Higher impulsivity after exposure to the internet for individuals with high but not low levels of self-reported problematic internet behaviors

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Abstract

The current study explored the impact of internet exposure on the impulsivity of individuals who reported higher or lower levels of problematic internet behaviors. Levels of problematic internet use in 60 individuals were measured using the Internet Addiction Test. Participants were exposed to a choice assessment, in which they could choose between a small immediately-delivered outcome (impulsive), a medium-sized outcome with a medium delay (optimal), and a larger longer-delayed outcome (self-controlled). They were given 15min access to the internet, and finally were presented with the choice test again. Of the sample, 28% (17/60) had internet-problems, with no difference being found between male and female rates of problematic internet use. Those reporting higher levels of internet-problems displayed no greater impulsive behaviours, prior to internet exposure, than those reporting fewer problems. After internet exposure, higher-problem users displayed greater impulsivity, reflected by a move from self-controlled to impulsive choices. These findings suggest that individuals reporting internet-related problems become more impulsive after exposure to the internet.

Key Words: Problematic internet use, impulsivity, choice.

1.**Introduction**

The association between behavioural and cognitive problems and excessive use of the internet is a growing concern for authorities in many countries (Dong, Huang, and Du, 2011; Niemz, Griffiths, and Banyard, 2005), and the prevalence of such problematic internet usage appears to be increasing (Byun et al., 2009; Christakis, 2010; Young, Yue, and Ying, 2011). These concerns have prompted the suggestion that a new psychiatric disorder – Internet Addiction Disorder (IAD) – should receive further study (Christakis, 2010). It has been noted that individuals who report problems associated with their internet usage also report experiencing severe problems across multiple areas of their lives, including work, social relationships, as well as with their physical and mental health (Caplan and High, 2011; Niemz et al., 2005; Shaw and Black, 2008). Such individuals also report needing to spend increasing amounts of time online to satisfy their internet-related needs (Griffiths, 2000), and display negative affect when separated from the internet (Romano, Osborne, Truzoli, and Reed, 2013). Additionally, there are a wide range of psychiatric co-morbid problems associated with problematic internet-usage, such as depression and social isolation (Bernardi and Pallanti, 2009; Kim and Haridakis, 2009), elevated psychotic and schizotypal traits (Bernardi and Pallanti, 2009; Romano et al., 2013), as well as lowered levels of inhibition and higher levels of aggression Dong et al., 2010; Ko, Hsiao, Liu, Yen, Yang, and Yen, 2010; Ko, Jen, Liu, Huang, and Yen, 2009). However, much of this evidence results from self-report studies, rather than from experimental analyses of behaviour, and, hence, the concept of IAD requires further empirical validation.

An area of particular importance and concern for many behavioural addictions is the relationship between excessive engagement in an activity and high levels of impulsive behaviour (Bechara, Tranel, and Damasio, 2000; Lawrence et al., 2009; Wetterneck et al., 2012), which has

also been suggested as a potential concern in terms of IAD (Dong et al., 2010; Yen, Cheng-Fang, Chen, Chang, Yeh, and Ko, 2012). Patterns of behaviour that can be described as 'impulsive' are associated with deficits in decision-making (Bechara et al., 2000), and predict engagement in many problematic behaviours, such as gambling or pornography usage (Lawrence et al., 2009; Wetterneck et al., 2012). As a consequence, attempts have been made to increase self-control in many groups showing clinical addiction problems (e.g., Dixon et al., 1998). Given the potential importance of impulsivity to behavioural addictions, such as IAD (e.g., Dong et al., 2010; Yen et al., 2012), a number of studies have examined associations between internet use and impulsivity. Survey-based reports indicate that high scores on the Internet Addition Test (IAT; Young, 2009), which measures life problems and disruptions associated with internet use, are associated with self-reports of greater impulsivity (Ko et al., 2010; Mottram and Fleming, 2009; Yen et al., 2012), and individuals with high self-reported internet usage also display lower levels of motor impulse control when tested experimentally (Dong et al., 2010).

