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Problematic Internet Use, is it time to be taken seriously? Physiological and behavioural markers of Problematic Internet Use with reference to established addictions

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Problematic Internet Use, is it time to be taken seriously? Physiological and behavioural markers of Problematic Internet Use with reference to established addictions

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Declaration

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Abstract

The main aim of this thesis was to investigate a controversial type of problematic behaviour; problematic internet use, and assess whether or not its characteristics resemble traditional types of addictions such as substance dependence and pathological gambling. Problematic internet use is a construct which has created fierce debates amongst researchers. This reflects inconsistencies in the evidence associated with various factors related to it, which have left researchers arguing whether it is a real psychopathological entity and similar to substance-related and addictive disorders or not. This necessitates further research with an emphasis on identifying similarities and differences regarding problematic internet use in relation to markers that have been reliably associated with the development and maintenance of addictive behaviours. Thus, in this thesis I followed a pragmatic approach and comprehensively investigated behavioural and physiological markers of addictive behaviours in the field of problematic internet use. More specifically, emphasis was given to cognitive markers such as decision-making and the physiological function underling them, attentional bias and inhibitory control processes, as these have been implicated as playing a major role in the initiation and maintenance of addictive behaviour. The main research questions were investigated using a sample of internet users whose internet use ranged from non-problematic to problematic and was associated either with generic or specific online applications; Social Networking Sites (SNS). Overall the results of this thesis support the view that problematic internet use resembles substance-related and addictive disorders and offers important implications for its legitimacy.

List of Abbreviations

AEQ	Addition-Engagement Questionnaire
APA	America Psychological Association
BIS-11	Barratt Impulsiveness Scale-11
BSI-53	Brief Symptom Inventory-53
C	Disinhibition
Cm	Centimeters
d'	Discrimination
DSM-5	Diagnostic and Statistical Manual of Mental Disorders (Version 5)
DSM-IV-TR	Diagnostic and Statistical Manual of Mental Disorders (Version IV-TR)
ERP	Event Related Potentionals
fMRI	Functional Magnetic Resonance Imaging
GMD	Gray Matter Density
GPIUS	Generalized Problematic Internet Use Scale
HE	High Engagers Internet Users
HESU	High Engagers Social Networking Users
HOSC	Healthy Online Self-Helping Centre
Hz	Hertz
IAPS	International Affective Picture System
IAST	Internet Addiction Scale for Taiwanese
IAT	Internet Addition Test
IGT	Iowa Gambling Task
IRABI	Internet-related Addictive Behaviour Inventory
MFN	Medial Frontal Negativity
MIU	Moderate Internet Use
MMORPG	Massively Multiplayer Online Role-Playing Games
Ms	Millisecond
MSU	Moderate Social Networking Use
NIDA	National Institute of Drug Abuse
NPIU	Non-Problematic Internet Use
NPSU	Non-Problematic Social Networking Use
OCD	Obsessive Compulsive Disorder
OCS	Online Cognitive Scale
PIU	Problematic Internet Use Questionnaire
PIUQ	Problematic Internet Use Questionnaire
PIUS	Pathological Internet Use Scale
QIUU	Questionnaire on internet use urges
ReHo	Regional homogeneity
RT	Reaction Time

SCR	Skin Conductance Response
SD	Standard Deviation
SMH	Somatic Marker Hypothesis
SNS	Social Networking Sites
US	United States
VBM	VBoxel-based morphometry
VMPFC	Ventromedial prefrontal cortex
WWW	World Wide Website
µs	MicroSiemens

Chapter One - *General Introduction*

1.1 Introduction

The internet is defined as "a global computer network providing a variety of information and communication facilities, consisting of interconnected networks using standardized communication protocols" (Oxford Dictionaries, 2014). Latest figures suggest that there is an increase of 21 million more people using the internet in 2014 than in 2006 (Office for National Statistics, 2014). The activities which internet users spent their time on include: social networking, wikis, downloading software, telephone or video calls via webcams, sending emails, finding information about goods and services and online banking (Office for National Statistics, 2014). Even though the internet is a powerful tool for performing various everyday activities with ease and flexibility, there is increasing concern that some internet users can lose control over their internet use and, as a consequence, experience various negative outcomes in their lives (Caplan, 2007; Cheung & Wong, 2011; Tsai et al. 2009; Xiuqin et al. 2010; Yen et al., 2008).

This type of behaviour, which is characterized by continuation of internet usage despite the rise of negative repercussions in a user's life, has been termed "internet addiction" (Griffiths, 2000; Young, 1996, 1998a, 1999). The term addiction has been employed to denote the observable similarities in symptomatology and phenomenology between this maladaptive behaviour and substance-related and addictive disorders. However, this term has not been consistently applied. Researchers have deployed various definitions, descriptions and assessments, which have created confusion as to whether they are communicating about the same behaviour (Chang & Man Law, 2008; Charlton, 2002; Charlton & Danforth, 2007, 2010; Chow, Leung, Ng, & Yu, 2008; Davis, 2001; Demetrovics, Szeredi, & Rózsa, 2008; Morahan-Martin, 2005; Morahan-Martin & Schumacker, 2000; Shapira, Goldsmith, Keck, Khosla, & McElroy, 2000; Young, 1996, 1998a, 1999). Additionally, even though a plethora of studies have been devoted to identifying those factors which are associated with problematic internet use, there is a lacuna with respect to studies assessing causality between them (Aboujaoude, 2010; Bernardi &

Pallanti, 2009; Cao, Su, Liu, & Gao, 2007; Caplan, 2007; Cheung & Wong, 2011; Dong, Lu, Zhou, & Zhao, 2011; Jang, Hwamg, & Choi, 2008; Kelleci & Inal, 2010; Kormas, Critselis, Janikian, Kafetzis, & Tsitsika, 2011; Montag, Jurkiewicz, & Reuter, 2010; Mythily, Qiu, & Winslow, 2008; Stieger & Burger, 2010; Tsitsika et al., 2011; Weinstein & Lejoyeux et al., 2010; Yen, Ko, Yen, Chen, & Chen, 2009; Yeon, 2009; Zboralski et al., 2009). This has led to the suggestion that the concept of "internet addiction" is at fault as some argue that the internet is just a medium used to satisfy or fulfil other underlying disorders (Pies, 2009; Stern, 1999). Adding to the debate researchers have questioned whether or not the internet per se is a source of addiction or whether it is the applications of the internet that people become addicted to (Griffiths, 1999, 2010; Shaffer, Hall, & Vander Bilt, 2000; Yellowless & Marks, 2007; Young, 1999). Thus, reflecting these inconsistencies, the Diagnostic and Statistical Manual of Mental Disorders: DSM-5 (American Psychiatric Association, 2013) does not include this type of behaviour as a distinct disorder. However, it does include one of its proposed subtypes that of online gaming under Section III in order to promote further research associated with this specific type of online behaviour. This thesis provides evidence pertaining to the debate of whether or not this type of problematic behaviour is a real psychopathological disorder and similar to substance-related and addictive disorders. However, in order to illustrate the contribution of my thesis it is necessary to give an extensive overview of the research conducted in the field so far.

1.2 Terminology and definitions related to problematic internet use

The various terminologies which have been employed to describe this type of problematic behaviour include: internet addiction, internet dependency, compulsive internet use, internet abuse, problematic internet use and pathological internet use (Caplan, 2002; Davis, 2001; Hall & Parson, 2001; Morahan-Martin & Schumacher, 2000; Scherer, 1997; Shapira et al., 2003; Young, 1998b). Considering the debate as to whether or not the term addiction should only be used to describe behaviours involving ingestion of chemical substances (Chou, Condron, & Belland, 2005) in this thesis the term *problematic internet use* has been used to describe a set of maladaptive behaviours which are associated with internet use. This term is descriptive of the definition employed in this thesis but at the same time, is free from any bias.

Even though there is currently no standardised definition for problematic internet use, many researchers have derived their definitions based on the criteria applied to pathological gambling and substance dependence disorders, DSM-IV-TR (American Psychiatric Association, 2000), due to the similarities in symptomatology and phenomenology between them (Chow et al., 2008; Christakis, 2010; Griffiths, 2000; Young, 1996, 1998a). Drawing on this, problematic internet use has been conceived as a behaviour which fulfils the core criteria for pathological gambling and substance dependence disorders which have been applied to internet use, DSM-IV-TR (American Psychiatric Association, 2000). These criteria have been consistently applied in the field. Although some modifications and adaptations (Charlton, 2002; Charlton & Danforth, 2007, 2010; Griffiths, 1996, 2000, 2005; Young, 1998a) have been made most of them cover Brown's (1991, 1993) proposed criteria for behavioural addictions which are:

1. Salience (the activity in question dominates the individual's life).
2. Euphoria (the feeling of a "buzz" or "high" from the activity).
3. Tolerance (the need to spend more time on the activity in order to get the same "buzz" as when initially engaged with the activity).
4. Withdrawal symptoms (the feeling of negative emotions or physical symptoms when the activity is halted).
5. Conflict (the activity leads to conflict with significant people around the individual or self-conflict).
6. Relapse and reinstatement (the activity is continued with just the same vigour subsequent to attempts to abstain).

Based on these criteria researchers have broadly defined problematic internet use as a set of behaviours including; constant preoccupation with the activity, repeated unsuccessful attempts to control internet use, changes in mood (irritability, anxiety etc.) related with any effort expended when trying to control or reduce it, use of the internet for a greater amount of time than was intended, as well as various negative outcomes due to internet use in the user's life such as those associated with employment, relationships, education, health etc. (Chow et al., 2008; Christakis, 2010; Young, 1996, 1998b). Other scholars have defined it in a similar way but the emphasis has been given to the requirements that excessive internet use does not occur exclusively during periods of hypomania or mania and is not better accounted for by Axis I disorders (Shapira et al., 2000). Moreover, Beard (2005) has given a more holistic definition and argued that a person has problematic internet use when the individual's psychological states, which include both mental and emotional ones as well as scholastic, occupational and social interactions, are impaired by the overuse of the medium. In this thesis, similar to Beard's definition, the emphasis was put on the criteria associated with negative outcomes in the person's life. This position reflects the DSM-5 definition of a mental health disorder: "A mental disorder is a syndrome characterized by clinically significant disturbance in an individual's cognition, emotion regulation, or behavior that reflects a dysfunction in the psychological, biological, or developmental processes underlying mental functioning. Mental disorders are usually associated with significant distress in social, occupational, or other important activities. An expectable or culturally approved response to a common stressor or loss, such as the death of a loved one, is not a mental disorder. Socially deviant behavior (e.g. political, religious, or sexual) and conflicts that are primarily between the individual and society are not mental disorders unless the deviance or conflict results from a dysfunction in the individual, as described above." (DSM-5, 2013). According to the DSM-5 definition, the significance of the negative outcomes is the factor which makes the behaviour significantly interesting. Thus, in this thesis problematic internet use has been defined as being a broad term which includes all the aforementioned criteria and emphasis is given to the significant harmful outcomes resulting from excessive internet use:

"A set of maladaptive behaviours and cognitions which are associated with excessive internet use and result in significant negative repercussions in the person's life and which are not covered by any Axis I disorders".

Another pitfall is this arena is the way researchers use the term problematic internet use interchangeably to describe behaviours which are associated with computer usage, gaming and social networking etc. This has created confusion as to whether all these types of activities are associated with a similar set of behaviours. It has been suggested by Young

(1999) that people are not becoming addicted to the internet per se but to its applications. She proposed that problematic internet use consists of different subtypes which are related to certain sets of online activities; cybersex, cyber-relationships, online stock trading or gambling, information surfing, as well as computer gaming. However, there is currently limited evidence assessing the characteristics of each proposed subtype and as a consequence, there is limited understanding of the similarities and differences which might exist between them. An exception is online gaming which has received extensive attention predominately because of the increased awareness of its addictive potential, especially in younger children and adolescents (Essig, 2012; Huang et al., 2010; Kuss & Griffiths, 2012; Li, Garland, & Howard, 2014; Shek, Tang, & Lo, 2008; Thatcher, Wretschko, & Fridjhon, 2008; Tone, Zhao, & Yan, 2014; Wang et al., 2011). Nevertheless, the majority of studies in the field use the terminology of problematic internet use without clarifying whether the set of behaviours examined are specific patterns associated with each proposed subtype. In order to validate the assumption that subtypes of problematic internet use exist, there is a need to directly assess not only overt phenomenological and symptomatic similarities between them, but also similarities and differences in other domains. This could impact upon our understanding as to whether or not they conform to a uniform set of behaviours and as a consequence, provide better insight into problematic internet use as a whole (Pawlikowski, Nader, Burger, Stieger, & Brand, 2014; Starcevic, 2013). For example, it has been found that factors such as shyness and life satisfaction were predictors regarding problematic internet gaming use whereas they were not for pornographic or generic problematic internet use (Pawlikowski et al., 2014). This suggests that the motives associated with each potential subtype of problematic internet use are different. Additionally, personality traits such as neuroticism were reported as predictive risk factors for problematic online shopping, the construct of openness was a risk factor for problematic online gaming whereas and neuroticism and low agreeableness predictive risk factors for problematic social networking (Kuss, Griffiths, & Binder, 2013). This evidence indicates that engagement with different online activities might be associated with different underlying risk factors. Similarly, research has revealed that problematic online gamers, for example, have enhanced cognitive function abilities such as attentional processing and inhibitory control, which have been associated with gaming training (Aguilera & Mendiz, 2003; Boot, Kramer, Simons, Febiani, & Gratton, 2008; Green & Bavelier, 2008). On the other hand, some evidence suggests that problematic internet users have impaired inhibitory control (Billieux & Van der Linden, 2012; Cao et al., 2007; Choi et al., 2014; Dong, Deviti, Du; & Cui, 2012; Dong, Zhou, &

Zhao, 2010, 2011; Kim, Namkoong, & Ku, 2008; Lee et al., 2012; Mottram & Fleming, 2009; Yau, Potenza, & White, 2013; Zhou, Yuan, Yao, Li, & Cheng, 2010). In light of this, impaired inhibitory control might be a risk factor associated with the development of problematic internet use whereas the same might not apply for online gaming. Similar to the above argument and referring to research in the field of addictions, it can be argued that even though there is uniformity regarding symptoms between individuals with substance misuse dependence, there are also differences between them. For example, a person who abuses heroin has characteristics distinct from a person who abuses alcohol or amphetamine such as differences in withdrawal symptoms and impairments in various cognitive areas (Barclay et al., 2008; Ornstein et al., 2000). These differences are reflected in the variety of intervention strategies adopted for each type of substance dependence in order to meet the specific requirements adequately (NIDA, 2014). Thus, further research is required in order to identify differences and similarities between these potential subtypes of problematic internet use in order to better understand the exact mechanisms associated with them which in turn will be informative for shaping intervention strategies.

Young (1999) suggested that activities such as cybersex, gambling and gaming constitute different expressions of problematic internet use. However, these activities can also be executed in the offline environment. This has brought into question the validity of the construct of problematic internet use and subsequently, some researchers have debated whether this type of behaviour is the outcome of another disorder (Acier & Kern, 2011; King & Delfabbro, 2013; Ross, Mansson, & Daneback, 2012). For example, it can be argued that a person with a gambling problem uses the internet because it is a convenient medium through which to pursue his/her gambling activities (Harris, Mazmanian, & Jamieson, 2013). Even though this assumption does not necessarily diminish the substantial evidence regarding online gaming, it does nevertheless highlight the need for further research with the emphasis given to those subtypes that entail activities such as social networking, which can only be carried out in the online environment.

1.3 Assessments related to problematic internet use

Assessing problematic internet use is an area subject to systematic criticisms as there are inconsistencies in the criteria, scales, cut-off points, populations assessed and methods employed to differentiate between problematic and non-problematic behaviour (Byun et al., 2009; Chou et al., 2005). In order to address these inconsistencies and provide in depth understanding of the nature of the phenomenon, researchers have employed qualitative and clinical interview methodologies. Interviews can give a thorough assessment of the different factors associated with this type of problematic behaviour and identify co-morbidity with other psychopathological conditions, which might be suggestive of commonalities between them. This type of assessment allows for a more systemic approach that incorporates areas in users' lives which might be affected and might be worthy of further evaluation (Beard, 2005; Bowen & Firestone, 2011; Chou, 2001; Douglas et al., 2008; Griffiths, 2000; Shapira et al., 2000; Solmaz, Belli, & Saygili, 2011; Stavogianis & de Abreu, 2009). Although qualitative methodologies have enriched our understanding of problematic internet use, they are not the preferred medium for assessing patterns of internet use. Another approach employed in this area is self-report assessment. Although this type of assessments lack the advantages of qualitative ones they are frequently used because they offer a quick, cheap and easy way for assessing patterns of internet use. This is the reason for why researchers in the field have used them as the most common medium. Below some of the most commonly deployed questionnaires are described along with their advantages and disadvantages.

Young (1996) was one of the first who developed a scale to assess problematic internet use by creating an eight-item questionnaire: Young's Diagnostic Questionnaire (YDQ). For this, participants were given a choice of yes/no answers and a minimum of five positive answers were required to identify a person as a problematic internet user. This questionnaire assessed a user's preoccupation with the internet, the amount of time spent on it and the effects of the internet on his/her life. Later, Young (1998a) developed it further and incorporated new symptoms and areas to make it into one of the most used and validated questionnaires established in the field to date: the Internet Addiction Test (IAT). This version consists of a 20-item questionnaire with each gauged on a 5-point Likert scale. The IAT assesses the degree of behavioural problems, level of preoccupation, emotional changes, compulsive use and general functioning in relation to internet use (Kelley & Gruber, 2010). Young (1998a) suggested three cut-off points based on the total scores: 1) between 20 and 49 shows average use, 2) between 50 and 79 moderate use and 3) between 80 and 100 problematic use. Nevertheless, many studies have used arbitrary cut-off points of 70 > or 50 > to distinguish between problematic and non-problematic internet use (Villella et al., 2011; Wang et al., 2011; Weinstein & Lejoyenx, 2010; Widyanto & McMurran, 2004). The IAT is not only the most widely used assessment tool but also has been employed extensively in studies examining the relationship between problematic internet use and other types of addictions, psychiatric co-morbidity and in general, to assess the factors associated with this type of problematic behaviour (Chang & Man Law, 2008). Research focusing on the different dimensions of the IAT has identified three factors: withdrawal and social problems, time management and performance and reality substitution (Chang & Man Law, 2008). Chang and Man Law argued that assessing the different dimensions of the scale can provide a better understanding of the different areas affected in an individual's life. This awareness can have a positive impact upon producing specialized treatments for targeting the areas of life which are most affected. However, the outcomes of probing the dimensionality of the scale have not been consistent. Some studies have identified six factors relating to the IAT: salience, excessive use, neglecting work, anticipation, lack of control, and neglecting social life, (Widyanto & McMurran, 2004) while others have reported one, two or five factors (Khazaal et al., 2008; Panayides & Walker, 2012; Pawlikowski, Altstötter-Gleich, & Brand, 2013; Watters, Keefer, Kloosterman, Summerfeldt, & Parker, 2013). It has been argued that these inconsistencies reflect differences in the research methods employed between studies as well as the differences in the population being assessed in each study (i.e. in terms of demographic and cultural backgrounds). Nevertheless, the three factor model proposed by Chang and Man Law has been validated by other studies conducted in the area which have combined Explanatory and Confirmatory Factor Analysis (Lai et al., 2013).

Furthermore, Demetrovics et al. (2008) drew on the IAT to develop an 18-item Problematic Internet Use Questionnaire (PIUQ) in order to accommodate new symptoms. It was proposed that these symptoms were associated with problematic internet use but were not assessed under the IAT. The PIUQ gauges several problem areas related to internet use (Kelley & Gruber, 2010) and consists of three factors: obsession, neglect and control disorder, all of which have been reliably validated with research conducted to assess the PIUQ'S psychometric properties (Kelley & Gruber, 2010; Koronczai et al., 2011). It was concluded that the PIUQ is a valid and reliable scale for the assessment of the problematic nature of an individual's internet use. Even though the PIUQ can be viewed as an improved version of the IAT it does, nevertheless, warrants further investigation in order to validate this claim for one of the criticisms of this questionnaire is the lack of defined cut-off points that differentiate between problematic and non-problematic internet use.

Given the inconsistencies in the field, it is not surprising that there are many other questionnaires which have been developed in an attempt to assess the various facets of problematic internet use. For example, there are scales such as the Internet-related Addictive Behaviour Inventory (IRABI) developed by Brenner (1997) and Morahan-Martin and Schumacker's (2000) Pathological Internet Use Scale (PIUS) which measures the effect of internet use with respect to academic achievement, interpersonal relationships, stress level, social withdrawal and mood alteration. The Online Cognitive Scale (OCS) was developed based on the assumption that the key development factors underlying problematic internet use include procrastination, impulsivity and social rejection (Davis, 2001). Caplan's (2002) seven factor Generalized Problematic Internet Use Scale (GPIUS), the five factor Internet Addiction Scale for Taiwanese high school students (IAST, Lin & Tsai, 2002), the three factor Problematic Internet Usage Questionnaire (PIUQ, Thatcher & Goolam, 2005) and the Problematic Internet Usage Scale (PIUS, Ceyhan, Ceyhan, & Gürcan, 2007) are some examples that demonstrate the various means employed to assess problematic internet use. However, with a few exceptions, such as the IAT and PIUQ (Chang & Man Law, 2008; Jelenchick, Becker, & Moreno, 2012; Kelley & Gruber, 2010; Koronczai et al., 2011; Lai et al., 2013; Lam, Peng, Mai, & Jing, 2009; Siomos, Dafouli, Braimiotis, Mouzas, & Angelopoulos, 2008; Tsimtsiou et al., 2014; Widyanto, Griffiths, & Brunsden, 2011; Widyanto, Griffiths, Brunsden, & McMurran, 2007), most of the aforementioned questionnaires have received limited validation (see Lortie & Guitton, 2013).

Another criticism related to the aforementioned questionnaires was raised by Charlton (2002) who argued that Brown's (1991, 1993) behavioural addiction criteria, which are included in most of the questionnaires, are not a unitary set of criteria when applied in areas such as computing addiction. This has cast doubt on the validity of the questionnaires used in the field. More specifically, according to Charlton (2002) these criteria capture an addiction as well as the factor of high engagement. He suggested that researchers should distinguish between these two because otherwise, there is the risk of mistakenly overestimating the severity of the problem. Charlton's argument developed from the observation that some individuals, even though they spent a lot of time on computer activities during their lives, do not suffer negative consequences. Thus, he proposed that it is the negative consequences of the addictive behaviour which differentiates it from a high level of engagement. He also noted that inconsistencies in the literature are due to the failure of researchers to make this distinction. Consequently, through a series of studies, this scholar developed the Addiction and Engagement Questionnaire (AEQ) which consists of a 24-item questionnaire with a 7-point Likert scale (Charlton, 2002; Charlton & Danforth, 2007; 2010). The AEQ consists of two factors, Addiction and Engagement. The former, addition, is covered in 12 items, seven of which relate to what are termed the core criteria of addiction (behavioural salience-2 items, conflict-3 items, relapse and reinstatement-1 item, and withdrawal symptoms-1 item). The latter, engagement, is measured in 12 items, two of which relate to the peripheral criteria of addiction (cognitive salience-1 item, euphoria-1 item). The presence or absence of core and peripheral criteria are indicative for categorizing problematic and non-problematic users. That is, high engagers only experience the mild or peripheral criteria of addiction (euphoria, cognitive salience) whereas the addicted experience the core criteria (withdrawal symptoms, relapse and reinstatement, conflict and behavioural salience). The AEQ has been validated not only with research probing computing activites but also it has been applied in the field of problematic internet use, with a specific online gaming application known as *Asheron's Call* which is a Massively Multiplayer Online Role-Playing Game (MMORPG), (Charlton & Danforth, 2007). Additionally, Charlton and Danforth (2010) in a study of MMORPG gamers, found that there were qualitative differences between the two factors in certain personality constructs (extraversion, emotional stability, agreeableness, negative valence and attractiveness). More specifically, the addiction factor was negatively associated with all five personality constructs whereas the engagement factor was negatively associated only with the negative valence, which validates the claim that there is a qualitative difference between them. Further validation for the distinction between pathological (addiction) and non-pathological (high engagement) online gaming has come from a study undertaken by Metcalf and Pammer

(2011). They investigated attentional bias (a Stroop task) amongst online gamers and found that those who were classified as pathological gamers showed an attentional bias for online gaming words, whereas the ones who were classified as high engagers did not show such a bias.

Overall, these findings have important implications. They indicate that methodologies based on a certain set of criteria for the assessment of problematic internet use, such as the YDQ or those questionnaires which include items from Brown's criteria for behavioural addictions such as the IAT, might have included criteria associated with the factor of engagement. Charlton pointed out that this might have led to the overestimation of the severity of problematic behaviour, but further research is required to support this claim. There is a pressing need to validate the applicability of this claim in areas other than online gaming or computing. Additionally, scholarship is required to assess whether qualitative differences associated with these two factors are observable in work aiming to capture differences between problematic versus non-problematic internet use in areas such as cognition and psychopathology.

1.4 The prevalence of problematic internet use

Considering the aforementioned evidence regarding inconsistencies in diagnostic criteria, definitions and terminology, it is not surprising that prevalence rates show similar patterns of discrepancies. Not only is there a lack of epidemiological data but also prevalence rates can vary across cultures and societies. Currently there are no official statistics on the global prevalence of this phenomenon.

In the United States (US), Aboujaoude, Koran, Gamel, Large, and Serpe (2006) in a random sample telephone survey using structured interviews found that 3.7% to 13.7% of the responders had either markers or presented potential markers of problematic internet use. Additionally, Christakis, Moreno, Jelenchick, Myaing, and Zhou (2011) found that amongst a US student population, the prevalence of problematic internet use was 4%, as assessed with the IAT questionnaire. Sussman, Lisha, and Griffiths (2011) taking all the evidence of prevalence rates amongst different populations and using different diagnostic criteria estimated a prevalence rate in the general adult population of the U.S., for the preceding 12-month period of 2%.

In Europe, rates vary between 5.6% and 7.6% in Italy (Pallanti, Bernardi, & Ouercioli, 2006; Villella et al., 2011) in the adolescent population. In Norway estimates reach 1% of the general population (ranged in age 16 to 74 years old) with 5.2% presenting internet users at risk for developing problematic internet use (Bakken, Wenzel, Gotestam, Johansson, & Oren, 2009). In Finland estimates varied between 1.7% and 1.4% for boys and girls respectively, in a range of groups aged from 12 to 18 years (Kaltiala-Heino, Lintonen, & Rimpela, 2004). Additionally, Zboralski et al. (2009) reported 6% of Polish adolescents reveal symptoms of problematic internet use with 19% classified as being at risk. In addition, in Greece rates vary between 1.5% and 8.2% in the adolescent population. Variations between genders exist with males varying between 6.2% and 7.1% and females between 2% and 5.1% (Fisoun et al., 2012; Kormas et al., 2011; Siomos et al., 2008). Finally, Niemz, Griffiths, and Banyard (2005) found a prevalence of problematic internet use of 18.3% among British students (28.7% males and 9.5% females). However this figure was lower for the adolescent population 5.2% (Lopez-Fernadez, Honrubia-Serrano, Gibson, & Griffiths, 2014). More recently a study which assessed the prevalence rates in 11 European countries revealed 4.4% of the adolescent population had problematic internet use (Durkee et al., 2012).

