Running Head: Novel psychoactive substance use and attentional bias

Selective attentional bias for novel psychoactive substance (NPS) and expectancy-related stimuli amongst non-problematic NPS users and never NPS users.

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Abstract

Background: Novel psychoactive substance (NPS) use has emerged as a new trend in the recreational drug market with increasing prevalence and availability rates. Little evidence has focussed on psychologically-based cognitive/motivational processes that may increase the likelihood of continuing NPS use leading to habitual behaviour patterns/dependence. One such process, highlighted in studies examining a plethora of addictive behaviours, concerns users’ preferential attention (attentional bias) to concern-related stimuli. Methods: The current study assessed whether current NPS users compared to never NPS users showed differential attentional processing of (i) NPS-related words, (ii) NPS positive expectancy words and, (iii) NPS negative expectancy words in a modified Stroop task. Results: For NPS users only negative expectancies captured increased attention - the semantic nature of the word interfered with the secondary task of colour-naming the ink within the Stroop task. In addition, the magnitude of this attentional bias was significantly different from zero (the point of no registered interference). Finally, we found no association between attentional biases for all word types and severity of problems associated with NPS use in NPS users. Conclusions: Among non-problematic NPS users, expectancy-based cognitions may be characterised by highly accessible negative NPS expectancies which are salient for attentional capture and preoccupation.

Keywords: novel psychoactive substances; attentional bias; expectancies

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Introduction

Novel psychoactive substances (NPS), previously known as “legal highs”, are synthetic chemicals, fungal or plant matter which are used to elicit a similar psychoactive response to illegal drugs such as ecstasy, cannabis or cocaine (Karila & Reynaud, 2011). NPSs can be categorised as either stimulants, psychedelics/hallucinogens or sedatives (McNabb, Russell, Caprioli, Nutts, Gibbons & Dalley, 2012). Until recently, the term ‘legal’ gave users the ability to obtain and carry these compounds without fear of prosecution or criminal conviction which presented a significant motivating factor for their use (Van Hout & Brennan, 2011, 2012; Sheridan & Butler, 2010). The lack of legal consequences may have led individuals to believe that legality arose from the safety of these compounds, resulting in any potential risks being underestimated (Ramsay, Dargan, Smyllie, Davis, Button, Holt & Wood, 2010). With the recent Psychoactive Substances Bill (2016) in the UK, NPS have become illegal, yet the impact that this change in the law will have on perceptions related to NPS, and ultimately their rates of use, is uncertain.

NPS use has emerged as a new trend in the recreational drug market with numerous studies highlighting increasing prevalence and availability rates (e.g. European Monitoring Centre for Drugs and Drug Addiction, 2014; McCambridge, Winstock, Hunt & Mitcheson, 2007; Measham, Wood, Dargan & Moore, 2011). Other reseach has shown impaired executive function among user groups (e.g. mephedrone: Freeman, Morgan, Vaughn-Jones, Hussain, Karimi & Curran, 2012), and concern over their detrimental usage including instances of abuse, dependence, habitual use, severe intoxication and fatality (e.g. Bajaj, Mullen & Wylie, 2010;Spiller, Ryan, Weston & Jansen, 2011). For some users, NPS have become their main drug of choice (Wood, Measham & Dargan, 2012).

Qualitative studies suggest various motivating factors associated with NPS use, for example legality, availability and accessibility, pricing, and social acceptability (e.g Van Hout & Brennan, 2011). Recent evidence has also begun to unpick the reasons for, and consequences of NPS use (Barnard, Russell, McKeganey & Tiffany, 2017).

