Assessing the effects of internet-related drug urges on inhibition using an anti-saccade task

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Abstract (246 words):

Title: Assessing the effects of internet-related urges on inhibition using an anti-saccade task

Background: The average adult spends two thirds of waking day online; many researchers propose that this excess internet usage is driven by some form of behavioural addiction. One feature of addictions, according to the Tiffany cognitive urge model, is the presence of urges (i.e., craving) to engage in the behaviour that are difficult to ignore. The current study attempted to establish whether urges occurs for internet usage and test whether such urges interferes with inhibition processes.

Method: Participants completed measures of impulsivity, internet addiction, self-esteem, metacognition and desire thinking and were randomly assigned to control or experimental groups. All participants completed an anti-saccade task as a baseline measure of inhibition. Then, the experimental group was told that they would receive 7 minutes of internet usage, but they were interrupted after 5 minutes. This interruption was designed to elicit internet-related urges. All participants then completed a second anti-saccade task.

Results: The results of a two way mixed design repeated measures ANOVA suggest that anti-saccade error rate in the experimental group significantly increased from baseline to time two after the interruption of internet usage. The control groups error rates marginally decreased. Additionally, the results of a regression analysis suggest that impulse control measures were not a significant factor in predicting scores on Young's Internet Addiction questionnaire.

Discussion: This is the first published study to empirically demonstrate that drug urges can be elicited and measured for Internet usage. In a world that so readily provides Internet usage to children and young adults, that this study may tentatively suggest that we take a more cautious approach to internet usage.

Introduction

“Anyone who has lost track of time when using a computer knows the propensity to dream”

-Tim Berners Lee (Credited as founder of the internet)

Tim Berners Lee understood that the internet was a unique phenomenon, a personalised Skinner box that tailors entertainment to each and every individual. It is unsurprising to see the average adult reports spending two thirds of their waking day online (Central Statistics Office, 2013) Despite this Psychology is still woefully unaware of its effects on individuals' biological and mental health. There is no consistency across the published researches on symptoms (Chou, Condon, & Belland, 2005), however it is generally accepted that internet usage in any amount can cause serious effects on our interpersonal relationships and mental health (Griffiths, 2000; Kraut et al., 1998; Kuss & Griffiths, 2011; Widyanto & Griffiths, 2006) ; just take a look around a café and see how many people are engaged with their phones as opposed to the person sitting opposite them. Despite those effects, the amount of time individuals spend online is still exponentially increasing (Central Statistics Office, 2013). Due to those reported negative symptoms, scholars have proposed that internet usage should be investigated as a standalone mental health disorder termed “Pathological Internet Usage” (PIU) (Davis, 2001), however the latest publication of mental health manuals still forego its inclusion (American Psychiatric Association, 2003; World Health Organization, 2004). In response to this the American Psychiatric Association (APA) commented that there was insufficient literature on its etiology, diagnostic criteria and a lack of pathophysiologic understanding of reported symptoms for it to be included in diagnostic manuals (American Psychiatric Association, 2003)

For a mental health disorder to be included in the APA diagnostic manual, it must be allocated to one of 24 unique divisions (American Psychiatric Association., 2003). There is no consensus among the existing literature on which sub category of disorders PIU would adhere too (Chou et al., 2005; Widyanto & Griffiths, 2006). One group of researchers proposes that internet usage represents an additive substance, one that causes drug urges with its withdrawal (Davis, 2001; Griffiths, 2005). This theory would see PIU being included in the category “Substance Abuse Disorders” within the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) (Davis, Chou et al., 2005). The alternative theory proposes that PIU is a specific disorder of the impulse control system, where individuals have reduced control for impulses towards this substance (Young, 1998, 2015). This classification would see PIU being included in the category “Disorders of the Impulse Control System” within the DSM-V. A lack of direction, and consistency across the research is preventing this field from moving forward (Chou et al., 2005). Until researchers can agree on the nature of the disorder, aspects such as symptoms and etiology will be unreachable

The presence or absence of certain symptoms should be key identifiers in placing PIU into the substance abuse or impulse control diagnostic category. For PIU to be accepted as a substance abuse disorder, the initial research would have to focus on presence of drug urges, which are an essential characteristic of an addiction according to the World Health Organisation (Jellinek et al., 1955; Tiffany, 1990; Tiffany & Carter, 1998). Some PIU questionnaires already attempt to measure drug urges for internet withdrawal (Young, 1998).

To date however, no empirical demonstration that drug urges can be measured for internet usage has been published in the literature (Spada, Caselli, Slaifer, Nikčević, & Sassaroli, 2014). This demonstration would require the application of Tiffany's Cognitive Model of Drug Urges and Drug-Use Behaviour, as the most cited explanation for the development of drug urges in addictions (Tiffany, 1990). The theory has gained popularity since it can demonstrate the link between a substance and drug urges without requiring a physiological interaction between the two materials, an important aspect for behavioural addictions (Tiffany, 1990). The theory achieves this by assuming that drug use is subjected to the theory of automaticity of behaviour.

The automaticity of behaviour theory was proposed by Bargh, Chen, and Burrows (1996) and states that complex cognitive tasks such as driving become easier over time and require less cognitive effort due to the development of schemata. These schemata are maps of a specific behaviour that an individual can follow when presented with a familiar stimulus. In terms of drug use, they allow an addict to inject a substance quickly and easily once they completed the task a number of times. However, these schemata only work when familiar stimuli are used, and the automatic process is not disputed. In the case that a drug substance runs out for the first time, an addict will have no previous experience to draw on and will require their full cognitive attention to deal with the task. The disruption of this automatic process of behaviour results in non-automatic cognitive process being activated, this non-automatic processes required increased cognitive effort since they are reasonable for developing new schemata (Tiffany, 1990).