It should be noted that many of the above reports rely on aggregated self-assessments of internet use and impulsive behaviour over a period of time (e.g., Yen et al., 2012), and the few experimental tests that have been conducted have been largely concerned with motor inhibition, rather than psychological inhibition (Dong et al., 2010). Moreover, it is unclear whether the high levels of impulsivity are the result of exposure to the internet or whether they predict its usage, and how impulsivity changes after exposure to the internet (although see Yen et al., 2012). Similarly, it is not known whether exposure to the internet will affect higher- and lower-level problematic-internet users in the same manner. The current study aimed to address these questions, and to provide further laboratory-based empirical exploration of the concept of an

IAD by establishing whether problematic internet usage is associated with an important problem (i.e. impulsivity) commonly seen with other behavioural addictions.

Impulsivity can be studied experimentally by presenting participants with several alternatives that pit choices between a smaller but more immediately-delivered reinforcement outcome (termed 'impulsive') against a larger but delayed reinforcement outcome (termed 'self-controlled'). Under such conditions, participants typically show greater numbers self-controlled choices (Ito and Nakamura, 1998; Reed Thompson, Osborne, and McHugh, 2011), but groups who display behavioural addictions, like gambling, tend to display more impulsive choices (Lawrence et al., 2009). It should be noted that, although 'self-controlled' behavior is typically encouraged (Dixon et al., 1998), it is not always the 'rational' behavior (i.e. the behavior that leads to the greatest or most optimal numbers of reinforcers). In fact, under some conditions, may not lead to the optimal outcomes. In fact, some studies find that humans demonstrate a bias toward self-control, rather than optimizing (Kirk & Logue, 1996; Reed et al., 2011; Sonuga-Barke, Lea, and Webley, 1989). For example, Kirk and Logue (1996) noted that adult humans tended to pick a larger, delayed reinforcer, even when this choice did not lead to the greatest overall number of reinforcing outcomes. In order to explore this issue, a three-alternative choice procedure is needed, which was previously developed by Reed et al. (2011), where one alternative reflects 'impulsivity' (small-immediate, reinforcers), one 'self-control' (large-delayed reinforcers), and a third option leads to optimal performance (a reinforcer with intermediate size and delay). Under such conditions, optimal performance could be disambiguated from both 'self-control' and 'impulsivity'.

As there has been no laboratory-based experimental study of how internet exposure impacts on changes in impulsivity. The current study aimed to employ the above behavioural

impulsivity test before and after a session of internet surfing to analyse how this internet-exposure impacts impulsive choices in those who do and do not report problematic internet behaviours.

2. **Method**

2.1 **Participants**

Sixty participants (30 males and 30 females) were recruited after responding to advertisements placed around a university campus. This number of participants has been used in previous demonstrations of internet-withdrawal symptoms (Romano et al., 2013). An online recruitment strategy was not employed, as this method may bias potential relationships in studies of internet use (see Widyanto and McMurran, 2004). All participants were students and were volunteers, and none received any form of compensation for their participation.

The participants had a mean age of 24.60 ($\pm$ 2.65, range 20 – 30) years old. The participants' self-reported ethnicity was: 42 (70%) White; 3 (5%) Mixed / Multiple Ethnic Groups; 10 (17%) Asian / Asian British; 4 (7%) Black / African / Caribbean / Black British; and 1 (1%) Other Ethnic Group. The marital status of sample was: 34 (57%) single, 5 (8%) married or in a civil partnership; 20 (33%) in other forms of relationship; and 1 (1%) divorced or widowed.

Participants were excluded if they had used the internet (broadly defined to include social networking sites, such as Facebook and Twitter, etc.) in the last four hours (including through use of their mobile phones). This procedure was adopted in an attempt to equate the length of time from last usage in lower and higher internet problem groups, and to try to maximize the impact of the current experimental exposure to be the internet, which might otherwise be trivial

in the context of daily use. Participants were also excluded if they reported a history of psychiatric problems.