In Asian countries estimates vary with figures as high as 37.9% (for the general population aged from 16 to 24 years): 6.7% to 12.2% estimated for adolescents: 9.6% to 21.19% for the student population (Cao, Sun, Wan, Hao, & Tao, 2011; Huang, Zhang, et al., 2010; Huang, Li et al., 2010; Leung, 2004; Li, Wang, & Wang, 2008; Lin, Ko, & Wu, 2011; Wang et al., 2011; Yan, Li, & Sui, 2014). In Korea, rates range from 1.6% (Kim et al., 2006) to 10.7% amongst adolescents (Cho, Sung, Shin, Lim, & Shin, 2013) and between 5.9% and 9.3% for the student population (Chou & Hsiao, 2000; Jang et al., 2008; Kubey, Lavin, & Barrows, 2001; Morahan-Martin & Schumacher, 2000). In Japan the reported prevalence for the student population is 18.7% (Yang, Sato, Yamawaki, & Miyata, 2013).

The above figures illustrate that until there is a consensus amongst researchers regarding the definition and assessment criteria there will be discrepancies in the reported prevalence rates not only across different countries but also within a single country. These figures illustrate the lack of reliability related to this type of problematic behaviour and may be one of the reasons why it has not be considered for inclusion under the DSM-5 (APA, 2013). Although identifying the severity of this type of problematic behaviour on a global scale is essential for future research, there are other areas of immediate importance which warrant further investigation. For example, identifying the characteristics of problematic internet use is an area which needs further development. Moreover, understanding the mechanisms which underlie problematic internet use can impact upon the development of a uniform set of criteria for applying to assessment.

1.5 Treatment and problematic internet use

Treatment options form another thorny area related to problematic internet use as there is variability regarding treatment which has led to there being a lack of consensus amongst health professionals. This has limited the efficacy and validity of the various treatments available. Thus, similar to prevalence rates, there are inconsistencies which show the lack of an officially recognised definition and means of assessment as well as the unknown causes of the disorders, and variety of sampling methodologies, which overall, lead to limited knowledge as to which type of intervention can be the optimal.

To illustrate the confusion surrounding this particular area, Thorens, Khazaal, Billieux, Van der Linden, and Zullino (2009) conducted a study to examine the attitudes and beliefs of Swiss mental health professionals concerning problematic internet use. They found that even though the majority of health professionals reported increased awareness of the problem, they were less likely to screen, diagnose and treat it, owing to the lack of official guidelines and protocols related to its definition, assessment and treatment. Even though there is a lack of consensus regarding treatments, there are various means which health professionals have employed in order to try to minimize the harmful consequences of excessive internet use. Psychosocial treatments, for instance cognitive behavioural therapy, motivational interviewing, reality therapy, group therapy, Naikan cognitive therapy, family therapy and multimodal psychotherapy are some of the options which have been proven to be very effective in controlling the amount of time spent online, as well as in ameliorating symptoms such as anxiety and depression which are associated with excessive internet usage (Essig, 2012; Winkler, Dorsing, Rief, Shen, & Glombiewski, 2013). However, each type of therapy is grounded in its own theoretical framework and as such, there is variety in the way problematic internet use is dealt with. More specifically, cognitive behavioural treatments help the person in need to modify maladaptive cognitions and encourage them to have more healthy cognitions and behaviours while motivational therapy helps individuals to change their maladaptive behaviours based on an empathetic and supportive approach. Moreover, reality therapy practitioners state that all responsibility lies with the individual and she/he needs to be reactive in changing actions and cognitions in order to deal with the negative effects of excessive internet use. Finally, Naikan therapy is a psychotherapeutic method that combines meditation-like body engagement with the recovery of memory and the reconstruction of one's life through applying the notions of the self and healing. Even though it is reported that the majority of these therapies are effective, there is a lack of studies that confirm their reliability and validity with the exception being cognitive behavioural therapy. More specifically, Young (2007) and Young and Nabuco de Abreu (2010) examined the efficiency of cognitive behavioural therapy specifically for problematic internet use. They assessed the outcome variables for individuals undergoing treatment in terms of client motivation, online time management, improvement in social and sexual functioning, engagement in offline activities, and ability to abstain from problematic applications. Clients were assessed in the third, eighth and twelfth sessions and a six-month follow-up. They found that most of the participants were able to manage their symptoms by the eighth session and symptom management was sustained at a six-month follow up. The effectiveness of cognitive behavioural therapy has also been supported with case study research (King, Delfabbro, Griffiths, & Gradisar, 2012).

Another treatment option which was first introduced in China by Su, Fang, Miller, and

Wang (2011) is the Healthy Online Self-Helping Centre (HOSC). It was found that participation in this programme was associated with a reduced amount on time spent online. Subjects reported less problematic internet use and improved online satisfaction one month after their participation. Although this programme is built around a paradox, for it necessitates online participation while trying to control online activities, it has some advantages which make it appealing as a treatment option. It is cost effective, provides immediate feedback to the user and it takes into account the willingness of the user to undertake a change. However, its clinical significance and effectiveness compared with other treatment options needs further investigation.

Pharmacological interventions have been applied as another mean for treating problematic internet use. Health professionals based on the observable similarities between problematic internet use and substance-related and addictive disorders, have administered pharmaceutical agencies which have been found to be effective for controlling substance taking behaviour. More specifically, similar to findings regarding substance-related and addictive disorders research has revealed deficiencies in the reward pathway in problematic internet users (Hou et al., 2012; Kim et al., 2011; Liu et al., 2010). It has been proposed that this deficit predisposes individuals to use substances or indulge in pleasurable activities such as gambling in an attempt to ameliorate pre-existing anhedonic states. Agencies such as naltrexone (an opioid block receptor) and escilopram (a serotonin release agent) which have been used effectively in treating substance and addictive disorders have also been found to be effective for treating problematic internet use (Bostwick & Bucci, 2008; Sattar & Ramaswamy, 2004).

Even though psychosocial and pharmacological treatments have shown positive outcomes, more research needs to be conducted in order to assess their long-term efficacy as well as whether a combination of both types of interventions could maximize treatment efficacy (Huang, Li et al., 2010; Winkler et al., 2013). Additionally, factors such as the inclusion of a control group, random sample allocation, effect size, uniformity in diagnostic criteria and definitions, specifications of which potential subtypes of problematic internet use are being targeted as well as protocols for pharmaceutical interventions are some of the grounds for the systematic criticisms made regarding the majority of studies conducted in the field (Huang, 2010; King, Delfbbro, Griffiths, & Gradisar, 2011). Thus, future research needs to accommodate these factors in order to validate the effectiveness of each potential intervention available for addressing problematic internet use.

1.6 Risk factors associated with problematic internet use

There is a plethora of studies that have been conducted in the field to identify factors associated with problematic internet use. These can be divided into the broad categories of: personality traits, social and economic characteristics, family functioning, psychological and psychiatric characteristics as well as patterns of internet use (Bozkurt, Coskun, Ayaydin, Adak, & Zoroglu, 2013; Çelik, & Odacı, 2013; Cho et al., 2013; Dalbudak et al., 2013; Durkee et al., 2012; Jie et al., 2014; Kaess et al., 2014; Kalaitzaki & Birtchnell, 2014; Khang, Kim, & Kim, 2013; Ko, Yen, Yen, Chen, & Chen, 2012; Mittal, Dean, & Pelletier, 2013; Odacı, & Çelik, 2013; Odacı, & Çıkrıkçı, 2014; Özdemir, Kuzucu, & Ak, 2014; Pace et al., 2014; Sariyska et al., 2014; Senormanci, Senormanci, Guclu, & Konkan, 2014; Servidio, 2014; Tsai et al., 2009; Weinstein & Lejoyeux et al., 2010; Xiuqin et al., 2010; Yang et al., 2013; Yen et al., 2009; Yu, Kim, & Hay, 2013).

A substantial amount of research has been devoted to identifying factors which are associated with problematic internet use during adolescence. This is prompted by the concern that the negative effects of excessive internet use might be more severe during this period as most developmental growth happens at this time (Dahl, 2004; Schepis, Bryon, & Rao, 2008; Spear, 2004). Moreover, adolescence is a period which is often associated with a variety of risk taking behaviours, such as experimenting with drug use, alcohol etc. (Johnston, Whitbeck, & Hoyt, 2005). Considering the body of evidence which has revealed that if adolescents are engaging in one risky behaviour, they are more likely to be engaged in another, then they might be particularly vulnerable to problematic internet use. It has been reported that during this period, adolescents are starting to get involved with high risk internet activities, such as giving out personal information, harassing other people, chatting with strangers and starting relationships (Dowell, Burgess, & Cavanaugh, 2009). For this reason a substantial amount of research has been devoted to this developmental period in the life course and internet use.

Research has shown that certain personality characteristics were evident amongst adolescents who were classified as high risk internet users or had developed problematic internet use. These include hostile and aggressive behaviour, psychological problems such as anxiety, depression, phobias and self-harm tendencies, dysfunctional coping strategies and interpersonal skills, lower subjective vitality and happiness, malfunctioning dynamics within the family, use and abuse of substances such as alcohol and tobacco, unhealthy patterns in routinely activities such as bedtimes and dietary, stress, gender (specifically being male) and poor academic performance as well as insecure attachment attitudes (Akin, 2012; Cheung & Wong, 2011; Fisoun et al., 2012; Guo et al., 2012; Kim, Park, Kim, Jung, Lim, & Kim, 2010; Ko, Yen, Yen, Lin, & Yang, 2007; Ko, Yen, Liu, Huang & Yen, 2009; Kormas et al., 2011; Lam et al., 2009; Li et al., 2014; Milani, Osualdella, & Di Blasio, 2009; Pace et al., 2014; Shek et al., 2008; Schimmenti, Passanisi, Gervasi, Manzella, & Fama, 2014; Tsitsika et al., 2011; Wang et al., 2011;Yen, Ko, Chen, Chang, & Cheng, 2009). In particular, the role of the family and parent-adolescent interaction has been identified as an area of significant importance. Conflicts and poor quality of communication between family members as well as strict parental rules with respect to internet usage are areas of critical concern during adolescence (Li & Newman, 2013; Li et al., 2014; Yen, Yen, Chen, Chen, & Ko, 2007).

Considering that the adolescent is going through a developmental period in which a sense of identity is formed, the role of self-esteem has been demonstrated to be an important risk factor (Huang, Zhang et al., 2010). More specifically, research has identified discrepancies between implicit and explicit measures of self-esteem, with problematic internet users reporting lower levels of explicit and higher levels of implicit self-esteem (Stieger & Burger, 2010). This discrepancy has been pointed to as a source of significant psychological distress. Moreover, it has been found that, specifically for female internet users, the link between low self-esteem and problematic internet use was mediated by their preference for online social interaction (Fioravanti, Dettore, & Casale, 2012). This indicates that for some internet users, the online environment might serve as a medium to ameliorate negative affective states by their receiving emotional support from it (Fioravanti et al., 2012).

Similar to adolescents, one of the populations which has been extensively assessed in relation to their levels of internet use are students. It has been found that they are particularly vulnerable as the life changes and transitions associated with student life can be particularly stressful, for example, stress related to exams and pressure to succeed, career concerns, and establishing new social circles (Chou, 2001). It has been suggested that students might use the internet in an attempt to try to cope with these stressful life events (Kim & Haridakis, 2009; Lam et al., 2009; Li, Wang, & Wang, 2009; Yan et al., 2014). Additionally, it has been argued that the internet has been developed and shaped in such a way as to satisfy most human needs, including the need to be: accepted, acknowledged, belonged and loved (Hinic et al., 2010). Thus, it could also be argued that students might use it as a medium to have fun. This has been validated with evidence showing that students who have high levels of problematic internet use also scored high on the fun-seeking subscale of the behaviour approach system scale (BAS), (Yen, Ko, Yen, et al., 2009). Moreover, factors such as unlimited and free access to the internet as provided by most universities nowadays, as well as encouragement to use the internet as part of the university curriculum, are some of the aspects of life that put students at a risk of too much internet usage (Young, 2004). The negative outcomes of excessive internet use can have a direct effect on university performance, an assumption which was validated in a study that found a negative correlation between the hours spent online and grade performance amongst university students (Englader, Terregrossa, & Wang, 2010).

Research conducted with adult populations has reported on some of the risk factors associated with problematic internet use. These are gender (being male) and an unsatisfactory financial situation (Bakken et al., 2009), increased time spent on the internet especially on leisure activities (Montag et al., 2010), elevated levels of impulsivity (Lin et al., 2011) depression (Young & Rogers, 1998), insecure attachment styles (Lin et al., 2011) and low self-esteem (Armstrong, Phillips, & Saling, 2000). In addition, one of the negative consequences of excessive internet use during adulthood concerns problems in family and relationship functioning. More specifically, Kerkhof, Finkenauer and Muusses (2011) examined the effects of compulsive internet use with respect to marital relationships by conducting a longitudinal study. They found that time spent on the internet was the key factor that affected the quality of these relationships. More specifically, compulsive internet use rather than moderate internet use was negatively related to the quality of relationships.

With reference to gender, research has revealed differences between males and females in the type of activities which they prefer online: females report using the internet more as a communication medium whereas males use it for activities such as gaming etc. (Durkee et al., 2012; Fisoun et al., 2012). Also, the predictive value of various psychopathological constructs has been found to differ between males and females. More specifically, factors such as depression, introversion, and psychological distress have been found to be associated with females' problematic internet use, whereas for males this reflected their reliance on the medium to ameliorate phobic anxiety (Hetzel-Riggin & Pritchard, 2011).

Online gaming, time spent online, information searching, using the internet to retrieve sexual information and visiting social networking sites have been demonstrated to be some activities which might be predictive of problematic internet use, especially for adolescent and student populations (Eijnden, Meerkerk, Vermulst, Spijkerman, & Engels, 2008; Fisoun et al., 2012; González & Orgaz, 2014; Kittinger, Correir, & Irons, 2012; Ko et al., 2007; Kuss & Griffiths, 2011; Milani et al., 2009; Mottram & Fleming, 2009; Neo & Skoric, 2009; Siomos et al., 2008; Tone et al., 2014; Tsitsika et al., 2011). Using the internet for communication and socialising have been identified as vulnerabilities underlying malfunctioning patterns of internet use. This type of online activity, that is, social networking, requires further investigation especially when taking into account the fact that some research has found constructs such as social phobia and anxiety to be risk factors for problematic internet use. Regarding this, an argument which has been put forward is that some of the properties of the internet such as anonymity might be particularly appealing for individuals with social phobia and anxiety, shyness, loneliness, self-conscious or who suffer with low self-esteem (Caplan, 1998; Griffiths, 2000; Morahan-Martin, 1999; Morahan-Martin & Schhumacker, 2000; Özdemir, Kuzucu, & Ak, 2014; Tokunaga & Rains, 2010;

Yao & Zhong, 2014). Further, it has been argued that internet users with the aforementioned qualities might perceive the online environment as a safe and secure environment for social interaction. Thus, they indulge in the virtual world in order to find the social support which they are missing in face-to-face interactions. Even though this might be a way for coping and developing further their social skills for many such individuals, it does nevertheless put them at risk of developing problematic internet use (Campbell, Cumming, & Hughes, 2006; Caplan, 2007; Yao & Zhong, 2014). However, due to the lack of studies assessing the causal relationships between these factors another contention is that the aforementioned qualities (social anxiety, loneliness etc.) are the consequence of the time they spend online, as internet users prefer online in lieu of real world interactions (Eijnden, et al., 2008; Morahan-Martin, 1999). This view is supported by emergent evidence which has indicated that problematic internet use to be the cause of various psychosocial problems (Yao, Han, Zeng, & Guo, 2013). Additionally, another proposition which can be advanced is that dysfunctional social skills might be a factor associated with a diathesis for the expression of problematic internet use. However, as for any other disorder, factors associated with its diathesis are not sufficient for its expression in that they might predispose the individual but nevertheless they require interaction with other constructs in order for the disorder to develop. Thus, according to this view, environmental stressors such as elevated levels of anxiety, loneliness and depression when combined with dysfunctional social skills can increase the chances of developing problematic internet use (Tokunaga, 2014). Considering the emphasis given to the aforementioned factors throughout the literature and the limited evidence assessing this specific potential subtype of problematic internet use, namely social networking, future research is warranted in order to identify the potential specific characteristics associated with this type of problematic behaviour. Moreover, comparisons can be made with another proposed subtype of problematic internet use that of online gaming, as there is a substantial amount of research which has been conducted to assess its characteristics on the cognitive, neurobiological and psychological levels (Kuss & Griffiths, 2012). Thus, this type of research can enrich our understanding regarding similarities and differences between potential different subtypes of problematic internet use and enhance our knowledge of the unique characteristics associated with each subtype of problematic behaviour. In addition, considering the argument (see subsection 1.2) that some online activities like gaming can also be pursed offline, researching an internet activity which arguably can only be executed online can provide evidence as to whether or not the internet is just serving as the medium for expressing another problematic behaviour.

One of the main criticisms of the majority of the aforementioned studies is their adoption of a cross-sectional design in preference to a longitudinal one. This has brought into question whether in fact the factors which have been highlighted as being associated with problematic internet use are the cause or the consequence of it. Understanding the various constructs which might represent a risk for this type of behaviour is a very important initial step but nevertheless necessitates further validation from future research with an emphasis placed on probing the unique characteristics of problematic internet use. For example, many of the factors mentioned above can be identified in various maladaptive behaviours. This implies that a person with certain personality, psychological and neurobiological characteristics might be predisposed to develop various maladaptive behaviours including problematic internet use. However, research has not clarified which ones are necessary for the development as well as those which are responsible for the maintenance of problematic internet use, once this has been developed.

1.7 Problematic internet use and co-morbidity with psychopathology

Various psychopathological constructs have been identified as vulnerability markers regarding problematic internet use. This co-morbidity (Aboujaoude, 2010; Bernardi & Pallanti, 2009; Cao et al., 2007; Caplan, 2007; Cheung & Wong, 2011; Cho et al., 2013; Dong, Lu et al., 2011; Jang et al., 2008; Kelleci & Inal; 2010; Ko et al., 2012; Kormas et al., 2011; Mythily et al., 2008; Tsitsika et al., 2011; Weinstein & Lejoyeux et al., 2010; Yen, Ko, Yen, Chang et al., 2009; Yeon, 2009; Zboralski et al., 2009) has created a fierce debate concerning the validity and reliability of problematic internet use, with arguments being raised regarding whether the internet is a medium through which to fulfil another dysfunctional behaviour or simply a symptom of one (Bell, 2007; Fu, Chan, Wong, & Yip, 2010; Miller, 2007). However, recent evidence suggests that claims like these are not valid. More specifically, Dong, Lu et al. (2011) in a longitudinal study assessed the presence of various psychopathologies in a sample of students, before and after they developed problematic internet use. They found higher scores on dimensions assessing depression, anxiety and hostility after they had developed problematic internet use. This validates the assumption that depression, anxiety etc. are the consequence and not the cause of the problematic internet use (Dong, Lu et al., 2011). Similarly, Fu et al. (2010) found discriminant validity for problematic internet use when there was a co-occurrence of variables such as depression and suicidal ideation. Additionally, it has been argued that in order for a set of criteria to form a disorder there is a need to establish not only its discriminant validity but for the characteristics need to be stable over time. Huang (2010) researched the concept of stability and found that the characteristics of problematic internet use were stable over time. Tokunaga (2014) found that it was associated with functional impairment uniquely and independently from the presence of another psychopathological condition and this was the case in both cross-sectional and longitudinal designs. Thus, Tokunaga (2014) suggested that the construct of problematic internet use is a genuine condition and not just the consequence of another psychopathological condition. Even though the aforementioned studies have provided supportive evidence for the validity of problematic internet use, they are nevertheless, far from conclusive for more research needs to be conducted in order to assess its etiology, pathophysiology, course, prognosis and response to treatment (Pies, 2009). As proposed above future research should investigate markers which are the unique characteristics of problematic internet use. In line with this proposition, the work should assess whether these markers are associated with different levels of psychopathology. It can be argued that if psychopathology does not associate with the potential identified markers of problematic internet use then this could indicate that it is a distinct disorder with unique characteristics.

1.8 Theoretical models of problematic internet use

A number of theories and models have been developed for problematic internet use in an effort to provide a clear understanding of its characteristics and causes. Davis (2001) proposed a cognitive-behavioural model in order to explain its etiology, development and the outcomes associated with it. He conceptualized problematic internet use as a distinct pattern of internet-related cognitions and behaviours that result in negative life outcomes. Further, he argued that it is malfunction cognitions which are its cause for example beliefs such as “I am only good at the internet” and “I can only be myself in the virtual world”. He proposed two distinct forms of problematic internet use, specific and generalized. The former involves engagement with specific internet applications such as online gambling or online gaming whereas the latter refers to a more global set of behaviours. According to Davis, the specific form pertains to a set of activities which can be performed in the absence of the internet.

Similar to Davis, Eastin (2005) developed a model in order to assess the role of social influence and self-regulatory processes as factors underlying problematic internet use. This model explored the role of cognitive functioning as an explanation of behaviours leading to certain internet behaviours. Eastin suggested that using the internet for information searching, entertaining purposes and social online activities were the most commonly preferred activities amongst internet users. Stern (1999) proposed two models for examining problematic internet use which are similar to Davis' proposition of generalized and specific forms. The first model sets out the idea that if the internet is available the problematic internet user will display maladaptive behaviours (generalized problematic internet use), whereas under the second model the internet is the medium used to execute another problematic behaviour (specific problematic internet use). The model served to explain that in the absence of the internet the person will still display the maladaptive behaviour and in addition varifies that this distinction is the reason why there is variation regarding the motives associated with usage amongst internet users.

Spada, Langston, Nikčević, and Moneta (2008) assessed the role of metacognitions, which refers to the awareness of one's own cognitions and internal states, in problematic internet use. Their theory was grounded in evidence which had shown strong associations between negative affective states such as depression, low self-esteem and problematic internet use (Kim et al., 2006; Morgan & Cotten, 2003; Sanders, Field, Diego, & Kaplan, 2000; Whang, Lee, & Chang, 2003; Young, 1998b). They assessed the relationship between metacognition, negative emotions and problematic internet use and found positive inter-correlations between all constructs. Furthermore, the relationship between negative emotions and problematic internet use was mediated by distorted metacognitions which confirmed the underpinning assumptions of their model. Kim and Haridakis (2009) proposed a uses and gratification theory to draw together characteristics, motives as well as patterns of internet use and consequently assessed their predictability regarding problematic internet use. They found factors such as shyness, sensation-seeking, and loneliness were positively correlated with problematic internet use whereas the internal locus of control and self-esteem, were negatively related to it. Further, they reported that using the internet for habitual entertainment and escape from everyday problems as well as the amount spent online were the strongest motives underling internet use. Similar suggestions have been made by Kardefelt-Winther (2014) who proposed the compensatory model of internet use. This model highlights the importance of considering psychological and motivational factors and was developed following evidence of the high co-morbidity between psychopathological problems and problematic internet use. Thus, according to this model it can be proposed that problematic internet users adopt the internet in an attempt to self-medicate existing problematic behaviours. This can, on the one hand, reduce the severity of their distress but, on the other, increase the chances of excessive internet use. Even though these models have provided a theoretical background to the factors associated with problematic internet use, they have been subject to limited validation. Although some might be associated with problematic internet use researchers have not explicitly stated whether these contribute to the initiation or maintenance of this problematic behaviour. Moreover, considering that any disorder is best understood by taking into account multiple factors which, when all put together, might increase the likelihood of its expression, future research should apply a more holistic approach with respect to the identification of the vulnerability markers of problematic internet use.

Beard (2005) following the aforementioned assumption put forward an explanatory model of problematic internet use, the biopsychosocial model, which incorporated biochemical, genetic, psychological, familial, environmental, and cultural dynamics. The biological view suggests that biological and neurochemical malfunctioning predisposes individuals to develop addictive behaviour. That is according to this stance, an underlying pre-existing biological malfunctioning might make individuals prone to problematic internet use. For example, a person with low dopamine, and/or serotonin levels or with a dysfunctional reward pathway might try to use the internet in an attempt to get the feeling of a “high”. This is consistent with the argument that for many users internet usage is conceived as a rewarding activity (Charlton, 2002; Charlton & Danforth, 2007, 2010; Young, 1998a).

Thus, in an attempt to create feelings of satisfaction they might indulge in the online world and similar arguments have been made for other addictive behaviours (Goudriaan, Oosterlaan, de Beurs, & van den Brink, 2006; Volkow, Wang, Tomasi, & Baler, 2013). However problematic internet use, as with pathological gambling, does not involve the chemical intoxication normally associated with substance ingestion and which have been described as causing alterations in the functional and structural brain systems related to the reward pathway (Volkow, Fowler, & Wang, 2004). However, these alterations have been found to be linked with the severity and duration of problematic internet use (Dong, Huang, & Du, 2011; Jun et al., 2010; Yuan, Qin, Liu, & Tian, 2011). Treatments which have deployed pharmacological means, such as naltrexone and escilopram, have been proven to be effective for controlling problematic internet use (Bostwick & Bucci, 2008; Sattar & Ramaswamy, 2004). This is in accordance with Beard's (2005) contention that neurochemical and biological imbalances might be risk factors relating to vulnerability in terms of problematic internet use. Moreover, this last point highlights that commonalities in vulnerability markers might be particularly prominent with regards to pathological gambling and problematic internet use as neither types of behaviour involve chemical intoxication.

From a psychological view operant and classical conditioning can account partially for the initiation and maintenance of this problematic behaviour. According to Beard (2005), internet users might link certain physiological arousals which relate to internal feelings of, for example, excitement, happiness, relief, and pleasure, with certain online features such as seeing a computer or waiting for the downloading of a webpage. When this pairing is consistently happening, in other words the processes of classical conditioning are occurring, some internet users might respond with physiological reactions when only given a glimpse of internet paraphernalia, as these items have been previously paired with certain emotional reactions. In this case, through the process of classical conditioning stimuli related to the internet (unconditioned stimuli) have acquired conditioned responses (physiological reactions) which were associated with the feelings experienced when a user was online (conditioned stimuli). If the reactions associated with unconditioned stimuli are strong enough they can result in "highjack"ing behaviour and, as such, become the focus of the internet user's attention. Additionally, Beard argued that the process of operant conditioning whereby the strong reinforcing properties of the internet can act as strong stimuli might result in problematic internet use. For example, the ease with which a user can have access to a great variety of information and the ease of communication are some of the strong reinforcing properties which make the internet appealing for many users (Aboujaoude, 2010; Bernardi & Pallanti, 2009; Cao et al., 2007; Caplan, 2007; Cheung & Wong, 2011; Dong, Huang et al., 2011; Jang et al., 2008; Kelleci & Inal, 2010; Kormas et al., 2011; Mythily et al., 2008; Tsitsika et al., 2011; Weinstein & Lejoyeux, 2010; Yen et al., 2009; Zboralski et al., 2009). Finally, the social view of the model addresses the influence of family, social and cultural environments as factors contributing to problematic internet use. Social isolation, family and marital conflicts, peer pressure, financial problems have been linked to the increase in the risk of an individual being engaged with problematic internet use (Bakken et al. 2009; Li et al., 2008; Tsai et al., 2009; Weinstein & Lejoyeux, 2010; Xiuqin et al., 2010; Yen, Ko, Yen, Chang et al., 2009).