Figure 1. . Summary of Tiffany model of Drug Urges. Automatic processes lead to drug rewards as in the top figure. However, a disruption of these processes such as a drug running out require non-automatic cognitive process to help an addict finish the drug admin

Some cases may present where an individual has begun the drug administration process and chooses to, or is forced not to finish. According to Tiffany, this will elicit the presence of non-automatic processes which are insistent on the individual completing the drug administration since they have activated, however there is an internal conflict of interest. This requirement for drug administration but the inability or unwillingness to do so will create an abstinence-avoidance drug urge (Tiffany, 1990). This drug urge is experienced when a smoker runs out of a package of cigarettes, they require the drug but are unable to, administer. In response to these drug urges, an individual will engage their self-control abilities to attempt to reduce these urges (Baumeister & Heatherton, 1996). The ego depletion theory proposes that self-control (or self-regulation) abilities are a limited cognitive resource (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Baumeister & Heatherton, 1996; Baumeister, Muraven, & Tice, 2000). During the activation of self-control processes, an individual may seem inattentive since most of their cognitive efforts is being utilised in a single area. This theory presents an interesting way to measure the presence of self-control in an individual, reduced cognitive ability from a baseline measure would suggest that an individual is diverting their limited attention to an alternate process, in this case self-control of drug urges. Tiffany suggests that by measuring the level of cognitive ability after the interruption of a drug administration process is an empirical way to demonstrate the presence of self-control in an individual which implies the additional presence of drug urges. The interruption of a substance administration has been identified as a process which successfully elicit drug urges (Tiffany, 1990). This theory has successfully been applied and

demonstrated the ability to measure drug urges in tobacco, alcohol, nicotine and cocaine addictions (Carter & Tiffany, 1999; Cepeda-Benito & Tiffany, 1996; Hester, Dixon, & Garavan, 2006; Waters & Green, 2003).

Within the psychological literature, many measures of cognitive attention are available. For the current study we choose to use an eye movement task to measure the ego-depletion theory. This task employs two types of eye movement, pro saccades (PS) and anti-saccades (AS). Pro saccade are natural eye movements, completed when we move our eyes to a new stimulus in our visual field. Since we perform millions of PS's every day, they do not require our active attention (Everling & Fischer, 1998; Munoz & Everling, 2004). Anti-saccades are the process of withholding a pro-saccade movement and moving the eye away from the new stimulus (Everling & Fischer, 1998). This task requires considerable cognitive effort, and therefore is an ideal measure of the presence of self-control processes. This process has been used to measure self-control in previous works (Kelly, Sünram-Lea, & Crawford, 2015). The measure presents a number of additional advantages most evidently participants do not suffer notable fatigue during the task, it is quick and easy to administer and there is no evidence of a learning effect on performance over time (Antoniades et al., 2013).

The use of an eye movement task will be an ideal measure of the presence of current drug urges at a specific moment in time. Within the drug urge literature, Desire Thinking (DT) and Metacognitions (MC) are two cognitive processes that are measures of the propensity to engage in drug urges throughout life (Caselli, Soliani, & Spada, 2013; Spada, Nikčević, Moneta, & Wells, 2007). The first of these, DT is a trait measure of how an individual fixates their thinking onto a certain desired object (Caselli & Spada, 2011). The degree that an individual engages in DT has been strongly linked to the experience of drug urges. The current literature has proposed that DT should be related to the experience of drug urges in PIU (Spada et al., 2014). The second cognitive trait process is metacognition, which is a measure of how an individual "thinks about thinking" (Spada, Langston, Nikčević, & Moneta, 2008). Negative metacognition is often known as worrying, or rumination. The degree to which an individual engages in these metacognitions is related to the experience of drug urges (Lee, Pohlman, Baker, Ferris, & Kay-Lambkin, 2010).

In the case that drug urges were not found to exist for PIU, the illness could be disorder of the impulse control system. Extensive research has proposed this theory, aiming to identify PIU as a standalone mental health disorder (Young, 1998, 2015). Existing research has drawn on questionnaire, neurological and tasked based evidence to suggest that poor impulse control is correlated to higher reported PIU symptoms (Choi et al., 2014; Dong, DeVito, Du, & Cui, 2012; Laconi, Rodgers, & Chabrol, 2014). However, one issue with the study of impulse control is the abundance of theories which account for its development in individuals. Two-trait theories of impulse control that are closely linked to the study of addiction are Delayed Discounting (DD) and Gray's Reinforcement Sensitivity Model (Corr, 2002; Odum, 2011b). These theories explain how an individual can have reduced impulse control for certain substances and not others. They have been previously used to examine the development of a number of addictions, including impulse control disorders such as pyromania and kleptomania (American Psychiatric Association, 2003). Both of these theories have previously been positively correlated with PIU scores we hope to replicate these finding in a student population (Meerkerk, van den Eijnden, Franken, & Garretsen 2010; Park et al., 2013; Saville, Gisbert, Kopp, & Telesco, 2010; Yen et al., 2012).

The first of these theories, DD is a trait measure of how an individual reduces the subjective value of future rewards compared with the value of a present reward (Odum, 2011a). A rational individual will always choose to receive a larger reward in the future rather than a smaller reward now. However, individual are inherently irrational and will often choice the smaller sooner reward rather than delay their enjoyment (Odum 2011). This is especially evident in the case of addictions, were individuals are focused on instantly rewards

Assessing the effects of internet-related drug urges on inhibition using an anti-saccade task of their substance (Kirby, Petry, & Bickel, 1999; MacKillop et al., 2011). The second theory, Gray's

Reinforcement Sensitivity Theory is a concept that falls between the impulse control and substance abuse literature, the theory proposes that our personality is affected by two independent trait systems; Behavioural Inhibition System (BIS) affects our sensitivity to unpleasant stimuli, while the Behavioural Approach System (BAS) affects our sensitivity to rewarding stimuli (Carver & White, 1994). These measures investigate our general impulse control towards all stimuli, but also our specific approach or inhibition to an addictive substance. The questionnaire that measures this theory has been proposed as a predictor for the development of drug abuse in later life (Franken & Muris, 2006).

Our study attempts to clarify the on-going debate on the classification of PIU. Firstly, we propose to investigate if drug urges can be empirically measured when Internet usage is the desired substance. Secondly, we hope to identify if impulse control is related to experience of PIU symptoms.

