

The Presence of New Psychoactive Substances in a Tor Network Marketplace Environment

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ABSTRACT

Prior research has documented the availability of drugs on many Tor Network websites, with the Internet playing a particularly vital role in the global new psychoactive substances (NPS) market. The primary objective of this research was to document types of NPS for sale on the largest operating Tor site (Agora) over a period of four months. Secondary objectives were to analyze countries and vendors sourcing NPS on Agora. Data from Agora were collected in February and June 2015. The number of total advertisements on Agora increased from 20,742 to 27,431 over the four months, while the number of NPS advertisements increased from 2,205 to 2,271 and the number of vendors increased from 157 to 288. The composition of NPS listings and source countries for NPS advertised on Agora diversified over time. Advertisements for ketamine and unclassified NPS experienced substantial growth, while the availability of phenethylamines decreased. However, phenethylamines remained the most frequently advertised NPS type. China and the U.S. were found to be the top two countries by volume selling NPS on Agora over the four months, but the number of countries identified as advertising NPS increased by nearly 43%. The United States housed the most NPS vendors.

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While not a “novel phenomenon” (UNODC 2013a, 1), the United Nations Office on Drugs and Crime (UNODC) has noted the increased prevalence and abuse of new psychoactive substances (NPS) worldwide. By December 2014, a total of 541 NPS had been reported by the European Monitoring Center for Drugs and Drug Addiction (EMCDDA 2015), though many of these drugs are not considered “controlled substances” under country-based drug legislation. NPS are largely of synthetic origin, created to mimic the effects of known illicit drugs (UNODC 2013a). Upon slight chemical alterations, coupled with the use of unregulated precursors, newly created NPS often fall outside of the legal realm, thus making it difficult for law enforcement, government officials, and academics to investigate and track patterns in abuse and trafficking. Approximately 100 new substances were reported in 2014, with surges in prevalence reported in Europe (e.g., the U.K., Poland, Hungary), North America (e.g., the U.S., Canada), and Oceania (e.g., Australia). However, over 95 countries have experienced emerging consumer markets for NPS. The most popular NPS include synthetic cannabinoids (e.g., Spice, K2, JWH-210), stimulants including phenethylamines (e.g., 4-

MMA, 2 C-B), serotonergic drugs including tryptamines (e.g., 5-MeO-DMT), and synthetic cathinones (e.g., MDPV, a common substitute for ecstasy and cocaine and commonly referred to as “bath salts”) (Goggin, Gately, and Bridle 2015; UNODC 2014, 2015).

The most recent Global Drug Survey (GDS) found the percentage of respondents seeking emergency medical treatment for NPS to be “at least” three times greater than for traditional illicit drugs (Global Drug Survey 2015). Further, the use of cyberspace by the drug user community has facilitated the rapid dissemination of information about newly synthesized NPS, including where to purchase the substances, user experiences, and perceived safety of the substances. Online NPS advertisements are increasingly catchy, “designed to attract customers—especially young people” (Corazza et al. 2014, 287). The Internet environment has also helped groups coordinate NPS production efforts and access to precursor chemicals (UNODC 2013a; Van Amsterdam et al. 2015). These studies highlight the growth and potential negative social impact of NPS abuse and underscore the need to better understand and respond to the cyber-driven distribution of these substances. Further, these early measurement indicators and the broadening geographic distribution of NPS suggest that the

growth and spread of NPS will require both the medical community and law enforcement to continue to adapt and respond to this evolving public health challenge (Corazza et al. 2014; van Hout 2014).