The multidimensionality of problematic internet use awaits further confirmation. Instead of looking at each dimension separately there is a need to assess theories which account for how all of these factors work together and increase an individual's degree of vulnerability to its expression. Moreover, problematic internet use has been associated with substance-related and addictive disorders. Drawing on this point, further research could be conducted for ascertaining whether or not some prominent theories available in the field of addictions which have been developed to account for their multidimensional nature could also be usefully applied to problematic internet use.

1.9 Similarities of problematic internet use with substance-related and addictive disorders

Problematic internet use has been conceived as a type of behavioural addiction. Behavioural addictions are conceptualised as a set of behaviours, not involving chemical intoxication, which resemble substance dependence disorders in their phenomenology, co-morbidity, tolerance, neurobiological mechanisms and response to treatment (Grant, Potenza, Weinstein, & Gorelick, 2010; Leeman & Potenza, 2012; Winkler et al., 2013). A major similarity between them lies in the symptomatology which includes: salience, mood modification, tolerance, withdrawal, conflict and relapse (Griffiths, 2000). One of this type of behaviours which has received substantial attention is pathological gambling. Although its observable commonalities are shared with substance dependence disorders it was classified under the category of impulse and control disorder in the DSM-IV-TR (American Psychiatric Association, 2000). In addition, research has revealed high levels of co-morbidity between behavioural and substance addictions (Pallati, Bernardi, & Quercioli, 2006; Sussman et al., 2011). This is suggestive of similarities in the underlying mechanisms associated with their development and maintenance (Grant et al., 2010). In keeping with the emergent evidence, the DSM-5 (APA, 2013) has included pathological gambling and substance dependence disorders under the same category, that of substance-related and addictive disorders. This is supportive of the proposition that behavioural and substance addictions are very similar constructs. In a similar way it could be argued that problematic internet use should be included in this category. Research has assessed and defined problematic internet use based on the diagnostic criteria derived from both pathological gambling and substance dependence DSM-IV-TR (APA, 2000), due to the observable similarities in their symptomatology (Chow et al., 2008; Christakis, 2010; Griffiths, 2000;Young, 1996; 1998a). Moreover, it has been found that problematic internet users have a lifetime prevalence for substance use disorders from 38% to 55% (Black, Belsare, & Schlosser, 1999; Shapira et al., 2000), which is reminiscent of the commonalities between them. However, further validation is needed to be able to draw firm conclusion in relation to these commonalities. In the next two sections I cover areas of research which have elicited evidence regarding robust similarities between problematic internet use and substance-related and addictive disorders and then identify gaps in the literature which require further evaluation.

1.9.1 Problematic internet use, impulsivity and inhibitory control

As mentioned above problematic internet use has been associated with substance-related and addictive disorders. The fundamental idea is that all these disorders share similar psychopathological origins, neuropathological and personality traits and thus, they could be conceived under the same spectrum (Shaffer et al., 2004). Despite Shaffer et al. (2000) criticism of conceptualising problematic internet use as a behaviour similar to other addictive disorders, emerging evidence alludes to commonalities between them (Grant et al., 2010;

Leeman & Potenza, 2013). One of these areas of similarities pertains to the construct of impulsivity and inhibitory control for inhibitory control reflects a behavioural component of impulsivity. Impulsivity is a complex multidimensional construct which has been broadly characterized by a tendency to react fast without thinking and planning, as well as having the tendency to make decisions based on immediate outcomes without considering future consequences (Moeller, Barratt, Doughrty, Scmitz, & Swann, 2001). Definitions and measurements of impulsivity vary across studies. Aspects of impulsivity can be captured by either self-report measurements of personality, or behavioural tasks which can be combined with brain activation assessments and measures of behavioural and underlying mechanisms related to specific dimensions of impulsivity (Reynolds et al., 2006). For example, self-report personality questionnaires such as the Barratt Impulsiveness Scale-11 (BIS-11) (Patton, Stanford, & Barratt, 1995), the Sensation Seeking Scale (Zuckerman, Kolin, Price, & Zoob, 1964) capture trait characteristics of impulsive behaviour. Some prominent behavioural tasks which have been used in the field of addictions are the Go/No-Go and Stop Signal tasks which gauge facets of impulsivity related to behavioural inhibition (Diamond, 2013) in the form of motor inhibition (withhold a response) and response inhibition to a prepotent learnt go signal respectively (Verbruggen & Logan, 2008). The Go/No-Go task requires participants to make quick and accurate responses to a series of stimuli that are associated with a "go" response while at the same time withhold their responses to stimuli that have been denoted as a "no-go" response. Similarly, in the Stop Signal task, participants are required to make quick and accurate responses to a series of stimuli associated with a "go" response while at the same time withholding their responses to the same stimuli when a "no-go" signal is presented. Participants in this task have already initiated a response to the go signal when the withhold indication is subsequently presented. Finally, using these tasks while assessing electrical brain activity with Event Related Potentials (ERPs) can be a valuable indication of the underlying mechanisms associated with inhibitory control. An interesting advantage provided by investigation of brain activity is that it can identify similarities between different psychiatric disorders and thus, can provide valuable information of the etiology and course of a new disorder.

Research probing substance-related and addictive disorders provides a substantial source of evidence which has linked impairments in impulsivity and inhibitory control to be as a risk factor associated with their development and maintenance (Adams, Ataya, Attwood, & Munafo, 2012; Billieux, Gay, Rochat, Khazaal, Zullino, & Van der Linden, 2010; Cheng, Lu, Han, Gonzalez-Vallejo, & Sui, 2012; Constantinou et al., 2010; Dawe & Loxton. 2004; Dom, Hulstijn, & Sabbe, 2006; Fillmore & Rush, 2002; Finn, Bobova, Wehner, Fargo, & Rickert, 2005; Fleming & Bartholow, 2014; Fuentes, Tavares, Artes, & Gorenstein, 2006; Goudriaan, Oosterlaan, de Beurs, & van den Brink, 2005; Grano, Virtanen, Vahtera, Elovainio, & Kivimaki, 2004; Hair & Hampson, 2006; Kertzman et al., 2008; Kozink, Kollins, & McClernon, 2010; Kreusch, Vilenne, & Quertemont, 2013; López-Caneda, Holguín, Cadaveira, Corral, & Doallo, 2014; Lorains, Stout, Bradshaw, Dowling, & Enticott, 2014; Margin & Colder, 2007; Margin, MacLean, & Colder, 2007; Murphy, Taylor, & Elliott, 2012; Noel et al., 2005, 2007; Pike, Stoops, Fillmore, & Rush, 2013; Verdejo-Garcia, Lawrence, & Clark, 2008; Verdejo-Garcia et al., 2012). Moreover, there is accumulating evidence that indicates abnormalities, both structurally and functionally, in brain areas which have been implicated as being associated with inhibitory control in addicted individuals (Cavedini, Riboldi, Keller, D'Annucci, & Bellodi, 2002, Feil et al., 2010; Franken, van Strien, Franzek, & van de Wetering, 2007; Hester & Garavan, 2004; Jentsch & Pennington, 2014; Kamarajan et al., 2004; Li et al., 2010; Li & Sinha, 2008; Luijten et al., 2013; Schulte, Muller-Oehring, Sullivan, & Pfefferbaum, 2012).

Similarly, emerging evidence has implicated elevated levels of impulsivity, inhibitory control as well as impairments in brain activity in these particular cognitive processes, as being associated with dysfunctional patterns of internet use (Billieux, & Van der Linden, 2012; Cao et al., 2007; Choi et al., 2014; Dong, Zhou, & Zhao, 2010, 2011; Dong et al., 2012; Kim et al., 2008; Lee et al., 2012; Meerkerk, van den Eijnden, Franken, & Garretsen, 2010; Mottranet & Fleming, 2009; Park et al., 2013; Yau et al., 2013; Zhou et al., 2010). More specifically, Cao et al. (2007) found that adolescents who were diagnosed with problematic internet use had higher levels of impulsivity when assessed with BIS-11. They also had higher scores compared to the control group in their behavioural impulsivity as measured with the Stop Signal task. Moreover, Mottram and Fleming (2009) found that high levels of lack of pervasiveness, which refers to the inability to control behaviour and complete a task when distracting stimuli are present (an aspect of impulsivity), was a strong predictive factor for problematic internet use. Further, Meerkerk et al. (2010) conducted a study to examine the role of the constructs of sensitivity to reward, punishment, and impulsivity as factors underlying vulnerability regarding the development of problematic internet use. Overall, their results revealed only functional and dysfunctional impulsivity as well as sensitivity to punishment were good predictors for problematic internet use. Functional impulsivity is conceptually similar to sensitivity to reward, whereas dysfunctional impulsivity refers to rash spontaneous impulse behaviour without giving consideration to consequences (Dawe & Loxton, 2004).

Activity in brain areas linked with inhibitory control as assessed by applying electrophysiological methodologies has confirmed the assumption of impairments in problematic internet users. More specifically, Dong et al. (2010) in a study examining event related brain potentials during the carrying out of the Go/No-Go task found that participants who were problematic internet users had a lower no-go/N200 amplitude, a higher no-go/P300 amplitude and a higher no-go/P300 peak latency compared to normal controls. The two measurements of ERPs in this particular task which is relevant to response inhibition, are the enhanced negative component in the conflicting stage (no-go) that peaks 200msec after the presentation of the stimuli and the enhanced P300 wave, which is a signal elicited after 300-500msec after the presentation of the stimulus. The implications of this study were that problematic internet users were impaired in their attention and ability to detect conflict as presented by the decreased N200 no-go amplitudes. Additionally, they had to increase their cognitive effort to solve the conflict arising in the incongruent condition as presented by the increased P300 amplitude. Overall, they displayed decreased efficacy in terms of information processing and response inhibition but on a behavioural level, no differences between group performances were observed. These data indicate that assessing underlying brain activation which served as the functioning of inhibitory control can provide an indication of the existence of impairments. These might, however, not have been so severe as to give rise to changes in behavioural performance but can be targeted earlier than otherwise would be possible with potential interventions. Similarly, Zhou et al. (2010) found no-go N200 lower amplitudes using the Go/No-Go task as were revealed in Dong et al.'s study. Dong, Zhou et al. (2011) conducted another study to assess brain activity, while participants both problematic and non-problematic internet users, were performing another task which assesses response inhibition, the coloured word Stroop task. The Stroop task requires participants to name the ink colour of a series of words. In the congruent condition, the colour name corresponds exactly to the colour of each as written out in letters; in the incongruent condition, the printed word and the actual colour of the letters are different. When participants are required to report the ink colour of the word greater difficulty is experienced when they are facing the incongruent condition. Dong et al. found that in the incongruent condition problematic internet users showed a longer reaction time and made more response errors compared to the controls. Moreover, the ERP data showed reduced Medial Frontal Negativity (MFN) in the incongruent condition for the problematic internet users. MFN is the amplitude of the ERP elicited between 400 to 500msec after stimuli presentation and has been associated with conflict detection. These authors suggested that problematic internet users have impaired executive control as compared to non-problematic internet users.

1.9.2 Functional and structural brain changes in problematic internet use

Problematic internet use has been found to be associated with molecular as well as functional and structural alterations in those brains areas which have been implicated in the development and maintenance of substance-related and addictive disorders (Kuss & Griffiths, 2012). Liu et al. (2010) in an fMRI study examined the encephalic functional characteristics of problematic internet users and compared these to control groups by applying the regional homogeneity (ReHo) method under resting conditioning. They revealed that problematic internet users showed abnormalities (enhanced synchronization) in regional homogeneity and enhancement of synchronization in encephalic regions such as the cerebellum, brainstem, limbic lobe, frontal lobe and apical lobe. They interpreted these dysfunctions as abnormalities associated with the reward pathway. Regarding this, impairments in this pathway have been associated with the initiation and exaggeration of substance-related and addictive disorders (Edward & Koob, 2010; Robinson & Berridge, 1993; 2001, 2003; Volkow, Fowler, & Wang, 2003).

Zhou et al. (2011) investigated brain gray matter density (GMD) changes in adolescents with problematic internet use using voxel-based morphometry (VBM) analysis on high-resolution T1-weighted structural magnetic resonance images. They found lower GMD in problematic internet users in the left anterior cingulate cortex, left posterior cingulate cortex, left insula and left lingual gyrus compared to their control group. Previously, these brain areas have been associated with processes related to the regulation of emotional behaviour. Zhou et al. proposed that changes in the GMD reflect changes associated with the functional processes related with these brain areas. This assumption has been validated with evidence that has found problematic internet use was highly associated with behavioural and emotional problems (see subsection 1.6: Risk factors associated with problematic internet use, for an extensive review). Thus, Zhou et al. interpreted their findings as providing support for vulnerability markers associated with structural brain alterations in problematic internet use. Moreover, dysfunctions in these brain areas have been implicated in connection with other addictive behaviours (Goldstein et al., 2007; Naqvi et al., 2007).

Moreover, Lin et al. (2012) researched white matter integrity in a sample of adolescents with problematic internet use. Overall results revealed abnormalities in white matter integrity in some brain areas including: the orbito-frontal white matter, corpus callosum, cingulum, inferior fronto-occipital fasciculus, and corona radiation, internal and external capsules. These have been indicated as playing a role in emotional processing, cognitive control and decision-making processes. This evidence further validates the assumption of there being similarities in the pathogenesis of problematic internet use with that of substance-related and addictive disorders. Research has shown that dysfunctions in these cognitive processes, as well as the structural and functional brain alterations underlying them, can play a role in the development and maintenance of substance-related and addictive disorders (Grant et al., 2006; Romero, Asension, Palau, Sanchez, & Romero, 2010; Volkow et al., 2003). On a molecular level, Hou et al. (2012) and Kim et al. (2011) found reduced dopamine transporters as well as reduced dopaminergic receptor availability in the striatum which are similar outcomes to findings from the field of substance-related and addictive disorders (Di Chiara, 2002; Thomas, Kalivas, & Shaham, 2008; Volkow et al., 2004). It has been suggested that reduced levels of dopamine might be associated with reward deficiency and as such predispose individuals towards the rewarding effects of substance-related and addictive disorders in an attempt to try to optimize an innate deficit of experiencing natural rewards, a state known as anhedonia (Volkow et al., 2013).

Even though the evidence (subsections 1.9.1 and 1.9.2) described above might suggest there are similarities in the pathogenesis of problematic internet use and substance-related and addictive disorders, which is accordingly to a syndrome model of addiction (Shaffer et al., 2004), there are nevertheless various factors which warrant further research. More specifically, the aforementioned evidence cannot infer causality as the majority of extant studies are cross-sectional. For example, deficits in inhibitory control or functional and structural alterations in brain areas associated with the reward pathway and inhibitory control, can be both vulnerability markers as well as consequence of excessive internet use. Therefore, a longitudinal design could better elucidate the directionality of the aforementioned relationships and enhance our knowledge of the causes and consequences associated with problematic internet use. In addition, researchers have being reporting on internet use in the aforementioned studies without clearly stating if their work is related to specific potential subtypes such as gaming or social networking etc. (Young, 1999). Considering the evidence which has shown that there are in fact differences between these (see subsection 1.2), further research is warranted in order to provide a better understanding of the different factors associated with each potential subtype of problematic internet use.

As mentioned above, problematic internet use has been conceptualized as similar to substance-related and addictive disorders due to the commonalities in their symptomatology. A core similarity between them is that a problematic internet user is characterized by persistence in continuing to use it despite the rise of negative consequences in the user's life which is similar to addicted individuals continuing to consume substances or gamble even when they know that these actions will have adverse consequences on themselves and others around them. A substantial amount of research in the field of substance-related and addictive disorders has been devoted to trying to identify the underlying mechanisms which mediate this type of behaviour. Thus, in this thesis the aim is to investigate whether similar factors can account for the initiation and maintenance of problematic internet use. Emphasis has been given to the assessment of cognitive processes such as decision-making, attentional bias and inhibitory control as well as physiological functioning as impairments concerning the aforementioned processes have been reliably evidenced as markers of addictive behaviours. These processes involve both higher-order/explicit and automatic/implicit cognitions. Explicit cognitions relate to goal-directed processes and depend upon our ability to evaluate the various available options and make decisions which will lead to an optimal outcome. Similarly, this depends upon our capacity to be able to control/inhibit our behaviour accordingly to adopt a goal-directed one. In contrast, implicit cognitions refer to processes which are influencing and guiding behaviour but are outside our awareness (Fazio & Olson, 2003). With regards to addictive behaviour there is increasing appreciation that implicit cognitions might better elucidate the underlying processes associated with them and as a consequence be very informative for enhance understanding and generating treatments (Wiers & Stacy, 2006). However, both types of cognition have been proven valuable for aiding our understanding of the different processes involved in the various stages of addictive behaviour. In light of this, investigating the applicability of both implicit and explicit cognitive processes in problematic internet use can enhance our understanding of the underlying mechanisms which associate with its initiation and maintenance, and at the same time, help in evaluating its relationship with other types of addictions.

For example, research has revealed that the uncontrollable urge to consume a drug without the consideration of potential the negative outcomes reflects impairments in cognitive and physiological functioning of addictive individuals. More specifically, an addicted individual's decision-making process is characterized by immediate gratification without assessment of the future consequences of such choices (Bechara & Damasio, 2002; Bechara, Dolan, & Hindes, 2002; Bechara et al., 2001; Brand, Recknor, Grabenhorst, & Bechara, 2007; Brevers, Cleeremance, Goudriaan et al., 2012; Goudriaan et al., 2005, 2006). This pattern of cognitive functioning has been said to partially reflect impairments in the capacity for emotional integration (physiological functioning) into current decision-making processes when future consequences are considered (Bechara & Damasio, 2002; Bechara, Damasio, Damasio, & Lee, 1999; Bechara et al., 2002; Damasio, 1994; Goudriaan et al., 2006). According to this, emotional integration is vital when considering the various outcomes of our choices and as such, can help us guide our decisions towards advantageous outcomes. It has been found that the stimuli related to substances of abuse have the power to "highjack" behaviour and elicit automatic responses amongst addicted population (Brevers, Cleeremans, & Bechara et al., 2011; Cousijn et al., 2013; Dickter & Forestell, 2012; Duka & Townshend, 2004; Field & Cox, 2008; Field, Mogg, Mann, Bennett, &

Bradley, 2013; Honsi, Mentzoni, Molde, & Pallesen, 2013; Robinson & Berridge, 1993; van Holst, van den Brink, Veltman, & Gourdiaan, 2010). For example, when the stimuli from such substances are encountered these have the power to control behaviour and cognition at the expense of more adaptive behaviours. Additionally, a substantial body of evidence indicates that addicted individuals show impairments in their ability to reflect upon this behaviour and control the initiated automatic responses (Adams et al., 2012; Bechara & Damasio, 2005; Billieux et al., 2010; Brevers, Cleeremance, Goudriaan et al., 2012; Fleming & Bartholow, 2014; Fuentes et al., 2006; Goudriaan et al., 2005; Kertzman et al., 2008; Kreusch et al., 2013; Lopez-Caneda et al. 2014; Lorains et al., 2014; Noel et al., 2005, 2007; Pike et al., 2013; Rose & Duka, 2008; Verdejo-Garcia et al., 2008, 2012; Weafer & Fillmore 2012; Wiers & Stacy 2006; Wiers et al., 2007).

Overall, it has been argued that interaction of the aforementioned processes underlies vulnerability pertaining to the initiation and maintenance of substance-related and addictive disorders. Considering that problematic internet use has been conceived as a type of behavioural addiction, one would expect the same processes to be associated with its initiation and continuation. However, there is currently limited evidence supporting such a claim. Thus, in my thesis I aim to investigate whether these markers of substance-related and addictive disorders are also evident in problematic internet use. In the following paragraphs I describe the theoretical models related with each vulnerability factor and hence provide a robust account of the underlying mechanisms involved along with a potential theoretical model of problematic internet use.

1.9.3 The Somatic Marker Hypothesis

In order to address the dimensionality of problematic internet use in this thesis emphasis was given to the theories from the field of addictions which have incorporated psychophysical and biopsychological factors. These theories have proposed the means through which different underlying mechanisms interact and account for addictive behaviours. More specifically, the psychophysical view outline the ways in which physiological reactions underlie structural and functional alterations in the brain systems which result in behavioural outcomes associated with impaired decision-making processes. Thus, observable cognitive deficits and the associated physiological measures can be related to impairments in brain systems which supports these functions. The Somatic Marker Hypothesis (SMH) has been employed in the field of addictions in order to account for deficits in decision-making processes which are evident in individuals with substance dependency and pathological gambling (Brevers, Cleeremance, Goudriaan et al., 2012; Damasio, 1994; Goudriaan et al., 2005, 2006; Murphy et al., 2012; Verdejo-García & Bechara, 2009). In detail, this theory explains why addicted individuals show patterns of decision-making processes which are characterized by a "myopia for the future". For example, individuals continue to use a drug or gamble even though they know this will lead to negative outcomes for themselves and others around them. According to the SMH our emotions or emotional-related signals play a significant role in the processes guiding decision-making (Damasio, 1994). Damasio conceptualized emotions as homeostatic changes that occur at different levels in the brain and the body in certain situations, referring to these changes as somatic markers (Damasio, 1994). The SMH states that for every choice we make a somatic marker is generated. Thus, in the future whenever a similar situation is encountered, somatic markers provide an emotional indication for that situation. One of the basic assumptions underpinning this theory is that individuals make decisions by encoding the consequences of alternative actions affectively (Damasio, 1994). Thus, especially in situations where the outcome of a decision is unknown, emotional markers can provide a gut feeling of the outcome of a particular choice. This assumption is based on the evidence which has found that negative outcomes are associated with stronger emotional reactions. This arousal can indicate that the expected outcome is disadvantageous and as such, works to guide decisions away and towards more advantageous outcomes (Bechara et al., 1999).

The SMH was developed after Damasio observed patients with Ventromedial Prefrontal Cortex (VMPFC) lesions, who started making disadvantageous choices regarding future outcomes. They also showed deficits in expressing appropriate emotions and feelings in certain situations. These processes were, however, evident in the absence of other cognitive impairments such as memory, attention, language and logical reasoning. This observation made Damasio conclude that there must be a link between the observed deficits in emotions and feelings and those in the decision-making processes of the patients. Under the SMH, the VMPFC is the part of the brain which reactivates the emotional valence of a stimulus (Weller, Levin, & Bechara, 2010) and damage to this causes a deficit in the generation of somatic markers and consequently, deficits in decision-making processes (Bechara, Damasio, & Damasio, 2000). Further, the amygdala is thought to have a pertinent role in the emotional process (Gupta, Koscik, Bechara, & Tranel, 2011) for it is argued that it plays a part in attributing affective value to a stimulus (Bechara & Damasio, 2002; Bechara et al., 2002; Gupta et al., 2011; Verdejo-García & Bechara, 2009; Weller et al., 2010). These two brain structures are of vital importance in the generation of somatic markers, and as a consequence in providing emotional valence especially to choices associated with ambiguous outcomes. The involvement of these brain areas in decision-making processes has been extensively studied through the application of the Iowa Gambling Task (IGT) which is a task that mimics the way people make decisions in an everyday scenario. Research combining neuroimaging techniques and the IGT has identified neural structures that are involved in the decision-making processes similar to the ones that have been implicated in the generation of somatic markers and thus has provided validation for the SMH (Bechara et al., 1999; Bechara & Damasio, 2005; Ernst et al., 2002; Fellows & Farah, 2005; Li, Lu, D'Argembeau, Ng, & Bechara, 2010; Manes et al., 2002; Tanabe et al., 2007; Windmann et al., 2006). In the IGT individuals have to make choices based on unknown outcomes and thus integration of emotions into making live choices is vital for optimal performance in the task. Emotional integration has been assessed with Skin Conductance Responses (SCRs) which associates physiological responses with cognitive and emotional processes (Bechara et al., 1999; Bechara & Damasio, 2002; Bechara et al., 2002; Verdejo-García & Bechara, 2009). Using this task, researchers have revealed deficits in decision-making processes in patients with bilateral lesions in the VMPFC and amygdala (Bechara et al., 1999). Moreover, these patients not only showed an overall deficit in performance on the IGT but this impairment was coupled with an inability to generate emotional arousal before they made a choice (anticipatory SCRs, for both amygdala and VMPFC patients) and/or when they received a reward or punishment (for only amygdala patients), (Bechara et al., 1999, Clark & Manes, 2004; Gupta et al., 2011). In this way, the assessment of physiological measures during decision-making processes can indicate whether or not impairments in cognitive processes are associated with VMPFC or amygdala functioning.

Bechara et al. (2001) conducted a study to assess decision-making processes in patients with VMPFC lesions and substance dependent individuals. Results from the IGT showed that substance dependent individuals and VMPFC patients had similar behavioural outcomes (i.e. choosing disadvantageously in the IGT) and SCRs (lower skin activation before choosing from disadvantageous cards). The VMPFC lesion patients' behavioural outcomes were characterized by a tendency for immediate rewards at the expense of negative future consequences (Bechara et al., 2001). Thus, deficits in the generation of somatic markers which are associated with impairment in decision-making processes in substance dependent individuals, could be partially due to a dysfunctional VMPFC. This dysfunction has been suggested as underlying the development of addiction via a mechanism which intensifies the importance of immediate rewards at the expense of long-term outcomes. Similar results have been revealed with studies conducted concerning behavioural addictions (gambling addiction) (Goudriaan et al., 2006). Evidence supporting these claims have come from neuroimaging studies which have shown the deficits in the brain areas of VMPFC and amygdala to be evident in addicted individuals (Verdejo-García & Bechara, 2009).

Considering that similar patterns of decision-making process are prominent in problematic internet users it can be inferred that these deficits are associated with impairments in somatic marker activation. However, there is currently no evidence to justify such an assumption. Thus, in my thesis I assess emotional integration into decision-making processes in problematic internet users and investigate whether deficits in somatic marker activation underlie deficits in decision-making processes.