Ethical approval for this research was obtained from the Department of Psychology Ethics Committee, Swansea University. The participants provided their written informed consent to participate in this study, and the Ethics Committee approved this consent procedure.

2.2 **Materials**

2.2.1 **Internet Addiction Test** (IAT; Young, 2009) is a 20-item scale covering the degree to which use of internet disrupts everyday life (work, sleep, relationships, etc.). Each item is scored on a 1-4 scale, and the overall score ranges from 20 to 100. The factor structure of the IAT is currently debated (cf. Chang and Man Law, 2008; Widyanto and McMurran, 2004), but a cut-off score of 40 or more for the total score of the IAT is taken as representing some level of problematic internet usage (Hardie and Tee, 2007; Romano et al., 2013; Young, 2009). The internal reliability of the scale has been found to be between .90 (Widyanto and McMurran, 2004) and .93 (Young, 2009).

2.2.2 **Choice Test:** The choice test (Reed et al., 2011) involved a computer task which presented the participant with three 3x3cm coloured squares (red, yellow, green) on the screen. The squares presented in a row, centrally on the screen, 10cm from the top of the screen, and separated from each other by 1cm. If clicked by the mouse, each colour was associated with the delivery of a particular number of points (10, 25, or 60), which remained constant throughout the experiment. When a square was clicked, all squares disappeared, and, after a delay, the words:

"*You have scored x points*" would appear in the centre of the screen, in 3cm high black letters, 15cm from the top of the screen. Each square was associated with a particular delay until the information was presented; the 10 point square was associated with a 5s delay, the 25 point square with a 10s delay, and the 60 point square with a 30s delay. Every 5s the words: "*You have X seconds left*" would appear in the bottom left of the screen, and remained visible for 1s. This counted down the time left in the study.

2.3 **Procedure**

The participants were tested individually in a room containing a desk, chair, and computer. All participants were presented with the choice task via the computer. They were given the following instructions:

"*In this study, your aim is to score as many points as you can. You do this by choosing one of the three colours displayed on the screen by clicking on it with the mouse. When you have clicked on the colour, the colours will disappear, and the number of points earned will be displayed. When you have seen the number of points that you have scored, the colours will reappear, and you can choose one again. This process will continue for the entire testing session, lasting for the number of seconds displayed on the screen.*"

This three-option choice test involved the presentation of a series of 'trials', in which the participant used the mouse to click one of three squares displayed on the screen (red, blue, or green). Each response led to the addition of a number of points to a total displayed on the screen. One choice resulted in 10 points, another in 25 points, and the remaining option resulted in 60 points. For a particular participant, the same points were always associated with the same colour square (but this colour association differed across participants). The 10-points square had

a 5s delay attached to receiving the points, the 25-points square had a 10s delay, and the 60-points square had a 30s delay. During the delay, the squares disappeared from the screen. The test session lasted for 15 min. This value was chosen on the basis of previous experimental studies of the impact of internet exposure (see Romano et al., 2013).

This particular selection of points and delays meant that exclusive impulsive (10 points), or self-controlled (60 points), responses would result in the same overall gain as one another (1,800 points); but exclusive optimal responses (25 points) would result in a greater overall amount of reinforcement (2,250 points).

After completing the choice test, the experimenter left the room, and the participants were allowed free access to the internet through the computer in the room for 15min. They were told that they could visit any websites that they wished to during this time. The websites that were visited during this period were recorded. Of the websites visited, 65% were social media (Facebook, twitter), 15% were e-mail, 10% were news/sports, and 10% were shopping. After 15min, participants were asked to complete the choice test again, with the same association between the various stimuli and outcomes as they had experienced prior to exposure to the internet. Finally, they were asked to complete the IAT (Young, 2009), which assessed for the extent to which their internet use disrupts their everyday life.

