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**Evidence for an internet addiction disorder: Internet exposure reinforces
color preference in withdrawn problem users**

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Abstract

Background: The study examined whether exposure to the internet could create a preference for colors associated with visited websites, and explored the possible relationship with self-reported problematic internet use and internet deprivation.

Method: 100 adult participants were divided into two groups; one was deprived access to the internet for 4 hours and the other was not. After this they were asked to choose a color and complete a series of psychometric questionnaires concerning mood (Positive and Negative Affect Scale; PANAS), anxiety (Speilberger State-Trait Anxiety Inventory), and depression (Beck Depression Inventory). They were then given a 15min exposure to the internet, and the websites they visited were recorded. They were then asked to again choose a color, complete the same psychometric questionnaires, and complete the Internet Addiction Test. The study was conducted between November 2013 and April 2014.

Results: For internet-deprived, but not non-deprived, subjects a reduction of mood and increased anxiety was noted in the higher problematic internet users following web cessation. There was also a shift towards choosing the color most prominent on the visited websites in these participants. There was no shift in mood, or toward choosing the dominant website color, in the lower problem users.

Interpretation: These findings suggest that the internet can serve as a negative reinforcer for behavior in higher problem users, and that the reinforcement obtained from the alleviation of withdrawal symptoms becomes conditioned with the color and appearance of the visited websites giving them a more positive value.

Funding: This study received no external funding.

Keywords: Internet, Reinforcement, Deprivation, Dependence, Withdrawal

Problematic use of the internet has been suggested to be a growing problem in many parts of the world^{1,2}, with between 2% and 20% of the population reporting some level of problematic internet use²⁻⁴. Such problematic internet use is manifest by individuals spending long periods each day on the internet at the expense of other important activities^{5,6}, resulting in disruptions to their social life^{7,8}, work and education⁹, psychological state¹⁰⁻¹², and physical functioning¹³⁻¹⁵. It has been suggested that such problematic use of the internet might be regarded as an addiction akin to other behavioral addictions such as gambling^{3,16}, and that further investigation into this phenomenon is needed¹⁶.

A number of reports have explored the degree to which 'internet withdrawal' effects can be seen in those who report high levels of problematic internet use when they cease using the internet^{12,17}. High problem internet users experience negative mood swings on cessation of an internet session¹², and a prolonged absence from the internet leads to increased levels of anxiety in these individuals¹⁷, suggesting that psychological internet withdrawal effects may occur in high problem users. The current experiment explored the phenomenon of internet addiction and withdrawal further by examining whether exposure to the internet can establish preferences for aspects of the websites visited in those sessions, such as their color, as has been noted for many addictive substances¹⁸⁻²⁰. If internet addiction follows the same pattern as other addictions¹⁸, then when an individual suffering from an addiction is given access to the target of that addiction, aspects of the situation associated with the presence of that target become positively valued.

Experiments have established that rats will show a preference for the place associated with the administration of heroin or cocaine¹⁸, and that humans will show a preference for a color associated with a caffeine drink^{19,21}. However, these caffeine-conditioning effects are only noted if participants are in a state of caffeine withdrawal – that is, they have been deprived access to caffeine for some time^{19,20}. This suggests that caffeine dependence and

withdrawal are potent factors in the establishment of reinforcement by caffeine in humans; the positive feelings associated with the alleviation of the withdrawal symptoms conditions to aspects of the situation/stimulus that produced alleviation of the withdrawal symptoms^{19,20}. The current experiment sought to use a procedure based on these caffeine-conditioning experiments to explore whether a period of internet deprivation (withdrawal) would produce similar effects in terms of color preferences that might be established as a result of exposure to the internet. Again, this would establish the similarity of the characteristics of problematic internet and other addictions, and investigate the strength of the concept of an internet addiction.