Scholars have documented popular websites (i.e., Silk Road, Evolution, Pandora) on one encrypted corner of cyberspace, the Tor Network, that function as virtual drug stores (Barratt 2012; Goggin, Gately, and Bridle 2015). The Tor Network uses anonymizing software to ensure that its users' activities are untraceable, and the online network is only accessible once the free Tor browser is downloaded and installed from TorProject.org. Thus, Tor provides added security when purchasing illegal items from Tor websites (i.e., marketplaces), reducing the chances of personal identification and parcel interdiction by law enforcement. Research into the scope of the drug trade present on Tor is emerging, although studies have found that both customers (i.e., drug users) and sellers (i.e., traffickers) are drawn to Tor marketplaces because of the network's anonymizing features, quality of products, and ease of delivery (Van Hout and Bingham 2013a, 2013b). The use of the Tor Network for these purposes, together with the growing speed of communication and movement of capital via cyberspace (Aas 2007; UNODC 2013a), have the potential to significantly impact the international distribution and demand markets for NPS. Tor provides customers around the world with faster, easier, and anonymous access to illicit

drugs while circumventing traditional street-based transactions; however, little is known about the international supply of NPS within this context. Additionally, prior studies regarding the general drug trade on Tor have largely focused on the original Silk Road marketplace (e.g., Aldridge and Décary-Héty 2014; Barratt 2012; Christin 2012; Martin 2014; Van Buskirk et al. 2013; van Hout and Bingham 2014), which operated from February 2011 until October 2013. This identifies an additional gap in the literature, demonstrating a need to research more recently operating major Tor marketplaces.

Although there are hundreds of drug-selling marketplaces currently operating on Tor, few have received the public reputation of being a "top-rated and recommended" marketplace for drugs and other illegal items. In 2015, Agora (see Figure 1) was recognized in public forums as the "largest drug market" on Tor by trade volume (AgoraDrugs.com 2015a; DeepDotWeb 2015). At its peak, researchers estimated that Agora grossed nearly \$600,000 per day in total sales, compared to \$300,000 per day grossed by Silk Road (Soska and Christin 2015).

Given the broad reach of the Agora marketplace, this study investigated the available supply of NPS on this international Tor platform. More specifically, this case study documented the volume and types of NPS for sale on Agora, as well as the countries of origin identified by "virtual traffickers" in each NPS advertisement. Data were

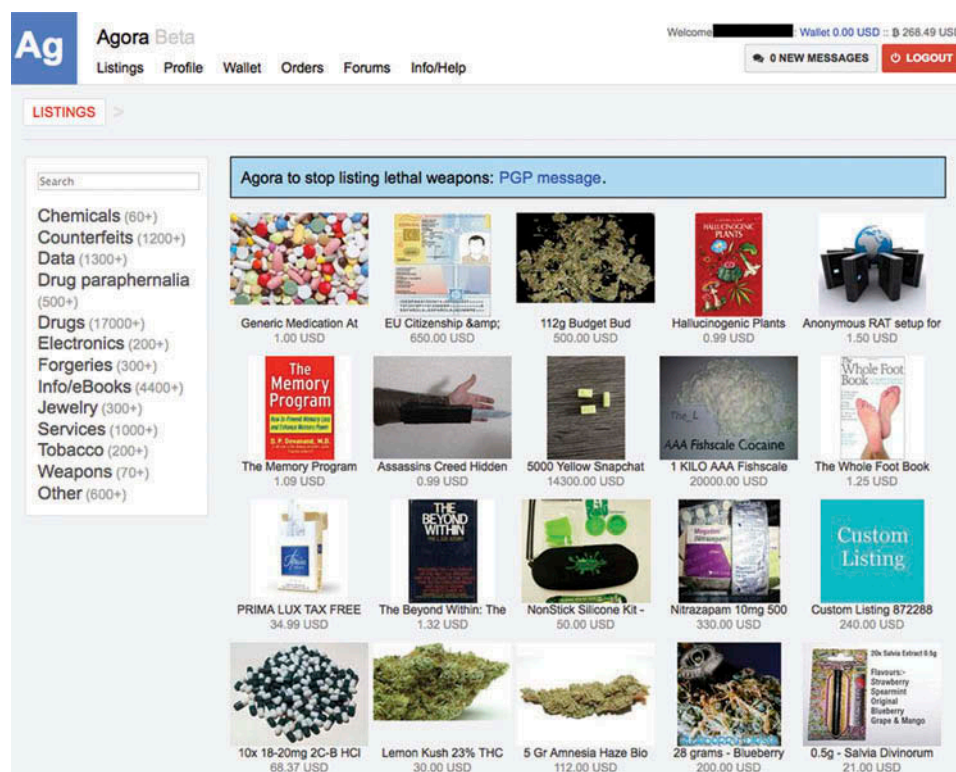


Figure 1. Agora home page.

collected at two points in time, four months apart (February and June 2015), to assess any changes in the types of NPS available for sale or the vendors (including geographic locales) supplying the drugs. This is the first study to provide a holistic, exploratory analysis of the NPS supply market on an international virtual platform. It offers a starting point for understanding more about the types of NPS supplied, and for understanding Tor-based NPS cross-country variability.