3. **Results**

The mean IAT score for the sample was 28.30 ($\pm$ 16.06, range 5–63); with males having a mean IAT score of 28.67 ($\pm$ 17.05, range 5–63), and females having a mean IAT score of 27.93 ($\pm$ 15.30, range 5–57). An independent group t-test revealed that males and females did not differ significantly from one another in terms of their IAT scores, $t < 1$. The proportion of the

sample that could be classified as having IAD, using the IAT cut-off score of 40 or more, revealed that 17 participants displayed IAD (see Figure 1)

Figure 1

Based on the IAT cut-off score of 40, the participants were divided into lower-level internet problems (N = 43, 22 male, 21 female; IAT = 20.00 $\pm$ 9.64, range = 5–38), and higher-level internet problems (N = 17, 8 male, 9 female; IAT = 49.29 $\pm$ 7.36, range = 40–63).

Figure 2

The percentage choice for the three alternatives ('impulsive', 'optimal', or 'self-controlled') over the last 5min of exposure to the initial (pre-internet exposure) choice test are shown in Figure 2, for both the groups with lower- and higher-levels of internet problems. The last 5min only was chosen for analyses, as this allowed analysis of choices after participants had the chance to learn about the potential outcomes from their choices. Inspection of these data shows little difference between the two groups, with the majority of choices being for either the 'optimal' or 'self-controlled' options.

A two-factor mixed-model analysis of variance (ANOVA), with group (lower- versus higher-level problems) as a between-subject factor, and stimulus choice (impulsive, optimal, self-controlled) as a within-subject factor, was conducted on the numbers of choices made for

each alternative. This revealed no statistically significant main effect of group, $F(1,58)=2.48$, $p>.10$, *partial eta*^{2}=.041, and no statistically significant interaction between group and stimulus, $F<1$, *partial eta*^{2}=.002, but there was a statistically significant main effect of stimulus choice, $F(2,116)=17.10$, $p<0.001$, *partial eta*^{2}=.228.

The mean number of websites visited during the 15min period by the participants was 2.81 (± .93, range 1 – 5) for the lower-problems, and 2.77 (± 1.56, range 1 – 8) for the higher-problems. A t-test revealed no statistically significant difference between the groups, $t<1$. The nature of the sites visited were categorised, and the percentage of these sites were highly similar across the two groups: lower-problems = 31% (37) social network; 21% (25) e-mail; 18% (22) games; 15% (18) news and sport; 11% (13) information seeking; 4% (5) shopping; and 1% (1) banking sites; and higher-problems = 30% (14) social network; 26% (12) e-mail; 26% (12) games; 11% (5) news and sport; 6% (3) information; 2% (1) shopping; and 0% (0) banking sites. A chi-squared test conducted on the numbers of site visited revealed no statistically significant difference between the groups, chi-squared < 1.

Figure 3

Figure 3 shows the change in the percentage choices for the three alternatives after internet exposure (post exposure minus pre exposure) in the lower-level and higher-level internet problem groups. Those with lower-level problems showed little change in their choices, with any movement being toward less ‘impulsive’ and more ‘self-controlled’ choices. However, the opposite pattern of results was seen in those with higher-level problems, with a pronounced drop in ‘self-controlled’ choices, and an increase in ‘impulsive’ choices.

A two-factor mixed-model ANOVA (group x stimulus) conducted on the change in the actual number of choices made for each alternative, revealed no statistically significant main effects of group, $F<1$, *partial eta*^{2}=.007, nor stimulus, $F(2,116)=2.53$, $p>.08$, *partial eta*^{2}= .042. However, there was a statistically significant interaction between group and stimulus, $F(2,116)=3.82$, $p<.05$, *partial eta*^{2}= .176. Simple effect analyses revealed that, for the lower-level problems, there was a no statistically significant difference in the change scores, $F<1$, *partial eta*^{2}= 0.003. For the higher-level problems, there was a significant change for choices of the three stimuli, $F(2,32)=3.43$, $p<.01$, *partial eta*^{2}= .154. Analysis of the changes showed a significant increase in 'impulsive' choices, $t(16)=2.46$, $p<.05$, no change in 'optimal' choices, $t<1$, and a significant decrease in 'self-controlled' choices, $t(16)=2.19$, $p<.05$.