To this end, following a period in which the participants were either denied access or could access the internet, they completed series of psychometric tests in order to establish their mood, and they were also asked to choose a color. Following a subsequent session on the internet, they were asked to choose a color and complete the psychological tests again, as well as completing the Internet Addiction Test. If individuals reporting high problem use of the internet display behaviors indicative of a behavioral addiction, then it might be expected that they would show a negative mood swing and increased anxiety following exposure to the internet^{12,17}. It was also hypothesized that, if internet addiction were similar to other addictions, then individuals with high levels of self-reported internet problems would show a shift in preference to the color most associated with the websites that they had visited during their exposure to the internet. This would suggest that exposure to the internet had produced a positive association with the characteristics of the websites visited. Again, if problematic internet use is similar to a behavioral addiction, then any such effect should be most readily manifest in the internet deprived individuals.

Method

Participants

One hundred participants (61 females and 39 males) were recruited in a Psychology Department of a University in the UK. All participants were students, and were volunteers – none received any form of compensation for their participation. The participants had a mean age of 22.47 (± 2.98 , range 18 – 30), and none reported any history of psychiatric problems or addictions. The study was granted ethics permission from the Department of Psychology Ethics Board, Swansea University.

Typical Internet Use

Participants were asked about their average internet use by asking them to estimate the number of hours per day that they had spent on the internet over the last two months; this measure is commonly taken in studies of problematic internet use^{14,22}. The mean number of hours per day internet use reported was 5.73 (± 3.73 , range=.33-16): 31% reported spending between 0 and 3 hours per day online; 36% reported spending between 3 to 6 hours per day online; 33% reported spending more than 6 hours a day online. For females this was 5.19 (± 3.45 , range = .33–16); and for males this was 6.58 (± 3.93 , range=.5–16). An independent group t test revealed that this difference was not statistically significant, $t(98)=1.83, p>.08, d=.38$.

The mean number of times that the internet was reported as being accessed per day by the participants was 10.35 (± 15.28 , range=1-100): 56% reported accessing the internet up to 5 times a day; 34% reported accessing the internet between 6 and 10 times per day; and 20% reported accessing the internet more than 10 times a day. The mean number of times the internet was accessed per day by females was 11.71 (± 17.73 , range=1–100), and, for males,

this was 10.41 (± 9.83 , range=1–50), this difference was not statistically significant, $t(98)=.42, p>.60, d=.10$.

Materials

Internet Addiction Test (IAT)²³ is a 20-item scale covering the degree to which use of internet disrupts everyday life. The overall score ranges from 20 to 100. The factor structure of the IAT is currently debated^{22,24}, but a cut-off score of 40 or more for the total IAT score is taken as representing some level of problematic internet usage^{5,12,23}. The internal reliability of the scale has been found to be between .90⁵ and .93² (this was calculated as .91 for the current sample). The scale also has good concurrent validity with other measures of disruptive internet use²².

Positive And Negative Affect Schedule (PANAS)²⁵ is a 20-item questionnaire designed to measure participants' positive and negative moods. The total scores can range from 10-50. The internal reliability of both the positive and negative scales is 0.90²⁵ (this was calculated as .84 for the current sample). The scale also correlates well with other measures of mood such as the Hospital Anxiety and Depression Scales²⁶.

Spielberger Trait-State Anxiety Inventory (STAI-T/S)²⁷ rates the affective, cognitive, and physiological manifestations of anxiety in terms of long-standing patterns (trait anxiety) and current anxiety (state), but only the latter was used for this study. The total score for each scale ranges from 20 to 80. The internal reliability of the scale is 0.93²⁷ (this was calculated as .82 for the current sample). There is strong evidence regarding its validity²⁷.

Beck's Depression Inventory (BDI)²⁸ is a 21-item questionnaire that assesses the clinical symptoms of depression through asking about feelings over the past week. The score ranges from 0 to 63. The internal reliability of the scale is 0.93²⁸ (this was calculated as .90 for the current sample). Reviews have noted that the scale has excellent validity²⁹.