Methods

Research Design

Our research is sub-divided into two separate studies, each of which is interested in adding substance to the literature in an attempt to under the nature of PIU disorder. The first study attempted to understand if PIU can be considered as a substance abuse disorder by investigating if drug urges can be elicited and measured by utilising Tiffany's Model of Drug Urges. In order to complete this, the study employed a repeated measure experimental design. All participants were divided into two groups; each group performed a saccade task at baseline and time two. The experimental group was subjected to interruption of Internet usage between the two saccade tasks while the control group voluntarily finished using the internet. The first hypotheses states that participants in the experimental group will have increased anti-saccade errors at time two compared with baseline, while no difference in error rates should be seen in the control group. The null hypotheses therefore expect to see no significant difference on task performance across time. The dependent variables for this hypothesis are anti-saccade error rate at baseline and time two, while independent variable is allocation to control or experimental group. Our second hypothesis is incorporated into the first study, but utilises a linear correlational measure. The hypothesis we propose states that scores on the Desire thinking and Metacognition questionnaires' should predict error rate performance in the experimental group. The null hypotheses expect that MT and DT will not predict drug urges. Dependent variables are experience of urges, a variable constructed from anti-saccade error rate and the independent variables are DT and MC.

Our second study replicated existing findings, which suggest that users suffering from PIU have lower trait impulse control. This study employed a linear correlational design. The third hypothesis we propose states that participants who have higher scores on PIU related questionnaires will also have higher scores on impulsivity related questionnaires (BIS/BAS) and an increased tendency to discount future rewards (DD). The null hypothesis states no correlational will be seen. Dependent variables include CIUS and YIAS and independent variables include BIS, BAS and DD.

Participants

The study recruited a convenience sample of University students ($N=63$, 40 females, $M age = 23$, $SD = 9.2$) from across a range of disciplines using on-campus advertisements. Since the study employed an eye tracking paradigm, participants who had been clinically diagnosed with any of the following disorders were asked to self-exclude at sign up; attention deficit hyperactivity disorder, major depressive disorder, schizophrenia, recent head injury or any other psychiatric disorder. All participants were volunteers to the study, although some did receive course credit points for attending. For experiment one, participants were randomly assigned to the either the control or experimental group

Measures

Note: Extended details on measurements including scoring details, alpha values and technical reports are in Appendix 1. All measures had a Cronbach's Alpha value of above .70.

Saccade task

The saccade program was designed and ran using SR-Research experimental builder on a SR-Eyelink 1000 tracking system utilising a desktop setup. The system tracked the movements of the participant's right eye. For each participant, a calibration process was completed followed by 64 trials of randomly allocated pro or anti saccade eye movements.

BIS/BAS Scales

The Behavioural Approach System (BAS) and Behavioural Inhibition System (BIS) were measured using a 24 item questionnaire designed by Carver and White (1994). The five point Likert responses are coded into four separate measures which each account for individual aspects of the behavioural approach/avoidance theory. The four measures are BIS, BAS-Fun, BAS-Drive and BAS-Reward.

Rosenberg Self-Esteem Scale (RSES)

The Rosenberg Self-Esteem Scale is a standardised questionnaire designed to measure global self-esteem developed by Rosenberg (1965). It is a 10 item questionnaire with responses on a four point Likert scale.

Compulsive Internet Usage Scale (CIUS)

The Compulsive Internet Usage scale is a 14 item questionnaire designed by Meerkerk, van Den Eijnden, Vermulst, and Garretsen (2009). The scales measures an individual's ability to restrain from internet usage.

Young's Internet Addiction Scale (YIAS)

Young's Internet Addiction Scale is a 20 item questionnaire developed by Young (1998). This is the mostly utilized scale in published research on PIU (Chou et al., 2005).

Metacognition Questionnaire - 30 Items (MCQ-30)

The brief Metacognition Questionnaire is a 30-item measure designed to investigate the presence of metacognitions in an individual, the questionnaire was designed by Wells and Cartwright-Hatton (2004).

Desire Thinking Questionnaire (DTQ)

The Desire Thinking Questionnaire is a 10 item questionnaire designed to measure the tendency towards desired thinking, the scale was designed by Caselli and Spada (2011). Questions were rephrased to reflect internet usage as the desired concept

Delay Discounting Task (DD)

A customised computerized delay discounting task “Price your Vice” was employed to measure an individual’s tendency to discount future monetary rewards (O’Hora, Carey, Kervick, Crowley, & Dabrowski, 2016). Each participant completed 20 trials which involved a choosing between two monetary rewards. One reward was offered immediately while the second larger reward was offered at a future delay.

Procedure

All participants attended the eye tracking laboratory located on the university campus. It was explained to the participants that they were undertaking an ethically approved research study on how eye tracking related to impulse control levels. This deception was employed to prevent participants thinking about the internet during the first saccade task. All the tasks that the participants would have to complete were explained in detail, finally signed voluntary consent was provided in line with internal university guidelines. Random identification numbers were issued to all participants to record responses and maintain confidentiality.

Participants were first asked to complete the BIS/BAS and RSEQ scales using an online form. Following this participants were asked to place their head onto a dedicated stand which ensured that their head remained fixed for the eye tracking task. Two calibration procedures were completed which involved participants moving their gaze towards a stimulus presented at nine evenly spaced locations on the computer screen including the four corners and the centre of the screen. The calibration task was completed a number of times for some participants until the correct settings could be identified. A practice trial for the saccade task was then completed.

All participants were briefed on the procedure for the saccade task. Each trial of the task began with the participant fixating on a white dot in the centre of the screen. This dot would change colour to either red or green for 1500 milliseconds, each colour denotes that a participant should perform an anti or pro saccade respectfully. Following this two evenly spaced white boxes appeared at edges of the screen, within one of these boxes there was a white dot. If a pro-saccade was required the participant would have to move their eye towards the box with the white dot. If an anti-saccade was required, the participant would have to withhold the voluntary movement toward the new stimulus and direct their eye movement to the opposite box. The task then moved to a new trial once fixation was in the correct box, or if 5000 milliseconds had elapsed. These trials were completed in blocks of eight, and 64 were completed at time one and another 64 at time two.