The perceived ‘legal’ status and availability of NPS are not the only motivating factors behind NPS use. Psychologically-based cognitive and motivational processes also warrant investigation. These psychological processes may increase the likelihood of continuing NPS use, generating habitual behaviour patterns that could lead to dependence. One such process concerns preferential attention (or attentional bias) to concern-related stimuli such as words or images associated with NPS. Such preferential attention has been consistently demonstrated across a number of different behaviours, including alcohol use (e.g. Sharma, Albery & Cook, 2001), cannabis use (e.g. Cane, Sharma & Albery, 2009), smoking (e.g. Attwood, O’Sullivan, Leonards, Macintosh & Munafo, 2008), dieting behaviour (Wilson & Wallis, 2013) and compulsive sex-related activity (Albery et al, 2016). It is argued that with repeated patterns of behaviour these concern-related stimuli are perceived without conscious awareness and are associated with an increased desire or predisposition to subsequently behave in the same way, ultimately leading to habitual behaviours, and possible dependence (see Field, Munafo & Franken, 2009, Janssen, Larsen, Vollebergh & Wiers, 2015).

Theoretically, attentional bias for different substances is likely to reflect a dopaminergic response which increases with repeated use and becomes sensitized (Robinson & Berridge, 2001). This sensitization results in the substance becoming increasingly salient, developing intrinsic motivational properties (i.e. incentives for continued use), and ultimately leading to the development of craving. Consequently, the substance itself, and related cues, will grab attention, be perceived as ‘wanted’, and guide future behaviour (Franken, 2003; Robinson & Berridge, 2001). This subjective “wanting” experience has already been identified in the mephedrone literature (Freeman et al, 2012). Given that attentional bias acts as a cognitive marker of this sensitisation, a heightened bias towards NPS stimuli could be evident in NPS users.

Another important process linked to habitual use of addictive substances concerns expectancies. Expectancies use previously learned information to *anticipate* the outcomes of one’s future behaviour and are *goal-orientated*. Expectancies have been demonstrated to facilitate (via positive expectancies) or inhibit (via negative expectancies) on-going addictive behaviours (see Reich & Goldman, 2015; Reich, Below & Goldman, 2010; Cox, Klinger & Fadardi, 2015; Sheeran, Aarts, Custers, Rivis, Webb, & Cooke, 2005; Albery, Collins, Moss, Frings & Spada, 2015). They have also been shown to discriminate between groups of users (see Goldman, Reich & Darkes, 2006; Connors, O’Farrell, Cutter, & Thompson, 1986), and to operate differently according to context (Monk & Heim, 2013). In particular, work from the alcohol field has demonstrated that priming individuals with related cues, and in theory, making such cues more salient/accessible, has an effect on subsequent behaviour (e.g. Moss & Albery, 2009; Friedman, McCarthy, Bartholow, & Hicks, 2007). Thus, selective attention to concern-related stimuli may be indicative of heightened accessibility and/or saliency, which differentiates individuals according to behavioural and exposure-related indices (see Field et al 2009; Albery et al, 2015).

To this extent, cognitive processes utilised in the regulation of behaviour (e.g. NPS use) may involve the interplay between those processes that are more automated (e.g. approach-avoidance tendencies, attentional processes) and those that are more reflective (e.g. executive functioning, controlled inhibitory functioning) (e.g Stacy & Wiers, 2010). Questions arise as to whether expectancy-based thought operates according to these principles. It is clear that expectations associated with the availability of a drug are related to attentional bias magnitude (e.g. Field et al, 2011) and that reward expectancy increases attentional bias more generally to related stimuli (Jones, Hogart, Christiansen, Rose, Martinovic & Field, 2012). It is also clear that not only do self-reported (and presumably explicit) reward-based expectancies predict ongoing addictive behaviour (see Goldman et al, 2006), but that implicit measures of such expectancies have been shown to be associated with related behaviours (e.g. Roehrich & Goldman, 1995; McCarthy & Thompsen, 2006; Kramer & Goldman, 2003; Wiers, van Woerden, Smulders & de Jong, 2002). Whilst a similar pattern of results could be predicted for NPS use, no evidence is as yet apparent. The current study provides the starting point for this by assessing whether current NPS users compared to never NPS users showed differential attentional processing of (i) NPS-related words, (ii) NPS positive expectancy words and, (iii) NPS negative expectancy words.

Method

*Participants.*

Thirty novel psychoactive substances users (NPSUs) and 39 never novel psychoactive substances users (nNPSUs) (43 female and 26 male; mean age = 23.77, SD = 5.70, range 18 – 49 years) were recruited from a UK-based London University and participated in return for course credit.