1.9.4 Incentive sensitization theory

The SMH suggests generic deficits in decision-making processes underlying vulnerability regarding addictive behaviour. However, other models of addiction have given emphasis to deficits in the cognitive processes which become predominately evident in the presence of substances and substance-related paraphernalia. Advocates of these theories argue that the presence of these stimuli have the ability to cause or exacerbate existing cognitive impairments and as a consequence, play a role in the initiation and maintenance of addictive behaviour. One of these prominent theories is the incentive-sensitization theory (Robinson & Berridge, 1993). According to this, addictive substances share the ability to produce long lasting adaptations in neural and brain systems that are normally involved in the process of incentive motivation and reward. Such critical neuroadaptations cause the brain's reward systems to become hypersensitive to substances and substance associated stimuli. However, the sensitized reward systems do not mediate the pleasurable or euphoric effects of substances but instead mediate a subcomponent of reward, termed incentive salience or "wanting". It is the psychological process of incentive salience that is specifically responsible for instrumental substance seeking and taking behaviour (Robinson & Berridge, 2000). According to this theory (Robinson & Berridge, 1993), dopamine levels in the mesolimbic dopamine system mediate the incentive salience mechanism process. Through the processes of classical conditioning the stimuli related to the substance of abuse are associated with the incentive motivation of substances and thus elicit conditioning responses (increase dopamine release). Thus, the stimuli associated with drugs become highly attractive, wanting and capturing attention, "highjack" behaviour and cause the maintenance of the drug taking behaviour. A paradigm that has been widely used to test the assumptions of incentive sensitization theory is the cue reactivity paradigm which assesses the power of substance-related paraphernalia to influence: cognitive process, behaviour (such as substance seeking), increase craving as well as the risk of relapse (e.g. nicotine addiction- Kang et al., 2012; cocaine addiction- Hester, Dixon, & Garavan, 2006; For review see Verdejo-Garcia & Bechara, 2009). However, it has been proposed that one of the processes through with which cue reactivity induces substance seeking behaviour is a mechanism which enhances attentional allocation to the cues. This process is termed attentional bias and it has been argued that this bias is either causing or indexing the underlying mechanisms related to substance seeking behaviour (Robbins & Ehrman, 2004). In the field of addictions there is substantial evidence supporting this claim (see Field & Cox, 2008 for review; alcohol e.g. Duka & Townshend, 2004; Field, et al., 2011, 2013; Ryan, 2002; Weafer & Fillmore 2013; nicotine e.g. Bradley, Mogg, Wright, & Field, 2003; Dickter & Forestell, 2012; Kang et al., 2012, opiate addiction e.g. Lubman, Peters, Mogg, Bradley, & Deakin, 2000; Lubman et al. 2009, cannabis use/dependence e.g. Cousijn et al., 2013; Field, Mogg, & Bradley, 2004a; pathological gambling e.g. Brevers, Cleeremans, & Bechara et al., 2011; see Honsi et al., 2013; van Holst et al., 2010 for review). Although the theory when first developed based its assumption on work pertaining to stimulant substances (amphetamine, cocaine etc.) there is now evidence that the same processes can explain the cycle of behavioural addictions for activities such as pathological gambling (Honsi et al., 2013) and, therefore, can also be applicable to problematic internet use. There is currently limited evidence in the field of problematic internet use which is suggestive that similar processes exist in internet users. An investigation to assess whether internet-related stimuli have the power to "highjack" behaviour in problematic internet users could be very informative of the mechanisms associated with the transition from regular to problematic internet use as well as regarding to its maintenance. In addition, behavioural addictions have the advantage of providing a clear understanding of the underlying processes associated with the addictive behaviour because any potential confounding factors which are the consequence of chemical intoxication are absent.

1.9.5 Dual-process theory

Recent theories of addiction have proposed that substance seeking behaviour is associated with not only incentive sensitization processes which elicit automatic responses to substance-related stimuli, but also with deficits in the processes which control these automatic responses; the dual-process theory of addiction (Wiers & Stacy 2006; Wiers et al., 2007). According to this theory human behaviour is governed by two interconnected systems: the impulsive and the reflective. The former deals with any information coming from our environments and its role is to provide fast and automatic reactions to incoming cues (Strack & Deutsch, 2004) and thus does not involve deliberate processing or consideration of potential future outcomes. From an evolutionary perspective this is vital for survival and associates with fight or flight responses. The latter, by contrast, is associated with deliberate processing, effortful control and consideration of the different outcomes associated with potential choices (Grenard et al., 2008). This system can control and mediate the automatic responses initiated by the impulsive system in order to succeed in achieving intended and desirable goals (Deutsch & Strack, 2004). However, due to effortful control and the energy associated with the processes of the reflective system and considering that our cognitive systems are programmed in a way to act quickly in order to perform an act, many of our everyday actions are heavily controlled by the impulsive system. In this way, after conducting a task repeatedly, it becomes an automatic act without us being aware of the decisions and the steps being followed.

In the field of addictions there is substantial evidence which indicates that the behaviour of addicted individuals is substance stimuli-driven. For example, according to Robinson and Berridge's (1993) theory it has been well validated that substance-related stimuli have the power to "highjack" behaviour (see subsection1.9.4). However, under the assumptions of the dual-process theory, it must also be impairments of the reflective system which lead to the inability to control these automatic responses prompting to substance seeking behaviour. This assumption has been confirmed with the evidence that has reported on impairments in addicted individuals regarding their ability to inhibit an initiated automatic response and regain control over their behaviour (alcohol; Kreusch et al., 2013; Lopez-Caneda et al 2014; pathological gambling; Fuentes et al., 2006; Goudriaan et al., 2005; Kertzman et al., 2008; nicotine; Billieux et al., 2010; polysubstance users; Verdejo-Garcia, et al., 2010). Additionally, this impairment has been found to be particularly evident when substance-related stimuli are encountered (Adams et al., 2012; Brevers, Cleeremand, Verbruggen, et al., 2012; Fleming & Batholow, 2014; Kreusch et al., 2013; Noel et al., 2005, 2007; Pike et al., 2013; Rose & Duka, 2008; Weafer & Fillmore 2012). Thus, according to the dual-process theory it is not only the substance-related stimuli which "highjack" behaviour and elicit automatic responses, but also deficits in inhibitory control which fail to take control over these automatic responses, that are associated with cycles of substance seeking and taking behaviour. Although the evidence points to deficits in inhibitory control in problematic internet users (Dong et al., 2010; Zhou et al 2010), there is currently limited knowledge as to whether these processes are particularly prominent in the presence of internet-related stimuli.

An interesting point is that all of the theories mentioned above are not mutually exclusive but a combination of them can provide a robust theoretical understanding of the construct of problematic internet use. This approach has been validated in the field of addictions (Murphy et al., 2012) for, it has been argued that there is a high interconnection in the various mechanisms which have been implicated as underling subtance-seeking behaviour. For example, impairments in the reward system might predispose an individual to be hypersensitive to the rewarding effects of drugs. This process can result in an increased vigilance regarding stimuli related to drugs and as such, these cues can become the focus of cognitive processes. As a consequence, this can limit the capacity to control and reflect upon behaviour and thus the individual might make decisions which are serving to maintain the rewarding effects of the drugs without considering the future outcomes of the choices. Until further research in the field of problematic internet use is conducted to provide a better understanding of the phenomenon, perceiving this type of behaviour as a multidimensional construct with many factors influencing its genesis, course, and prognosis etc. is deemed to be the most appropriate approach.

1.10 Hypothesis and Aims

Taking into consideration all the aforementioned inconsistencies which surround the area of problematic internet use the overall aim of this thesis was to examine whether robustly cognitive and physiological markers of substance-related and addictive disorders are also evident in problematic internet use. The hypothesis was that if problematic internet use is another type of behavioural addiction, then these markers would be associated with the development and maintenance of this problematic behaviour. By focusing on this hypothesis, I attempted to provide some of the first experimental evidence with respect to the decision-making processes, attentional bias and inhibitory control that can cause and account for the maintenance of problematic internet use. The contribution of my research is twofold: first, to provide further evidence as to whether problematic internet use is a distinct psychopathological disorder and hence, similar to other types of addiction, and second, if these markers are evident in problematic internet users, then to provide a theoretical understanding of the phenomenon.

As well as assessing the relationship between markers of addictive behaviour in problematic internet use, this thesis also investigated other factors which may mediate this relationship. For example, considering the lack of a causal relationship between problematic internet use with various psychopathological and personality constructs, researchers have argued as to whether problematic internet use is a symptom for another disorder or the medium used to purse an existing problematic behaviour. Thus, in an attempt to investigate this, in all the experiments I assessed self-report measures of the aforementioned constructs and investigated, when applicable, whether markers of cognitive and physiological functioning are evident in problematic internet users, regardless of the co-existence of various psychopathological and personality constructs. Another aim of this thesis was to investigate whether problematic internet use constitute different subtypes. Therefore, an emphasis was placed on the assessment of similarities and differences between two potential subtypes of problematic internet use which predominantly associate with activities that can only be executed online; generic and Social Networking Sites (SNS) problematic internet use. SNS are devoted to peoples' interaction and communication via websites and applications with the most popular websites, according to the latest statistics in UK being Facebook, Twiter, LinkedIn and Google Plus+ and are those which are chosen as the focus of this thesis (UK Social Media Statistics for 2014). The impact of this type of investigation is again twofold. First it can provide evidence regarding whether different potential subtypes of problematic internet use exist by investigating similarities and differences in the aforementioned cognitive processes and, second, by focusing on online applications that can only be pursued online it can provide evidence for or against the debate as to whether or not problematic internet use is the medium for pursuing an already existing problematic behaviour.

Chapter two focused on assessing decision-making processes and the physiological functioning associated with them. The aim of this experiment was to examine whether deficits in the cognitive and physiological processes can explain behavioural patterns of problematic internet use which is characterized by continuation of internet usage despite the rise of negative consequence of its use in the user life. Chapter three then sought to examine whether these specific patterns of internet usage are also associated with attentional bias for stimuli related to internet use as has been reliably found for substance-related and addictive disorders. The focus of this experiment was not only to assess attentional bias in problematic internet users but also to investigate whether this bias was associated with the online activities internet users showed a preference for, which elucidates the presence of different subtypes of problematic internet use. Chapter four attempted to validate further the assumption that attentional bias might be subtype specific and thus assessed internet users whose primary problematic online behaviour was associated with using SNS. Finally, in Chapter five by building upon the previous chapters the aim was to examine whether the behavioural pattern of problematic internet use was not only associated with deficits in decision-making processes and attentional bias for those stimuli which “highjack” behaviour, but also the inability to reflect upon and control these behaviours. Research from substance-related and addictive disorders has found that it is also impairments in the ability of addicted individuals to control these automatic responses (attentional bias etc.). Thus, in this Chapter, I examined the role of internet-related cues on inhibitory control processes. Moreover, these processes were assessed for two potential subtypes of problematic internet use, generic and SNS, and considered along with stimuli related to the preferred online activities for each.

Chapter Two

Study 1: Underlying physiological mechanisms related to decision-making processes in problematic internet use

2.1 Abstract

Rationale: Substance-related and addictive disorders have reliably been found to relate with blunted emotional reactions to risky choices. Problematic internet use is a relatively new concept which has reliably been shown to associate with addictive tendencies. However, it is currently unknown whether it also associates with emotional reactions similar to the ones characterized in established addictions.

Objective: This study aimed to explore emotional reactions processing during risky decision-making via the assessment of physiological functioning in individuals with various levels of problematic internet use.

Methods: Seventy two participants performed the Iowa Gambling Task (IGT) which provides an index of an individual's ability to process and learn the probability of reward and loss. Integration of emotions into current decision-making frameworks is vital for optimal performance on the IGT and thus Skin Conductance Responses (SCRs) to reward, punishment and in anticipation of them were measured in order to assess the integration of emotions into decision-making.

Results: There was an enhanced disruption in choice behaviour in situations of ill-defined risk in association with severity of problematic internet use which resulted from a

delayed learning of the contingencies of the decks. Moreover, individuals with higher levels of problematic internet use had increased sensitivity to punishment as revealed from stronger SCRs in the trials that received punishment.

Conclusions: On the behavioural level, there seems to be similarities between problematic internet use and other types of addictions. However, SCRs data revealed that there are differences in the physiological mechanisms between them that lead to similar behavioural outcomes.

2.2 Introduction

Internet usage has become an inevitable part of our everyday lives, with most of us enjoying the convenience, flexibility and beneficial effects that its varied applications offer (Office for National Statistics, 2014). Nevertheless, this has come at a cost for a minority of individuals, who lose control over their internet use and as a consequence, experience significant negative repercussions in their lives (Caplan, 2007; Cheung & Wong, 2011; Tsai et al., 2009; Xiuqin et al., 2010; Yen et al., 2008). This type of behaviour has led researchers to debate whether problematic internet use can lead to what has been termed “internet addiction” (Griffiths, 2000; Hinic, Mihajlovic, Spiric, Dukic-Dejanovic, & Jovanovic, 2010; Pies, 2009; Shapira et al., 2000; Treuer, Fabian, & Furedi, 2001; Weistein & Lejoyeux, 2010; Young, 1996, 1999). The debate regarding problematic internet use as another type of behavioural addiction has derived from evidence where similarities have been found in the processes underlying problematic internet use and well-established types of addictions (notably, substance dependence and pathological gambling) on the behavioural and neurobiological level (Dong, Huang et al., 2011; Dong et al., 2010; Grant et al., 2010; Kuss & Griffiths, 2012; Pallanti et al., 2006; Sussman et al., 2011; Yen et al., 2007; Zhou et al., 2010, 2011). Additionally, evidence is suggestive of a co-morbidity between them (Bakken et al., 2009; Pallanti et al., 2006; Sussman et al., 2011; Villella et al., 2011; Yen, et al., 2007, 2008). Considering the proposition that all types of addiction originate from a single syndrome (Shaffer et al., 2004), it could be argued that problematic internet use and the more established addictions involve similar pathogenesis and symptomology (Shaffer et al., 2004). However, for firmer conclusions to be made it is necessary to investigate further whether these similarities hold true for other markers which have been reliably associated with the development and maintenance of addictive behaviours.

Problematic internet use is characterized by persistence in continuing to use it despite the rise of negative consequences in the user’s life. This is similar to addicted individuals consuming substances or gambling even though they know that these actions will have adverse consequences on themselves and others around them. This type of behaviour has been characterized as "myopia for the future" and suggests that addicted individuals express biases in decision-making where they ignore the negative outcomes of their behaviour unlike non-addicts (Bechara & Damasio, 2002). This bias could also reflect a decreased ability to learn from the risky contingencies of their choices, a pattern which has been linked with the maintenance of the addiction cycle (Bechara & Damasio, 2002; Bechara et al., 2001, 2002; Brand et al., 2007; Brevers, Cleeremans, Verbruggen et al., 2012; Clark & Robbins, 2002; Gavedini, Roboldi, Keller, Annucci, & Bellodi, 2002; Goudriaan et al., 2005, 2006; Gullo & Stieger, 2011; Kertzman, Lidogoster, Aizer, Kotler, & Dannon, 2011; Li et al., 2013; Vaidya et al., 2012; Verdejo-García & Bechara, 2009; Verdejo-García, Perales, & Pérez-García, 2007). Thus, the aim of this study was to assess decision-making patterns in individuals with varied degrees of problematic internet use. If individuals with elevated levels of problematic internet use express similar decision-making biases that are robustly found in the more established addictions, this will support the view that problematic internet use is compatible with other types of addictions.

A task that has been used widely to assess decision-making processes is the Iowa Gambling Task (IGT) (Bechara, Damasio, Damasio, & Lee, 1999). The IGT simulates an everyday decision-making scenario, in which the contingencies of various unknown outcomes must be learned through repeated exposure, and assesses whether decisions are short-term (which results in overall loss) or long-term driven (which results in overall gains), (Bechara et al., 1999). In the IGT, participants are instructed to try to win as much hypothetical money as possible by selecting a card from four decks of cards for 100 trials. Unknown to the participants each deck of cards varies in financial rewards and penalties. Half of the cards lead to short-term higher wins, but long-term higher losses (disadvantageous decks/bad decks) and the other half of cards to short-term lower wins but long-term lower losses (advantageous decks/good decks). In order to perform advantageously in the IGT, participants have to make choices from good decks more often than from bad decks.

Moreover, advantageous performance in the IGT has been associated with the generation of emotional related signals (somatic markers). According to the Somatic Marker Hypothesis (SMH), somatic markers are a necessity that help us guide our decisions, by providing a gut feeling about the emotional valence of an anticipated outcome (Damasio, 1994). It has been suggested that somatic activation is stronger (higher emotional arousal) when a stimuli is associated with negative outcomes. This is happening in order to provide stronger feedback indicating that this choice is a risky one and as such, to guide behaviour away from it and towards an advantageous outcome (Bechara et al., 1999). Research has revealed that failure in the generation of somatic markers before selecting a card from a bad deck, as indexed by the levels of physiological emotional arousal with Skin Conductance Responses (SCRs), relates to impaired performance (i.e. higher losses) on the IGT (Bechara & Damasio, 2002; Bechara et al., 1999, 2002; Goudriaan et al., 2006).

The SMH makes important predictions of not only the physiological functioning in association with decision-making processes but also of the brain areas involved in the generation of physiological reactions (Damasio, 1994). Thus, by assessing physiological markers, it is possible to make inferences about the underlying mechanisms associated with their generation. More specifically, it has been suggested that the brain areas which play a significant role in the generation of somatic markers and as a consequence, in the IGT performance, are the ventromedial prefrontal cortex (VMPFC) and amygdala (Bechara et al., 1999; Bechara, Damasio, Damasio, & Anderson, 1994; Bechara, Tranel, & Damasio, 2000; Damasio, 1994; Gupta et al., 2011). The amygdala has been argued to play a role in attributing affective value to a stimulus whereas the VMPFC's role is to reactivate this affective value of a stimulus (Bechara & Damasio, 2002; Bechara et al., 2002; Gupta et al., 2011; Verdejo-García & Bechara, 2009; Weller et al., 2010). Thus, according to the assumptions of SMH, any malfunctioning in these brain areas is associated with deficits in decision-making processes. This is because the links of attributing or reactivating the emotional valence of a stimulus are dysfunctional and as such, it is difficult to use emotional indications to obtain a gut feeling of the emotional valence of the stimulus. These assumptions have been validated with neuroimaging studies which have identified activation in the amygdala and VMPFC during IGT performance (Frangou, Kington, Raymont, & Shergill, 2008; Li, et al., 2010; Tanabe et al., 2007; Windmann et al., 2006). Additionally, further validation comes from studies conducted with patients who have lesions in the aforementioned brain areas. More specifically, these patients not only showed an overall deficit in task performance on the IGT but this impairment was coupled with an inability to generate emotional arousal before they made a choice (anticipatory SCRs, for both amygdala and VMPFC patients) and when they received a reward or punishment (only amygdala patients), (Bechara et al., 1999, Clark & Manes, 2004; Gupta et al., 2011). Similar patterns of physiological activity have also been implicated regarding deficits in decision-making in addicted individuals (Bechara & Damasio, 2002; Bechara et al., 2002; Goudriaan et al., 2006; Verdejo-García & Bechara, 2009). These physiological patterns have also been associated with functional deficits in amygdala and VMPFC brain areas in addicted individuals. It has been argued that hypersensitivity of the amygdala and/or hypo-activity of the VMPFC predisposes addicted individuals towards disadvantageous choices. More specifically, when stimuli related to substances of abuse are encountered, the amygdala renders strong emotional valence to those stimuli and as such they “highjack” behaviour. Additionally, because the VMPFC which is crucial for processing long-term outcomes is hypoactive, this causes addicted individuals to make choices according to immediate rewards (i.e. to consume a drug or gamble) while ignoring the long-term outcomes of their actions (Verdejo-García & Bechara, 2009).

Considering that deficits in somatic markers and decision-making processes are hallmarks of addictive behaviour (Verdejo-García & Bechara, 2009), the aim of this study was to assess whether similar deficits are evident in problematic internet users. Researching the area would contribute to our understanding of the underlying mechanisms that might be involved in the development and/or maintenance of problematic internet use and identified potential similarities in behavioural as well as biophysiological functioning with other types of addiction.

To the best of my knowledge only two studies have assessed decision-making processes in problematic internet users with the IGT but they both lacked physiological assessment, therefore, an understanding of somatic marker functioning is currently absent (Ko et al., 2010; Sun, Chen, Ma, Zhang, Fu, & Zhang, 2009). In addition, there was a discrepancy between the two studies regarding task performance. Sun et al. (2009) found that problematic internet users’ overall performance was more impaired compared to that of the controls, whereas Ko et al. (2010) found that they performed better than the controls. However, the lack of physiological assessment (SCRs) in both studies makes it impossible to assess somatic marker functioning and thus provide a possible explanation as to whether or not these inconsistencies might reflect differences in the underlying mechanisms associated with decision-making processes. For example, research that explored within-group differences in substance dependent individuals who performed the IGT, found that the apparent degradation in somatic marker functioning was not evident for all individuals (Bechara & Damasio, 2002; Bechara et al., 2002). More specifically, one subgroup performed advantageously in the IGT and had similar physiological responses (SCRs) as the normal controls. Another subgroup performed disadvantageously and had similar physiological responses (SCRs) as VMPFC patients (impaired generation of anticipatory SCRs). Finally, a third subgroup performed disadvantageously, although their performance was linked to enhanced reward sensitivity and decreased sensitivity to punishment (stronger SCRs before and after they made a choice with a higher reward magnitude and weaker SCRs when they made a choice with a higher punishment magnitude), (Bechara et al., 2002). These findings elucidate biases in the processes underlying decision-making and highlight the necessity for the assessment of SCRs. Additionally, it posits the possibility that the discrepancies in the findings in relation to problematic internet use could also reflect differences in the underlying mechanisms related to decision-making processes. Thus, in the present study both anticipatory SCRs (somatic markers before they made a choice from either advantageous or disadvantageous decks) and SCRs related to outcomes associated with reward and punishment in the IGT were assessed.

Another aim of this study was to assess whether psychopathology had an effect regarding task performance. More specifically, evidence suggests that factors such as anxiety or impulsivity can either improve or degrade performance on the IGT (Davis, Patte, Tweed, & Curtis, 2007; Miu, Heilman, & Houser, 2008). Further, it is well documented that problematic internet use has been linked with various psychopathological and personality constructs such as depression, anxiety, social phobia, hostility, impulsivity etc. (Cheung & Wong, 2011; Dong, Lu et al., 2011; Fisoun et al., 2012; Kim et al., 2010; Ko et al., 2009; Kormas et al., 2011; Lam et al., 2009; Shek et al., 2008; Tsitsika et al., 2011; Wang et al., 2011; Whang et al., 2003; Yen et al. 2008). This evidence has encouraged researchers to contest whether problematic internet use is just the medium used to pursue another coexisting problematic behaviour (Collier, 2009; Griffiths, 2000; Pies, 2009). Thus, there is a need to research whether certain behavioural patterns are characteristics of problematic internet use which are independent of the coexistence of another psychopathology. This investigation would impact upon our understanding of whether or not problematic internet use is a distinct psychopathological construct.

The final objective in this study was to identify which were the online applications internet users spent most of their time on. Building upon the aforementioned argument as to whether or not the internet is just the medium to pursue an already problematic behaviour, researchers have gone further and have questioned whether it is the internet per se or for certain applications that individuals display problematic internet use (Davis, 2001; Griffiths, 1999, 2000; Stern, 1999; Yellowless & Marks, 2007; Young et al., 1999). Researching this area can have important implications for primary and secondary diagnosis. If, for example, a gambler uses the internet to gamble then the behavioural profile and the primary diagnosis will fit that of pathological gambling. However, if a problematic internet user uses online applications which can only be pursed online, then this would validate the argument that problematic internet use is a distinct psychopathological condition. Moreover and following this argument, if it is with respect to the internet per se that internet users display problematic behaviour it could be suggested that some internet users might show a preference for certain online activities, whereas others might display a more generic problematic online behaviour (Davis, 2001). Thus, it is not an issue that a problematic internet user whose primary online use is for example, social networking sites, would also spend time on other online applications. Instead, it could be argued that there might exist problematic internet users whose internet use is specific or generic (Davis, 2001). As long as the applications that the problematic internet users show a preference for can only be found online, this would validate the argument that problematic internet use is a distinct psychopathological construct. Building upon these assumptions in this study specific online applications were assessed in order to investigate whether internet users tend to use the internet for applications that can only be found online (social networking sites, discussion forums etc.) or for applications that can be found both offline and online (e.g. gambling and gaming). If internet users use the internet for applications that can only be found online then it could be argued that different potential specific subtypes of problematic internet use might exist (such as:

generic, eBay and social networking problematic internet use). However, if the majority of applications that they use can be found offline then it could be argued that the internet is serving as the medium to pursue an already existing problematic behaviour.

To sum up, given the increased awareness of the addictive potential of problematic internet use, it is of great importance to identify the potential underlying mechanisms related to its development and maintenance, which is crucial for the development of intervention strategies. This project investigated whether reliably found behavioural and physiological markers of substance-related and addictive disorders were also the characteristics of problematic internet use, thus adding evidence as to whether problematic internet use should be classified within the established addiction spectrum. Based upon studies conducted with substance dependent individuals and pathological gamblers (Bechara & Damasio, 2002; Bechara et al., 2000, 2002; Goudriaan et al., 2006; Verdejo-García & Bechara, 2009), it was hypothesized that IGT performance would be inversely correlated with the severity of problematic internet use, and the impaired performance on IGT would be associated with blunted somatic activation (impairment in the generation of anticipatory SCRs). Moreover, a secondary aim of this study was to assess various psychopathological and personality constructs which they have been suggested to impact upon IGT performance and to investigate whether the hypothesized impaired performance is a marker of problematic internet use independent of the coexistence of other psychopathological and personality constructs. Finally, I investigated the association between the severity of problematic internet use and quantity of time spent on different internet applications, which can either be found online or both online and offline in order to provide evidence regarding whether or not the internet is just the medium to pursue an already problematic behaviour.

2.3 Method

2.3.1 Participants

Participants were recruited from the University of Bath and the city of Bath through online and local magazine advertisements. In the initial phase of the experiment, an online questionnaire assessing participants' internet use was administered (Internet Addiction Test

- IAT, Problematic Internet Use Questionnaire - PIUQ). From a total number of 374, 72 were contacted for further testing (phase two) based on their total scores on these two questionnaires. I tried to recruit participants whose scores ranged from low to high on the IAT and PIUQ. The mean age of participants was 23.08 years (*SD* = 4.61) and there were 45 females. There was an imbalance in the male-to-female ratio in this study. The number of participants who undertook the second phase of testing reflected the ratio of males and females that initially showed an interest in participating in the study (initial stage ratio, 1:1.3; second stage ratio, 1:1.6). Such inconsistency has been noted previously within several articles related to this field of research and many researchers have surmised that this discrepancy might reflect the willingness of female participants to disclose personal information compared to that of males (Young, 1998a). For example, Aboujaoude et al. (2006) conducted an epidemiological telephone survey to assess the prevalence and patterns of problematic internet use and found a substantial higher number of female participants in the survey, which supports the argument that females were more willing to disclose personal information. Similarly, in Campbell et al.'s (2006) study the ratio of male : female was 1:1.13, while in Caplan's (2005) study it was 1: 2.3, 1: 2.9 in Jang et al.'s (2008) study, 1: 2.1 in Mottram and Fleming's (2009), 1: 2.25 in Su et al.'s (2011), 1: 1.9 in Widyanto & McMurran's (2004), and 1:7 in Yau et al.'s (2013). Considering that in the present study questions related to personality characteristics and mental health were asked, this might have made male participants less willing to disclose such information. Even though efforts were made specifically to advertise the study in departments of the university with a high proportion of male students such as Computer Science and Mechanical Engineering it was very difficult to recruit male participants.