Figure 2 . Participant view of anti-saccade and pro-saccade task. Red fixation point required movement away from the white box with the dot, while green fixation point required movement toward the white box with the dot. Eye symbols and arrows were not actually

Following the completion of the first 64 trials, participants were informed that they had been allocated either a five or seven minutes break to allow the computer to analyse data. They were also informed that they could spend the time using internet enabled devices. A small countdown timer was placed beside each participant. Following five minutes, all participant were asked to resume the saccade task, this involved interrupting the experimental group. The control group had already been informed they only had five minutes. A calibration process identical to the original task was completed and another 64 saccade trials were completed. No practice round was provided at time two, however the instructions were reiterated to participants.

On completion of the saccade task, the head stand was removed and all participants were asked to complete the MCQ, DT, YIAS and CIUS questionnaires. A delayed discounting task was also completed in the middle of the four scales to disrupt the repetitiveness of completing the questionnaires. Instructions for completing each questionnaire was provided, as well as for the delayed discounting task. This task required participant to make 20 monetary choices where they had to choose between receiving a small monetary reward immediately or a larger reward to at a specific point in the future.

Finally, participants were debriefed as to the true hypothesis of the study and retroactive consent was provided by all participants. These consent form were approved by the internal ethics board and example are attached to appendix three.

Figure 3 Participant view of delayed discounting task. Future rewards was always placed on the left hand side of the screen.

Statistical analyses

Data for questionnaires was scored and reserve coded in line with details provided in the first appendix. This excluded delayed discounting data which we use the area under the curve method to extract K values for each individual. For saccade data, we reported Anti-saccade error rate, Peak velocity for pro and anti saccades and mean latency for pro and anti-saccades at both baseline and time two. The first step of statistical analyses employed tested all data for normality using Q-plots and Shapiro-Wilk test. Descriptive statistics were then compiled were required. Dependent t-test were ran to investigate the significances of allocation of data between gender and group allocation. In order to test hypothesis one, a mixed design repeated measure ANOVA was employed. Hypothesis two was tested using a linear correlational design while hypothesis three was tested using a hierarchical regression design. Proposed sample sizes for these tests were calculated using G*Power Version 3.1.9.2 IBM SPSS. Software version 22 window editions was employed for all statically analysis.

Results

Descriptive statistics:

The study was completed by 63 individuals, however some participants did not correctly complete the questionnaire measures or delayed discounting task which resulted in missing data. In addition to this, 12 participants saccade data was excluded from the final comparison after a technical error in the program occurred. An unscheduled software update changed the visual presentation of the program without the researcher knowledge, since these participants essentially completed a different task their data was excluded at post hoc. We present the means, standard deviations and confidence intervals for all measures in table 1. All data was tested for normal distribution using the Shapiro-Wilk test and results are also included in Table 1

Table 1.

Demographic values, summary of means, standard deviation and confidence intervals for 10 questionnaire measures.

	<i>n</i>	<i>M</i> Age	<i>SD</i>		
Male	19	22.56	7.57		
Female	44	25.3	12.12		
	<i>n</i>	<i>M</i>	95% <i>CI</i>	<i>SD</i>	Shapiro-Wilk
RSES	62	20.65	(19.44,21.84)	4.72	<i>p</i> = .286
MCQ-30	62	63.87	(60.34,67.40)	13.9	<i>p</i> =.015
BAS-Drive	62	11.27	(10.60,11.94)	2.64	<i>p</i> =.100
BAS-Fun	62	11.66	(12.13,13.16)	2.0	<i>p</i> =.001
BAS-Reward	62	17.29	(16.76,17.82)	2.08	<i>p</i> =.001
BIS	62	21.52	(20.65,22.39)	3.43	<i>p</i> =.368
CIUS	62	24	(21.42,26.58)	10.16	<i>p</i> =.453
YIAS	62	32.73	(29.2,36.26)	13.92	<i>p</i> =.653
DT	62	18.90	(17.37,20.44)	4.91	<i>p</i> =.022
K Value	42	.69	(.64,.75)	.17	<i>p</i> =.015

DT= Desired thinking questionnaire, MCQ-30= metacognition questionnaire, YIAS= Young's internet addiction questionnaire, RSES= Self-esteem questionnaire, BAS-Drive= Behavioural approach system drive, BAS-Fun=behavioural approach system fun, BAS-Reward= behavioural approach system reward, BIS= behavioural avoidance system, CIUS= compulsive internet use scale, DD=Delayed discounting value. CI= Confidence interval, SD=Standard deviation

Participants completed seven questionnaire measures. Only three of these measures had proposed interpretation of their results within the literature. According to these interpretations, only 6% of participants reported low self-esteem according to the RSES (Galanou, Galanakis, Alexopoulos, & Darviri, 2014). The majority of participants report no internet addiction (88%), according to the self-

assigned cut off points on the YIAS questionnaire (Young, 1998). Only 12% of the participants who completed the questionnaire scored in the “mildly” addicted range, no participant scored in the “highly” addicted range. While 30% were considered internet addicted according to the CIUS (Armstrong, Phillips, & Saling, 2000). A Spearman’s Rho correlational matrix for all questionnaire measures is presented in table 2.

Our participant’s scores on questionnaires did not significantly differ when divided by gender or group allocation. This supports the process of randomization and suggests that gender was not a significant factor in the results of our study. The results of dependent t-tests are presented in the appendix two.

Hypothesis one: Measurement of drug urges for internet usage.

A two way mixed design ANOVA was employed to investigate whether participants anti-saccade error rates differed after the experimental manipulation depending on which group they had been assigned to. The between subject factor had two levels, participants were randomly allocated to interruption (experimental) or no interruption (control) group. The within subject repeated measure variable was time (baseline versus time two). Anti-saccade error rates (ASER) were calculated by summarizing the number of failed anti-saccade movement made during the 64 trials. Drug urges are hypothesised to increase inhibition failure due to the presence of non-automatic cognitive schemata as outlined by the ego depletion theory. Increased error rates after the interruption task suggest the presence of drug urges in the experimental group.

