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Identifying emerging trends in recreational drug use; outcomes from the Psychonaut Web Mapping Project

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ABSTRACT

Background: This paper presents the outcomes of the 2-year European Union funded Psychonaut Web Mapping Project which aimed at developing and implementing an integrated web mapping system to promptly identify and learn about novel psychoactive substances (NPS; "legal highs") through the regular monitoring of the Internet.
Methods: More than 200 discussion forums, social media, online shops, websites and other Internet resources (e.g. YouTube, eBay, Google, Google Insight) have been extensively and regularly monitored in 7 European countries (UK, Finland, Norway, Belgium, Germany, Italy and Spain) for emerging trends of NPS throughout the period of the study.
Results: Key online resources have been identified as "leading edge" which have provided accurate and timely information on novel emerging compounds. In total more than 400 substances/products have been recorded. NPS have been noted online before reaching wider audiences.
Discussion: Although a high number of novel psychoactive substances have been identified in the 2-year duration of the project, not all have become trends that needed public health response. Conversely, new recreational drug phenomena such as "spice drugs," mephedrone and naphyrone were all identified as emerging trends in forums and websites. In addition, it has been possible for the first time to collate detailed information on these and several more compounds even though no or limited scientific publications were available. It is therefore recommended that these monitoring activities are to be continued, that more countries, researchers and health professionals are involved, and that the findings are widely shared with all the relevant agencies, health professionals and future research projects.
Implications, advantages and limitations of using the Internet as primary source for identifying emerging trends are also discussed.

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1. Introduction

Is it possible, using the Internet, to identify emerging trends in recreational drug use and learn about novel psychoactive substances? Over the past few years there has been increasing recognition from the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA, 2009, 2010a, 2010b, 2011a, 2011b), International Narcotics Control Board (INCB, 2008, INCB, 2009, INCB, 2010), governments and regulatory bodies (e.g. ACMD, 2011), the scientific community (e.g. Hillebrand et al.,

Abbreviations: EMCDDA, European Monitoring Centre for Drugs and Drug Addiction; INCB, International Narcotics Control Board; ACMD, Advisory Council of the Misuse of Drugs; NPS, Novel psychoactive substances; EWS, Early Warning System; MDAI, 5,6-methylenedioxy-2-aminoindane; MDPV, methylenedioxypyrovalerone; GBL, Gamma-butyrolactone; EU, European Union.

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2010; Ramsey et al., 2010; Schmidt et al., 2011) as well as the public and media (e.g. Jack, 2009; Townsend, 2010) of the major role that the Internet is now playing in shaping the recreational drugs market. Various surveys and studies have shown that the Internet is the most popular source of information about illicit drugs and their use (e.g. Eurobarometer, 2011) and that this information is often biased and potentially inaccurate (Deluca et al., 2007; Schifano et al., 2006). More recently these trends have expanded to include novel psychoactive substances (NPS), which are widely discussed (Davey et al., in press) and available for purchase online (EMCDDA, 2011a, 2011b).

NPS, also known as 'designer drugs', 'herbal highs', 'synthetic drugs', 'research chemicals' and 'legal highs' are a relatively new phenomenon and they often are marketed as legal substitutes for more common illicit drugs. These include for example mephedrone, methylenedioxypyrovalerone (MDPV), synthetic cannabimimetics "Spice drugs", GBL, methoxetamine, and salvia divinorum, that are, or were when they emerged onto the drug market, not controlled by relevant drug legislation.

In recent years the novel psychoactive market has expanded rapidly and has become highly innovative and dynamic and able to adapt quickly to new legislations (Brandt et al., 2010). Indeed, in 2011, 49 new psychoactive substances have been reported to the EMCDDA via the EU Early Warning System (EMCDDA, 2012). However, this constant innovation and production limits the knowledge of both the pharmacodynamics, and the acute and chronic toxicity of these substances (Schifano et al., 2011a; Wood et al., 2011). Moreover, polysubstance use involving NPS (e.g. pregabalin with either mephedrone or Salvia divinorum) adds further uncertainty in terms of the medical consequences of this combined intake (Schifano et al., 2011b).