Methods

The research questions addressed in this study are: (1) what kinds of NPS were advertised as available on Agora and how did the types of NPS change over time; (2) which countries were vendors advertising from and did this change over time; and (3) did the number of vendors selling NPS in each country change over time. To address these questions, the Agora marketplace was mirrored using similar webcrawling techniques from past studies (Dolliver 2015a; Dolliver and Kenney *forthcoming*; Soska and Christin 2015). These webcrawling techniques produce static copies of a website while retaining the site's relative link structure and enable offline browsing. Prior to the two complete crawls¹ used in this study, multiple partial and full test crawls were conducted to properly configure the web-crawler. This process required many hours to direct the crawler to target the individual listings of items for sale on Agora and to reduce redundancies in each crawl (Dolliver 2015b). The first complete crawl of Agora was conducted in February 2015, requiring over 25 continuous hours. This date was selected as part of a monthly Agora-monitoring project conducted by the first author. The date of the second complete crawl was originally scheduled in accordance with the monthly monitoring project, but was delayed due to repeated DDoS (distributed denial of service) attacks conducted on the site throughout May and early June 2015 (AgoraDrugs.com 2015b). Thus, the second crawl was conducted in mid-June 2015, requiring approximately 70 continuous hours. It is important to note that the Agora marketplace is no longer operating; Agora went offline in July 2015 to allegedly allow for security updates (Van Buskirk et al. 2016), and was never re-launched.

Soska and Christin (2015) raised concerns regarding the reliability of accurately crawling Agora. However, their calculations were based on an assumption that it was not possible to confirm whether each crawling attempt completely captured the website; these authors concluded that crawling Agora was too problematic an endeavor. However, the authors likely ran into a number of problems that confounded their crawling attempts.² The current study was able to maximize the efficiency of the webcrawler by directing it to only collect HTML data specific to Agora's

listings. Further, this study was able to verify that the crawls of Agora were complete by hand-checking the captured data and comparing the number of listings per category on the live Agora website to the listings captured in the February and January crawls.

Upon completion of the crawls, sorting software was used to record information from each item's advertisement. When creating a new advertisement (i.e., listing), vendors enter the title of their item(s) for sale, the quantity, price,³ and description of the item(s), the country(ies) the vendor is willing to ship to, as well as the country that the item(s) ship from. The vendor also lists the available shipping methods and any extra shipping-related costs. This information was sorted from each advertisement on Agora, using a series of algorithms, into respective variables for further analysis.

Tor customers complete purchases from vendors anonymously, so that the only publically available evidence of past transactions on Agora is "feedback" provided by customers after the purchase is completed. The Agora website required each customer to rate the vendor (on a scale of 0 to 5) and leave comments if desired. This feedback data (with the customer's name redacted) is available on each advertised item's webpage. However, there is no publicly available data regarding the quantity of drugs purchased (i.e., the advertisement might offer 5 grams of ketamine for sale, but the customer may purchase 10 grams), the price paid for the drugs, the customer's name, or the geographic location of the customer. As such, this study focused on the advertised, supply side of the NPS market on Agora.

Once sorted, the data were cleaned and coded. Items for sale were first coded as drug or non-drug (1, 0); the drug items were then further coded as NPS or non-NPS (1, 0), and vendor accounts were coded as NPS or non-NPS (1, 0).⁴ Using multiple sources to identify the substances (e.g., EMCDDA 2015; UNODC 2011, 2012, 2013a, 2013b), all NPS data (regardless of the legality of the substances) were further coded into 10 categories: aminoindanes, ketamine, phencyclidine-type substances, phenethylamines, piperazines, plant-based substances, synthetic cannabinoids, synthetic cathinones, tryptamines, and "other." The "other" category contained NPS that have been reported to international governing bodies (e.g., UNODC), but have either not yet been classified (as of the date of this study), or the classification remains unknown pending further research. Table 1 presents the most common NPS found in this study.