Procedure

The participants initially experienced a 4-hour teaching session, unrelated to issues concerned with the internet, which took place in the University. Half of the participants ($n = 50$) were explicitly told to switch off their mobile devices, and to leave them at the door of the teaching room in which the session occurred. The PCs in the room had their internet connection disabled. The other participants experienced the same teaching session, but were allowed to keep their mobile phones with them and the PCs were not internet disabled (they were not explicitly told that they could access their mobiles, etc.). The 4-hour length of the period was chosen for a number of reasons: it is similar to lengths of time that have been chosen for studies of substance abuse²⁰, but it also corresponded to the longest period of teaching that was already scheduled in the timetable (which was organizationally fortuitous and would not make the session seem out of the ordinary for the students).

All subsequent testing was completed individually in small experimental cubicles. Participants were told that this was an assessment of personality and color preferences. The participants were then asked to name the first color that came into their mind (which was recorded by the experimenter), and were asked to complete the BDI, STAI, and PANAS questionnaires.

After completing the psychometric tests, the participants were told that the questionnaires had to be scored, and that the experimenter would return in a short time to complete the experiment. The participants were asked to wait in the experimental room, and were told that they could access the internet through the computer in the room. All participants accessed the internet, and the content of the websites they visited was recorded. A short 15min internet period was used in this study, as this has been found previously to be long enough to produce psychological changes in high problem users¹². Moreover, shorter

periods of internet use are more reflective of current methods of interacting with the internet since the advent of mobile devices¹⁷.

After a 15min period of internet exposure, the experimenter returned to the room, and the participants were asked to switch off the internet, and were told that the next part of the study comprised a further series of questionnaires. They were again asked to name the first color that came into their mind, and were asked to complete the PANAS and STAI questionnaires again (in that order), as well as the IAT questionnaire, which was always completed last.

After the participants had left the room, the record of their internet activity was recovered from the internet browser history (the participants had not been informed that their browsing activities would be checked). The number of websites that were visited during the 15min period was recorded, along with their address. It was possible to recover these records for 83 participants – 17 had deleted this record from the computer. The dominant color of the websites visited by each participant was assessed by two independent raters who were blind to the results of the psychometric tests from the participants. Each rater separately visited each of the websites recorded on the browser history for each participant. The raters noted the main colors displayed on those website pages (i.e. those colors that occupied more than 25% of the webpage, so that it was theoretically possible to have more than one prominent color per website). The dominant colors on each web page were assessed by visual inspection. This was done for each webpage separately. The color most often noted across all the webpages visited by the individual was then calculated. There was a 97% agreement between the raters regarding the dominant colors. Disagreements were settled by negotiation.

The study was conducted between November 2013 and April 2014.

Results

The mean number of websites visited during the 15min by the participants was 2.66 (± 1.75 , range 1 – 8). The internet deprived group visited 2.91 (± 2.06 , range 1 – 8) websites during their internet exposure, and the non-deprived group visited 2.43 (± 1.36 , range 1 – 8) websites, $t(98)=1.25, p>.20, d=.29$.

The mean IAT score for the sample was 35.57 (± 11.72 , range 11–72), and 27 participants scored higher than the IAT cut-off (i.e., 40) for mild or worse problematic internet use. The mean IAT score for females was 35.69 (± 12.35 , range 11–72; 26.2% scored above the cut-off), and the mean IAT score for males was 35.38 (± 10.82 , range 11–72; 28.2% scored above the cut-off). The difference between the genders in terms of their IAT scores was not statistically significant, $t(98)=.12, p>.90, d=.03$. The mean IAT score for the internet-deprived group was 35.50 (± 12.17 , range 11–72; 24% scored above the cut-off), and for the non-deprived group the mean was 35.64 (± 11.38 , range 11–72; 30% scored above the cut-off). The difference between these groups was not statistically significant, $t(98)=.06, p>.90, d=.01$. The IAT score had significant correlations with depression (BDI), $r(98)=.208, p<.05$; anxiety (STAI), $r(98)=.252, p<.01$, hours spent on the internet, $r(98)=.257, p<.05$, and number of visits to the internet per day, $r(98)=.388, p<.001$.