Traditional early warning and monitoring systems tend to have or collect data from different sources, which are then used to validate and complement their findings (Griffiths et al., 2000; Mounteney et al., 2010). Although much still needs to be done to improve earlier detection and precision of such systems (Mounteney et al., 2010), these systems were set up to monitor trends in illegal substances using mostly official data from national surveys, police, and customs, which might well not be appropriate to monitor the legal highs phenomenon.

However, over the past few years these drug monitoring/information systems (e.g. DMIS, Brunt and Niesink, 2011; EU Early Warning System/EWS, EMCDDA, 2007) are increasingly sensitive and open to the Internet as a resource for identifying trends and triangulating data collected from other sources (e.g. EMCDDA, 2010b, 2011b).

Monitoring the Internet is therefore becoming essential to identifying and understanding new trends. Indeed, in the case of NPS the Internet should be regarded as the main resource and trend indicator. NPS are widely available and aggressively marketed online, with online shopping opportunities being on the increase and more people being accustomed to it (Corazza et al., 2011, 2012). Through online drug related forums, the Internet also provides a unique opportunity to access a range of user generated content on the use, positive and negative effects, subjective experience, popularity, and availability of NPS (Davey et al., in press). Therefore, we argue here that it might be possible to understand this challenging phenomenon of NPS on the web and identify emerging trends by monitoring online shops, their marketing strategies, and other key online resources and communities.

The paper presents the main outcomes of the 2-year European Union funded Psychonaut WebMapping Project (2008–2010).

1.1. Main objective

The main objective of the project was to develop and implement an integrated and multi-lingual web mapping system to promptly identify and learn about novel psychoactive substances (legal highs) through the regular monitoring of the Internet.

1.2. Specific objectives

The specific objectives of the project were as follows:

1. To develop and implement an integrated multilingual web scanning system which takes into account both suggestions from the web and qualitative information given by groups of identified 'key informants/sentinel networks'.
2. To monitor the Internet (i.e., websites, chatrooms, newsgroups) with respect to novel (synthetic and herbal) drugs of misuse and novel combinations and emerging trends.
3. To technically evaluate the novel compounds/novel combinations, and to prepare technical reports for a set of shortlisted compounds.

2. Methods

The methodology used by the Psychonaut Web Mapping project is articulated in two main steps.

2.1. Monitoring of the web

This step involved an extensive and regular monitoring of the Internet (i.e., websites, online shops, chatrooms, newsgroups, forums, eBay, YouTube, Facebook, Twitter, Google Insights for Search) with respect to novel (synthetic and herbal) drugs of misuse, combinations, and methods of administration (e.g., tampering with pharmaceutical products) for emerging trends.

Emerging trends are broadly defined here to include the emergence of a new psychoactive substance, or combination of substances, or a new way of using an existing substance/combination of substances. The focus was primarily on novel psychoactive substances.

Qualitative exploratory online searches were conducted between 1 and 5 times per week during the first year of the project in each of the eight participating research centers using the Google search engine. Generic search queries with terms such as 'legal highs', 'herbal highs', 'smart drugs', and 'research chemicals' were formulated in 8 languages (English, Finnish, Norwegian, Dutch, Italian, German, Spanish, Swedish).

Of the thousand websites and Internet resources identified, 203 websites were selected and searched internally for any information/discussion related to the recreational use, sale, or availability of novel psychoactive compounds/combinations. Of these, 106 websites were monitored on a regular basis i.e., daily (n = 21), weekly (n = 32), or monthly (n = 53) depending on their relevance, for the whole duration of the project.

In addition, the full content of the most popular websites and other Internet resources (e.g. YouTube videos) were copied onto a dedicated server. This was done primarily for historical archiving and for allowing a more thorough and flexible content search.