When vendors create a new listing on Agora, they are able to write-in locations (e.g., single countries, groups of countries, regions) they ship the item(s) from. This resulted in several occurrences of misspelled countries and

Table 1. Top 5 most common NPS on Agora by category.

Aminoindanes	Other	Phencyclidine-type substances	Phenethylamines	Piperazines	Plant-based	Synthetic cannabinoids	Synthetic cathinones	Tryptamines
MDAi	MXE	3-MeO-PCP	25I-NBOMe	MT-45	Kratom	AB-FUBINACA	α -PVP	5-MeO-MiPT
	AL-LAD		2 C-series	mCPP	Salvia Divinorum	AB-PINACA	MDPV	4-HO-MET
	4-CMC		2-FA		Changa	5 F-AKB48	4-MMC	4-AcO-DMT
	3,4 CTMP		4-APB		Mimosa hostilis	MAM-2201	MDPPP	4-HO-MiPT
	HPBCD		6-APDB			THJ-2201	4-EMC	α MT

Note: Ketamine is omitted from the table because this single substance comprises this category.

unidentifiable locations (e.g., “Torland,” and “the home of body bags”). If the country (or countries) could not be discerned from the listing’s description and comments, the geographic location was coded as either “unidentified” or “worldwide.” This occurred in less than 1% and 2% of drug-related items for the February and June crawls, respectively.

Since the data from the two time periods are not independent (e.g., advertisements may have remained on the website during the four months, while new advertisements were created and old advertisements removed), statistical tests could not be conducted to determine whether any significant differences existed between the two datasets.

Results

The Agora website primarily advertised drugs at both points of data collection, and experienced a 32% growth in total number of listings⁵ over the four-month time period. Drugs as a percentage of all listings declined, however, from 69% of total drug items for sale to 62%. The composition of drugs advertised on Agora at both points in time remained fairly stable. Stimulants (omitting NPS products) and cannabis (including THC products) were the most commonly advertised substances, comprising approximately 30% and 26% over time, respectively, of all drug items. In February, there were approximately 993 active vendors on Agora, 899 of whom advertised any type of drug. In June, the number of total active vendor accounts increased to 1,065; the number of those vendors advertising any type of drug also increased to 988. Out of all drug vendors, 44% of the accounts were still active by the end of the study period.

Composition of the NPS market on Agora

The NPS market overall on Agora remained fairly stable. While the number of NPS advertisements grew slightly over the four months (from 2,205 advertisements to 2,271), NPS as a percentage of Agora’s overall drug market decreased from 18% to 15%. Table 2

displays the 10 categories of NPS found on Agora. At both points of measurement, phenethylamines (e.g., 2 C-series, 25I-NBOMe) and synthetic cathinones (e.g., MABP, 4-BMC) comprised the top two categories of NPS advertised on Agora. However, the number of listings for both of these categories of NPS experienced a decline over the four-month data collection period. Synthetic cannabinoids (e.g., AB-PINACA, JWH-series) and tryptamines (e.g., 4-AcO-DMT, 5-MeO-DALT) were also well-represented on Agora, and listings for both drug types increased over time. Ketamine advertisements experienced the greatest percentage in growth,⁶ while aminoindanes (e.g., MDAi), plant-based substances (e.g., kratom, salvia), and phencyclidine-type substances (e.g., 3-MeO-PCP) were rarely advertised on Agora.