*Design.*

A 2 x 2 facotrial designs were used in this study, with (Group: NPSUs, nNPSUs) as the between-participants factor in each design and Word Type (either NPS-related words vs neutral words; or NPS positive expectancy words vs neutral words; or NPS negative expectancy words vs neutral words) as the within-participants factor. The key dependent variables were millisecond correct response latencies to name the colours in each of the blocks of legal high words and their matched neutral counterparts.

*Materials*.

To generate words for inclusion in each of the three modified Stroop tasks, legal high forums and websites were accessed and candidate stimuli generated for NPS-related, positive expectancy-related and negative expectancy related categories. Subsequently five current NPS users (none of whom participated in the main experiment) rated each word for how representative (on seven point scales with values ranging from ‘completely representative’ to ‘not at all representative’) of the NPS/legal high category, or positive expectancy category or the negative expectancy category. Words considered highly representative of the legal high category and the expectancy categories were matched for word length and frequency of use in the English language using Kučera and Francis (1967). A total of six words in each category were identified and each matched with six neutral words (see Appendix 1 for a lits of the words used). These words were then used to create three separate modified Stroop tests for (i) NPS-related words, (ii) NPS positive expectancy words and, (iii) NPS negative expectancy words.

NPS use was initially ascertained by asking participants “Have you *ever* used legal high drugs?” (Yes, No). For those who reported ever having used legal highs/NPS a series of ten questions derived from the Drug Abuse Screening Tool [DAST] (Skinner, 1982) were asked (e.g. “Are you always able to stop legal high drug use when you want to?”, “Does your spouse (or parents) ever complain about your involvement with legal high drugs?”, “Have you engaged in illegal activities in order to obtain legal high drugs?”, “Have you ever experienced withdrawal symptoms (felt sick) when you stopped taking legal high drugs?”). Possible scores ranged from 0 to 10 with increasing scores related to degree of problems related to NPS use.

*Procedure.*

Participants completed the Stroop tasks in a single occupancy experimental cubicle. To familiarise themselves with the demands of the task all participants completed a set of 48 practice trials in which letter strings (e.g. YYYY, PPPP) were randomly presented in the centre of the computer screen in each of the four colours used in testing (green, red, yellow, blue). Participants were instructed to place their first and forefingers of each hand over four keys on the computer keyboard labelled to correspond with one of the four colours on the keyboard (i.e. two keys per hand). Key assignment was counterbalanced across participants such that half completed the task with green and red on the left and yellow and blue on the right and the other half the yellow and blue on the left and green and red on the right. They were then asked to ignore the practice letter strings and respond to colour in which the letter strings were presented by pressing one of the assigned four colour-coded keys as quickly and as accurately as possible. In the experimental testing phase participants were told that they would be presented with words and reminded that their task was to ignore the word itself and respond to the ink colour in which the word was presented in as quickly and as accurately as possible. Words were randomly presented in six blocks (NPS-related, NPS-neutral, positive expectancy-related, positive expectancy-neutral, negative expectancy-related, negative expectancy-neutral) with the proviso that neither the same word nor same colour could be presented sequentially. Category-based blocks (e.g. NPS-related, NPS neutral) were presented sequentially such that matched neutral words either preceded or succeeded their category-based word blocks. Presentation of related blocks was counterbalanced. Each participant responded to a total of 288 trials. There were six blocks in total with each block comprised of 48 trials (six words presented in four colours twice). Demographic information and whether the participant had ever used legal high was collected prior to the modified Stroop tasks and indicators of more problematic legal high drug was collected after the experimental tasks.

Results

*DAST scores for NPSUs*

Responses for each of the 10 items were totalled for each NPS user (NPSU). Results showed that according DAST criteria (see Skinner, 1982) on average NPSUs reported a low level of problems associated with their NPS use (mean = 2.80, SD = 1.09, range 2 to 6). Initial analyses highlighted that DAST scores were not associated with the difference in response latencies between NPS-related words and matched neutral words (r = .13, p = .49), the difference in response latencies between negative NPS-related expectancy words and matched neutral words (r = -.12, p = .53), and the difference in response latencies between positive NPS-related expectancy words and matched neutral words (r = .01, p = .97). As such DAST scores are not considered in any subsequent analyses.