The novel compounds identified were entered into local databases in each of the participating research centers with the following descriptive information in order to identify and categorize the compounds with regard to their contents, novelty, and diffusion:

- Name (binomial/chemical/common/slang/trade)
- Active constituents/ingredients
- URL of website page
- Number of hits on PubMed/Medline (searched in English)
- Available information on the Erowid website (Erowid, 2012)
- Google Insights snapshot

The local databases were consolidated into one single online database, and the entry for each compound/combination was reviewed.

2.2. Preparation of technical reports

The technical evaluation of the novel compounds relied primarily on Internet-based resources, but was integrated with medical/scientific

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literature, when available, and individual assessments carried out within groups of 'key informants' (i.e., clinicians in the Psychonaut Web Mapping network, Community Drug Teams, clients, and web users).

These technical reports were developed for those compounds that fulfilled the following criteria:

- Being a psychoactive substance;
- Few or no information available from PubMed;
- The compound being available to be purchased online;
- The compound being identified in searches carried out from at least two European countries.

The full technical evaluation of the selected compounds included, where available, pharmacological and toxicological information, details of psychoactive effects and negative side effects, slang terms and synonyms for particular compounds, appearance and routes of administration, and related fatalities. Each technical report contained up to 30 fields (see Psychonaut Web Mapping Research Group, 2009a, 2009b, 2009c).

3. Results

3.1. Monitoring the web for early emerging trends

Although monitoring the web might look a daunting prospect, it is possible with the appropriate tools to identify "leading edge" websites or trend setting forums where a multitude of compounds are discussed and promoted. During the study period we identified 203 websites (see Table 1 for top 20 resources), which were key online resources. These primarily consist of sites with user generated content, however, specific websites and online shops, albeit often changing, have also provided accurate and timely information on emerging NPS.

By monitoring these resources, 414 substances/products have been recorded, including 121 herbal compounds, 153 chemical compounds (synthetic, semi-synthetic, pharmaceutical products), and 140 combinations/mixed products. A total of 31 technical reports were also prepared, including a report on mephedrone (Psychonaut Web Mapping Research Group, 2009a, 2009b, 2009c; see also following section). Online activity and interest in specific compounds anticipated widespread interest in one or more countries of these same compounds. In the two-year study period we have monitored the rapid rise of "spice drugs" (synthetic cannabimimetics); mephedrone; naphyrone; 5,6-methylenedioxy-2-aminoindane (MDAI); and methylenedioxypyrovalerone (MDPV). We noted how these compounds were becoming popular initially online and subsequently in the wider community. We have also noted that some early discussion about specific substances have occurred first in one country and then the interest for this compound moved across other countries (e.g. by using Google Insight for search interest overt time). Conversely, other countries did not seem to show the same interest for the index NPS. For instance, we started monitoring mephedrone from some threads identified from a Finnish forum in 2008. However, it was not until it reached the UK- based forums and was picked up by wider media that its popularity escalated both online and in the real world (see Fig. 1 below). Moreover, since its ban in Europe mephedrone has been widely marketed in the US. A similar trajectory across countries was followed earlier by the "Spice drugs" (Schifano et al., 2009). Overall, however, most NPS identified here did not reach the same widespread level of online interest and have remained so far relatively unknown to potential users.

In addition to monitoring the increased popularity of specific compounds through the number of threads in forums, we also used 'Google Insights for Search' (Google, 2012) to gauge the increasing popularity of any compound. This tool provided a timely indication of the amount of interest, defined as the relative frequency of search terms entered by Google users, and how this changed over time and by geographic location. In the past few years it has also been used to successfully study a variety of social phenomena and diffusion of medical conditions, repeatedly showing that search engine data correspond quite closely with other exiting measures (e.g. Breyer et al., 2011; Brownstein et al., 2009; Carneiro and Mylonakis, 2009; Scheitle, 2011).

Fig. 1 shows Google insights reports on how interest in mephedrone, partly driven by media coverage and its subsequent ban, was several times greater than the interest in the other three relatively popular compounds (synthetic cannabimimetic 'Spice Gold', naphyrone, and MDAI).

Interestingly, online search activities for the index substances have decreased once these compounds have been controlled (e.g. December 2009 for "spice drugs" and April 2010 for mephedrone) and have been replaced by other NPS.