4. **Discussion**

The current study provided experimental documentation of the immediate impact of internet exposure on the behavioural impulsivity of individuals who report higher levels of problematic internet use and who have recently exposed to the internet. Impulsivity has been linked to many behavioural addictions, such as gambling and pornography (Lawrence et al., 2009; Wetterneck et al., 2012). The present data showed that internet exposure differentially impacted those with higher IAT scores: increasing their likelihood of making 'impulsive choices', and reducing their 'self-controlled' choices. These are the first data to show, experimentally, changes in choice behaviour as a result of exposure to the internet in those with potential internet-related problems, and they are the first to show this change behaviourally, as opposed to relying on correlational self-report data.

The reason for the increase in impulsive choices in individuals with higher- but not lower-levels of internet-related problems is unclear. However, one possibility is provided by the literature on from learning theory, which may have some relevance in the context of internet exposure. Rats who have been exposed to a highly variable reinforcement context show a pronounced tendency to shift toward impulsive choices in choice tests such as the ones employed here, relative to rats who have been exposed to a less variable reinforcement contingency (Mazur, 2012). It may be that the internet offers more such variability in outcomes, making those who spend more time in that environment more likely to display impulsive choices, which are triggered by exposure to that environment. This is admittedly speculative, but provides a potential suggestion for further exploration. It is also the case that factors such as induced attention bias, and cue-induced craving, may impact on the development of impulsivity after exposure to the object of the addiction. However, it is difficult to see how they would explain the current impact on a test not using any computer-related cues to which attention could be drawn.

The key finding that exposure to the internet induced those with higher levels of problematic internet use to display greater levels of impulsivity, not only establishes a link between IAD and other behavioural addictions, but also has further implications for understanding the potential subsequent development of IAD-related behaviours as a clinical phenomenon. The behavioural acts that are encompassed by IAD, such as increasing amounts of exposure to the internet over time (Griffiths, 2000), may serve to increase the likelihood of further impulsive behaviours. These impulsive behaviours have been shown to predict further internet usage (Bernardi and Pallanti, 2009; Dong et al., 2010; Romano et al., 2013), which may produce a circle of addiction to the internet.. In addition, as noted above, impulsive behaviours

are also associated with engagement in other problem behaviours, such as gambling and pornography (Lawrence et al., 2009; Wetterneck et al., 2012).

Correlational associations between problematic internet use and psychometrically-measured impulsivity have been shown previously (Ko et al., 2009; Ko et al., 2010; Mottram and Fleming, 2009), as have correlations between internet-use and psychometrically-measured aggression (Ko et al., 2009; Ko et al., 2010) and psychoticism (Romano et al., 2013), which are both associated with impulsivity. However, the findings derived from the current behavioural test of impulsivity/self-control, suggest little difference between those with lower- and higher levels of problematic internet use prior to their engagement in internet activities. In this regard, the previously noted associations between self-reported impulsivity and IAT scores (Ko et al., 2009; Ko et al., 2010; Yen et al., 2012) differ from the current finding that, prior to internet exposure, and following a period of internet abstinence, there was little difference in impulsivity between those with lower- and higher levels of internet addiction test scores. Of course, this difference may well reflect differences between the behavioural test used in the current study, and the previously employed aggregate self-report measures of impulsivity (e.g., Yen et al., 2012). Although procedural differences certainly may explain these differences in this particular outcome, it may also be that many of the previous self-report studies do not differentiate between pre- and post-internet usage levels of impulsivity. It may be noted that the current pre-internet-exposure choice data are, in fact, consistent with previous investigations of choice patterns using this paradigm: participants tend not to emit many 'impulsive' choices, but deviate away from 'optimal' toward 'self-controlled' choices (Ito and Nakamura, 1998; Reed et al., 2011).