Geographic dispersion of NPS listings on Agora

Table 3 illustrates the countries of origin for NPS listings on Agora. Although the top two countries of origin were the same over time, the number of source countries/regions identified by vendor accounts for each NPS listing increased from 14 countries and one region (i.e., Europe) to 20 countries and one region (i.e., Europe). China supplied Agora with 43% of all NPS advertisements; however, after four months, China remained the top source country on the Agora site for only 30% of total NPS listings. The United States, Europe, and Canada also experienced a decline in the percentage of NPS listings over the four months as NPS listings were diffused among a greater geographical range, including countries such as South Africa, Mexico, the Philippines, Austria, and Switzerland.

Almost every category of NPS (with the exceptions of ketamine and phencyclidine-type substances) experienced an increase in the number of countries selling the substances over time, regardless of whether the frequency of listings for those substances likewise increased. For instance, listings for phenethylamines and synthetic cathinones experienced a 16 to 23% decline by the end of the four-month period; however,

Table 2. Agora NPS listings metrics (vendors).

	Feb. 2015	June 2015	% Listing growth
Aminoindanes	10 (1)	10 (3)	0.0
Ketamine	84 (25)	188 (50)	123.8
Other	142 (21)	206 (80)	45.1
Phencyclidine-type substances	6 (2)	3 (2)	−50.0
Phenethylamines	771 (69)	649 (128)	−15.8
Piperazines	1 (1)	5 (6)	400.0
Plant-based	52 (13)	54 (17)	3.9
Synthetic cannabinoids	299 (13)	385 (29)	28.8
Synthetic cathinones	644 (54)	496 (91)	−23.0
Tryptamines	196 (37)	275 (59)	40.3
<i>Total</i>	<i>2,205 (236)</i>	<i>2,271 (465)</i>	<i>3.0</i>

Note: Vendor totals may exceed 157 and 288, respectively, due to some vendors listing multiple types of NPS for sale.

Table 3. NPS listings on Agora by country.

Feb. 2015		June 2015		
Country	Frequency (Vendor)	Country	Frequency (Vendor)	% Listing growth*
China	955 (14)	China	680 (14)	−28.8
United States	355 (43)	United States	319 (89)	−10.1
Europe	171 (16)	Australia	250 (49)	233.3
Canada	170 (11)	United Kingdom	243 (31)	117.0
<i>Blank</i>	<i>136 (16)</i>	<i>Blank</i>	<i>178 (28)</i>	30.9
United Kingdom	112 (24)	Canada	151 (24)	−11.2
Netherlands	76 (11)	Europe	113 (18)	−33.9
Australia	75 (20)	Netherlands	113 (14)	48.7
Germany	69 (9)	Germany	81 (13)	17.40
Poland	30 (2)	<i>Worldwide</i>	<i>51 (10)</i>	155.0
<i>Worldwide</i>	<i>20 (5)</i>	Sweden	20 (3)	150.0
Czech Republic	13 (2)	India	19 (4)	216.7
Sweden	8 (1)	Poland	13 (1)	−56.7
India	6 (2)	Belgium	11 (2)	
Norway	4 (1)	Norway	6 (2)	50.0
Denmark	3 (1)	Austria	4 (1)	
Pakistan	2 (1)	Spain	4 (1)	
		Philippines	3 (1)	
		<i>Undeclared</i>	<i>3 (3)</i>	
		Denmark	2 (2)	−33.3
		France	2 (1)	
		Mexico	2 (1)	
		South Africa	2 (1)	
		Switzerland	1 (1)	
<i>Total</i>	<i>2,205 (179)</i>		<i>2,271 (314)</i>	

Note: * If the value is blank, the country did not appear in the February 2015 data. Vendor totals may exceed 157 and 288, respectively, due to some vendors listing different countries or origin per listing (including regions, undeclared, blank, and worldwide).

the number of countries advertising these particular drugs increased, to include Mexico, the Philippines, Sweden, Spain, Belgium, and India.⁷

Listings for synthetic cannabinoids and tryptamines experienced increases over time (29% and 40%, respectively), with China as the top country of origin for both drug types. However, synthetic cannabinoid listings from China remained stable, while corresponding tryptamine listings from the country declined. The United States experienced a substantial increase in listings for synthetic cannabinoids (258%), while tryptamine listings from

Canada significantly declined (−78%). These findings indicate that, for these two NPS categories, increases in listing frequencies were not caused by vendors shipping more products from the same group of countries; rather, there was an increase in vendors participating on Agora from a broader array of countries (e.g., Australia, the Netherlands, South Africa, Sweden).