The data met the assumption of a mixed design ANOVA, Levene’s test was non-significant. The ASER data was normally distributed. No significant main effect were noted for anti-saccade error rate ($F(1,49)=.917$, $p=.34$, $\eta^2=.018$) suggesting that the overall ASER did not significantly differ between baseline and time two. No significant main effect was noted for group ($F(1,49)=.095$, $p=.759$, $\eta^2=.002$). However a significant interaction effect was noted for error rate between group ($F(1,49)=4.66$, $p=.03$, $\eta^2=.087$). The results suggest that participants in the control group reduced their error rate from baseline to time two, while participants in the experimental group increased their error rate by 11% (Figure 4)

Additional saccade data that was collected was saccade latency and peak velocity. According to the results of two repeated measures ANOVA’s, the experimental manipulation did not affect saccade latency or peak velocity during the task. Results are presented in the appendix two. The results of an independent t-test propose no significant difference in mean ASE scores at baseline ($t(50) = 1.57$, $p = .122$) and time two ($t(5)=-.589$, $p=.558$).

Table 3.

Means and Standards Deviations for ASER between groups

Condition	Baseline		Time two	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Experimental	.51	.11	.58	.11
Control	.55	.11	.53	.12
Total	.53	.11	.55	.11

ASER=Anti-Saccade Error rate, which is a measure of inhibition failure.

Figure 4 . ASER=Anti-Saccade Error Rate. Mean scores for ASER are provided at baseline and time two. Blue line indicates the experimental group who received the interruption, their error rate increased. The red line indicates the control who did not receive an i interruption, their error rate decreased.

Hypothesis two: Effects of DT & MC on drug urges

A number of Spearman's Rho correlations were ran to investigate if DT and MC predicted experience of urges during the task. A measure of urges was constructed by subtracting error rate at baseline verse time two. The results suggest that MC positively correlate with experience of internet related urges (rs (63)=.293, $p < .037$). Scores on CIUS and IAD did not significantly correlate with experience of urges during the task.

Table 4.

Summary of Spearman's Rho correlation between experience of urges and trait measures of drug urges.

	CIUS	YIAS	DT	Urges	MC
CIUS	1.00				
YIAS	.883**	1.00			
DT	.59**	.6**	1.00		
Urges	.15	-.02	.60	1.00	
MC	-.092	-.158	.226	.04	1.00

*= Significant at .05, **= Significant at >.00

DT= Desired thinking questionnaire, MCQ= metacognition questionnaire, YIAS= Young's internet addiction scale, CIUS= compulsive internet use scale,

Hypothesis three: Impulsivity and pathological internet usage.

We employed a hierarchical multiple regression to investigate how impulse control questionnaires were related to PIU questionnaires. The dependent variable in the model was YIAS. The first step accounted for demographic variables of gender and age, both of which have previously been seen to

relate to YIAS scores (Chou et al., 2005). The second step accounted for our five impulse control measures, BIS-Fun, BIS-Drive, BIS-Reward, BAS and DD. The final step accounted for MC and DT scores. Pairwise comparison reduced the sample size to 45. The model met all the proposed assumptions of a linear regression. Tolerance and VIF values were adequate and the correlations among predictor variables were low, indicating that multicollinearity was not present.

The overall model was significant ($F(9,44)=5.75$, $p=.000$, $R^2=.60$, Adjusted $R^2=.49$). As was the first step of the model which predicted 10.4% of the variance in YIAS ($F(9,44)=3.56$, $p=.000$, $R^2=.14$, Adjusted $R^2=.10$). The second step of the model was not statically significant however. Investigation of beta weights suggest that DT and MC significantly contributed to the model in step three.

Table 5

Summary of hierarchical regression for YIAS

	β	R^2	Adj R^2	F change	Sig F Change
Step 1	20.783	.145	.104	3.651	.037
Step 2	39.603	.216	.067	.668	.650
Step 3	6.248	.597	.493	16.539	.000

Step 1. Age, Gender; Step 2. BAS Drive, BAS Fun, BAS Reward, BIS,DD, Age, Gender ; Step 3. BAS Drive, BAS Fun, BAS Reward, BIS,DD, Age, Gender, DT, MC,

Table 6

Summary of standardized beta coefficients for hierarchical regression.

	Standardized β	P value
Age	.159	.213
Gender	.145	.288
BIS	.104	.439
BAS-Drive	-.071	.615
BAS-Fun	-.120	.344
BAS-Reward	.021	.885
DD	.077	.521
DT	.567	.000
MC	-.266	.044

DT= Desired thinking questionnaire, MCQ-30= metacognition questionnaire, YIAS= Young's internet addiction questionnaire, RSES= Self-esteem questionnaire, BAS-Drive= Behavioural approach system drive, BAS-Fun=behavioural approach system fun, BAS-Reward= behavioural approach system reward, BIS= behavioural avoidance system, CIUS= compulsive internet use scale, DD=Delayed discounting value.

Additional results

Within the PIU literature, the CIUS and YIAS questionnaires are primarily used to investigate the presence of PIU symptoms. Few studies however use both questionnaires on the same sample. A strong spearman's rho correlation was noted between CIUS and YIAS scores, ($r_s(63) = .88$, $p = <.000$) (Figure X) which supports the idea that both questionnaires measure the same concept. In addition, scores on the DT scale also correlated with both YIAS ($r_s(63) = .59$, $p = <.000$) and CIUS ($r_s(63) = .59$, $p = <.000$).

Figure 5 Graphical representation of the results from the compulsive internet usage questionnaires (CIUS) and Young's internet addiction scale (YIAS). A strong positive correlational suggests both scales measure the same concept.

Discussion

Half of the world's population accesses the internet on a daily basis, yet psychologists have a limited understanding of its actual effect on people. Our contribution to this effort is the presentation of two separate hypothesis, the first of which investigates the presence of drug urges in internet usage in order to expand the debate as to which disorder classification PIU should be placed in. Our second study investigates the link between internet usage and impulse control.