Although not a prevalence study, the current data suggest that the percentage of IAD in the current sample was broadly with several previous studies (Christakis, 2010; Park, Kim, and

Cho, 2008; Villella et al., 2010). However, it has previously been suggested that males will display higher levels of IAD than females (Johansson and Götestam, 2004), which was not noted in this report. This difference may reflect the relatively younger age of the sample employed in this study, as well as the rapidly changing nature of internet usage.

There are, of course, a number of limitations and caveats that should be mentioned regarding these findings. Firstly, these data are based on a laboratory study that was conducted over a short period of time. Further investigation of the impulsivity and IAT association will need to be conducted over time, although a longitudinal approach mitigates against a laboratory-controlled study. The length of the internet exposure (15min was not very long, and this factor could be further explored. However, it should be noted that the changing nature of internet access (i.e. via mobile devices rather than desktop machines) may make it likely that individual internet sessions, often engaged upon on the move, are now shorter than those experienced previously. Secondly, it may be that the types of website visited during the internet exposure in the current experiment were not completely representative of the type of website normally visited by the participants. The impact of the types of website chosen outside of the laboratory setting on participants' impulsivity will need to be explored. It should be noted that the differential impact of the internet on behaviour in the current study was not as a result of differences in the internet content visited during the exposure – both groups visited highly similar sites during this period. Nevertheless, this is a further issue that should be examined, although getting people who may be viewing socially-unacceptable material to report, or allow to be measured, this behaviour, may present a barrier to such research. Thirdly, the number (which was relatively small), and type (students), of participants in the current study might also be considered as producing a limitation on the degree to which the results can be generalised to the

population s a whole. A further larger-scale study using a wider range of internet users might be warranted to check the degree to which these results generalise.

In summary, these findings suggest that individuals reporting internet-related problems become more impulsive after exposure to the internet. This finding mirrors previous work conducted in terms of other behavioural problems, giving further validation to the construct of IAD, and suggesting that these individuals may be at greater risk of engaging in other problem behaviours associated with impulsive choices (gambling and pornography) after exposure to the net.

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Figure Captions

Figure 1. Percentage of participants defined as having Internet Addiction Disorder (IAD) as identified by the Internet Addiction test (IAT) cut-off of 40 or more – the inset show the percentage of males and females exhibiting IAD.

Figure 2. Mean percentage choice for the impulsive (10 point 5s delay), optimal (25 point, 10s delay), or self-controlled (60 point, 30s delay), option, for the lower-level and higher-level internet-user groups, prior to internet exposure (error bars are 95% confidence intervals).

Figure 3. Mean change in percentage choices for the impulsive (10 point 5s delay), optimal (25 point, 10s delay), or self-controlled (60 point, 30s delay) option for both the lower-level and higher-level internet user groups following internet exposure (error bars are 95% confidence intervals).