The cohort was split into lower problem users (i.e., those scoring below the IAT cut off of 40), and a higher problem user group (i.e., those scoring 40 or above on the IAT). This split according to IAT score combined with the deprivation group allocation to create four groups: low problem users with no deprivation ($n = 35$; mean IAT = 30.06 ± 7.78 , range = 11–39); low problem users with deprivation ($n = 38$; mean IAT = 30.08 ± 4.93 , range = 20–39); high problem users with no deprivation ($n = 15$; mean IAT = 48.67 ± 6.82 , range = 40–61); and high problem users with deprivation ($n = 12$; mean IAT = 52.67 ± 12.44 , range = 40–72).

 Figure 1 about here

Figure 1 shows the change in the psychological ratings (the score after the internet minus the score before the internet session) for the high and low problematic internet user groups who had and had not been deprived of internet access. Inspection of these data shows that, for the internet-deprived groups, higher problem users demonstrated a decreased positive mood and increased levels of anxiety following internet-exposure compared to lower problem users. However, there was no effect in the internet-nondeprived groups. Separate two-factor between-subject analyses of variance (ANOVA), with IAT group (lower versus higher) and deprivation group (deprived versus non-deprived) were conducted on each of the three psychological measures. For the change in positive mood, there was a significant main effect of IAT, $F(1,96)=3.63$ $p<.05$, $partial\ eta^2=.036$, but not of deprivation, $F(1,96)=2.10$, $p>.10$, $partial\ eta^2=.021$, and there was a significant interaction between the factors, $F(1,96)=3.69$, $p<.05$, $partial\ eta^2=.037$. Simple effect analyses conducted for each deprivation group revealed a significant simple effect of IAT group for the internet deprived condition, $F(1,96)=6.84$, $p<.01$, $partial\ eta^2=.067$, but not for the non-deprived condition, $F<1$, $partial\ eta^2=.001$. For the change in negative mood, there were no significant main effects or interactions, all $ps>.20$, all $partial\ eta^2s<.01$. For the change in anxiety, there was a significant main effect of IAT, $F(1,96)=6.06$, $p<.05$ $partial\ eta^2=.064$, but not of deprivation, $F(1,96)=1.89$, $p>.10$, $partial\ eta^2=.021$, and there was a significant interaction between the factors, $F(1,96)=3.84$, $p<.05$, $partial\ eta^2=.038$. Simple effect analyses conducted for each deprivation condition revealed a significant simple effect of IAT group for the deprived condition, $F(1,96)=9.59$, $p<.01$, $partial\ eta^2=.091$, but not for the non-deprived condition, $F<1$, $partial\ eta^2=.002$.

Figure 2 about here

Figure 2 shows the change in color selection as a result of the internet session for the higher and lower problem user groups who had and had not been deprived of internet access. A change to the predominate color of the websites (i.e., this color was selected after but not before internet exposure) was scored as a change toward the dominant webpage color experienced by that participant; no change in selection, or a random change unrelated to the website colors, was scored as no change; and a change away from the predominate website color (i.e. this color was selected before but not after internet exposure) was scored as a change away. Inspection of these data reveals that, for the internet-deprived groups, there was a marked change toward the predominant webpage color for the higher problem users, but not for the lower problem users. There was little difference in color change noted between the higher and lower problem user groups for the internet non-deprived groups, with their color shifts tending to be random relative to the website colors.

These data were analyzed using a chi-square for three categorical variables (change in color preference, lower versus higher problem user groups, and internet deprivation. This analysis showed that, while there was an overall significant effect of IAT level on the change in color choice, $\chi^2(2)=6.40, p<.05$, the partial chi-square was only significant for the participants who had been internet deprived, $\chi^2(2)=6.93, p<.01$, and not for the participants who had not been internet deprived, $\chi^2(2)=4.56, p>.10$.