Many psychologists propose that the internet could be an addictive substance in the eyes of certain individuals, in the same manner heroin or cocaine is. However the evidence to support this claim is tentative. To date, no published work has experimentally investigated if drug urges can be empirically elicited for internet usage, a symptom that the WHO suggests is a fundamental requirement for identifying addiction disorders (Chou et al., 2005; Tiffany, 1990). Our study applied Tiffany Models of Drug Urges to internet usage by eliciting drug urges through substance interruption and measures the presence of these using a cognitively demanding task as proposed by the ego depletion theory (Baumeister et al., 1998). The presence of these urges was empirically demonstrated when anti-saccade error rate significantly increased for the experimental group after the interruption of internet usage. This increase in error rate is categorised by increased self-regulation which may be due to the presence of drug urges if we accept the existing research by Baumeister et al. (1998); Tiffany (1990). By accepting this, we have empirically demonstrated that within our sample, display drug urges toward internet usage when it is suddenly withdrawn. In much the same way as individual go to great lengths not to let their phones lose power when they are away from the internet. This result requires additional research, ideally with a large sample. However two key points that could be proposed are firstly that PIU could be included in substance abuse disorder category within the DSM-V. This provides a direction for future research where the existing work on addiction etiology that has already

been established in the domain of psychology and medicine can be applied to internet usage. Secondly, our society goes to great lengths to prevent individuals, especially children from forming addictions. The current generation of children will be the first to have internet access since birth, the presence of these urges may have unforeseen consequences on our children in future years.

We note two limitations to the above results however. The first of which is that error rates at all stages of the task were close to means scores. The interaction effect we measured may be due to regression to mean effect, when an extreme measure will likely be closer to a mean score on the second measure due to mathematical probability and not the experimental manipulation. This is supported by the result which suggest mean ASER were not significantly different. The second limitation is the change in error rate observed. Previous studies have reported up to a 40% increase in error rates when self-regulation abilities are required. Although different paradigms were employed, we would have expected to see a main effect for error rate across time if self-regulation abilities were really presence at time two. Despite these, we still successfully reject the null hypothesis of this study.

In an attempt to improve the generalizability of our research, our study employed both trait measures of drug urges (DT, MC) as well as measures of the current presences of drug urges (saccade task). The results of our correlations suggest that DT did not predict experience of internet related urges during the experimental task. This is conflicting with a proposal by Spada et al. (2014) who suggests that DT should predict drug urges for PIU based on his interruption of the literature. A possible explanation is that desired thinking is not a contributing factor to the experience of PIU drug urges. Our second trait measure of drug urges is MC, the positive correlation suggests that the cognitive process of MC predicts drug urges in internet usage. This supports the existing proposal by Spada et al. (2008). We are forced to accept the null hypothesis in this case.

Interestingly, both DT and MC were seen as good predictor of scores on the YIAS when entered into the multiple regression. The YIAS claims to measure the presence of drug urges for internet usage, however our correlations suggest it had no relation to actually experience of drug urges. We suggest increased research is required on one of the most highly used measures for PIU diagnostics.

Some theorists in the PIU literature propose that excessive use of internet applications is due to failure of the impulse control system with specific regard to internet substances (Young, 1998). The acceptance of this theory would see PIU being included under impulse control disorders within the DSM-V as opposed to substance abuse disorders. A growing number of studies have proposed that impulse control is lower for PIU individuals (Dong, Huang, & Du, 2011; Dong, Lu, Zhou, & Zhao, 2010). However, our results provided conflicting evidence to the established work. The results of our regression analysis suggest that none of our five impulse control measures predicted scores on the YIAS, despite having done so previously in the literature (Cao, Su, Liu, & Gao, 2007; Dong et al., 2010; Meerkerk, van den Eijnden, Franken, & Garretsen, 2010; Park et al., 2013; Saville et al., 2010). These published studies that propose a relationship between impulse control and internet usage report small effect sizes, or use of a highly selected sample. This relationship may only been seen in a larger samples then we employed. It has also been proposed that the results of these studies is seen because poor impulse control is a symptoms of many mental health illness, research suggests that up to 73% of individual who can be classified as internet “addicted” have at least one co-occurring mental health illness (Widyanto & Griffiths, 2006). Regardless, for the purpose of this study we can accept the null hypothesis which states that pathological internet usage is not predicted by impulse control disorders.

A number of important results outside the scope of either hypothesis were seen. Firstly looking at the CIUS and YIAS questionnaires, although both of these questionnaires have been applied many times in the literature separately, few studies have applied both simultaneously. Our study found a very strong correlation between these two scales. A similar result was seen in Laconi study which reviewed over 80 PIU research papers (Laconi et al., 2014). Both of these scales have proposed cut-off points which identify an individual as internet addicted. Within our sample, there was a large discrepancy between the results based off each interruption (Meerkerk et al., 2010; Young, 1998). Young’s scale suggested 12% of our population was mildly addicted while the CIUS predicted 30% of our

population were internet addicted. This is an important consideration for future research, where the reporting of “addicted” patients is a highly subjective process.

In our study, the desired thinking showed a strong positive correlation to scores on the YIAS and CIUS. This results is a replication of a similar correlation seen in Spada et al. (2014) between other PIU questionnaires and DT. This results suggests that DT may be an alternate measure of PIU symptoms. One should note however that according to our correlations, the YIAS may not predict drug urges for internet usage as previously thought.

Throughout our research study, three considerable limitations were noted. The first of which was the use of a convenience sample, despite having reached the required sample size our population was predominantly female students in there’s 20’s. This might limit our research in how it can be generalized to the population as a whole. In order to assess the differences between the sample and the population, we compared our results to published populations averages where possible. To begin with, mean self-esteem levels match a similar population report completed in 2002 using the same RSES measure (Mullan and NicGabhainn 2002). Our four BIS/BAS measures also matched on mean scores to an American student population (Chang et al., 2007). Our mean K value was slightly above that found in national Irish sample by (O’Hora, Carey et al. 2016). Finally, employing the clinical cut-off points suggested in the YIAS questionnaire by (Young, 1998), it is proposed that 12.7% of our population was classified as “addicted”. Compared with a national Irish survey on second year school children, a similar mean score was found (13.4) (Durkee et al., 2012). These comparisons suggest our sample was a fair representation of the whole population, in so far as we can compare. However, many of the research studies we have reviewed have employed clinically selected samples who all scored highly on the PIU questionnaire, our sample has better generalizability than the non-clinical population however.

The second and third limitation concerned the experimental paradigm, specifically the saccade task. The first of which was the length of time required to calibrate the eye tracking equipment at time two. Some participants took considerably longer to calibrate than others, it was discovered that this was due to slippage in the focus lens of the camera. This limitation means that some participants may have lost the experience of drug urges before actually being tested. Similarity the third limitation concerned the administration of internet exposure. Although participants were informed they might use internet-enabled devices, not all participants did and some only did for a limited percentage of the time. We did not account for this limitation in the results of the study, but future research should ensure a more control paradigm is used.