*Response latency analyses*

All analyses were undertaken for mean correct reaction times (RT). Responses greater than two standard deviations from the mean RT in any of the legal high and matched neutral categories were removed before analysis (five sets of reaction times, all never NPSUs (nNPSUs), were removed) leaving a total of sixty-four complete data sets (30 NPSUs and 34 nNPSUs). Three two-way ANOVAs were conducted to examine differences between NPSUs and nNPSUs in mean correct reaction times (milliseconds) separately for (i) NPS-related words vs neutral words, (ii) NPS positive expectancy words vs neutral words and, (iii) NPS negative expectancy words vs neutral words (see Table 1 for means and standard deviations).[[1]](#footnote-1)1 For NPS-related words vs neutral words no main or interaction effects for Word Type or Group (NPSUs, nNPSUs ) were shown (all ps > .24).

For NPS positive expectancy words vs neutral words main effects for both Word Type, F (1, 62) = .01, p = .98, and Group, F (1, 62) = .03, p = .86) were not significant. The Word Type X Group interaction was significant, F (1, 62) = 5.37, p < .05. Simple effects analysis showed no significant difference in response times between positive and neutral words for NPSUs, F (1, 62) = 2.49, p = .12, nor for nNPSUs, F (1, 62) = 2.90, p = .094. However, a significant difference for positive expectancy words was shown between NPSUs and nNPSUs, F (1, 62) = 5.37, p < .05 with NPSUs being significantly slower in average colour naming responses. The simple effect within neutral words between NPSUs and nNPSUs was not significant, F (1, 62) = .03, p = .86.

For NPS negative expectancy words vs neutral words no main effect for Group (F (1, 62) = .382, p = .54) was shown. However, the main effect of Word Type, F (1, 62) = 7.49, p < .01 and the Word Type X Group interaction were significant, F (1, 62) = 7.06, p < .05. Simple effects analysis for the interaction showed a significant difference in response times between negative and neutral words for NPSUs, F (1, 62) = 13.68, p < .001, and not for nNPSUs, F (1, 62) = .003, p = .954. NPSUs were significantly slower to positive words relative to matched neutral words. No differences between NPSUs and nNPSUs in response times for negative words, F (1, 62) = 2.64, p = .109, or for neutral words, F (1, 62) = .162, p = .689 were shown suggesting that neither user group processes negative or neutral words differentially.

Table 1 here

*Attentional bias scores*

Attentional bias scores were calculated for each category by subtracting the mean correct RT to category-matched neutral words from the mean correct RT to NPS words, negative NPS expectancy words and positive NPS expectancy words separately. Positive attentional bias scores reflect increased response latencies to the concern-related words relative to matched neutral words (see Table 1 for means and standard deviations). To explore whether users and non-users displayed significant attentional bias scores for NPS-specific, negative and positive expectancy words, a series of one-sample t-tests were conducted. This analysis compares mean scores against the AB score value indicative of no bias present (i.e. zero). For NPSUs AB was not shown to differ significantly from zero for NPS specific words, t (29) = 1.67, p = .11, nor positive NPS expectancies, t(29) = 1.47, p = .15. However, the AB score was shown to differ significantly from zero for negative NPS expectancies, t(29) = 3.74, p < .01. In contrast, for nNPSUs, AB scores for NPS-specific words, positive NPS expectancy words and negative NPS expectancy words did not differ significantly from zero, t (33) = -.07, p = .94, t (33) = 1.83, p = .08 and t (33) = .58, p= .95 respectively.