2.3.2 Iowa Gambling Task (IGT)

The Iowa Gambling Task was first introduced by Bechara et al. (1994) in order to assess the way individuals make decisions when factors such as uncertainty, reward and punishment are combined together. In this task, participants were instructed to try to win as much hypothetical money as possible by choosing a card from four decks of cards. The participants were unaware of the contingencies of the decks. Choices from the decks of cards which were labelled disadvantageous decks (decks A, B) lead to higher wins and losses of money. Choosing from these decks in the long-term leads to higher loss of money and for this reason these decks have been termed disadvantageous. On the other hand, selecting from decks C and D (advantageous decks) was associated with lower wins and losses, however, the long-term outcome of these choices resulted in a higher profit (wins of money). Moreover, in addition to the difference between the magnitude of the potential wins and losses between the decks (advantageous versus disadvantageous), there was a difference within the decks related to the frequency of losses. That is, one out of the two advantageous decks gave more frequent lower losses whereas the other deck was associated with less frequent higher losses (but both had the same net total wins in the long-term) and similarly for the disadvantageous decks. The sequence of frequencies and magnitude of wins and losses was similar to Bechara et al.'s (1994) study (Table 2.1). The goal of this task was for participants to identify which decks were disadvantageous and which decks were the advantageous ones, in order to make more choices from the advantageous ones and avoid choosing from disadvantageous ones.

In this experiment a computerized version of the IGT was administered, similar to Bechara et al. (1999). E-Prime was used to generate the computerized version of the IGT, using Intel Core 2 stone desktop computers and a monitor display (1280 x 1024) to present the experiment. The decks of cards (A, B, C, D) were identical in appearance (real decks of cards) and were presented in the middle of the computer screen. The participants chose a card from one of the four decks by clicking on one of the four allocated keys which was associated with each deck of cards. When they did this, the card face changed and appeared on the deck in a different colour, either black or red, and a message was displayed on the screen indicating the amount of money won or won and lost (Figure 2.1). On the top of the decks of cards there were two bars, one green, which got longer when they won money, and a red one that got longer when they lost money. As the money was added to the green and red bars, the card that was selected (which has turned either red or black) changed back to its normal colour and the participant could select another card. The total number of card selections was set to 100 trials and the experiment shut off automatically, but, as with the original version of the task, the participants were not told for how long the task would last. The inter-trial interval was set to six seconds in order to allow for valid recording of the psychophysiological response (SCRs). During the six second inter-trial interval the decks were displayed continuously on the screen and participants could ponder from which deck of cards to choose next. However, if participants clicked on one of the four keys on the keyboard to select a card during this interval, the computer would not respond, and therefore no recording was generated.

Each deck of cards had been programmed to have 40 cards; 20 of the cards with a black face and 20 with a red face. The sequence of the red and black cards in each deck was random and was based on the original version of IGT (Bechara et al., 1994). There was the possibility of running out of cards in each deck. In this case, a message appeared where the card had originally appeared on the screen and this informed participants that the cards had run out and they had to choose from the remaining three decks. The dependent variables for IGT performance were the total number of cards selected from advantageous minus disadvantageous decks for the 100 trials and for blocks of 20 trials (five blocks) in order to assess the learning rate regarding the contingencies of the decks.

Table 2.1- The sequence of frequencies of wins and losses in four decks of cards for 40 trials.

Response Option	***A*** ***+100***	***B*** ***+100***	***C*** ***+50***	***D*** ***+50***
1				
2				
3	-150			
4				
5	-300		-50	
6				
7	-200		-50	
8				
9	-250	-1250	-50	
10	-350		-50	*-250*
11				
12	*-350*		*-25*	
13			*-75*	
14	*-250*	*-1250*		
15	*-200*			
16				
17	*-300*		*-25*	
18	*-150*		*-75*	
20				
			-50	*-250*
21		*-1250*		
22	*-300*			
23	*-350*			
24			*-50*	
25			*-25*	
26	*-200*		*-50*	
27	*-250*			
28	*-150*			
29			*-75*	*-250*
30			*-50*	
31	*-350*			
32	*-200*	*-1250*		
33	*-250*			
34			*-25*	
35			*-25*	*-250*
36				
37	*-150*		*-75*	
38	*-300*			
39			*-50*	
40			*-75*	

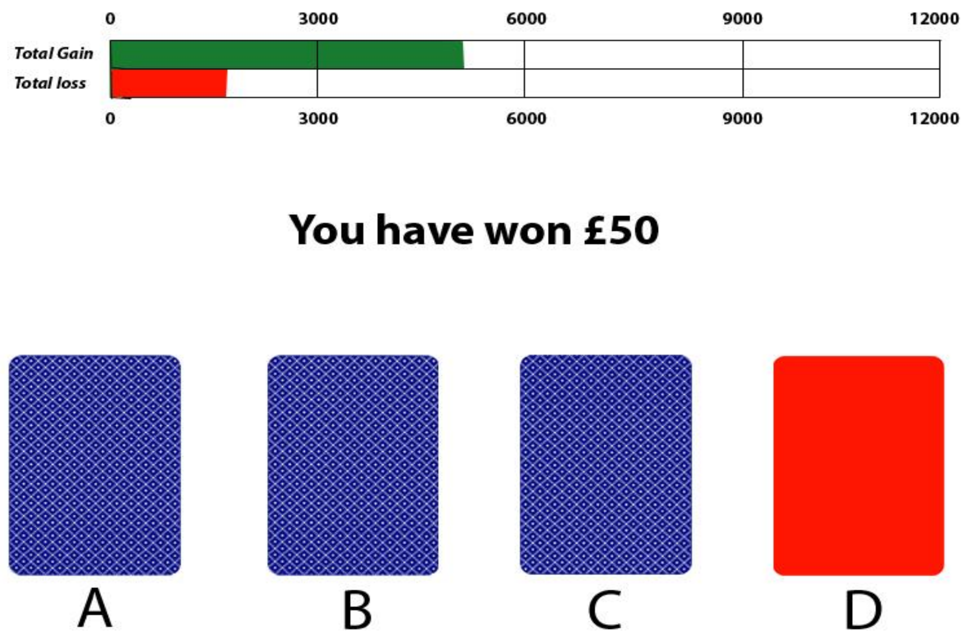

Figure 2.1 Example of an experimental trial in the computerized Iowa Gambling Task

2.3.3 Self-report measures - Questionnaires

Internet Addiction Test (IAT)

The IAT is a 20-item self-report questionnaire (Young, 1998a). It assesses the severity of negative repercussions arising from excessive internet use. It was developed based on diagnostic criteria from the DSM-IV (America Psychiatric Association, 1994) for pathological gambling. Respondents rate each item on a 5-point scale (1: rarely, 2: occasionally, 3: frequently, 4: often, 5: always). A total score is obtained by adding the scores for all items. Young (1998a) suggested three cut off points: 1) between 20 and 49 shows average use, 2) between 50 and 79 moderate use and 3) between 80 and 100 problematic use. Nevertheless, many studies have used arbitrary cut-off points of 70 > or 50 > to distinguish between problematic and non-problematic internet use (Villella et al., 2011; Wang et al., 2011; Weinstein & Lejoyenx, 2010; Widyanto & McMurran, 2004). Thus, in order to overcome the aforementioned inconsistencies and based on the belief that any disorder is best understood as falling along a continuum (Helzer, van de Brink, & Brink, 2006), in this study the severity of problematic internet use was assessed with the IAT by using a continuum similar to that adopted in Spada et al.'s (2008) study. Moreover, Chang and Man Law (2008) assessed the dimensionality of the IAT and argued that problematic internet use can be best understood based on three factors: withdrawal and social problems, time management and performance and reality substitute. The withdrawal and social problems factor assesses mood changes and interpersonal conflicts arising from excessive internet use (e.g. "How often do you feel depressed, moody or nervous when you are offline, which goes away once you are back online?"). The time management and performance factor assesses the ability to control the amount of time spent online and occupational problems arising from excessive internet use (e.g. "How often do you find that you stay on-line longer than you intended?"). The reality substitute factor assesses dependence on the online environment for escaping everyday stresses (e.g. "How often do you fear that life without the Internet would be boring, empty, and joyless?"). Thus, in this study I obtained both a total IAT score and scores for each of its three subscales. The Cronbach's alpha coefficient was 0.90 for the whole scale and 0.79 (withdrawal and social problems), 0.84 (time management and performance) and 0.72 (reality substitute).

The Problematic Internet Use Questionnaire (PIUQ)

The PIUQ is an 18-item self-report measure assessing problems arising from internet use (Demetrovics et al., 2008). It was initially developed to accommodate new symptoms that have been considered to be associated with problematic internet use but which have not been assessed with the IAT. Respondents rate each item on a 5-point scale (1: never, 2: rarely, 3: sometimes, 4: often, 5: always). The PIUQ consist of three factors: obsession, neglect and control disorder. A total score can be computed by adding the scores from all three factors. The obsession factor assesses mental preoccupation and consequences (anxiety, depression) related to internet use (e.g. "How often do you fantasize about the Internet, or think about what it would be like to be online when you are not on the Internet?"). The neglect factor assesses any negative consequence concerning social and occupational functioning which arises from internet use (e.g. "How often do you choose the Internet rather than spending time with your partner or friends?"). The control disorder factor assesses any difficulty arising from an inability to control internet use (e.g. "How often do you think that you should ask for help in relation to your Internet use?"). The Cronbach's alpha coefficient was 0.93 for the whole scale and 0.89 (obsession), 0.83 (neglect) and 0.85 (control disorder). The problematic internet use has no standard cut-off point to define PIUQ (Demetrovics et al., 2008; Kelley & Gruber, 2010) and following the same approach as with the IAT, I viewed problematic internet use along a continuum.

In this study problematic internet use was assessed based on two different well-established and validated questionnaires (the IAT and PIUQ) in order to accommodate for the discrepancies in relation to assessment and diagnosis criteria.

Brief Symptom Inventory (BSI-53)

The BSI is a 53-item self-report questionnaire assessing levels of psychopathology (Derogatis & Melisaratos, 1983). The BSI-53 consists of nine subscales; somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation and psychoticism. Respondents rate each item on a 5-point scale (1: not at all, 2: a little bit, 3: moderate, 4: quite a bit, 5: extremely). The BSI also contains three global indices of distress: the general severity index (GSI), the positive symptom total (PST) and the positive symptom distress index (PSDI).The BSI-53 has good internal consistency with a range of 0.71 to 0.85 and test-retest reliability with a range of 0.68 to 0.91 (Derogatis & Melisaratos, 1983) The Cronbach's alpha coefficient was 0.96 for the whole scale and 0.82 (somatization), 0.83 (obsession-compulsion), 0.88 (interpersonal sensitivity), 0.86 (depression), 0.87 (anxiety), 0.85 (hostility), 0.86 (phobic anxiety), 0.83 (paranoid ideation), 0.82 (psychoticism). All raw scores were converted to T-scores using adult non-patient norms for each gender (Derogatis, 1993).

Barratt Impulsiveness Scale version 11 (BIS-11)

The BIS-11 is a 30-item self-report measure of trait impulsivity (Patton et al., 1995).

Respondents rate each item on a 4-point scale (1: rarely/never, 2: occasionally, 3: often and 4: almost always/always). The BIS-11 consists of three factors: non-planning, motor and cognitive (or attentional) impulsivity. A total score can be computed by adding the scores from all three factors. The non-planning factor assesses whether an individual is present or future oriented (e.g. "I plan for job security"). The motor factor assesses an individual's propensity to physically act without thinking (e.g. "I act on the spur of the moment"). The cognitive factor assesses an individual's tendency to make rapid decision (e.g. "I concentrate easily"). The Cronbach's alpha coefficient was 0.80 for the whole scale and 0.71 (non-planning), 0.70 (motor) and 0.68 (cognitive).

Questionnaire assessing Internet-related Activities

An 18-item self-report questionnaire assessing engagement with specific online applications was based on similar questions as those generated in Van Rooij (2011) and Eijnden et al.'s (2008) studies. Respondents rate each item on a 4-point scale (1: never, 2: rarely, 3: sometimes, 4: often). The Cronbach's alpha coefficient for the current sample was 0.80.

Questionnaires assessing co-morbidity of psychopathology

A 9-item self-report questionnaire assessed the presence of emotional and psychiatric problems. Specific questions were asked such as: Have you ever had 1) depression, 2) attempted suicide /deliberate self-harm, 3) manic episode/manic depression/bipolar, 4) anxiety/panic/phobia, 5) obsessive compulsive disorder, 6) psychotic episode/schizophrenia, 7) eating disorders, 8) drug and alcohol problem, 9) other psychopathology? A score of either 0 (absent) or 1 (present) was assigned. In order to obtain an index of the co-morbidity, I summed the scores obtained from each of the psychopathologies (scores ranging from 0 to 9) were summed.

2.3.4 Procedure

The participants were invited to complete an online questionnaire assessing levels of internet use (IAT and PIUQ) on an online data collection website (the Bristol Online Survey). In this phase, the participants were given information about the study and offered the opportunity to ask any further questions. Based on the IAT and PIUQ scores, a convenient sample was contacted via email and asked to participate in the second phase of the experiment. In the second phase, an effort was made to recruit participants whose internet use ranged from low to high. Those invited for the second phase were asked to attend the Psychology Lab at the University of Bath where they were given information explaining the procedure for the experiment and a consent form, which they had to sign once they agreed to take part in the study. Subsequently, they were asked to fill in an online questionnaire assessing different aspects of psychopathology (BSI-53), personality dimension of impulsivity (BIS-11), questions related to online activities and finally questions assessing the co-morbidity of psychopathological disorders (depression, substance misuse etc.). Then they proceeded to the computerized task (IGT). Completing prescreen assessments such as those detailing psychopathological and demographic information has been reported in prior studies using the IGT and there is no indication that this order has an effect over performance (Miu et al., 2008; Briggs et al., 2015). The task was performed in a sound proof room in order to control for any noise which might have interfered with the physiological recordings (SCRs).

In order to record the SCRs, before participants started the IGT two electrodes were attached to the middle and index fingers in the distal phalanx area of the non-dominant hand by applying an electrolyte gel and waiting for about 5 minutes. It has been suggested that this area of the hand provides the best responsivity to SCRs (Bouscein et al., 2012). These fingers were selected so that participants could use the dominant hand to give responses while performing the IGT and the waiting time is considered sufficient for the electrolyte gel to be absorbed and thus enable better contact between the skin and the electrodes. At this stage participants were asked to rest their hand, to which the electrodes had been attached in a comfortable position and not to move it throughout the experiment. Also, they were asked to try to not to move and stay still during the experiment as any movement would have an impact on data acquisition. Once it was assured that there was good connectivity of the electrodes by asking participants to take a deep breath and checking for an appropriate SCR response, they started the IGT. Participants read the following instructions on the computer screen:

On the screen in front of you there are four decks of cards: A, B, C, and D. I want you to select one card at a time, by pressing on A, B, C and D keys on the keyboard. Each time you select a card from a deck, the colour of the card will turn red or black, and the computer will tell you that you have won some money. Every time you win, the green bar gets longer. However, every so often when you click on a card the computer will tell you that you have won some money but also it will tell you that you have lost some money. Every time you lose, the red bar gets longer. You are absolutely free to switch from one deck to another at any time you wish. The goal of the game is to win as much money as possible. All I can say is that you may find yourself losing money on all of the decks, but some decks will make you lose more than others. If you have any questions please ask now.

Press the SPACE bar to begin.

The total participation time was 30 minutes. Participants received a payment of £10 for their time and they were verbally debriefed at the end of the experiment.

2.3.5 Psychophysiological Responses

Skin Conductance Responses (SCRs)

Electrodermal responses are the index of the changes in electrical activity in a person's skin (Bach, Flandin, Friston, & Dolan, 2009). SCRs have been widely used to measure levels of arousal associated with emotional and cognitive processes (Bach et al., 2009). In the present study SCRs were acquired using a Biopac system (MP150) in combination with the modules for skin conductance (GSR100C). AcqKnowledge software was used in order to set up: acquisition parameters, real time monitoring, and the recording and analysis of the measurements for the SCRs data. In this study, the Biopac amplification was linked up to no hardware high-pass filters. That is, the switches were set to DC-which meant that the current flows and the two electrodes were polarized in opposite directions. This method provides an exosomatic measure of SCRs by applying a direct current (0.5V). The sampling rate was set to 1000Hz. Reusable electrodes Ag/AgCl, were used, filled with electrolyte gel (NaCl isotonic-a solution that has the same salt concentration as the normal cells of the body and the blood), which is specially formulated with 0.5% saline in a neutral base and these were cleaned after each use. SCRs were measured in MicroSiemens (μS) and the threshold value for analysing SCRs was set at 0.02 μS and the rejection rate was set to 0% (all SCRs were included in the analysis). The rejection rate has been used in order to control for contextual information which might affect the SCR amplitude. For example, a rejection rate of 10% suggests that detected SCRs with an amplitude smaller of the 10% of the maximum SCR amplitude in this segment are excluded. However, due to the nature of this experiment, there is a possibility that the maximum SCR amplitude might reflect the initial activation when the secure contact of the electrodes was checked. This might then mask any SCR amplitudes associated with the task so it was decided to include all SCR responses.

For this study, three types of SCR were measured; punishment SCRs, which were generated after turning a card for which there was a reward immediately followed by a penalty; reward SCRs, which were generated after turning a card for which there was a reward, and anticipatory SCRs, which were generated prior to turning a card from any given deck. Event-related analysis was used to analyse the SCRs in this study. The time window for the reward and punishment SCRs was set from the 2nd second after participants made a response, until the 5th second. This time window was long enough to capture SCRs related to the stimulus for it has been suggested that the electrodermal response begins between 1 and 4 seconds after stimulus presentation (Dawson, Schell, & Courtney, 2011). Moreover, it is short enough to avoid noise in terms of electrodermal activity related to non-specific changes in autonomic arousal. Additionally, those SCRs generated during the end of the reward/punishment window and before the next click of a card were considered as anticipatory SCRs. The time window varied from trial to trial as there was a set-up period of 6 seconds where participants could not make a response, and after this time interval on average participants made a response within two to three seconds after the end of these 6 seconds. Thus, the time window for the anticipatory SCRs was set from the end of the 6th second (where the four decks of cards appeared on the screen and another choice could be made) for a duration of 3 seconds. This measure differs from Bechara et al.'s (2002) time window of 5 seconds that participants took to respond. In our sample participants made quicker choices, within 3 seconds and thus the time window chosen was the best possible fit of the data, in order to control for overlapping activity between trials and events. For each participant two dependent variables for reward, punishment and anticipatory SCRs were obtained respectively, for both advantageous and disadvantageous decks.

SCRs activity was recorded continuously while performing the IGT and their choice of cards was recorded as a ''mark'' on the polygram. Thus, it was possible to associate SCRs activity with choices from a specific deck of cards each time. The room temperature conditions were the same for all the participants and averaged between 20 and 22 degrees Celsius.

2.3.6 Statistical Analysis

All statistical analyses of the data presented below were conducted using the software SPSS 20. The Pearson correlation coefficients assessed whether performance on the IGT degraded as the severity of problematic internet use increased. Performance was analysed for the total number of trials (100 trials) and for each of the five blocks (20 trials each). Additionally, biserial correlations assessed the association between the severity of problematic internet use and psychopathological co-morbidity. Moreover, due to the higher number of females in our sample, gender was initially introduced in the analysis as a covariate but it had no effect on performance and therefore it was excluded from further analysis. Although problematic internet use was viewed along a continuum, in order to assess the distribution of the scores within the samples two groups were created based on the median split scores on the IAT (median = 50.5, thus individuals with lower/no levels of problematic internet use scored lower than 50.5 and individuals with higher levels of problematic internet use scored higher than 50.5) as well as on the PIUQ (median = 46.5, thus individuals with lower/no levels of problematic internet use scored lower than 46.5 and individuals with higher levels of problematic internet use scored higher than 46.5). The median value for PIUQ of our sample was similar to the cut off mean value of 46.7 which, according to Demetrovics et al. (2008), is a cut off that reliably distinguishes problematic from non-problematic internet users. Thus, performance on the IGT for the two groups (conducted separately, either based on the IAT or PIUQ median split) was assessed with a 2 (groups) x 5 (blocks) mixed way ANOVA, followed up with post-hoc tests to identify differences in performance between the blocks in the IGT.

Due to technical difficulties seven participants had no SCR data and thus were excluded from further analysis. Furthermore, data were excluded from the analysis when they were deviating more than three times the interquartile range from the 25th or 75th percentile (2.8% of the data) in order to control for movement artefacts and when there was a missing value for that particular event (9.7% of data). A Spearman correlation was used to correlate SCRs with the IAT and PIUQ scores because the SCR data violated parametric assumptions, i.e. highly skewed with high levels of kurtosis. Finally, Mann-Whitney and Wilcoxon tests assessed between and within group differences on SCRs data respectively. SCRs data were averaged for each type of deck in relation to the whole task performance in a similar way to Goudriaan et al. (2006), Miu et al. (2008) and Bechara et al.'s (1999) methodologies.

Additionally, Pearson correlation coefficients assessed the association between various psychopathological constructs and impulsivity with the severity of problematic internet use, as well as the association between various online applications with the severity of problematic internet use. Finally, multiple regressions assessed the predictability of various online applications in association to the severity of problematic internet use.

2.4 Results

2.4.1 Relationship between psychopathological co-morbidity, psychopathological and personality constructs with IAT, PIUQ and IGT performance.

Table 2.2 revealed that severity of problematic internet use as assessed with IAT and PIU was not associated with psychopathological co-morbidity ($p > .05$).

Table 2.2- Biserial Correlations (Pearson) of psychopathological comorbidities with IAT and PIUQ.

	IAT Total		PIUQ Total	
Psychopathological co-morbidity	*Rho* value	*p* value	*Rho* value	*p* value
Depression	.05	.661	.04	.716
Suicide attempt/deliberate self-harm	.05	.668	.05	.692
Manic episode/manic depression/bipolar disorder	.16	.179	.11	.339
Anxiety/panic/phobia	.07	.527	.09	.465
Obsessive-compulsive disorder	-.16	.177	-.14	.235
Psychotic episode/schizophrenia	.19	.093	.17	.159
Eating disorders	.06	.625	.05	.654
Drug and alcohol problems	.03	.827	.06	.624
Other	.04	.727	.08	.488

Note. Values are correlation coefficients (two-tailed). IAT = Internet Addiction Test; PIUQ = Problematic Internet Use Questionnaire. For psychopathological co-morbidity a score of either 0 (absent) or 1 (present) was assigned.

There were positive correlations between the severity of problematic internet use (IAT and PIUQ) with BSI and BIS (Table 2.3). However, none of the psychopathological and personality constructs were associated with IGT performance. In addition there was no correlation between the total number of symptoms related to psychopathological co-morbidity with severity of problematic internet use as well as IGT performance.

Table 2.3- Correlations (Pearson) of IAT, PIUQ, IGT with BSI, total number of symptoms of psychopathological co-morbidity and BIS.

	IAT Total		PIUQ Total		IGT Total Net Scores	
	Rho value	*p* value	*Rho* value	*p* value	*Rho value*	*p* value
BSI global severity index	**.47****	.001	**.50****	.001	-.11	.337
BSI positive symptom total	**.43****	.001	**.45****	.001	-.07	.58
BSI positive symptom distress index	**.53****	.001	**.52****	.001	-.11	.374
BSI somatization	**.42****	.001	**.37****	.001	-.02	.833
BSI obsession-compulsion	**.49****	.001	**.46****	.001	-.09	.434
BSI interpersonal sensitivity	**.26***	.027	**.34****	.003	-.08	.526
BSI depression	**.35****	.002	**.41****	.001	-.11	.362
BSI anxiety	**.37****	.001	**.41****	.001	-.19	.107
BSI hostility	**.40****	.001	**.37****	.001	-.09	.446
BSI phobic anxiety	**.32****	.007	**.32****	.006	-.08	.498
BSI paranoid ideation	**.34****	.003	**.41****	.001	-.12	.306
BSI psychoticism	**.42****	.001	**.42****	.001	-.02	.834
Co-morbidity of psychopathological symptoms	.11	.366	-.19	.104	.14	.249
BIS total	**.20***	.043	**.23****	.024	-.10	.21
BIS attention	**.26***	.013	**.28****	.009	.07	.28
BIS motor	.09	.23	.09	.023	-.14	.11
BIS non-planning	.14	.12	**.20***	.05	-.13	.14

Note. Values are correlation coefficients; bold coefficients are statistically significant (two-tailed). IGT Total Net Scores [the total number of cards selected from decks C' and D' (advantageous) minus decks A' and B' (disadvantageous), i.e. (C+D) − (A+B)] for the 100 trials, IAT = Internet Addiction Test; PIUQ = Problematic Internet Use Questionnaire; BSI = Brief Symptom Inventory, BIS = Barratt Impulsivity Scale, Co-morbidity of psychopathological symptoms = Total number of psychopathological symptoms. $p < .01^{**}$, $p < .05^{*}$

Overall, these results imply that any deficit in IGT performance would be a marker of problematic internet use as severity of psychopathology and symptoms co-morbidity as well as elevated levels of impulsivity were not associated with task performance (Table 2.3). This suggestion was further validated with the finding that there was no relationship between the various psychopathological comorbidities and severity of problematic internet use (Table 2.2).

2.4.2. Behavioural performance

Table 2.4- Correlations (Pearson) of performance on the IGT with IAT and PIUQ with their subscales.