Many researchers propose that the effects of internet usage are going to become a fundamental focus of psychological research in the next century. Our research was a pilot study to investigate if drug urges could be empirically measured for internet usage. The results of our first hypothesis tentatively suggest that an empirical measure and demonstration of drug urges for internet usage is possible by applying Tiffany model and utilising an anti-saccade task. This would advocate that internet usage could share the same addiction etiology that has already been established for addictions in the domain of psychology and medicine. According to our results PIU would be better included in the category of substance abuse disorder rather than disorder of the impulse control system since no relationship was seen here. Future research should attempt to replicate this result in a larger, and ideally clinically defined population of PIU individuals, this research should also investigate if DT and MC are truly related aspects of the experience of drug urges as has been proposed. In addition to accepting one hypothesis, we were forced to reject our second and third, contradictory to previous research our study did not find any relationship between reduced impulse control and internet usage. We propose that it is time for research to experimentally investigate the relationship between impulse control and internet usage, as opposed to correlational measures.

The internet is quickly creeping into almost every minute of our lives, it’s going to affect our lives, the lives of our children and their children. As a society we need to understand the effects of this phenomenon on our lives, least we understand them too late.

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Appendices

Appendix 1.

Saccade task

Stimuli were presented on a 27" BenQ XL2720Z monitor with a 1920×1080 LCD TN pixel display at 144 Hz refresh rate. Eye movement data was recorded via SR-Eyelink 1000 eye tracking system running at 1000 Hz and developed by SR Research Ltd. The Eyelink 1000 employed a desktop mounting and head supported option. (sampling rate 2000 Hz, accuracy 0.25° -0.5, resolution 0.01° RMS, micro-saccade resolution of 0.05° and real time data access of 1.4 msec (SD < 0.4 msec) @ 2000 Hz).

The saccade program was designed and ran using SR-Research experimental builder (Version 1.4.624). The program was freely downloaded from the SR-Research website (Prosaccade and antisaccade task). The recommended settings for detection of fixation and saccades as suggested by SR research were used (velocity threshold of 30°/sec, an acceleration threshold of 8000°/sec² and a motion threshold of 0.15° . A minimal track status of 80% was employed.).

Participants were presented with a coloured fixation in the centre of the screen, in the case of a red point an anti-saccade was required while a green point required a pro saccade. The fixation point disappeared after 1500 milliseconds and two white boxes were presented on the left and right hand side of the screen. A white dot randomly placed in the centre of one box. A pro-saccade required the participant to move their eyes toward this dot, while an anti-saccade required the participant to move their eyes to the opposite box. All stimuli were present in the visual field, however eye movement was still required.

BIS/BAS Scale

A 24-item questionnaire was administered using a four point Likert response scale. The Cronbach alpha was .819 for BAS drive, .715 for BAS fun, .674 for BAS reward and .758 for BIS. The scale also displays good test-retest reliability (Jorm, Christensen et al. 1998). Item two and 22 were reverse coded. 1 = very true for me ,2 = somewhat true for me , 3 = somewhat false for me and 4 = very false for me.

Rosenberg Self-Esteem Scale (RSES)

Participants complete ten questions where answers are on a four point Likert scale. Participants are scored 1 to 30, scores below 15 are indications of low self-esteem according to Rosenberg (Schmitt & Allik, 2005). Cronbach alpha for the scale was .881, The test also displays strong test-retest reliability (Blascovich & Tomaka, 1991). Strongly Agree=3, Agree=2, Disagree=1, Strongly Disagree=0. Items 2,5,6,8,9 were reverse coded.

Compulsive internet usage scale (CIUS)

There is no clinically defined cut-off point on this scale for diagnosis of compulsive internet usage, however a suggested level is proposed by (Kuss, van Rooij, Shorter, Griffiths, & van de Mheen, 2013). The questionnaire displays strong internal consistency with a Cronbach's alpha of .88, and good test-retest reliability (Meerkerk, van Den Eijnden, Vermulst, & Garretsen, 2009). Strongly Agree=3, Agree=2, Disagree=1, Strongly Disagree=0.

Youngs Internet addiction scale (YIAS)

There is no clinically defined cut-off point on this scale for diagnosis of compulsive internet usage, although Young suggests anything scored over 69 suggest problems with Internet usage. The questionnaire displays

strong internal consistency with a Cronbach's alpha of .92. Strongly Agree=3, Agree=2, Disagree=1, Strongly Disagree=0.

Metacognition questionnaire -30 Items (MCQ-30)

The scale had a Cronbach's alpha of .90 . Participants completed the 30 items by rating answer on a five point Likert scale. Strongly Agree=3, Agree=2, Disagree=1, Strongly Disagree=0.

Desire Thinking Questionnaire (DTQ)

Participants then rated their desire for internet usage on a scale a four point Likert scale. The overall questionnaire has a cronbach alpha of .85, with good test-retest reliability for the task required (Caselli & Spada, 2011). Strongly Agree=3, Agree=2, Disagree=1, Strongly Disagree=0.

Delay discounting task (DD)

The study employed a delayed discounting program designed by O'Hora and used in O'Hora (2016). The program was designed to calculate a participant's indifference point, the value at which a monetary reward has the same subjective value as a future monetary reward at a greater delay, for example €16 today has the same subjective value as €30 in two weeks.

All participants were explained the requirements of the task. They were asked to complete the task as if they would actually receive the rewards. The program presented each participant with 20 monetary choices, divided into blocks of four choices. Each choice offered a participant a reward now or a reward a future delay. The first decision was between €8 now and €16 in 1 week. If the participant choice the future option the now value increased, were the choice of a now value caused the future value to increase until the indifference point was calculated. This process is termed a staircase procedure, and values that were presented to the participants are input into figure 6.

Figure 6 Procedure for delayed discounting task

Appendix 2

Table 7.

Descriptive results for saccade task.