Discussion

The current results demonstrated that a color preference could be conditioned by exposure to the internet in higher- but not lower-problem users, and that this effect was only

seen when there was some degree of internet deprivation prior to the test. This effect is further evidence about the nature of problematic internet use as a potential addiction¹⁶, and also gives insight into the potential impact of internet exposure on preference development in some individuals.

This finding regarding deprivation on the internet-conditioning effect is consistent with the caffeine-conditioning literature^{19,20}. It suggests that the mechanism of action for this internet conditioning effect is the alleviation of negative symptoms of withdrawal generating a positive valence for the stimuli associated with that alleviation^{20,30}. The differences found between the lower and higher problem internet user groups are likely to be due to the higher problem user group suffering from withdrawal symptoms from the internet, which are alleviated by re-exposure to the internet^{12,17}. The participants are conditioned to associate the alleviating effects of internet-exposure with the stimuli associated with the visited webpages, resulting in an increase in positive valence for those stimuli^{19,30}. That this effect was not seen in the lower problem users, for whom the internet-exposure did not increase the valence of stimuli associated with the webpages, suggests that in the absence of withdrawal effects in lower problem users suggests that there is no negative reinforcing effect of the internet per se; providing further evidence that internet can act as a negative reinforcer.

The current study replicated the psychological withdrawal effect on cessation of using the internet^{12,17}. However, a novel aspect of the current data was that this psychological withdrawal effect was limited to those with high levels of self-reported problematic internet use who had been deprived from the internet for at least 4 hours, which is similar to previous studies of the effects of substance abuse²⁰. That only those who were internet deprived showed this effect, and that only those who were internet deprived showed the internet-conditioning effect, suggests that alleviating this withdrawal state may well be critical in

maintaining internet use in some problematic internet users, as it is in some caffeine users^{19,30}.

The demonstration that color choice can be conditioned from internet exposure, at least in the short-term, might allow the use of further conditioning techniques to revalue the status of the internet, and alter the behavior of high problem users. It has been shown in many contexts that altering the hedonic status of a stimulus (e.g., a color) associated with a second stimulus (e.g., the internet), can, without further conditioning, alter the status of that second stimulus (the internet)³¹. The use of this procedure could act to reduce subsequent internet use, and help maintain longer periods of abstinence in problematic users. Of course, this is speculative, and would require further work to explore its potential.

It is worth noting that around a third of the current sample displayed a mild or worse form of internet addiction. This value is similar to those found in previous studies from the same areas in the world^{2-4,15}. The fact that this problem appeared to be distributed similarly among males and females is also in line with contemporary reports that have shown a narrowing in the gender gap in terms of problematic internet use⁹. Levels of internet addiction were also correlated with levels of depression and anxiety, as has been noted in several previous investigations^{5,8}.

As with any study there are some methodological limitations that should be acknowledged. The current study, although attempting to be ecological valid, may not capture all of the aspects of everyday internet use that might contribute to these effects. It is unknown how long the current preference conditioning lasts, which could be further examined in subsequent work. The level of deprivation was chosen on the basis of previous work, but this level might have an effect on the results, and should be explored in some more detail. More precise methods of establishing dominant colors on the screen could be examined in future work.

In summary, the current data has shown that problematic internet users who have been deprived access to the internet for some hours will display both psychological withdrawal effect after finishing an internet cessation. This exposure is enough to generate an internet-conditioning effect for stimuli associated with the visited webpages, making stimuli associated with the webpages more valued, which is an effects seen with some addictive substances. These findings add to the evidence that the concept of internet addiction should be given serious consideration.

Clinical Points

- The nature of ‘internet addiction disorder’ is not well understood, and the current report attempted to assess whether those scoring high on a self-report measure of problematic internet use displayed similar reactions to the object of their addiction to those with substance abuse problems.
- The results demonstrated that the cues associated with internet exposure may gain hedonic status in withdrawn heavy internet users in a similar way as they do for substance abusers.
- The findings suggest that individuals scoring highly on psychometric measures of problem internet use should be considered similarly to those with other addiction problems.