Ketamine and “other” NPS also experienced a surge in listing frequencies on Agora over the four-month period, particularly with regards to ketamine (45% and 124%, respectively). The “other” category contains NPS that have either yet to be assigned a governmental classification or require further research prior to categorization. The high rate at which new substances are discovered may also account for the doubling of countries selling this type of NPS (increasing from six countries and one region to 13 countries and one region)—large increases in participation from the United States (320%), the Netherlands (280%), and Australia (433%) are noteworthy. Ketamine listings experienced the greatest increase (123%), yet the growth of ketamine listings is attributable to increased activity from a small group of countries (primarily the United States, the United Kingdom, and Australia). Ketamine shipped from the United Kingdom increased by 1,140% and also increased from the United States (188%). Ketamine was the only NPS categories observed on Agora to experience a decrease in the number of countries selling the substance over time (nine countries vs. eight, respectively). Countries that had initially advertised ketamine but were no longer observed in the ketamine market on Agora over time included Denmark and Pakistan.

The remaining four NPS categories were found to be relatively rare on Agora. Plant-based substances (e.g., kratom and salvia) originated primarily from Poland, with limited activity from Germany, United States, the United Kingdom, and the Czech Republic. However, by the end of the time period, China and Australia were the most often reported countries listed, with broader, yet limited, geographical participation from France, India, the Netherlands, and Denmark. Listings for aminoindanes were limited solely to China initially, but after four months China was no longer participating in this particular NPS market. Instead, aminoindanes only originated from Australia, Germany, and the United Kingdom. The initial single listing of piperazines originated from Germany; after four months, the few piperazines listings originated solely from Australia. Finally, phencyclidine-type substances originated from Europe and the United States at the beginning of the data collection period, diversifying to

include Canada after four months; however, the availability of these substances remained limited.

NPS vendors on Agora

The total number of vendors supplying Agora with NPS products increased from 157 active accounts to 288 over the study period. However, the number of NPS vendor accounts outpaced growth in NPS listings, resulting in fewer listings per vendor account over time. Thirty-three percent of all NPS vendors remained active over time, indicating that there was greater turnover among NPS vendors than all drug vendors on Agora. However, 65% of the top 20 NPS vendors remained active, indicating that NPS traffickers with high volumes of NPS advertisements were more likely to remain active on Agora in this study.

The ratios of NPS to other drug-type advertisements per vendor were also found to shift among top NPS vendors—at the first point of data collection, four NPS vendors among the top 10 solely advertised NPS, whereas, by the end of the four-month period, only one vendor among the top 10 solely advertised NPS. This indicates that top NPS vendors began to diversify their drug supply over time. Further, the top NPS seller on Agora supplied a substantially greater amount of NPS for sale than any other vendor (peaking at 497 NPS listings), yet this vendor's listings fell from 23% of the total NPS advertisements to 16% during the study period. This vendor also greatly increased the volume of listings for other drug types over time by 83%, again supporting drug supply diversification. However, the overall percentage of NPS vendors who solely advertised NPS drugs increased over the study period from 18% to 25%. These findings indicate two potential trends: top NPS traffickers had the ability to and expanded their drug supply to include substances other than NPS, while vendors with lesser volumes of NPS specialized in NPS products alone.

This study also found that approximately 65% of vendors listing 10 or fewer NPS items advertised a significantly greater number of other drug types. The most significant case uncovered one vendor listing two NPS items for sale while also advertising 300 other drug items. This suggests that vendors particularly active in other drug markets may have restricted access to or a limited desire to engage in NPS trafficking.

The number of vendors advertising ketamine, “other” NPS, phenethylamines, and synthetic cathinones substantially increased over the study period (Table 2). These results corresponded with an increase in the number of listings for each substance, with the exception of phenethylamines and synthetic cathinones.