	<i>N</i>	<i>M</i>	<i>95% CI</i>	<i>SD</i>	<i>Shapiro-Wilk</i>
<i>Pro Saccade Time 1</i>					
Latency	51	243.85	(197.95,289.76)	158.09	<i>p</i> =.000
Accuracy	51	.53	(.49,.56)	.11	<i>p</i> =.862
Error rate	51	.47	(.43,.50)	.11	<i>p</i> =.862
Peak velocity	51	196.12	(178.88,213.37)	59.37	<i>p</i> =.123
<i>Anti-Saccade Time 1</i>					
Latency	51	223.56	(215.97,231.16)	26.15	<i>p</i> =<.000
Accuracy	51	.46	(.42,.49)	.11	<i>p</i> =.551
Error rate	51	.53	(.50,.57)	.12	<i>p</i> =.573
Peak velocity	51	196.23	(178.88,213.6)	59.78	<i>p</i> =.039
<i>Pro Saccade Time 2</i>					
Latency	51	226.52	(218.05,234.99)	29.180	<i>P</i> =.017
Accuracy	51	.51	(.49,.54)	.10	<i>p</i> =.793
Error rate	51	.48	(.45,.50)	.10	<i>p</i> =.793
Peak velocity	51	194.28	(177.84,210.72)	56.63	<i>p</i> =.031
<i>Anti-Saccade Time 2</i>					
Latency	51	268.04	(210.65,235.43)	197.64	<i>P</i> =<.000
Accuracy	51	.44	(.40,.47)	.11	<i>p</i> =.735
Error rate	51	.55	(.52,.59)	.11	<i>p</i> =.735
Peak velocity	51	199.11	(179.42,218.76)	67.79	<i>p</i> =.001

The sample was not evenly distributed between the two gender groups. Ten independent t-test were ran with gender was the independent variable. The results suggest that no measure had significantly different means scores between gender groups. Gender was not a significant factor in our results.

Figure 8.

Summary of independent t-tests investigating the significant of gender within the sample

	Equality of variance assumed:	t	df	Sig	95% CI
MC	No	-.694	(56,46)	.429	(-9.8,4.2)
RSES	Yes	-.811	(56,40)	.421	(-3.6,1.4)
BAS Drive	Yes	-.893	(55,29)	.375	(-2.3,.9)
BAS Fun	Yes	1.556	(55,26)	.125	(-.3,2.19)
BAS Reward	Yes	1.104	(55,23)	.275	(-.7,2)
BIS	Yes	1.187	(55,28)	.240	(-.9,3)
K value	Yes	1.310	(44,17)	.197	(-.05,.2)
CIUS	Yes	.773	(56,39)	.443	(-3.1,7.6)
YIAS	No	.997	(56,52)	.323	(-2.4,10.1)
DT	Yes	.838	(56,44)	.405	(-1.4,3.9)

DT= Desired thinking questionnaire, MCQ- 30= metacognition questionnaire, YIAS= Young internet addiction questionnaire, RSES= Self esteem questionnaire, BAS-Drive= Behavioral approach system drive, BAS-Fun=behavioral approach systemfun, BAS-Reward= behavioral approach system reward, BIS= behavioral avoidance system, CIUS= compulsive internet use scale, DD=Delayed discounting value.

In order to test hypothesis one, randomised allocation was used to divide participants into control and experimental groups. 11 independent t-tests were ran to investigate if the groups differed on any factor. Group allocation was the independent variable. There was no significant indication that they did, expect for a small significant difference in self-esteem levels. This result supports the process of random allocation and will allow us to investigate if the intervention had a significant effect between groups.

Figure 9.

Summary of independent t-tests investigating random allocation.

	Equality of variance assumed:	t	df	Sig	95% CI
Age	Yes	.647	(56,30)	.520	(-18.14,35.46)
BAS Drive	No	-.832	(60,51)	.409	(-1.9,.79)
RSES	Yes	-2.085	(61,60)	.041	(-4.74,-.099)
BAS Fun	Yes	-.203	(60,56)	.840	(-1.15,.93)
BAS Reward	Yes	.328	(60,59)	.744	(-.89,1.24)
BIS	Yes	1.225	(60,53)	.225	(-.67,2.80)
K Value	Yes	1.742	(48,39)	.088	(-.01,.18)
CIUS	Yes	.204	(61,60)	.839	(-4.69,5.75)
YIAS	Yes	-.181	(61,53)	.857	(-7.76,6.47)
MC	Yes	.615	(60,54)	.541	(-3.42,2.04)
DT	Yes	-.503	(61,60)	.617	(-3.42,2.04)

DT= Desired thinking questionnaire, MCQ- 30= metacognition questionnaire, YIAS= internet addiction questionnaire, RSES= Self esteem questionnaire, BAS-Drive= Behavioral approach system drive, BAS-Fun=behavioral approach system fun, BAS-Reward= behavioral approach system reward, BIS= behavioral avoidance system, CIUS= compulsive internet use scale, DD=Delayed discounting value.

To further analyse eye movements during the anti-saccade task, four additional two way mixed design repeated measure ANOVA's were conducted to assess differences in saccade latency and peak velocity at baseline and time two when divided by condition for both pro and anti-saccade. Some of the data was log transformed to correct for distribution. Results are presented in table 10.

Table 10.

Summary of mixed design ANOVA for Latency and Velocity

	<i>F value</i>	<i>DF</i>	<i>P value</i>	n_p^2
<i>Pro Saccade</i>				
Pro Saccade Latency	.09	(1,47)	.772	.00
Group	.65	(1,47)	.423	.01
Pro Saccade Latency * Group	.56	(1,47)	.458	.01
Pro Saccade Peak Velocity	.020	(1,47)	.887	.00
Group	.88	(1,47)	.352	.01
Pro Saccade Peak Velocity * Group	.106	(1,47)	.746	.00
<i>Anti-Saccade</i>				
Anti Saccade Latency	4.12	(1,47)	.056	.08
Group	.27	(1,47)	.602	.00
Anti Saccade Latency * Group	.14	(1,47)	.706	.03
Anti Saccade Peak Velocity	.17	(1,47)	.685	.00
Group	.81	(1,47)	.371	.01
Anti Saccade Peak Velocity * Group	.45	(1,47)	.50	.01