Potential Conflicts of Interest

Lisa A. Osborne certifies that she has no potential conflicts of interest.

Michela Romano certifies that she has no potential conflicts of interest.

Federica Re certifies that she has no potential conflicts of interest.

Alessandra Roaro certifies that she has no potential conflicts of interest.

Roberto Truzoli certifies that he has no potential conflicts of interest.

Phil Reed certifies that he has no potential conflicts of interest.

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Figure 1. The change in levels of positive mood (PANASP = Positive and Negative Affect Scale: Positive), negative mood (PANASN = Positive and Negative Affect Scale: Negative), and anxiety (STAI = Spielberger State Trait Anxiety Inventory) after relative to before an internet session, for lower and higher problem users, who had either been or not been deprived of internet access. Error bars = 95% confidence intervals.

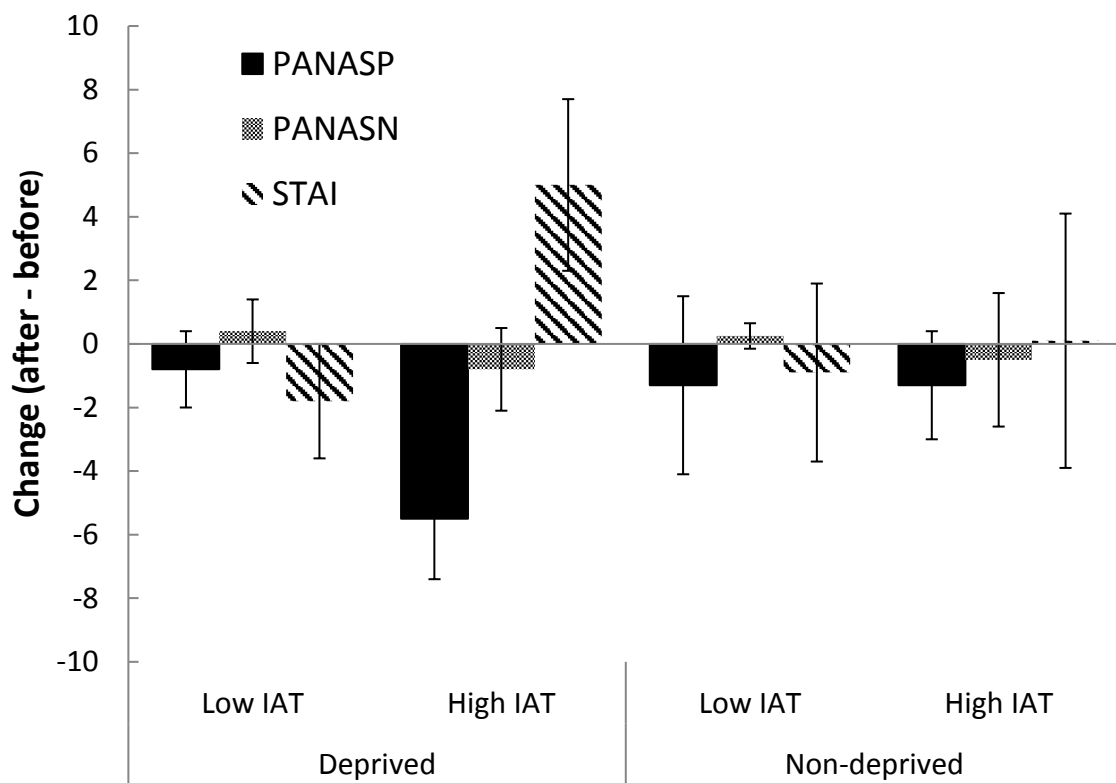


Figure 2. The change in the selective of colors after relative to before an internet session, for lower and higher problem users, who had either been or not been deprived of internet access.