3.2. Preparation of technical reports

With the exception of a few compounds, the vast majority of those NPS here identified were only little known to professionals working in the addiction field, and limited scientific peer-reviewed data was

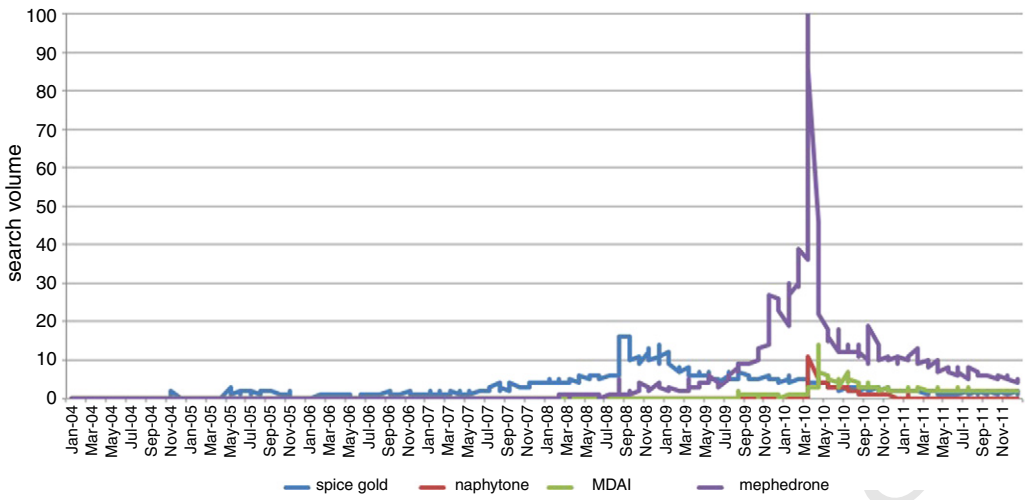
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Table 1
List of 20 main resources.

Name	Type of resource	Country/language	Web address	Access
Bluelight	Forum	International/English	http://www.bluelight.ru/	Open
Drugs Forum	Forum	International/English	http://www.drugs-forum.com/	Open
Erowid	Website	International/English	http://www.erowid.org/	Open
Legal Highs Forum	Forum	International/English	http://www.legalhighsforum.com/	Open
Neo Organics	Website	International/English	http://www.neorganics.net	Open
The Funky-Fertilizer	Website	International/English	http://www.funky-fertilizer.com	Open
Future Legals	Website	International/English	http://www.futurelegals.co.uk	Open
Champs Legals	Website	International/English	http://www.champslegals.co.uk	Open
PsyVault	Forum	Finnish	http://www.trippi.info/psyvault/	Open
Paihdelinkki	Forum	Finnish	http://www.paihdelinkki.fi	Open
Norshroom	Forum	Norwegian	http://www.norshroom.org	Closed
Freakforum	Forum	Norwegian	http://freak.no/forum/forumdisplay.php?f=178	Closed
Cannabis café	Forum	Spanish	http://www.cannabiscafe.net	Open
Energy Control	Forum	Spanish	http://www.energycontrol.org	Open
Alkemico	Forum	Italian	http://www.alkemico.com/	Open
Tabaccheria 21	Website	Italian	http://www.tabaccheria21.net/	Open
Azarious	Website	German	http://de.azarius.net/	Open
Shayana	Website	German	http://www.shayanashop.de/	Open
De Sjamaan	Website	Belgium/Dutch	http://www.de-sjamaan.nl	Open
Bazaar Roosendaal	Website	Dutch/French	http://www.bazaar-roosendaal.nl/	Open

These resources are a selection among those regularly monitored during the study period. Note some of these sites are no longer available.

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Note - Google Insights for Search shows search volume patterns for specific keywords across time frames since 2004. The Figure above compares the relative search volume for those compounds over time plotted on a scale from 0 to 100; 100 represent the highest point relative to that keywords. It does not represent an absolute value.