	IAT Total	PIUQ Total	IGT Total Net Scores	IGT Total Net Scores for 1st block	IGT Total Net Scores for 2nd block	IGT Total Net Scores for 3rd block	IGT Total Net Scores for 4th block	IGT Total Net Scores for 5th block
IAT Total	**1**	**.90****	-.13	.02	-.01	**-.29***	-.07	. 09
IAT Withdrawal Subscale	**.92****	**.78****	-.12	.01	-.01	**-.25***	-.07	.07
IAT Time management Subscale	**.85****	**.85****	-.15	-.04	-.12	**-.26***	-.08	.06
IAT Reality Subscale	**.79****	**.70****	.05	.14	.04	-.15	.05	.13
PIUQ Total	**.90****	**1**	-.19	-.01	-.19	**-.34****	-.12	.11
PIUQ Obsession Subscale	**.80****	**.87****	-.15	-.02	**-.21***	**-.20***	-.12	.10
PIUQ Neglect Subscale	**.88****	**.93****	-.17	.00	-.07	**-.32****	-.10	.03
PIUQ Control Disorder Subscale	**.76****	**.91****	**-.20***	-.00	**-.22***	**-.39****	-.10	.16

Note. Values are correlation coefficients; bold coefficients are statistically significant (one-tailed). IGT Total Net Scores [the total number of cards selected from decks C' and D' (advantageous) minus decks A' and B' (disadvantageous), i.e. (C+D) − (A+B)] for the 100 trials and for each of five blocks (20 trials each), IAT = Internet Addiction Test, PIUQ Total = Problematic Internet Use Questionnaire Total Scores. $p < .05^{*}$; $p < .01^{**}$

The relationship between severity of problematic internet use and degradation in overall performance approached significance as assessed with PIUQ, $r = -.19$; $p = .052$, 95% CI [-.403, .043]. Exploration of performance by block (Table 2.4) revealed that severity of problematic internet use was negatively correlated with performance in the third block as assessed with both the IAT, $r = -.29$; $p = .006$, 95% CI [-.488, .063] and PIUQ, $r = -.34$; $p = .002$, 95% CI [-.529, .118] and approached significance in the second block, as assessed with PIUQ, $r = -.19$; $p = .055$, 95% CI [-.403, .043].

2.4.3. Partial-correlations between IAT, PIUQ and performance on the IGT after controlling for gender.

This study had a gender imbalance. Thus, it was assessed whether gender had an effect in task performance on the IGT.

Table 2.5- Partial correlations (Pearson) between performance on the IGT with IAT and PIUQ after controlling for gender.

	IGT Total Net Scores	IGT Total Net Scores for 1st block	IGT Total Net Scores for 2nd block	IGT Total Net Scores for 3rd block	IGT Total Net Scores for 4th block	IGT Total Net Scores for 5th block
IAT Total	-.12	.02	-.09	**-.27****	-.08	.08
PIUQ Total	-.19	-.01	-.18	**-.33****	-.13	.11

Note. Values are correlation coefficients; bold coefficients are statistically significant (one-tailed). IGT Total Net Scores [the total number of cards selected from decks C' and D' (advantageous) minus decks A' and B' (disadvantageous), i.e. (C+D) − (A+B)] for the 100 trials and for each of five blocks (20 trials each), IAT = Internet Addiction Test, PIUQ Total = Problematic Internet Use Questionnaire Total Scores. $p < .05^{*}$; $p < .01^{**}$

Results revealed that after controlling for gender, the severity of problematic internet use as assessed with the IAT was significantly negatively associated with IGT performance on the third block (r = -0.27; p = .01). Similarly, there was a significant negative association between performance on the third block and severity of problematic internet use as assessed with PIUQ (r = -.33; p = .003). Finally, the overall performance approached significance in association to severity of problematic internet use; PIUQ (r = -.19; p = .057), (Table 2.5). These results revealed that gender did not affect performance as the overall findings were similar to Table 2.4. Thus, gender was excluded from further analysis as a covariate.

In order to investigate the learning rate between the blocks in the IGT I conducted further analysis based on the IAT and PIUQ median splits (two groups; lower/no and higher levels of problematic internet use group) separately.

2.4.4. Differences in group performance based on the IAT median split (Figure 2.2)

A 2 x 5 mixed ANOVA revealed a no significant main effect of group, $F(1,70) = 1.25$, $p = .26$, a significant main effect of block, $F(3.48, 243.51) = 7.25$, $p = .001$, $\eta p^2 = 0.09$ (the Greenhouse–Geisser correction was used because the assumption of sphericity was violated), and significant interaction between block and group, $F(3.48, 243.51) = 3.91$, $p = .006$, $\eta p^2 = 0.05$, (Greenhouse–Geisser correction), indicating that the two groups differed in their performance on the IGT at certain times within the task. Thus, separate within-subjects ANOVAs were performed for each group and revealed that there was a significant difference in performance between the blocks for both internet users with higher levels of problematic internet use, $F(4, 140) = 5.99$, $p = .001$; $\eta p^2 = 0.15$, and internet users with lower/no levels of problematic internet use group, $F(4, 140) = 5.07$, $p = .001$; $\eta p^2 = 0.13$. Post-hoc tests using Bonferroni correction revealed that internet users with lower/no levels of problematic internet use even though they started to make more disadvantageous choices in block one (*M* = -2.61, *SD* = 5.91) showed a significant shift in their performance towards advantageous choices from the second block, $t(35) = -2.99$; $p = .005$, 95% CI [-8.39, -1.61], $d = 1.01$, and continue this for the third block $t(35) = -3.50$; $p = .001$, 95% CI [-10.79, -2.87], $d = 1.18$ (Table 2.6). No other significant differences in task performance were found between blocks which indicated that internet users with lower/no levels of problematic internet use acquired a learning strategy early in the task and continued this advantageous performance (Figure 2.2).

Internet users with higher levels of problematic internet use started to make more disadvantageous choices in block one (*M* = -3.94, *SD* = 4.77) however, they did not show a significant shift in their performance towards advantageous choices until they reached the fourth block, $t(35) = -3.52$; $p = .001$, 95% CI [-9.28, -2.50], $d = 1.19$, and persevered with the same strategy on the fifth block , $t(35) = -4.55$; $p = .0001$, 95% CI [11.65, -4.56], $d = 1.54$. No other significant differences were found in task performance between blocks (Table 2.7). These findings imply a delayed learning strategy compared to internet users with lower/no levels of problematic internet use (Figure 2.2).

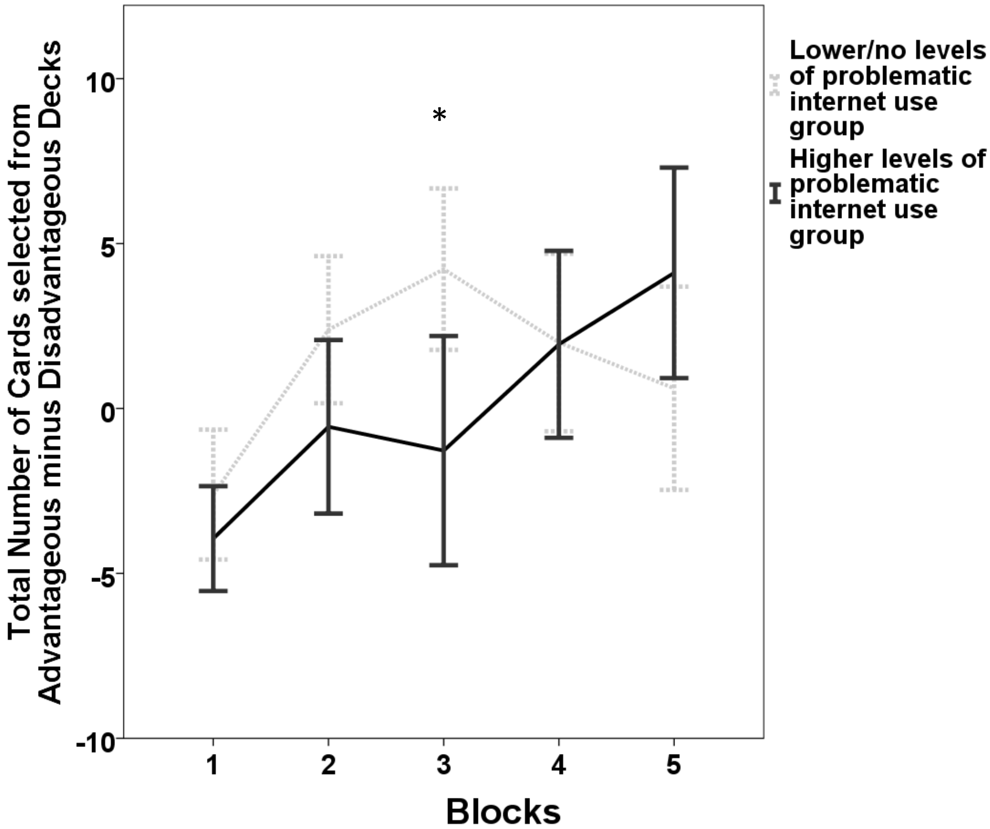

Figure 2.2 Performance on the IGT for each block for internet users with lower/no and higher levels of problematic internet use as assessed with IAT and CI error bars.

The between-groups differences in relation to IGT performance were significant for the third block, $t(70) = 2.6$, $p = .012$, 95% CI [1.26, 9.74], $d = 0.61$. No other significant group differences were found (Figure 2.2), indicating that it is within this block in particular that the learning rate was significantly lower for internet users with higher levels of problematic internet use. However, toward the fourth block they showed similar performance to that of users with lower problematic internet use.

Table 2.6- Performance between blocks in the IGT for internet users with lower/no levels of problematic internet use as assessed with IAT. Bonferroni correction was applied.

	Blocks	Mean	SD	P value	t(35)	95 % CI	
Pair 1	Block 1	-2.61	5.91	**.005***	-2.99	-8.39	-1.61
	Block 2	2.39	6.69				
Pair 2	Block 1	-2.61	5.91	**.001***	-3.50	-10.74	-2.83
	Block 3	4.22	7.34				
Pair 3	Block 1	-2.61	5.91	.011	-2.67	-8.12	-1.11
	Block 4	2	8.07				
Pair 4	Block 1	-2.61	5.91	.08	-1.80	-6.85	0.40
	Block 5	0.61	9.24				
Pair 5	Block 2	2.39	6.69	.14	-1.5	-4.31	0.65
	Block 3	4.22	7.34				
Pair 6	Block 2	2.39	6.69	.78	0.28	-2.42	3.19
	Block 4	2	8.07				
Pair 7	Block 2	2.39	6.69	.28	1.09	-1.53	5.08
	Block 5	0.61	9.24				
Pair 8	Block 3	4.22	7.34	.13	1.53	-0.72	5.16
	Block 4	2	8.07				
Pair 9	Block 3	4.22	7.34	.04	2.08	0.09	7.13
	Block 5	0.61	9.24				
Pair 10	Block 4	2	8.07	.29	1.07	-1.24	4.02
	Block 5	0.61	9.24				

*Note.*CI = confidence interval; bold coefficients are statistically significant. $p \leq .005^{*}$

Table 2.7- Performance between blocks in the IGT for internet users with higher levels of problematic internet use as assessed with IAT. Bonferroni correction was applied.

	Blocks	Mean	SD	P value	t(35)	95 % CI	
Pair 1	Block 1	-3.94	4.77	.033	-2.21	-6.49	-0.28
	Block 2	-.56	7.89				
Pair 2	Block 1	-3.94	4.77	.187	-1.34	-6.69	1.36
	Block 3	-1.28	10.42				
Pair 3	Block 1	-3.94	4.77	**.001***	-3.52	-9.28	-2.49
	Block 4	1.94	8.50				
Pair 4	Block 1	-3.94	4.77	**.000***	-4.55	-11.65	-4.46
	Block 5	4.11	9.57				
Pair 5	Block 2	-.56	7.89	.634	0.48	-2.33	3.78
	Block 3	-1.28	10.42				
Pair 6	Block 2	-.56	7.89	.175	-1.38	-6.17	1.17
	Block 4	1.94	8.51				
Pair 7	Block 2	-.56	7.89	.031	-2.24	-8.89	-0.44
	Block 5	4.11	9.57				
Pair 8	Block 3	-1.28	10.42	.071	-1.86	-6.74	0.29
	Block 4	1.94	8.51				
Pair 9	Block 3	-1.28	10.42	.009	-2.76	-9.35	-1.42
	Block 5	4.11	9.57				
Pair 10	Block 4	1.94	8.51	.220	-1.25	-5.69	1.35
	Block 5	4.11	9.57				

Note.CI = confidence interval; bold coefficients are statistically significant. $p \leq .005$*

2.4.5. Differences in group performance based on the PIUQ median split (Figure 2.3)

A 2 x 5 mixed ANOVA revealed a significant main effect of block, $F(3.46, 242.56) = 7.11$, $p = .0001$, $\eta p^2 = 0.09$ (the Greenhouse–Geisser correction was used because the assumption of sphericity was violated), a no significant main effect of group, $F(1,70) = 2.35$, $p = .13$, and the interaction between block and group approached significance, $F(3.46, 242.56) = 2.49$, $p = .053$, $\eta p^2 = 0.03$, (Greenhouse–Geisser correction), indicating that there was a strong trend for the two groups to differ in their performance on the IGT at certain times within the task. Thus, separate within-subjects ANOVAs were performed for each group and revealed that there was a significant difference in performance between the blocks for both internet users with higher levels of problematic internet use, $F(4, 140) = 4.63$, $p = .001$; $\eta p^2 = 0.12$, and internet users with lower/no levels of problematic internet use, $F(4, 140) = 4.99$, $p = .001$; $\eta p^2 = 0.12$. Post-hoc tests using Bonferroni correction revealed that internet users with lower/no levels of problematic internet use even though they started to make more disadvantageous choices in block one (*M* = -2.83, *SD* = 5.05) showed a significant shift in their performance towards advantageous choices from the second block, $t(35) = -3.49$; $p < .005$, 95% CI [-8.7, -2.3], $d = 0.58$, and continue with a similar strategy for the third block $t(35) = -3.66$; $p < .005$, 95% CI [-10.71, -3.10], $d = 1.2$ (Table 2.8). No other significant differences in task performance were found between blocks which indicated that internet users with lower/no levels of problematic internet use group acquired a learning strategy early in the task and continued this advantageous performance (Figure 2.3).

Internet users with higher levels of problematic internet use started to make more disadvantageous choices in block one (*M* = -3.72, *SD* = 5.72) however, they did not show a significant shift in their performance towards advantageous choices until they reached the fourth block, $t(35) = -3.43$; $p = .001$, 95% CI [-8.39, -2.16], $d = 0.57$, and carried on with the same strategy in the fifth block , $t(35) = -4.02$; $p = .001$, 95% CI [-10.53, -3.46], $d = 1.36$. No other significant differences were found in task performance between the blocks (Table 2.9). These findings imply a delayed learning strategy compared to internet users with lower/no levels of problematic internet use (Figure 2.3).

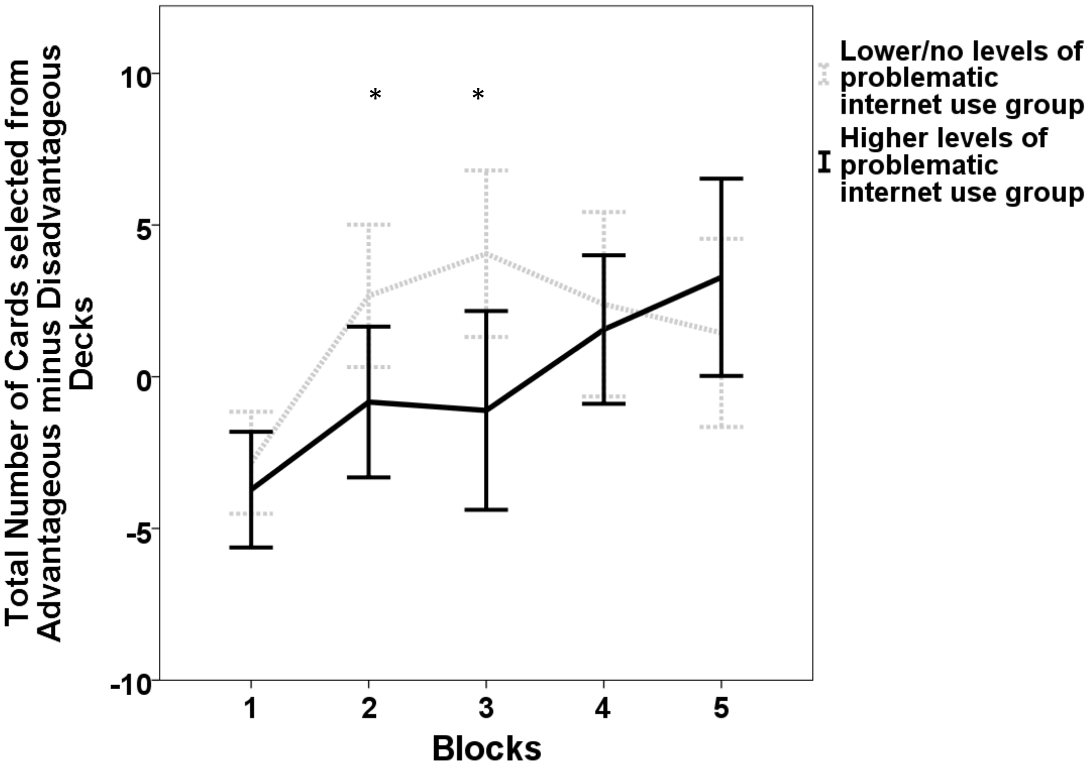

Figure 2.3 Performance on the IGT for each block for internet users with lower/no and higher levels of problematic internet use as assessed with PIUQ and CI error bars.

The between-groups differences in relation to IGT performance were significant for the second block, $t(70) = 2.05$, $p = .04$, 95% CI [0.09, 6.91], $d = 0.68$ and the third block, $t(70) = 2.42$, $p = .02$, 95% CI [0.091. 9.43], $d = 0.81$. No other significant group differences in other blocks were found (Figure 2.3), indicating that it is within these two blocks in particular that the learning rate was significantly lower for the internet users with higher levels of problematic internet use. However, toward the fourth block they showed similar performance to that of participants with lower problematic internet users.

Although the limitations of dichotomizing continuous data into categorical grouping variables are known, results from both correlations and post-hoc tests revealed similar findings, which justify the statistical approach. Moreover, the severity of problematic internet use was assessed by using two of the most thoroughly validated questionnaires; the IAT and PIUQ. Similarities in task performance validates that both questionnaires are reliable measures of problematic internet use.

Table 2.8- Performance between blocks in the IGT for internet users with lower/no levels of problematic internet use as assessed with PIUQ. Bonferroni correction was applied.

	Blocks	Mean	SD	P value	t(35)	95 % CI	
Pair 1	Block 1	-2.83	5.05	**.001***	-3.49	-8.7	-2.3
	Block 2	2.67	7.04				
Pair 2	Block 1	-2.83	5.05	**.001***	-3.66	-10.71	-3.07
	Block 3	4.06	8.23				
Pair 3	Block 1	-2.83	5.05	.008	-2.82	-8.99	-1.46
	Block 4	2.39	9.12				
Pair 4	Block 1	-2.83	5.05	.029	-2.28	-8.09	-0.47
	Block 5	1.44	9.30				
Pair 5	Block 2	2.67	7.04	.335	-0.978	-4.273	1.495
	Block 3	4.06	8.23				
Pair 6	Block 2	2.67	7.04	.86	0.17	-2.994	3.55
	Block 4	2.39	9.12				
Pair 7	Block 2	2.67	7.04	.493	0.69	-2.36	4.8
	Block 5	1.44	9.30				
Pair 8	Block 3	4.06	8.23	.256	1.15	-1.26	4.59
	Block 4	2.39	9.12				
Pair 9	Block 3	4.06	8.23	.143	1.49	-0.92	6.15
	Block 5	1.44	9.30				
Pair 10	Block 4	2.39	9.12	.471	0.73	-1.69	3.57
	Block 5	1.44	9.30				

*Note.*CI = confidence interval; bold coefficients are statistically significant. $p < .005^{*}$

Table 2.9-Performance between blocks in the IGT for internet users with higher levels of problematic internet use as assessed with PIUQ. Bonferroni correction was applied.

	Blocks	Mean	SD	P value	t(35)	95 % CI	
Pair 1	Block 1	-3.72	5.72	.081	-1.79	-6.15	0.38
	Block 2	-0.83	7.46				
Pair 2	Block 1	-3.72	5.72	.21	-1.28	-6.76	1.54
	Block 3	-1.11	9.83				
Pair 3	Block 1	-3.72	5.72	**.002***	-3.43	-8.39	-2.16
	Block 4	1.56	7.35				
Pair 4	Block 1	-3.72	5.72	**.0001***	-4.02	-10.53	-3.46
	Block 5	3.28	9.75				
Pair 5	Block 2	-0.83	7.46	.837	0.21	-2.44	3
	Block 3	-1.11	9.83				
Pair 6	Block 2	-0.83	7.46	.147	-1.48	-5.66	0.88
	Block 4	1.56	7.35				
Pair 7	Block 2	-0.83	7.458	.049	-2.041	-8.2	-0.02
	Block 5	3.28	9.75				
Pair 8	Block 3	-1.11	9.83	.143	-1.49	-6.28	0.95
	Block 4	1.56	7.35				
Pair 9	Block 3	-1.11	9.83	.04	-2.13	-8.57	-0.20
	Block 5	3.28	9.75				
Pair 10	Block 4	1.56	7.35	.33	-0.98	-5.28	1.84
	Block 5	3.28	9.75				

Note.CI = confidence interval; bold coefficients are statistically significant. $p < .005^{*}$

2.4.6. Skin conductance responses

SCRs (reward, punishment and anticipatory) in relation to choices made from advantageous and disadvantageous decks were analysed in association with the severity of problematic internet use, as assessed with the IAT and PIUQ. There were significant correlations between problematic internet use as assessed with PIUQ and SCRs after receiving a reward (r_s = .22; p = .046) and punishment (r_s = .31; p = .012) from disadvantageous decks and approached significance after receiving punishment from advantageous decks (r_s = .23; p =.057). Similarly, the association between severity of problematic internet use as assessed with the IAT and SCRs after receiving punishment from advantageous decks approached significance (r_s = .22; p =.058), (Table 2.10).

Table 2.10- Correlations (Spearman) of IAT and PIUQ with reward, punishment and anticipatory SCRs.

SCRs	IAT Total		PIUQ Total	
	Rho value	p value	Rho value	p value
Reward Disadvantageous	.14	.147	**.22***	.046
Punishment Disadvantageous	.20	.070	**.31***	.012
Reward Advantageous	.13	.167	.15	.122
Punishment Advantageous	.22	.058	.23	.057
Anticipatory Disadvantageous	.09	.236	.09	.257
Anticipatory Advantageous	.06	.330	.11	.212

Note. Values are correlation coefficients; bold coefficients are statistically significant (one-tailed). IAT = Internet Addiction Test, PIUQ Total = Problematic Internet Use Questionnaire Total Scores. $p < .05^{*}$

2.4.7. Group differences in SCRs based on IAT median split (Figure 2.4)

There was a significant difference in the mean rank of SCRs associated to punishment from advantageous decks between the two internet use groups. Internet users with higher levels of problematic internet use had stronger arousal when they received a punishment compared to internet users with lower/no levels of problematic internet use, U = 407, Z = 2.01, p = .044, r = .28 (Figure 2.4).

A Wilcoxon Signed-ranks test showed that there were no differences in the SCRs arousal for each of the internet use groups when they received a reward, punishment or in anticipation of choices from advantageous compared to disadvantageous decks (Figure 2.4).

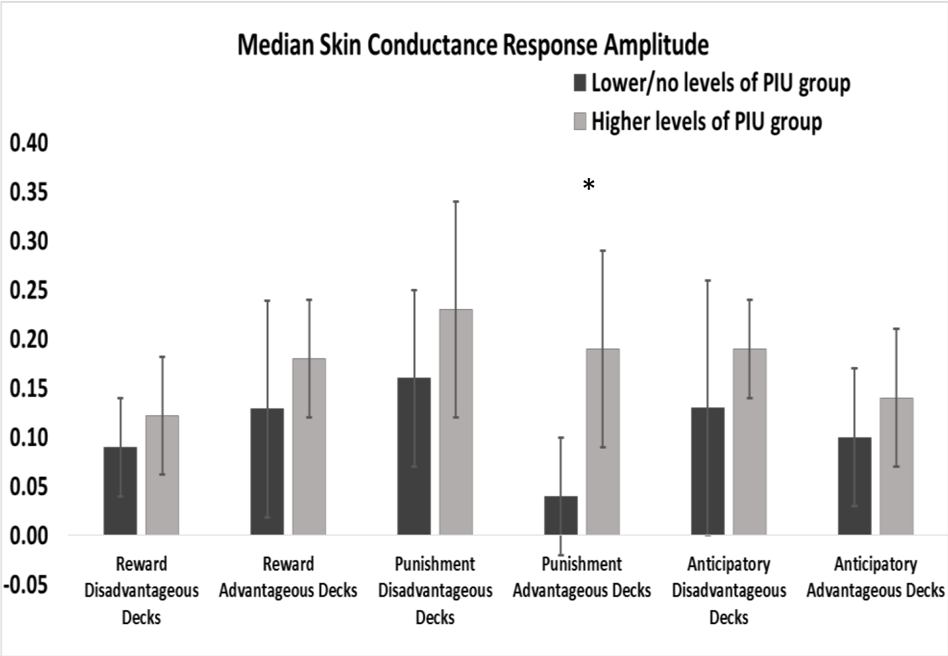

Figure 2.4 The SCRs for individuals with lower/no and higher levels of problematic internet use as assessed with IAT after they received reward, punishment and in anticipation of these for advantageous and disadvantageous decks on the IGT with CI error bars.

2.4.8. Group differences in SCRs based on PIUQ median split (Figure 2.5).

Internet users with higher levels of problematic internet use had significantly stronger SCRs when they received a punishment from disadvantageous decks, $U = 492$, $Z = 2.29$, $p = .022$, $r = .31$, and advantageous decks, $U = 440$, $Z = 2.52$, $p = .012$, $r = .36$, as compared to internet users with lower/no levels of problematic internet use (Figure 2.5). Additionally, there was a tendency of internet users with higher levels of problematic internet use to have stronger arousal before making a choice from advantageous decks compared to those internet users with lower/no levels of problematic internet use, $U = 513$, $Z = 1.58$, $p = .115$.

Further analysis assessing the SCRs arousal for each internet use group when they received a reward, punishment or in anticipation of choices from advantageous compared to disadvantageous decks, revealed that individuals with lower/no levels of problematic internet use had stronger SCRs when they received a reward from advantageous compared to disadvantageous decks, $W = 238$, $Z = 2.03$, $p = .042$, $r = .41$, and significantly stronger

SCRs before making a choice from disadvantageous compared to advantageous decks, $W = 79$, $Z = -2.247$, $p = .025$, $r = -.45$, (Figure 2.5). This suggests that internet users with lower/no levels of problematic internet use showed the expected psychophysiological anticipatory responses to the disadvantageous decks whereas the internet users with higher levels of problematic internet users expressed equal responses to both decks.