Discussion

The present study explored how NPS users and never-NPS users differentially process NPS-related stimuli. Given a common pattern of responding to cognitive measures of attentional preference across addictive behaviours and the operation of such biases in the development and maintenance of such behaviours (see Field et al, 2009), NPS use should also show a similar pattern of responding. Whilst previous research had demonstrated this effect for several addictive behaviours we found no difference between NPS users and non-NPS users in reactions times to NPS-related words (e.g. Spice, Bliss, Ching, Poison, Rush) compared to matched neutral words. It must be noted, however, that the majority of the words used in this modified Stroop version were the proper nouns of legal high brands names (e.g. Spice, Bliss, etc). That the matching of neutral words to these words was based on the common noun version of each NPS word it could be that they did not effectively represent a comparator in terms of frequency of use or lexical representativeness. Future studies of attentional preference for NPS-related stimuli may benefit from using measures that do not rely solely on the presentation of proper nouns, and could potentially incorporate image stimuli. Such measures include the pictorial Stroop, flicker induced change blindness paradigm or the picture-based dot probe, all of which have been shown to consistently differentiate individuals according to patterns of addictive behaviour or habitual use (e.g. dot probe –Frankland, Bradley & Mogg, 2016; e.g, pictorial Stroop – Bruce & Jones, 2004; flicker induced change blindness – Barry, Bruce, Livingstone & Reed, 2006).

Aside from issues surrounding the use of proper nouns and the selection of matched words (as detailed previously), NPS users reported low levels of problems associated with their NPS use. This finding is of particular significance as problem use and the corresponding frequency of exposure to concern-related stimuli are positively associated with the magnitude of attentional biases (see Albery, Sharma, Noyce, Frings & Moss, 2015; Sharma, Albery & Cook, 2001). As a result, we might not expect large biases for NPS-related words in our sample consisting predominantly of nonproblematic users. Thus, future studies should extend our adopted measure of *problematic* NPSuse to incorporate, for example, frequency of use.

In addition to examining attentional bias for NPS-specific stimuli, this study also explored whether NPS users and never-NPS users differentially processes expectancy-based stimuli. In line with expectancy-based models of substance use and misuse and evidence that positive and negative expectancies are linked to an increased likelihood of performing addictive behaviours (e.g. Reich & Goldman, 2015), we were interested in whether such expectancies extend to NPS use. Even though NPS users were found to respond significantly slower in average colour naming of negative expectancy words, both groups were equivalent in their response times for positive expectancy words and matched neutral words. This lack of difference in attentional preference among NPS users and non-NPS users alike is further emphasised by the magnitude of any observed bias for positive expectancy words failing to significantly differ from zero. In contrast, negative expectancy words slowed colour-naming response times in NPS users compared to matched-neutral words. For these individuals, negative expectancies captured increased attention to the extent that the semantic nature of the word interfered with the secondary task of colour-naming the ink within the modified Stroop task. Moreover, the magnitude of the attentional bias observed among NPS users for negative expectancy words was significantly different from zero.

Taken together, these results suggest that the processing of negative expectancy, and not positive expectancy stimuli differentiates NPS users and non-NPS users. This difference in NPS users only is characterised by slower response times and heightened attention to negative expectancy-related stimuli indicative of a significant bias to NPS-related stimuli. This is inline with evidence in the alcohol expectancies field, which indicates that *only* heavy drinkers cued with an alcohol-related stimulus showed interference for arousing (positive) expectancy words in a modified Stroop paradigm. On the other hand, *only* light drinkers showed interference for sedating (negative) expectancy words when so primed (Kramer and Goldman, 2003). Given that the current sample comprised of individuals for whom NPS use was non-problematic, we would expect selective attentional biases for negative NPS expectancies but not positive NPS expectancies. As such, among non-problematic NPS users, expectancy-based cognitive space may be characterised by highly accessible and salient negative NPS expectancies. That is not to say that positive NPS expectancies are not represented in memory but that such expectancies are not as active or accessible in non-problematic NPS users. Therefore, it would be useful to replicate and extend this work to include problematic NPS users and examine the pattern of responding throughout the development of problematic behaviour.