Fig. 1. Google search queries for mephedrone, spice gold, naphyrone, MDAI since 2004.

available. Some of them were pure research chemicals, which had never been tested on humans or had only been synthesized recently (e.g. mephedrone, MDPV, naphyrone). Moreover, those websites promoting and selling NPS compounds were providing no or only little information on the psychoactive effects, side effects, and modality of use.

Through an accurate monitoring of forums and other online resources, however, it was possible to better understand the main characteristics of these psychoactive compounds. Taking into account this analysis of anecdotal online data, combined with other available information, a range of detailed reports relating to the substances listed in Table 2 have been prepared. These reports related to the most

Table 2
List of the 30 most common products or substances identified.

Product name	Category	Effect	Active constituent/s
Ephedra sinica	Plant	Stimulant	Ephedrine/pseudoephedrine
Gotu Kola (*Centella asiatica*)	Plant	Stimulant	Triterpenoids
Ikathazo (*Alepidea amatymbica*)	Plant	Sedative	Dehydrokaurenoic & kaurenoic acids
Jurema (*Mimosa hostilis*)	Plant	Psychedelic	Dimethyltryptamine
Kanna (*Sceletium tortuosum*)	Plant	Stimulant	Mesembrine
Peyote (*Lophophora williamsii*)	Plant	Psychedelic	Mescaline
Phalaris arundinacea	Plant	Psychedelic	Dimethyltryptamine (DMT)
Salvia divinorum	Plant	Psychedelic	Salvinorin A
Sassafras	Plant	Psychedelic	Safrole
Sinicuichi (*Heimia salicifolia*)	Plant	Sedative	Vertine
Syrian Rue (*Peganum harmala*)	Plant	Psychedelic	Harmine
Wild dagga (*Leonis leonorus*)	Plant	Sedative	Leonurine
2C-B	Chemical	Psychedelic	4-bromo-2,5-dimethoxyphenethylamine
4-AcO-Met	Chemical	Psychedelic	4-acetoxy-N-methyl-N-ethyltryptamine
5-MeO-AET	Chemical	Psychedelic/Stimulant	5-methoxy-alpha-ethyltryptamine
5-MeO-MiPT	Chemical	Psychedelic	N-[2-(5-methoxy-1H-indol-3-yl)ethyl]-N-methylpropan-2-amine
BromodragonFly	Chemical	Psychedelic	Bromo-benzodifuranyl-isopropylamine
GBL/GHB/1-4BD	Chemical	Sedative	Gammabutyrolactone; gamma-hydroxy-butyrate; 1, 4 butanediol
Herkinorin	Chemical	Psychedelic	Herkinorin
HU-210	Chemical	Psychedelic	9-(Hydroxymethyl)-6,6-dimethyl-3-(2-methyloctan-2-yl)-6a,7,10,10a-tetrahydrobenzo[c]chromen-1-ol
JWH-018	Chemical	Psychedelic	Naphthalen-1-yl-(1-pentylindol-3-yl)methanone
JWH-073	Chemical	Psychedelic	Naphthalen-1-yl-(1-butylindol-3-yl)methanone
MDAI	Chemical	Stimulant	5,6-Methylenedioxy-2-aminoindane
MDPV	Chemical	Stimulant	3,4-methlenedioxypyrovalerone
Mephedrone	Chemical	Stimulant	4-methylmethcathinone (2-methylamino-1-p-tolylpropan-1-one)
Naphyrone	Chemical	Stimulant	Aka naphthylpyrovalerone
Benzydamine	Pharmaceutical	Psychedelic	Benzydamine Hydrochloride
Pregabalin	Pharmaceutical	Sedative	Pregabalin
Transdermal buprenorphine	Pharmaceutical	Sedative	Buprenorphine
Spice	Combination	Psychedelic	Combination of herbs + synthetic cannabinoid

These substances were selected among the 414 identified based on their increasing popularity across forums, websites and other online resources.

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popular NPS identified (i.e. mentioned in at least two online sources and across two or more countries) during the study period.