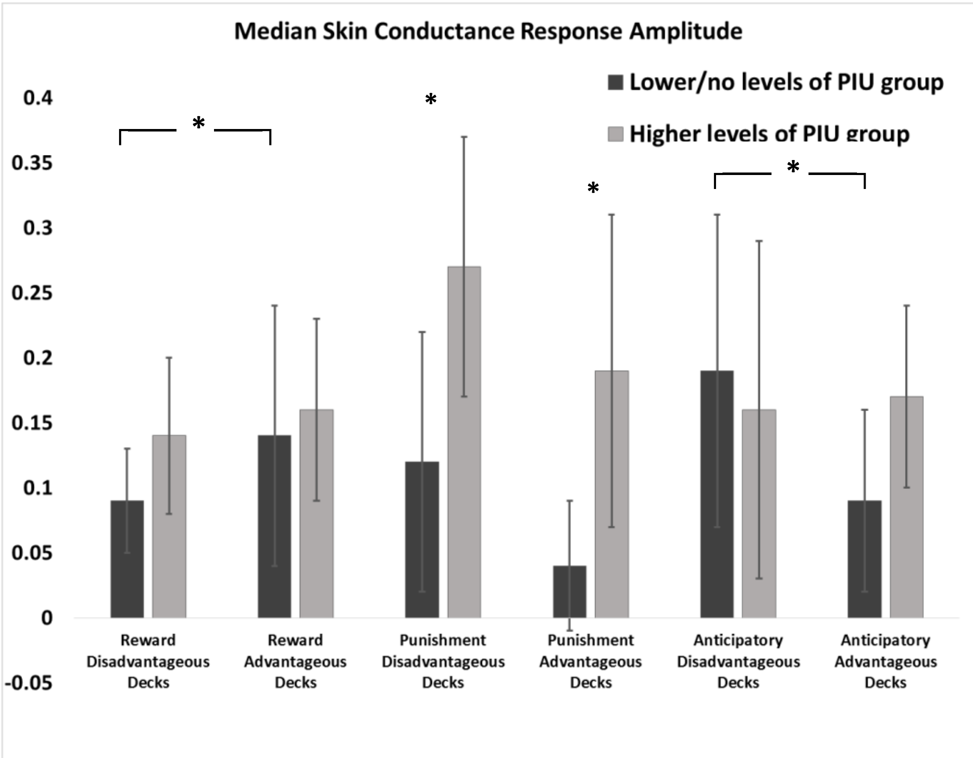

Figure 2.5 The SCRs for individuals with lower/no and higher levels of problematic internet use as assessed with PIUQ after they received reward, punishment and in anticipation of these for advantageous and disadvantageous decks on the IGT with CI error bars.

2.4.9. The online applications on which internet users spent most of their time

Table 2.11-Correlations (Pearson) between the IAT and PIUQ with quantity of time spent on various online applications/activities.

Online activity	IAT Total		PIUQ Total	
	Rho value	p value	Rho value	p value
Searching information for goods or services	.01	.93	.03	.80
Reading and writing e-mails	-.14	.25	-.15	.20
Playing online games	**.29***	.01	**.27***	.023
Downloading software	.11	.36	.13	.26
Communicating with friends	.08	.51	.15	.22
Keeping track of new developments in areas of personal interest	.01	.42	.22	.063
Downloading information	.13	.25	**.28***	.016
Reading and posting messages on newsgroup/discussion groups	**.27***	.02	**.40****	.001
Meeting new online friends	**.34****	.003	**.33****	.004
Updating personal homepage	**.34****	.004	**.36****	.002
Seeking advice from professionals	-.05	.69	.02	.84
Communicating with online friends	**.43****	.001	**.47****	.001
WWW-surfing, browsing	**.27***	.02	**.30***	.01
Participating in discussion	.13	.28	.19	.11
Buying goods online	.05	.70	.03	.77
Meeting new people for romantic relationships	.01	.92	.08	.48
Watching video content	**.33****	.005	**.49****	.001
Online gambling	.02	.88	.08	.49

Note. Values are correlation coefficients; bold coefficients are statistically significant (two-tailed). IAT = Internet Addiction Test, PIUQ Total = Problematic Internet Use Questionnaire Total Scores. $p < .05^{*}$; $p < 0.01^{**}$

Table 2.11 reveals that the online activities which were associated with severity of problematic internet use (as assessed with the IAT and PIUQ) could be grouped into three categories: category one was associated with online gaming, category two was associated with social networking sites (SNS) and reflected activities such as meeting new online friends, updating a personal homepage, as well as communicating with online friends and, finally category three covered a more generic set of online activities such as reading and posting messages on newsgroup/discussion groups, WWW-surfing, browsing and watching video content.

2.4.10 Predicting the severity of problematic internet use as assessed with the IAT from online activities

Table 2.12- Online activities as predictors for severity of problematic internet use as assessed with IAT

Predictor Value	*B*	*SE B*	*B*	*P* value
Constant	13.37	9.2		
Communicating with online friends	5.55	1.66	*.37*	.001**
Watching video content	5.07	2.45	*.23*	.042*

*p < .05 *; p < 0.01***

By applying the backwards method it was found that using the internet to communicate with online friends and watching video contents explained a significant amount of the variance in the value of severity of problematic internet use, $F(2,71) = 10.43$, $p = 0.0001$; Adjusted $R^2 = 0.21$. The analysis showed that communicating with online friends was the greatest predictor, $t = 3.35$, $p = .001$, $b = 0.37$, followed by watching video content, $t = 2.07$, $p = .042$, $b = 0.23$. The backward method was used because the number of potential independent variables was not very large and it has the advantage that it can identify a set of independent variables that together have predictive capability even though each individual variable does not.

2.4.11 Predicting severity of problematic internet use as assessed with the PIUQ from online activities.

Table 2.13- Online activities as predictors for the severity of problematic internet use as assessed with PIUQ

Predictor Value	*B*	*SE B*	*Β*	*P* value
Constant	3.12	7.64		
Communicating with online friends	4.66	1.47	*.34*	.002*
Watching video content	6.69	2.05	*.33*	.002*
Reading and posting messages on newsgroup/discussion groups	4.27	1.93	*.30*	.031*

$p < 0.05^*$

By adopting the backwards method it was found that using the internet to communicate with online friends, watching video contents and reading and posting messages on newsgroup/discussion groups explained a significant amount of the variance in the value of severity of problematic internet use, $F(4,71) = 10.82$, $p = .0001$; Adjusted $R^2 = 0.39$. The analysis showed that watching video contents, $t = 3.27$, $p = .002$, $b = 0.33$ and communicating with online friends, was the greatest predictor, $t = 3.16$, $p = .002$, $b = 0.34$, followed by reading and posting messages on newsgroups/discussion groups $t = 2.21$, $p = .031$, $b = 0.30$.

2.5 Discussion

Overall, the results from this study showed that there was a strong trend of the severity of problematic internet use to negatively associate with performance on the IGT. More specifically, as levels of problematic internet use increased, there was a tendency for enhanced disruptions in choice behaviour in situations of ill-defined risk. In the IGT participants have to make choices between decks that lead to higher immediate rewards but long-term higher losses (disadvantageous decks) or decks that lead to lower immediate rewards but lower losses in the long-term (advantageous decks), (Bechara et al.,1994). Thus, impaired performance in the IGT in this study suggests that as severity of problematic internet use increased, there was a tendency of internet users to make more choices from decks with higher immediate rewards without considering the long-term higher losses associated with these decks, a behaviour that resembles that of substance dependence (Bechara et al., 2002; Bechara et al., 2001; Clark & Robbins, 2002; Gullo & Stieger, 2011; Li, Zhang, Zhou, Zhang, Wang, & Shen, 2013; Vaidya et al., 2012; Verdejo-García & Bechara, 2009; Verdejo-García et al., 2007) and pathological gambling (Brevers, Cleeremance, Goudriaan et al., 2012; Gavedini et al., 2002; Goudriaan et al., 2005, 2006; Kertzman et al., 2011).

However, closer inspection of the data revealed that this tendency reflected a delayed learning strategy regarding the contingencies of the decks in internet users with higher levels of problematic internet use. More specifically, it was found that even though both groups made more disadvantageous choices in the first 20 trials, only internet users with lower/no levels of problematic internet use showed an early shift in their performance from the second block (21-40) onwards, towards more advantageous choices. However, internet users with higher levels of problematic internet use did not show this shift until they reached the fourth block (trials 61-80). This is in accordance with Sun et al.'s (2009) study which also found similar learning patterns in individuals with higher levels of problematic internet use. Considering the main hypothesis for this present work, it can be validly argued that choice biases prevalent in addiction are also apparent in problematic internet use, potentially indicating common underlying contributory factors (Bechara & Damasio, 2002; Bechara et al., 2001; Goudriaan et al., 2006; Verdejo-García et al., 2007). The internet users with higher levels of problematic internet use did show similar performance to those with lower/no levels of problematic internet use when they reached the fourth block in the IGT. This is somehow different to the task performance of addicted individuals (Bechara & Damasio, 2002; Bechara et al., 2001). Even though addicted individuals showed an improvement in their performance as revealed with the delayed learing strategy, they still made more disadvantageous choices in the fifth block as compared to normal controls (Bechara & Damasio, 2002; Bechara et al., 2001). This difference might reflect the neurotoxic effects of substances which can cause alterations in the neural systems of the brain underlying various cognitive functions (Gallinat et al., 2006; Garavan, Kaufman, & Hester, 2008). Thus, it could be argued that chemical intoxication might worsen task performance. This claim has been supported by Verdejo-García et al.'s (2007) study. More specifically, in their study they assessed decision-making with the IGT in groups of cocaine users, cannabis users and normal controls. They were interested in assessing how learning took place over time in these groups and thus participants performed the IGT twice. The time interval between the two sessions was 25 minutes. They found that cocaine and marijuana users did have an overall slower learning rate, even in the second session of the IGT, compared to the control group. However, they did perform similarly to the control group when they reached the fifth block of the second session. This supports the claim made and the findings related to this study's data, that neurotoxic effects of substances might worsen task performance and that, similar to internet users with higher levels of problematic internet use, addicted individuals can reach similar performance to normal controls by a second session.

This study was the first to assess emotional integration as gauged with SCRs during performance on the IGT in association with the severity of problematic internet use. The main outcome was that internet users with higher levels of problematic internet use expressed increased arousal when they received punishments from both types of decks when compared to internet users with lower levels of problematic internet use. This suggests that they had increased sensitivity to negative feedback. However, this evidence contrasts with some of the literature on addiction which indicates sensitivity to reward and/or decreased sensitivity to punishment to be as a marker of addictive behaviour (Bechara et al., 2002; Goudriaan et al., 2006).

Additionally, internet users with lower levels of problematic internet use showed the expected tendency of expressing significantly stronger SCRs before choosing from the disadvantageous compared to the advantageous decks, indicating an intact somatic marker function. Similarly, internet users with higher levels of problematic internet use, although they did generate emotional arousal before they made disadvantageous choices, this was equal in amplitudes of SCRs to before making choices from either type of deck. Most importantly, it was similar to the amplitude of the SCRs generated by internet users with lower levels of problematic internet use before they made a choice from disadvantageous decks (see the two rightmost bars in Figure 1.4 and 1.5). This suggests that internet users with higher levels of problematic internet use expressed a heightened physiological response to both disadvantageous and advantageous decks. However, this evidence is in opposition to research in the field of addiction which has demonstrated blunted somatic markers to be a marker of addictive behaviour (Bechara & Damasio, 2002; Bechara et al., 2002; Goudriaan et al., 2006). The internet users with higher levels of problematic internet use showed enhanced physiological response to punishment and this implies that elevated levels of sensitivity to punishment led them to perceive both types of decks as risky ones, due to the inclusion of punishments in all decks, regardless of magnitude. Thus, internet users with higher levels of problematic internet use could be argued to be more risk-sensitive.

A question remains as to how this hyper-sensitivity to punishment drives IGT performance in internet users with higher levels of problematic internet use. The IGT has been posited to capture decisions made under ambiguity for the first half of the task where the contingencies of the decks are being progressively learnt and under risk for the second half where the participants have a better understanding the contingencies of the decks, (Brand et al., 2007; Gansler, Jerram, Vannorsdall, & Schretlen, 2011; Guillaume et al., 2009). According to the SMH, effective performance has been linked to stronger somatic activation before making choices of higher risk, (disadvantageous decks) especially in situations of ambiguity (Bechara et al., 1999; Damasio, 1994; Goudriaan et al., 2006). It is therefore suggested that internet users with higher levels of problematic internet use were impaired in their ability to rely on this implicit emotional feedback in order to be able to get a gut feeling of which decks were the risky ones, as their anticipatory SMs encoded choice outcomes equally (similar anticipatory SCRs for both advantageous and disadvantageous choices). Instead, they had to rely on more explicit knowledge of the contingencies of the decks which is achieved toward the second half of the task and hence the delayed learning rate. Thus, because sensitivity to punishment rendered internet users with higher levels of problematic internet use to perceive both types of decks as risky they acquired a strategy basing their choices on higher immediate rewards (from disadvantageous decks) when the contingencies of the decks were unknown. However, when they acquired a better understanding of the contingencies of the decks, sensitivity to punishment guided them away from risky choices. This was illustrated with their improved performance towards the second part of the task which reflects choices based more on explicit knowledge. By contrast, internet users with lower/no levels of problematic internet use did generate stronger SMs before they made disadvantageous choices and thus they could rely on implicit affective input which was reflected in the improvement in their performance early in the task. The implications of the current study are that although there seem to be behavioural similarities between problematic internet use with other types of addiction, the underlying mechanisms associated with biased decision-making differ between them (Bechara & Damasio, 2002; Bechara et al., 2002; Goudriaan et al., 2006).

Sensitivity to reward and punishment reflect individual differences in approach and inhibition behaviour (Dawe & Loxton, 2004; Gray, 1991). In the field of addiction, research has revealed that addicted individuals have elevated levels of approach behaviour (Franken, Muris, & Georgieva, 2006) which has been related to a dysfunctional brain reward system. This renders an innate deficit of experiencing natural rewards (a state described as anhedonia) and thus there is an increased vulnerability to the rewarding effects of drugs and other highly rewarding stimuli (Bechara et al., 2002; Dawe & Loxton, 2004; Goudriaan et al., 2006; Grant, Brewer, & Potenza., 2006; Reuter et al., 2005; van Holst et al., 2010; Volkow et al., 2013). Additionally, drugs of abuse not only stimulate the brain areas involved in natural rewarding processes but they can also cause neuroadaptations in these brain areas (Davis, et al., 2007; Edward & Koob, 2010; Robinson & Berridge, 1993; 2001; Volkow et al., 2003). This produces an enhanced experience of the rewarding effects of drugs and as a consequence increases drug seeking behaviours which leads to the vicious cycle of addiction. This vicious circle shows up visibly in neuroimaging studies (Goldstein et al., 2009; Janes et al., 2010; Kang et al., 2012; Li & Sinha, 2008; Verdejo-García & Bechara, 2009).

On the other hand, similar to the findings from the present study, research has demonstrated elevated levels of sensitivity to punishment in internet users with higher levels of problematic internet use (Franken, & Garretsen, 2010; Meerkerk, van den Eijnden, Franken, & Garretsen, 2010). Moreover, personality traits as well as psychological states in which sensitivity to negative feedback is a component such as anxiety, neuroticism and psychoticism have also been implicated as vulnerability factors related to problematic internet use (Cao, et al., 2011; De Leo & Wulfert, 2013; Hetzel-Riggin & Pritchard, 2011; Li et al., 2008; Lin et al., 2011). However, the question still remains as to how sensitivity to punishment relates to severity of problematic internet use. Research from pathological gambling has found differences in the motivation to gamble in a subgroup of gamblers, slot machine gamblers, who have elevated levels of sensitivity to punishment (Goudriaan et al., 2005). It has been argued that their primary motivation for gambling was to escape the stresses of everyday life which is in opposition to the reward-seeking motivation normally associated with gambling (Blaszczynski & Nower, 2002; Ledgerwood & Petry, 2006). Thus, it can be suggested that in situations with increased chances of averse outcomes some individuals with elevated levels of sensitivity to punishment might engage in approach behaviour in order to ameliorate averse experiences. In a similar way it can be argued there is a possibility that some individuals with elevated levels of sensitivity to punishment might engage with online activities in order to escape averse stressful situations found in everyday life. Support for such an assumption comes from studies that have found strong links between social anxiety and problematic internet use (Caplan, 2007, 2005; Clayton, Osborne, Miller, & Oberle, 2013; De Leo & Wulfert, 2013). Socially anxious individuals perceive face to face interactions as highly unfavourable, whereas they typically perceive the online environment as a safe place for social interaction due to the lack of physical face-to-face encounters (Campbell et al., 2006). Thus, this preference for online interaction might make them more vulnerable to the addictive potential of internet use. In this study, the severity of problematic internet use was strongly positively correlated with various anxiety-related psychopathological constructs, providing further support for our conclusion. This argument has been further validated from research which demonstrates that using the internet for socialising (chat rooms, instant messenger etc.) is one of the activities which is highly correlated with problematic internet use (Kuss & Griffiths, 2011). Thus, it seems that motivational mechanisms associated with the pursuit of online activities, which are based on punishment aversion, appear to be different from the ones associated with drug seeking behaviour that is reward seeking behaviour.

However, a paradox emerges which is; if sensitivity to punishment guides decision-making processes, why then do problematic internet users continue to use the internet even though there is an increase in the negative consequence of its use in their lives? One would expect that negative outcomes (punishment) to guide internet users away from the internet. However, it could be argued that even though sensitivity to punishment initiates/motivates internet use, once online, it might be the rewarding effects of the internet which reinforce such behaviour (Hinic et al., 2010). Therefore future research should aim to assess the power of internet stimuli to influence behaviour in problematic internet users, an assumption which was investigated further in the next study.

Although the present study cannot infer causality between sensitivity to punishment and problematic internet use, it is the first to provide a better understanding of the underlying processes related to problematic internet use. Based on this knowledge, future research should further investigate the issue of causality with longitudinal designs with an emphasis on personality traits and psychopathological characteristics regarding which sensitivity to negative feedback is a component. This would serve to provide a better understanding of the vulnerability markers for problematic internet use.

The findings of this study have important neurobiological implications. Deficits in performance in the IGT have been suggested as underling functional and structural alterations in brain areas related to the ventromedial prefrontal cortex (VMPFC) and amygdala (Bechara et al., 1999). These brain areas are vital for the generation of somatic markers and they have been associated with deficits in decision-making processes in addicted populations. More specifically, hypo-activity of the VMPFC (Bechara & Damasio, 2002, Goudriaan et al., 2006; Verdejo-García & Bechara, 2009) and hyperactivity (Bechara et al., 2002) or hypo-activity (Goudriaan et al., 2006) of the amygdala have been implicated with deficits in performance in the IGT. Additionally, it has been suggested that they play a role in the addiction cycle (substance dependence, pathological gambling) thought mechanisms which either diminish the long-term consequences of the behaviour (VMPFC) or exaggerate the rewarding value of drug and drug related stimuli (amygdala). This is an assumption that has been supported with neuroimaging studies which have revealed deficits in the function and structure in these brain areas in addicted individuals (Goldstein & Volkow, 2002; Goudriaan, de Ruiter, Van den Brink, Oosterlaan, & Veltman, 2010; Naqvi & Bechara, 2009).

A dysfunctional VMPFC is associated with deficits in the generation of anticipatory SCRs in the IGT (Bechara & Damasio, 2002; Bechara et al., 1999). Thus, in this study considering that internet users with higher levels of problematic internet use generated anticipatory somatic markers, it can be suggested that the VMPFC functions normally in this group. However, this group of internet users showed hypersensitivity to punishment. Regarding the fact that the amygdala has been implicated as playing a role in responses related to punishment (Bechara et al., 1999), it can be argued that the behavioural and physiological outcomes of this group of internet users could be explained according to hypersensitivity of amygdala in such a way that stimuli related to punishment magnify processing especially in situations of risk. However, this can only be an assumption. Future research should investigate this area further with the assessment of brain activation imaging methods. Problematic internet users' brains could be assessed while they performed the IGT so that firmer conclusions could be made regarding the role of amygdala in decision-making processes.

Another objective of this study was to assess the relationship of problematic internet use with psychopathological and personality constructs and to investigate whether these constructs affected performance on the IGT. Overall, there were positive correlations between various psychopathological constructs and personality characteristics associated with impulsive behaviour with the severity of problematic internet use; which is in accordance with established literature (Cheung & Wong, 2011; Dong, Lu et al., 2011; Fisoun et al., 2012; Kim et al., 2010; Ko et al., 2009; Kormas et al., 2011; Lam et al., 2009; Shek et al., 2008; Tsitsika et al., 2011; Wang et al., 2011; Whang et al., 2003; Yen et al., 2008). However, and most importantly, none of these constructs were associated with performance on the IGT, which suggests that decision-making patterns were a unique characteristic of problematic internet use. This assumption was also supported by the lack of association between psychopathological co-morbidity with problematic internet use. In general, the evidence validates the suggestion of conceptualizing problematic internet use as an independent construct and not just a symptom of another psychopathology. If the internet was just the medium to pursue an already existing problematic behaviour then we would expect to find associations between psychopathology and performance on the IGT.

A final objective of this study was to assess which particular online applications internet users prefer to spend their time on. This investigation has important implications for our understanding of the construct of problematic internet use because it builds upon the aforementioned argument as to whether or not the internet is just the medium to purse another problematic behaviour. There is currently very limited evidence in the area, with some exceptions which have found applications such as instant messenger, online gaming and erotica (Meerkerk et al., Regina, Van Den Eijnden, & Garretsen, 2006; Wan & Chiou, 2006) to be associated with problematic internet use. In sum, in this study, the online activities which were associated with severity of problematic internet use could be grouped into three categories: online gaming, social networking sites which included activities such as meeting new online friends, updating a personal homepage, communicating with online friends, and finally, the last category which contained a more generic set of online activities such as reading and posting messages on news/discussion groups, WWW-surfing, browsing and watching video content. These findings were in accordance with Davis' (2001) categorization of problematic internet use as generalised and specific where the former reflected generic online activities and the latter relates to certain sets of applications. However, contrary to Davis who argued that specific subtypes represent activities which can only be pursued offline such as gambling, gaming, pornography etc., in this study it was found that specific activities which can be executed both online only or online and offline associated with problematic internet use. Further analysis showed consistently that the two online applications which were the best predictors of problematic internet use were applications which were predominantly pursued online; watching video content (e.g. YouTube) and talking to online friends (e.g. social networking sites). This evidence supports the argument that the internet is not just the medium used to pursue another problematic behaviour. However, one of the online activities which was associated with severity of problematic internet use was online gaming, which arguably can also be pursued offline. It has been suggested that problematic online gamers use the internet primarily for gaming (van Rooij, 2011). However, it could be argued that once online, they might find other online activities appealing such as talking to online friends etc., which in the long run, might put them at risk of developing problematic internet use. Thus, either way the finding that the best predictor for problematic internet use were those applications which can only be pursued online justify the argument that it is a distinct psychopathological construct. Furthermore, the evidence is in line with Young's et al.(1999) conceptualization of problematic internet use as forming different potential subtypes, such as problematic internet use pertaining to gaming, general usage, and social networking sites. However, considering that very little research has been conducted with specific online applications, in depth investigation of specific subcategory characteristics is required in future so as to enhance our understanding of the construct of problematic internet use as a whole.

In conclusion, the results from the present study revealed that on a behavioural level, there were similarities between problematic internet use and other addictions in the way problematic internet users acquired learning strategies during decision-making processes. However, the underlying mechanisms underpinning these choices differed between them. More specifically, sensitivity to punishment has been suggested as guiding decision-making in problematic internet use which is in opposition to sensitivity to reward associated with other addictions. Additionally, the role of different psychopathological constructs as a risk factor for the development of problematic internet use was discussed. Finally, it was revealed that the best predictor for problematic internet use were those activities which could only be pursued online, which further validates the argument that this is a distinct psychopathological construct. Overall, this study suggested that sensitivity to punishment should be incorporated into any measure and, potentially, any intervention, regarding problematic internet use.

Chapter Three

Study 2: Attentional bias in problematic internet users

3.1 Abstract

Rationale: Stimuli related to substances of abuse have the power to influence behaviour through a mechanism which enhances attentional allocation to those cues and this has been termed "attentional bias". It has been suggested that this bias is either causing or indexing the underlying mechanisms related to substance seeking behaviour. There is currently limited evidence to validate whether or not similar processes underlie problematic internet use.

Objective: This study aimed to explore attentional bias for internet-related stimuli in internet users with various levels of problematic internet use.

Methods: Sixty eight participants performed the Visual Dot-Probe task containing generic internet-related images while their eye movements were recorded to provide a direct measure of the allocation of attention. In addition, the Pleasantness Rating task provided an index of the perceived pleasantness of each image presented in the Visual Dot-Probe task.

Results: Overall, internet users with higher levels of urges to be online spent more time looking at internet images compared to internet users with lower levels of urges to be online. This was particularly evident for problematic internet users who demonstrated higher levels of urges to be online compared to problematic internet users with lower levels of urges to be online. All internet users rated internet images as being more pleasant as compared to control images.

Conclusions: There seem to be similarities in the mechanisms which have been implicated regarding the development and maintenance of substance-related and addictive disorders with those for problematic internet use. This is suggestive of commonalities between them.

3.2 Introduction

The evidence from the decision-making processes assessment (see Chapter two) demonstrated that sensitivity to punishment guides choices in problematic internet users. However, a paradox emerges such as that if sensitivity to punishment guides decision-making processes, why then do problematic internet users continue to use the internet even though there is an increase in the negative consequences of its use in their lives. It would be expected that sensitivity to punishment, which indicates avoidance regarding negative outcomes, should keep problematic internet users away from internet activities, once the negative repercussions have developed. However, it could be argued that sensitivity to punishment might initially motivate internet use, but once online, it might be the rewarding effects of the internet which make problematic internet users continue with this practice. This assumption has been well validated in the field of addiction, where it has been illustrated that it is not only the rewarding effects of the substances and non-substances (e.g. gambling) but also stimuli related to them that have the power to influence behaviour in substance dependent individuals and pathological gamblers (for a review see Field & Cox, 2008; Honsi et al., 2013). Thus, the aim of this study was to assess whether or not similar behavioural patterns which are markers of addictive behaviour are evident in problematic internet use. Researching this area would be advantageous for furthering our understanding of problematic internet use.

A prominent theory of addiction which has been developed to incorporate the suggestion that it is not only the effects of substances but also stimuli related to them that can influence behaviour, is the incentive sensitization theory (Robinson & Berridge, 1993, 2001). More specifically, according to this theory, repeated substance administration can cause alterations (neuroadaptations) in the rewarding and motivational systems of the brain (dopaminergic) in such a way that these systems increase the incentive salience value of substances. Through the processes of classical conditioning, stimuli related to substances of abuse are associated with the incentive motivation of substances and thus elicit conditioning responses (increased dopamine release). Dopamine levels in the mesolimbic dopamine system mediate the incentive salience mechanism process (Robinson & Berridge, 1993). The increase in incentive salience has as a consequence in that substance-related stimuli are perceived as highly "wanting" and "highjack" behaviour (Robinson & Berridge, 1993). Although the assumption on which this theory was based when first developed pertained to psychostimulant drugs (amphetamine, cocaine etc.) there is now evidence that the same processes can explain the cycle of behavioural addictions, such as that for pathological gambling (Honsi et al., 2013) and, therefore, can also be applicable to problematic internet use.

