicatively active, they are still engaged with the site's content and thus majorly impact on the CSE community. This study demonstrates the value of having had access to a specific and very detailed dataset of forum movements, comprising click data that highlights the hidden behavior of non-communicating members that would otherwise remain unknown.

Although the verbally active members may have the greatest public visibility on the site and the greatest potential of becoming a keyplayer, the potential risk of those members that are not verbally active should not be underestimated. Previous research on Darkweb CSE hidden services clarified that lurkers on one platform may actually be active participators on other locations. In the case of Darkweb CSE hidden services, members may use one platform/site for downloading solely and another platform/site to communicate with fellow members (Van der Bruggen & Blokland, 2021). Lurkers, once thought to simply be passive observers, are now understood to be more engaged and still have important ties with influential fellow members or with the larger network (Cranefield et al., 2015; Tagarelli & Interdonato, 2013). Moreover, law enforcement experience combined with findings from the current study and previous research also demonstrates that lurkers are still individuals that identify with the forum's predicated interests and experience a sense of belongingness to that community (Lutz & Hoffmann, 2017; Mousavi et al., 2017). Additionally, when one considers that 93.6% of members (attempt to) download illegal CSE material, it can be concluded that members intend to consume material related to those topics that interest them (Gong et al., 2015). Just like with any other member engaged on the site, the active pursuit and consumption of CSE material may affect attitudes and future behavior, which means that lurkers may also be a risk to children in the physical world. Therefore, the authors conclude that "being active" is a comprehensive and broad concept that includes unseen behavior, and illicit activities can be conducted without an obligation of verbal communication.

Additionally important, the results of this study imply that attempts to download illegal content is the main reason for the majority of members to visit the CSE hidden service. It is important to note that this finding applies to all members, despite their level of verbal activity on the site. Given the low number of members who were verbally active, combined with the broad downloading activities of all members, this particular CSE hidden service can be considered a download platform. This is also in line with the fact that the hidden service was an "open forum" (apart from having to register with a username and password, there were no further restrictions or activity requirements), with a low threshold to become and stay a member.

These findings have an important implication for law enforcement intervention.

Based on these findings, suspects testifying that they accidentally visited a CSE hidden service and unknowingly viewed/downloaded CSE material is not very plausible. The results of the current study imply that individuals active on Darkweb CSE hidden services, including the lurkers, purposefully and actively search for copious amounts of CSE material to view and download. Although a lack of resources contributes to law enforcement having to prioritize when dealing with large groups of suspects, the results of the current study infer that in addition to focusing on keyplayer members, there may also be value in detecting emotionally involved lurkers with high volumes of (attempted) downloads and movement activity (clicks) on the site.

Finally, the hidden service analyzed in this study could be considered a "girl-lovers" site. The girl-related sub-forums were most popular, and based on their clicking and downloading behavior, most members (including the administrators) demonstrated a preference for girls. The group of members primarily interested in boys or other specific sexual interest such as fetishes, appear to be a small minority. This is not surprising, given Seto and Eke (2015) found that the majority of CSE offenders have a preference for girl content with their collections reflecting this preference. The group of offenders with exclusively boy material was very small, leading researchers to conclude that girl content was much more common. Consistent with this study, these findings can be partly explained by the members' behavior and the logic behind the development of a site, that girl-environments will logically develop and expand (in terms of number of threads, potential material and links etc.) and consequently cause a greater volume of behavior flow. However, law enforcement experience indicates that there are separate and dedicated forums for "boy-lovers" or sexual fetishes. An interesting direction for future research would be to establish patterns in behavior flow and material downloaded across other Darkweb CSE hidden services, and potentially even to innovatively relate this to the specialization/versatility debate (Mazerolle & McPhedran, 2019).

The current study acknowledges a few limitations. Most importantly, only one CSE hidden service was analyzed during a limited timeframe, which affects the generalizability of the results. It is suggested that future research should compare the current results with CSE hidden services with a different focus, management style and levels of restriction. Moreover, the current study was not able to assess the content of attempted downloads, meaning that clicking on a link did not necessarily mean that the source file was ultimately accessed (the link could potentially be inaccessible, faulty or broken). Moreover, one cannot assume every link was associated with CSE material. However, this predicated hidden service was dedicated to and promoted the exchange of CSE material and the content uploaded to the site was moderated by the administrators. Furthermore, FBI special agents downloaded and reviewed over one million

files from this hidden service during their investigation and concluded that nearly all of the depicted files contained illegal CSE material (Department of Justice, 2019). The authors were, thus, fairly certain that an attempted download indeed concerned an illegal act.

Despite these limitations, the current study has value in informing operational practice, foremost because it focused on a platform (a Darkweb CSE hidden service) that attracted greater attention among CSE offenders at the time. It is important that research stays up to date with the (technical) developments of the crime field under study. Moreover, the fact that the current study had access to a unique dataset including all member clicks on the website, led to the conclusion that the verbally inactive members are no less important members within the hidden service community. Lurkers may be active downloaders, who may have evidence of these downloading activities on their computers. Moreover, they may even be contact offenders, or producers of CSE material in their physical life. The results of this study suggest that law enforcement should also focus on lurker members. Additionally, these results can inform forensic teams on what to look for during a search warrant. Moreover, the results of the current study may help prosecutors in explaining in court that despite no verbal activity, the chances are great that a suspect had a more active role in maintaining the CSE community by clicking through the site and attempting to download illegal material. With the results of the current study, the authors hope law enforcement investigators and prosecutors will be able to assess and compare the behavior of individual suspects, using a more accurate "general profile" of members. For example, prosecutors could exemplify that a certain suspect deviates from the general profile regarding the number of visits, clicks, and downloads on a hidden service. Building on this research direction, eventually a more complete insight into the anonymous online CSE offender population will be gained.