The above technical reports formed the basis for subsequent full peer-review publications on "spice drugs" (Schifano et al., 2009), pregabalin (Schifano et al., 2011b), bromo-dragonfly (Corazza et al., 2011), 2C-T-7 (Schifano et al., 2005), mephedrone (Schifano et al., 2011a) and methoxetamine (Corazza et al., 2012).

4. Discussion

In the last few years our research group has been monitoring the Internet and as a result we have seen the rise and fall of a number of NPS. These included magic mushrooms, ketamine, Salvia divinorum, GHB, GBL, BZP, spice drugs, mephedrone, naphyrone, MDPV, and occasionally of illicit compounds such as 2C-T-7.

The current project has been able to set up an integrated mapping and monitoring system of the Internet, which has allowed the early identification of emerging trends in recreational drug use over the past few years, including spice drugs and mephedrone (Schifano et al., 2009, 2011a, 2011b). As such, we have demonstrated that emerging trends can be picked up, monitored and understood by looking at what is happening online, in discussion forums, websites, online shops, YouTube, eBay, and other online resources (Schifano et al., 2011a, 2011b).

Moreover, the project has also shown that it is possible to rely on the information available and shared on the Internet to build up a reasonably accurate understanding of the characteristics of these novel, recreational substances. Indeed, in the absence of any scientific and toxicological study, the project's technical reports (e.g. mephedrone, spice drugs, bromo-dragonfly) provided an accurate picture of the effects, side effects and users' experiences of these compounds or combinations.

However, knowledge of both the NPS pharmacodynamics and acute/chronic toxicity remains pretty limited, which is per se a clinical concern. Furthermore, some of the NPS are ingested together in an idiosyncratic way, adding more uncertainties in terms of the medical consequences of this combined intake (Schifano et al., 2011a). For example, pregabalin with mephedrone, which one could wonder if the consumer might want to take advantage of the increased pregabalin-associated GABAergic output to better modulate the mephedrone-related stimulant DAergic/NAergic effects; or clonazepam and the psychedelic/entactogenic phenethylamine 2-C-T2 (e.g. 2,5-dimethoxy-4-ethylthiophenethylamine). In this second example one could speculate about the misuser resorting to the intense clonazepam-associated GABAergic/sedative properties to cope with the stimulant/psychedelic effects associated with the phenethylamine intake (Schifano et al., 2011b).

This information is to be considered of great interest for a range of health professionals. From this point of view, one could consider that the online database and technical reports may help in filling this gap in knowledge. Crucially, these findings have been subsequently confirmed by other studies (e.g. Auwärter et al., 2009), online surveys and focus groups with recreational drug users (e.g. Winstock et al., 2011) and published in peer review journals (Corazza et al., 2011, 2012; Schifano et al., 2009, 2011a, 2011b).

It is also important to note that new trends are appearing in different countries at different times and with different substances (e.g. "spice drugs", benzydamine). Even though some compounds reach a wider diffusion quickly (e.g. "spice drugs", mephedrone), others remain confined to one or two countries for quite some time and the vast majority remains unknown to the wider public and have not yet become trends that needed public health action or policy intervention.

It is therefore important that these monitoring activities are to be continued; that more countries, languages, resources, researchers and health professionals are involved, and that the findings are widely shared with relevant public health agencies, health professionals and future research projects.

5. Conclusion

The European Union-funded Psychonaut Web Mapping project has monitored the Internet for over two years for novel psychoactive substances. During this period the Psychonaut researchers have identified more than 400 novel compounds/legal highs compared with 90 identified in the previous Psychonaut 2002 project or respectively the 13 (2008), 24 (2009), 41 (2010) and 49 (2011) formally notified to the EMCDDA Early Warning System. It is apparent that the issue of online availability of NPS information is becoming a growing phenomenon. The Internet is now a major marketplace for psychoactive substances, including prescription drugs, allowing retailers to offer to a broad public a range of suitable alternatives to controlled drugs.

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Contributors

Authors PD and FS designed the study and wrote the protocol. All authors contributed to the data collection and analysis. PD wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

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