Figure 1

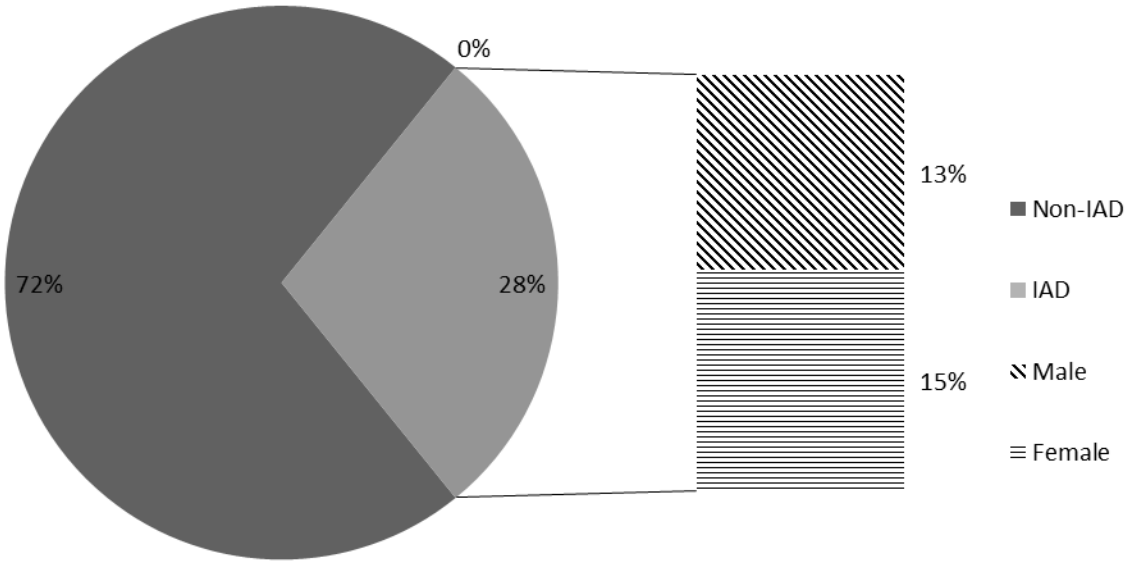


Figure 2

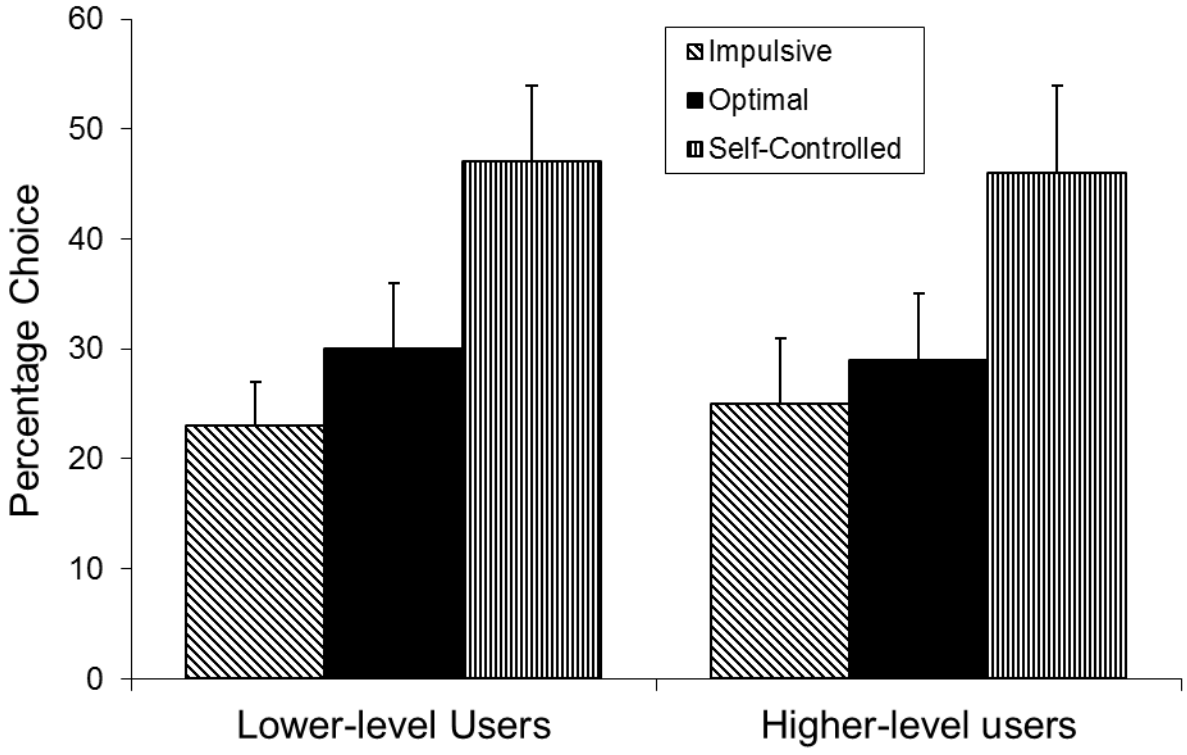
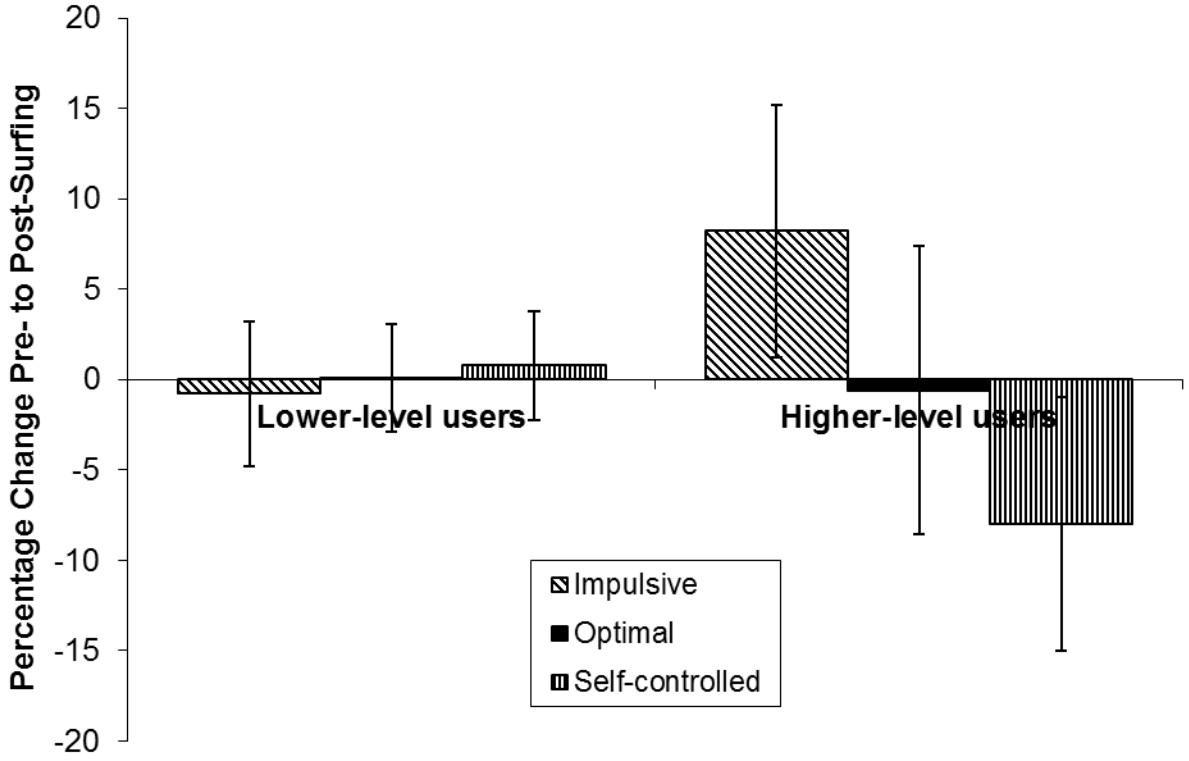

60
50
40
30
20
10
0
Percentage Choice
Impulsive
Optimal
Self-Controlled
Lower-level Users
Higher-level users

Figure 3


20
15
10
5
0
-5
-10
-15
-20
Percentage Change Pre- to Post-Surfing
Lower-level users
Higher-level users
Impulsive
Optimal
Self-controlled