For these two substances, the number of listings declined while the number of vendors participating in these markets increased by 86% and 69%, respectively. This may suggest that more individuals entered the Agora markets for phenethylamines and synthetic cathinones, but were unable to obtain or stock greater quantities of the drugs.

Finally, this study found a substantial increase in vendor participation in the NPS market on Agora from the United States and Australia over the study period, while other countries (e.g., China, the United Kingdom, the Netherlands, and Germany) remained stable in the number of vendors (Table 3). Further, a considerable number of all NPS listings originated in China but were supplied from a small group of 14 vendors over time (eight of the original 14 vendor accounts remained active).

Discussion

First, it is clear that Agora's online drug market was fully active and dynamic, and its activity likely contributed to global online NPS distribution specifically. Our study documented observed changes in the types of NPS advertised on Agora and the countries the items were reportedly shipped from, despite the relatively stable number of NPS listings over time. Ketamine and unclassified NPS substances (categorized as “other” in this study) experienced a significant growth in listings over four months, while phenethylamines and synthetic cathinones (the most frequently advertised NPS categories) experienced negative growth, despite an increase in the number of vendors offering to sell both substances. Synthetic cannabinoids and tryptamines were routinely advertised on Agora, but aminoindanes, plant-based substances, and phencyclidine-type substances were rarely advertised during the study timeframe. The broadened geographic base of NPS vendors on Agora was also apparent over the four-month observation period. Every NPS category, with the exceptions of ketamine and piperazines, experienced increased country participation from drug sellers. While China, the United States, Australia, and Canada were most often mentioned on the Agora as potential sources of NPS sales (see also Dolliver and Kenney [forthcoming](#); Van Buskirk et al. 2016), this short-term longitudinal analysis found new NPS listings originating from countries including Denmark, Switzerland, Mexico, South Africa, Sweden, Spain, and the Philippines. Additional research is needed to monitor global NPS presence on Tor marketplaces, particularly with regards to newly emerging NPS. Future research should also compare clearnet NPS markets to

Tor-based NPS markets to gain a more comprehensive understanding of the online NPS market.

Findings support past research on online drug distribution models involving a wide range of countries and vendors (Aldridge and Décary-Hétu 2014; Dolliver and Kenney *forthcoming*; Soska and Christin 2015). Online drug distribution, particularly on Tor, often includes newly created and modified substances that would appeal to curious users who are interested in broadening their substance use experiences and motivated sellers looking to expand their product lines (Corazza et al. 2014; Dolliver and Love 2015; van Hout and Bingham 2014). This study found ketamine listings grew by 124% over four months, yet this trend was partially attributable to increased vendor activity from a small group of primary countries (the United Kingdom, the United States, Canada, and Australia). However, synthetic cathinones and “other” NPS nearly doubled in the number of countries sourcing these substances (and more than doubled in the number of vendors), while synthetic cathinone listings decreased by 23% over time. The country sourcing the most NPS listings on Agora—China—experienced market participation from only 14 vendors. Causes for these changes are not found within this data, and future research should focus on market indicators (e.g., supply/demand variations, law enforcement pressure, changing access to precursor ingredients) that impact changes in the NPS markets to better understand these transaction trends. One potential indicator requiring further analysis includes detection and interdiction of Tor-bought NPS. While there are obvious risks involved with relying on legitimate delivery channels (e.g., postal services, private delivery companies) for illegitimate drug distribution activities, the challenges of effective interdiction at the post office are substantial and, at minimum, perhaps comparable to those at the border.

This study suggests that certain types of NPS appeared to be more often advertised (and therefore potentially more in demand) than others (the volume of NPS category listings over time is an assumed proxy for supply and/or demand). There were limited mentions of piperazines and aminoindanes (for instance) from a small number of vendors; however, newly created (and thus temporarily unclassified) NPS were more readily advertised (e.g., AL-LAD, 4-CMC) by a large number of vendors. These patterns may indicate interest and demand from the drug user community to perhaps experiment with new substances that are not yet outlawed or captured in various drug tests. These patterns may also indicate that vendors had fewer piperazines and aminoindanes in stock. Additional research is needed to determine the extent to which

consumer demand is tied to (advertised) vendor supply on Tor marketplaces.