Whilst we were able to categorise NPS users from never-NPS users, the current study did not ascertain pre-existing differences either within- or between-groups for other current or past drug use behaviour (both NPS and non-NPS related). As such the true effect of NPS use *per se* on attentional biases towards negative expectancy-based stimuli over and above that attributable to generic drug use can not be fully assured. What is clear from previous research is that the pattern of attentional responding to related cues is *likely* to be specific to one’s ongoing activity. Users consistently show increased attentional biases relative to non-users (e.g. Marks, Robert, Stoops, Pike & Rush, 2014; Bradley, Field, Mogg & De Houwer, 2004; Munafo, Mogg, Roberts, Bradley & Murphy, 2003) and the magnitude of the bias is proportional to the quantity and frequency of substance use (e.g. Albery, Sharma, Noyce, Frings & Moss, 2015; Sharma, Albery & Cook, 2001; Field, 2005). Finally, in studies comparing polydrug users and single drug users, attentional biases have been shown to be specific for the relevant group. For example, in a recent study comparing attentional biases for cocaine and alcohol-related cues among cocaine-only and alcohol plus cocaine (poly drug) groups, cocaine users showed a bias for cocaine-related stimuli *only*, and alcohol plus cocaine users showed attentional biases for both alcohol and cocaine related stimuli (see Marks, Pike, Stoops & Rush, 2015).

Finally, for NPS users, we found no relationships between attentional biases for NPS-specific words, positive and negative expectancy words, and severity of problems associated with NPS use. These findings replicate studies which have shown that the effect of such processing only becomes apparent with more problematic drug use, whether that be heavy drinking or smoking, or in-treatment groups (e.g. Sharma et al, 2001; see Field et al, 2009; Waters, Shiffman, Sayette, Paty, Gwaltney & Balabanis, 2003). Current models have also emphasised the fundamental role of the relationship between craving and attentional preference in understanding an individual’s transition from *liking* the hedonic effects of drug use to *wanting* that experience (Robinson & Berridge, 2003). This transition is attributed to the sensitisation of a dopaminergic response with repeated use, such that properties related to the substance become increasingly salient and motivationally relevant (i.e. incentive-based) to the extent that craving occurs. It is also argued that once established, the addictive behavioural pattern is best described as the result of a reciprocal relationship between craving and attentional preference (Franken, 2003; see Field & Cox, 2008). In our sample of NPS users , it is likely that individuals have not made this *wanting-to-liking* transition. Future work with problematic NPS users should include craving or desire-related indices to fully elucidate this idea.

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Table 1.

*Mean correct response times (ms) and attentional bias scores (standard deviations in parentheses) by novel psychoactive substance users (NSPUs) and never novel psychoactive substance users (nNSPUs) for category and matched neutral words.*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Novel Psychoactive Substance User Group | Word Type | | | | | | | | |
|  | LH NPS Specific | Neutral | AB score | Positive | Neutral | AB score | Negative | Neutral | AB score |
| NPSUs | 860.97 (122.64) | 834.47 (128.02) | + 26.5 (87.05) | 841.00 (117.90) | 806.13 (135.93) | + 34.87 (129.89) | 860.70 (114.09) | 796.90 (107.04) | + 63.8 (93.57) |
| nNPSUs | 815.68 (155.54) | 816.86 (140.47) | - 1.18 (97.79) | 800.94 (135.94) | 836.24 (145.14) | - 35.29 (112.44) | 811.06 (128.61) | 810.121 (149.36) | + 0.94 (95.25) |
| Total | 836.91 (141.83) | 825.11 (134.01) | + 11.8 (93.22) | 819.72 (128.39) | 822.13 (124.93) | - 2.41 (125.03) | 834.32 (123.62) | 803.92 (130.40 | + 30.4 (93.22) |

Note: NPSUs = novel psychoactive substance user; nNPSUs = non novel psychoactive substance user

Appendix

*Words used in each of experimental categories*

*NPS Matched NPS+ Matched NPS- Matched*

*Words Neutral Expectancy Neutral Expectancy Neutral*

Dose ferry euphoria raincoats paranoid stairways

Spice aces excited degrees headache bearings

Poison sewing relaxed sweater withdraw thermostat

Bliss scalp elation mittens depressed narrator

Ching scoop pleasure library seizures feather

Rush grip energetic acrylic sweating timetable

1. 1 Error rates for all word group categories were less than 2 per cent. [↑](#footnote-ref-1)