This study collected only publically available data from Agora, and was unable to capture data related to the actual transactions being completed from each NPS listing. Thus, the authors could not tabulate the quantity of NPS being sold per advertisement. It may be that larger quantities of aminoindanes (for instance) were being sold than the number of listings indicated. Further, only one Tor marketplace was examined, and findings are not generalizable to all NPS advertised and/or sold on Tor. Due to the unindexed nature of Tor, it is infeasible to identify a representative sample of marketplaces. However, this case study analysis of one reputable and sizable Tor website offers an initial measurement of NPS advertised in this unique cyber context. Finally, this study collected data over a period of four months. To better understand long-term trends in NPS market fluctuations on Agora (or on Tor sites in general), additional longitudinal research is needed. However, Agora went offline less than one month after the final point of data collection in this study. International Tor marketplaces like Agora often have short lifespans, thus complicating attempts to gain a more complete measurement of the drug trade on Tor and how that drug trade evolves.

Conclusion

Online drug markets expand what has historically been a geographically constrained activity—use of certain illicit substances (Mazerolle, Soole, and Rombouts 2007). These markets present challenges for law enforcement, which has historically focused attention on eradicating trafficking processes/organizations, arresting users, and disrupting street-level markets (Mazerolle, Soole, and Rombouts 2007). Many traditional models of drug market enforcement would be less effective, or altogether ineffective, at disrupting Tor-based NPS markets. Law enforcement leaders in the United States have recommended developing task forces, working directly with private corporations and universities, identifying and training talented personnel, and educating the community as promising strategies for addressing cybercrime more broadly (Police Executive Research Forum 2014). Other law enforcement strategies, including those developed for responding to child pornography (Wortley and Smallbone 2006), might be modified, adapted, and applicable for responding to the online NPS marketplace.

On the other hand, many traditional challenges associated with illicit street markets (user and seller safety concerns, violence, territorial disputes, cost of

employees and product distribution, access and availability) are perhaps lesser concerns in Tor-based transactional environments. The benefits of transacting online (expansion of customer base, global market, ability to transact anonymously, and the opportunity to reduce risk) are readily apparent. It may be that increasingly active Tor-based (or online, in general) NPS markets may help decrease drug-related violence, and some evidence suggests that this may already be occurring in Australia (Nasseri 2015). Yet, public and private delivery companies will need to increase their investigative capabilities (to enhance interdiction effectiveness) and their security (as those who are “trafficking” NPS will likely be targeted by both rivals and users). Future studies should explore the ways in which the medical community, law enforcement, and private industry adapt to shifts in illicit NPS distribution within Tor marketplaces. Further, efforts to disrupt online NPS marketplaces should be developed and tested to determine which strategies might deter potential users and sellers from shopping for and distributing these illicit drugs online. Finally, the possibility that online drug transactions may reduce drug-related violence is worth exploring (Nasseri 2015), as countries develop strategies and laws to minimize cross-country distribution of NPS.

Notes

1. “Complete” and “full” crawls capture the entirety of the website regarding all advertisements and vendor information publically available on the day of the crawl. “Partial” crawls do not capture the totality of this information and are used to help direct and configure the webcrawling software.
2. For instance, mirroring user forums as well as active listings greatly decreases the efficiency of the webcrawling software and significantly increases the chances for the software to become sidetracked.
3. Prices are displayed in the customer’s preferred currency, although all transactions are conducted in BitCoin.
4. Vendor accounts were coded as “NPS vendors” if they advertised any NPS listings, regardless of how many other drug or non-drug items the vendor advertised. In other words, if Vendor 1 advertised one ketamine listing and five heroin listings, Vendor 1 was coded as an NPS vendor. Vendor names are not reported in this study.
5. In February, Agora advertised approximately 20,742 items for sale; in June, that number increased to 27,431.
6. Piperazines were a percentage change outlier.
7. It is important to note that these data do not reflect the geographic locations of consumers. It may be the case that a large number of ketamine vendors in the Netherlands (for instance) do not represent a large Dutch consumer base for ketamine.

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