A paradigm that has been widely used to test the assumptions of incentive sensitization theory is the cue reactivity paradigm, which assesses the power that substance-related stimuli have in influencing cognitive process, behaviour (such as substance seeking), increased craving and risk of relapse. For example, research has revealed that when substance dependent individuals viewed images related to their substance of abuse (such as cigarettes or bottles of alcohol) there was an increased activation in brain areas that were normally involved in natural rewarding processes such as the mesocorticolimbic reward system, which suggests that these stimuli were perceived as highly rewarding (e.g. nicotine addiction- Kang et al., 2012; cocaine addiction-Hester, Dixon, & Garavan, 2006; Sinha, Fuse, Aubin, & O'Malley, 2000; for a review see Verdejo-Garcia & Bechara, 2009). Moreover, there was an increase in the levels of craving, as indicated by self-report assessments which was also associated with increased activation in brain areas normally involved in motivational processes, such as the limbic areas, amygdala, anterior cingulate and left dorsolateral prefrontal cortex, which suggests that these stimuli had strong motivational valence (for a review see Carter & Tiffany, 1999; Maas et al., 1998). Additionally, there was a disruption in ongoing cognitive processes ("Dual Task"- alcohol/nicotine addiction, Cox, Yeates, & Regan, 1999; Sayette & Hufford, 1994) and an increase in approach behaviour towards those stimuli (Field, Mogg, & Bradley, 2004a; Mogg, Bradley, Field, & De Houwer, 2003; Willem, Vasey, Beckers, Claes, & Bijttebier, 2013). The ability of substance-related stimuli to influence behaviour has been suggested to be one of the factors which are associated with the initiation and/or maintenance of substance seeking behaviour (Field & Cox, 2008). More specifically, it has been proposed that one of the processes by which cue reactivity induces substance seeking behaviour is through a mechanism which enhances attentional allocation to the cues. This process has been termed attentional bias and it has been argued that this bias is either causing or indexing the underlying mechanisms related to substance seeking behaviour (Robbins & Ehrman, 2004). It has been suggested that attentional bias might cause the facilitation of any cognitive process associated with substance-related stimuli (detection, memories etc.) and as a consequence, limits the availability of other cognitive resources (such as mechanisms that can be used to control drug use) which could then put the individual at risk of abusing the substance (Franken, 2003).

Attentional bias has significant clinical importance as it does not only correlate with addiction but also with severity in terms of the quantity and frequency of substance use in a non-clinical population and thus, it can be very informative regarding identifying individuals at risk of developing addiction (Cousijn et al., 2013; Field & Cox, 2008). Moreover, it provides an indication of relapse risk for those individuals who try to abstain (Hogarth, Dickinson, Janowski, Nikitina, & Duka, 2008; Marhe, Luijten, van de Wetering, Smits, & Franken, 2013; Miller & Fillmore, 2010; Waters, Marhe, & Franken, 2012). Attentional bias in addiction has been indexed directly and indirectly with various forms of behavioural responses which relate to substance specific stimuli by using experimental tasks such as the addiction/emotional Stroop task (Cox, Fadardi, & Pothos, 2006; Stroop, 1935), Visual Dot-Probe task (e.g. MacLeod, Mathews, & Tata, 1986; Posner et al., 1980), Dual task and Flicker task (e.g. Brevers, Cleeremans, & Verbruggen et al., 2011). From these tasks research has revealed that substance dependent individuals and pathological gamblers showed an attentional bias for their preferred substance or activity (see Field & Cox, 2008 for a review; alcohol e.g. Duka & Townshend, 2004; Field et al., 2011, 2013; Ryan, 2002; Weafer & Fillmore 2013; nicotine e.g. Bradley et al., 2003; Dickter & Forestell, 2012; Kang et al., 2012; opiate addiction e.g. Lubman et al., 2000, 2009; cannabis use/dependence e.g. Cousijn et al., 2013, Field, Mogg, & Bradley, 2004a; pathological gambling e.g. Boyer & Dickerson, 2003; Brevers, Cleeremans, & Bechara et al., 2011; Honsi et al., 2013; see van Holst et al., 2010 for review). Thus, in the present study the question of whether or not similar processes could be identified in the field of problematic internet use was investigated. More specifically, the focus of the present study was whether internet-related stimuli had the power to influence behaviour and by assessing whether an attentional bias for these stimuli was evident in problematic internet users in a similar way to that found in other types of addiction.

Research which has focused on a particular online application, online gaming, has demonstrated that online gaming related stimuli (gaming images) had the ability to influence motivation for gaming, such as enhancing urges for gaming (as assessed with self-report measures) which was validated with increased brain activity in areas normally involved in emotional/motivational processes, namely; the dorsolateral prefrontal cortex, anterior cingulate cortex and right inferior parietal lobe and thalamus (Han, Hwang, & Renshaw, 2010; Han, Kim, Lee, Min, & Renshaw, 2010; Ko et al., 2009; Lorenz et al., 2013; Sun et al., 2012; Thalemann, Wölfling, & Grüsser, 2007). Additionally, problematic online gamers have shown an attentional bias for online gaming related stimuli (words and images) as assessed with the addiction Stroop task (Metcalf & Pammer, 2011; van Holst et al., 2012) and Dot-Probe task (Lorenz et al., 2013; van Holst et al., 2012). However, although, these findings indicate commonalities between problematic online gaming and substance-related and addictive disorders, there are significant methodological considerations that need to be accommodated in order for firmer conclusions to be made. These concern whether the interference effects caused by cue reactivity, as measured with the aforementioned tasks, actually reflect only attentional processes and/or whether problematic online gaming is the same as problematic internet use.

Two of the aforementioned studies assessed attentional bias with the addiction Stroop task (Metcalf & Pammer, 2011; van Holst et al., 2012). In this task two categories of words were used, one relating to online gaming and the other containing neutral words (matched in length and frequency of occurrence). In each trial a coloured word was presented from either category and participants were required to name the colour of the word as quickly and as accurately as possible while trying to ignore the actual meaning of the word. Attentional bias was evident if problematic online gamers took longer to name the colour of the online gaming words as compared to matched neutral ones as indexed with reaction times. It was proposed that due to sematic relevance of online gaming words in problematic online gamers, these words would have the ability to capture attention and thus cause interference in the ongoing task and as a consequence, slow down performance (Metcalf & Pammer, 2011; van Holst et al., 2012). Even though the addiction Stroop task is a well validated task for the assessment of cue reactivity, there is some criticism regarding whether the interferences effect reflects not only attentional but other cognitive processes such as the cognitive effort to suppress ongoing processes that might be caused by memories that these stimuli trigger, or general deficits in inhibitory control which can also disturb performance in the task (Cox et al., 2006; Field & Cox, 2008; MacLeod, 1991; Mogg et al., 2003). In addition, although this task can index allocation of attention, it cannot distinguish whether this reflects mechanisms related to avoidance or approach behaviour (Townshend & Duka, 2007).

The other two studies assessed attentional bias with the Visual Dot-Probe task (Lorenz et al., 2013; van Holst et al., 2012), which provides a more direct measurement of visual-spatial attention compared to the addiction Stroop task. In this task, participants were briefly presented simultaneously with online gaming related and matched control stimuli (either words or images) followed by a probe which appeared replacing one of the two stimuli. Participants were required to respond to the probe as quickly and accurately as possible. The idea was that participants would respond to the probe replacing the area they attended to more quickly than the other. Thus, attentional bias was evident if problematic online gamers responded faster to probes replacing online gaming related stimuli compared to matched control ones (Posner et al., 1980). Although the Dot-Probe task is a well validated task for the assessment of attentional bias there are some criticisms in relation to the duration of the stimuli presentation. Variability in this has been implicated as accounting for inconsistencies in findings related to attentional bias in addicted populations (e.g. Field, Mogg, & Bradley, 2004a; Noel et al., 2006). Presentation duration varies amongst studies from 50ms to 2000ms. Moreover, it has been suggested that brief presentations, e.g. 200ms or less, relate to initiation of attention as this duration is only sufficient to allow for one shift of attention, whereas longer presentations, e.g. 1000ms or more, relate to the maintenance of attention as multiple shifts of attention can be made (Field & Cox, 2008). Making this distinction is of great importance as it has been proposed that different cognitive mechanisms relate to these two processes (Field, Mogg, & Bradley, 2004a). For example, research has revealed that initiation of attention links with the trait characteristics of addiction (such as dependence) whereas maintenance of attention relates to state characteristics such as increased levels of craving (Field, Mogg, & Bradley, 2004a; Field, Munafo, & Franken, 2009; Field et al., 2013; Noel et al., 2006; Stormark, Field, Hugdahl, & Horowitz, 1997). Understanding the exact cognitive components which might be affected in an addicted population is of vital importance for the development of optimal interventions. In both Lorenz et al. (2013) and van Holst et al.'s (2012) studies presentations of stimuli were relatively brief (200 and 500ms) which was not long enough to account for the maintenance of attention and thus there is a lack of assessment of the different components of attentional processes. Moreover, in van Holst et al.'s (2012) study, only the errors in performance were taken as indication of attentional bias for problematic online gamers, rather than reaction times.

Considering the methodological limitations of the aforementioned tasks, the inconsistencies in data, that is, error performance versus reaction times, (van Holst et al., 2012), the lack of assessment of the different components of attention (initiation versus maintenance) as well as clinical importance, in the present study attentional processes were assessed based on direct measures of the allocation of attention, namely eye movements (Wright & Ward, 2008). Assessing attentional processes based on overt eye movement has been argued to be the best methodological approach because attentional and visual systems are highly interconnected (Field, Mogg, & Bradley, 2005; Miller & Fillmore, 2010). Thus, in the present study attentional processes were gauged using a Visual Dot-Probe task where internet-related and matched control images were presented for 2000ms while recording eye movements. This method allowed for assessment of both initiation (i.e. which of the two images the participants looked at first) and maintenance of attention (i.e. how much time participants spent looking at each image).

Moreover, the aforementioned studies were conducted based on a specific online application, online gaming. As mentioned in Chapter one (subsection 1.2) and Chapter two, online gaming refers to an activity which arguably can also be executed in the offline environment. This has led researchers to debate the existence of problematic internet use. However, currently there is limited evidence linked to the aforementioned argument as the majority of studies in the field have assessed problematic internet use without placing emphasis on specific applications with the exception being online gaming. Thus, the present study based on evidence from Chapter two assessed patterns of problematic internet use with reference to three potential subtypes. The first one refers to generic problematic internet use and it characterised users with preference to generic online activities. The other two are related to specific applications: social networking sites and online gaming. These two subtypes were chosen as they are the two activities with the highest addictive potentials (Meerkerk et al., 2006; Wan & Chiou, 2006). Moreover online gaming is an application which can be pursued both in the offline and online environment whereas social networking sites can only be pursued in an online environment. The aim of this study was to assess whether these potential subtypes of problematic internet use would show cognitive biases for general internet-related stimuli. This would elucidate upon whether these biases are specific and relate to the online activities internet users show a preference for.

This is the first study to assess not only the similarities and differences between problematic internet use and substance-related and addictive disorders but also the relationship between general and specific online problematic internet use. For example, research from pathological gambling has revealed differences in attentional bias for a group of gamblers when their primary gambling activity was either poker or racing (McCusker & Getting, 1997). More specifically, using the addiction Stroop task, McCusker and Getting (1997) found a gambling specific interference effect such that poker gamblers had increased reaction times to poker related words compared to racing related words and the opposite effect was evident for racing gamblers. Their study emphasized that attentional bias was activity specific and that differences within a clinically homogenous group of pathological gamblers can exist. In a similar way it could be argued that similar cognitive processes might be evident for different subtypes of problematic internet use. More specifically, attentional bias might be prominent for general problematic internet users as the stimuli which have been used in this study were related to general online applications. This type of research can be very informative regarding whether or not certain subtypes of problematic internet use relating specifically to certain online applications exist.

Research from the field of addiction has implicated other factors such as increased levels of craving and evaluative bias for substance-related stimuli (the bias of perceiving these stimuli as highly pleasant) to associate with attentional bias and as a consequence, with substance seeking behaviour (Field & Cox, 2008; Field, Mogg, & Bradley, 2004a; Field et al., 2009, 2013; Kang et al., 2012). These findings are in accordance with the assumptions of the incentive sensitization theory, which suggests that these factors are associated with each other because they originate from the same sensitised dopaminergic system (Robinson & Berridge, 1993, 2001). Moreover, Franken (2003) who expanded upon the assumptions of the incentive sensitization model of addiction proposed that the relationship between attentional bias and craving is reciprocal such that attentional bias can lead to increased cravings and drug seeking behaviour and the increased craving can lead to attentional bias and drug seeking behaviour (Franken, 2003). Although the role of craving and evaluative bias in drug seeking behaviour is well established, there is a lack of studies assessing their role in the field of problematic internet use. Thus, in the present study levels of craving were assessed. Craving was conceptualized as a psychological/motivational state and indexed as an increased urge to pursue the activity in question. In addition, assessement was made of the evaluative bias for internet-related images and in relation to the attentional bias regarding those particular images for individuals with elevated levels of problematic internet use.

Finally, further to Charlton and Danforth's (2007, 2010) model, which was developed to distinguish between individuals with and without problematic computer and online gaming use, in the present study assessment was made in order to distinguish between problematic and high engagers and to determine whether there were qualitative differences between groups of internet users with reference to general internet use were assessed. A breakthrough assumption of this model is that even though problematic and high engager internet users spend a significant amount of time on engaging with the activity in question, there is a qualitative difference between them, such that problematic users experience negative repercussions in their lives due to this activity whereas the high engagers do not. Charlton and Danforth's (2007, 2010) failure to draw a distinction between the two groups can result in classifying high engagers as problematic users, and to an overestimation of the significance and level of the problematic behaviour. Validation for qualitative differences between the two groups with reference to online gaming has been found in a study assessing attentional bias for online gaming words (Metkalf & Pammer, 2011). More specifically, it was found that an attentional bias as assessed with the addiction Stroop task was only evident for individuals with problematic online gaming, with no such bias found for high engagers (Metkalf & Pammer, 2011). In this study the presence of qualitative differences between groups of internet users with an emphasis given to making a comparison between problematic and high engager internet users was investigated. This was carried out by assessing not only attentional, evaluative biases and levels of urges to be online but also differences in psychopathological and personality constructs. Considering that substantial sources of evidence have found strong links between problematic internet use and various psychopathological and personality constructs (Cheung & Wong, 2011; Dong, Lu et al., 2011; Fisoun et al., 2012; Kim et al., 2010; Ko et al., 2009; Kormas et al., 2011; Lam et al., 2009; Shek et al., 2008; Tsitsika et al., 2011; Wang et al., 2011; Whang et al., 2003; Yen et al., 2008) identifying qualitative differences between the two groups can provide further evaluation of their relationship. Charlton and Danforth (2007, 2010) argued that high engagement may be a developmental stage preceding problematic use so assessing which factors associate with high engagement can be very informative in identifying individuals at risk of developing problematic internet use.

To sum up, based on observable similarities between internet and well established addictions, in the present study whether the same mechanisms which have been implicated as playing a role in the development and maintenance of the addiction cycle, could also be associated with problematic internet use were investigated. More specifically, attentional bias has been suggested to be one of the factors that increase substance seeking behaviour in addicted individuals through a mechanism that facilitates cognitive processes associated with substance-related stimuli. Thus, the focus of the present study was to investigate whether individuals with problematic internet use showed an attentional bias for internet-related stimuli, in a similar way to that found in substance-related and addictive disorders. It was hypothesized that individuals with problematic internet use would show an attentional bias for internet-related images compared to matched control images, and this bias would be evident for both initiation and maintenance of attention. Further, following the principles of the incentive sensitization theory, it was hypothesized that individuals with problematic internet use would also show an evaluative bias for internet-related images compared to the control images. Furthermore, recent models of addiction have also implicated not only trait characteristics (dependence) but also state characteristics such as motivational factors such as elevated levels of cravings as being associated with attentional and evaluative bias. Thus, in this study the role of urges to be online were probed further by assessing the relationship between attentional bias, evaluative bias, levels of urges to be online, and the severity of problematic internet use. Moreover, based on Charlton and Danforth’s (2007, 2010) model it was hypothesized that there would be qualitative differences between individuals with and without problematic internet use in relation not only to attentional and evaluative biases and levels of urges to be online but also with respect to psychopathological and personality constructs. A final objective of this study was to assess problematic internet use for general and specific applications (social networking sites and online gaming) and, to this end whether there were differences in cognitive biases between them was investigated. It was hypothesized that if problematic internet use reflects a homogeneous set of behaviours then both individuals with general and specific problematic internet use would show attentional and evaluative bias for general internet-related images compared to matched control images. By contrast, if certain subtypes exist then only individuals with general problematic internet use would show such biases.

3.3 Method

3.3.1 Participants

Participants were recruited through advertisements placed within the University of Bath. In the initial phase of the experiment an online questionnaire assessing participants' internet use was administered (the Addiction-Engagement Questionnaire - AEQ). From a total number of 126, 68 were contacted for further testing (phase two) based on their scores on the AEQ. This was a random selection from the initial group and aimed to recruit equal number of participants who fulfilled the criteria for problematic, high engagement and non-problematic internet use. The mean age was 26.09 years (*S.D* = 6.82) and there were 51 females. All participants in the second phase of the study had normal or corrected-to-normal vision. It was possible to conduct the experiment with participants wearing contact lenses by checking that the eye tracker calibration was possible. There was an imbalance in the male-to-female ratio in this study. The number of participants who carried out the second phase of testing reflected the ratio of males and females of those who had initially shown an interest participating in the study (initial stage ratio, 1:2.5; second stage ratio, 1:3). Although efforts were made to specifically advertise the study in departments of the university with a predominantly male population of students such as Computer Science and Mechanical Engineering it was very difficult to recruit male participants. Moreover, the gender ratio between groups did not differ significantly between groups for males $x^2 = 0.89$, females $x^2 = 0.76$. This was also evident in Study One (Chapter two). See section 2.3.1 for an explanation for why this might have occurred.

3.3.2 Pictorial stimuli for the Visual Dot-Probe and Pleasantness rating tasks

Internet-related stimuli consisted of pictorial colour images containing generic internet-related activities (Google search websites, email websites etc.) and internet-related logos (internet explorer logo, eBay logo etc.) which were retrieved from a Google image search (see Appendix I for examples of the images). In order to obtain the most relevant images as sample stimuli a total of 60 internet-related images was retrieved (pictures). Twenty individuals (who did not participate in the study) rated all images on a 10-point scale according to their relatedness to the internet (ranging from 1 “not at all related” to 10 “very related”). From the 60 images, 15 were selected as the most relevant internet images (based on the highest scores they received). Each of these internet images was matched with a control image. The visual characteristics such as colour, brightness, size etc. of each image were manipulated with an Adobe Photoshop (www.adobe.com) in order to produce visual similarity between the pairs of images following similar procedures to those adopted in the field of addiction (Field, Mogg, & Bradley, 2004b; Mogg, Field, & Bradley, 2005). Considering that this was the first study in the arena of problematic internet use where pictorial stimuli were used to assess attentional bias there was a major challenge in the development of control images which were to be used as comparison images against the internet-related ones. Similar research conducted pertaining to addiction has proven to be less challenging. For example, the critical images (related to the substance of abuse) containing simple objects (a pint of beer, a pack of cigarettes) or scenes from everyday life (images of bars where people are drinking or individuals are smoking) were matched with objects from everyday life which were very similar in perceptual characteristics, such as a pint of beer was matched with a pint of water or a pack of cigarettes with a pack of chewing gum or for more complex images a scene from a bar was matched with one from a birthday party where no alcohol was involved. However, the generation of control images that were perceptually similar to images related to generic internet activities was not so straightforward. Thus, two additional types of control images were developed. One type referred to as control-computer related images, were generated using Microsoft Office Word or PowerPoint (see Figure 3.2) and were visually very similar to internet-related images. The main difference between them was that the control-computer images related to the offline environment, that is, common visual images you see when you work with the computer offline. The other type of control images shared similar lower visual information with internet-related and internet logo-related images. However, they had no visual reference to the online environment or computer characteristics, and were termed control non-computer images. These types of images were generated in order to control for the possibility that individuals who might show an attentional bias for internet-related stimuli might also show a bias for computer related stimuli, as computers are commonly used as a medium to be online. Examples of the stimuli are presented in Figures 3.1, 3.2, and 3.3.

Figure 3.1: Presentation of internet-related stimulus (logo) on the left, matched with the control stimulus on the right.

Figure 3.2: Presentation of internet-related stimulus (online YouTube activity) on the left, matched with the control-computer related stimulus on the right (Power Point generated image).

Figure 3.3: Presentation of internet-related stimulus (online YouTube activity) on the left, matched with the control non-computer related stimulus on the right.

Three of the internet stimuli were logo related images (see Figure 3.1) and were paired with visually similar symbols. In addition, two of the internet images were online news websites and were matched with images from newspapers. The remaining 10 internet images containing generic online activities were matched in half of the trials with control-computer related images (see Figure 3.2) and in the remaining other half, with control-non computer related images (see Figure 3.3). Thus, there were two experimental conditions. One consisting of internet-related images matched with control-computer images (the computer condition) and the other where internet-related and internet-logo related images were matched with control non-computer images and symbols (the non-computer condition). Additionally, 45 neutral images were taken from the International Affective Picture System (IAPS) database (Lang & Bradley, 2008) and used in fillers and practice trials. The neutral pictures contained images of everyday objects such as a lamb, fork, book, landscapes etc. (mean arousal = 4.35, *SD* =.92; mean range = 3.34). The size of the pictures was 15.5cm wide and 11cm high and the distance between the inner edges of each picture in each pair was 3cm (visual angle of 1° between the fixation position and the inner edge of each picture).

3.3.3 Visual Dot-Probe Task

The Visual Dot-Probe task was generated with E-prime 2.0 Professional software (Psychology Software Tools, Pittsburgh, PA) and was presented on a 19inch monitor. Each trial started with the fixation cross ("+") which was presented centrally on the computer screen for 1000 milliseconds (ms), followed by the presentation of the pair of images (internet and control or neutral and neutral images) side by side for 2000 ms. Immediately after the offset of the images, a probe (dot, ".") appeared either on the left or right side of the computer screen (the distance between the two probe positions was 11.5cm) replacing one of the images (Figure 3.4). The task required participants to respond as quickly and as accurately as possible in the location where the probe appeared on the screen (for detailed instructions see Appendix II). The dot remained on the screen until participants made a response, indicated by pressing one of the response buttons on the keyboard ("m" when the dot appeared on the right side of the computer screen and "z" when it appeared on the left side). A participant's response terminated the trial and the next one began 2000ms later. The duration of the image presentation was chosen accordingly in order to assess for both initial orientation and maintenance of attention (Allport, 1989). There were 8 practice trials and 80 experimental trials (60 critical and 20 filler trials). During the 60 critical trials (which were the trials where the pair of images consisted of internet and matched control ones) each of the 15 internet-related and logos-related images were presented four times and appeared twice on the left side and twice on the right side of the screen. Moreover, there were matched and counterbalanced in half of the trials with control-computer (computer condition) and the other half with control non-computer and symbols (non-computer condition). The probe appeared in the location of either the internet or control images with equal frequency and there was an equal number of trials for each probe location (right versus left). Similarly, the aforementioned sequence of stimuli presentation and probe display was also counterbalanced for the remaining 20 filler trials where neutral images were paired together. Critical and filler trials were pseudorandomized and presented in the same order for all participants.

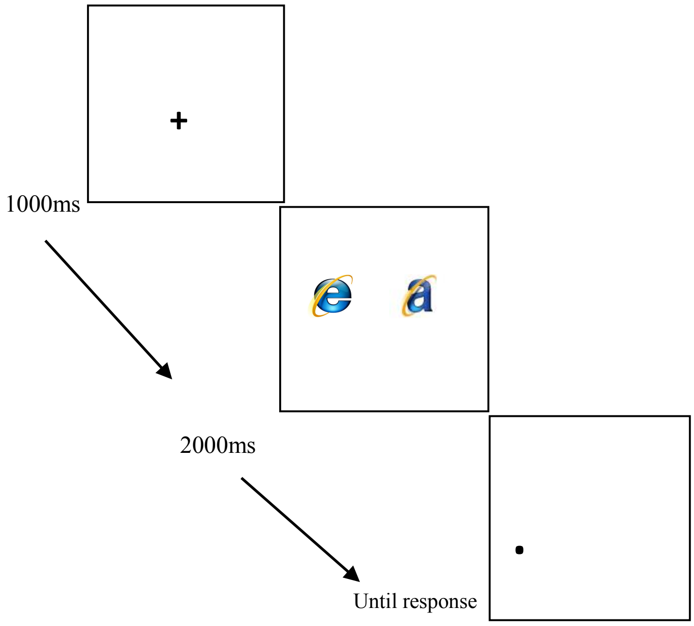

Figure 3.4: Example of an experimental trial in the Visual Dot-Probe Task.

3.3.4 Pleasantness Rating task

The Pleasantness Rating task was generated with E-prime 2.0 Professional software (Psychology Software Tools, Pittsburgh, PA). The main requirement of this task was to rate the pleasantness of each of the 40 images (15 internet and 25 control images) which were presented in the Dot-Probe task, with the exception of the neutral images which were used for the practice and filler trials. Following the presentation of each image (2000ms) participants rated on a 7-point scale how pleasant each image appeared to them (ranging from 1 “not pleasant” to 7 “very pleasant”) by pressing one of the seven corresponding keys on the keyboard (numbers 1 to 7). The size of the pictures was 15.5cm wide and 11cm high and there was a 2000ms inter trial interval.

3.3.5 Eye tracking

A head-free Eye Tracking System, Desktop 6 (D6) Optics ASL (Applied Science Laboratories, Bedford, MA) tracked and recorded eye movements. Some of the advantages of this type of eye tracker are: 1) it does not require any equipment to be attached to the participant; 2) it allows for free movement of the head; 3) it records the gaze’s horizontal and vertical location at a sample rate of 60Hz with an accuracy of 0.5^{o} of visual angle; and, 4) it uses a facial recognition program to find the participant's eye and thus the calibration procedure is carried out very quickly. Eye-tracking equipment was calibrated by presenting the numbers 1 to 9 on the screen in a 3x3 array (with number 1 at the top left of the screen and 9 at the bottom right). Participants were instructed to look at each number in turn, whilst their gaze position was recorded for each number. The direction of gaze was measured in degrees, and sampled once every 17ms. If eye movements were stable within 1^{o} degree of the visual angle for 100ms or more, this was classified as a fixation on that position, the duration of which was recorded. The eye tracker was placed below the computer monitor display at a distance of 70cm away from the participant's chair. Eye movements were recorded for each trial from the offset of the fixation cross until participants made a response to the probe. Data were analysed with ASL Results^{+} GM data analysis software (Applied Science Laboratories, Bedford, MA).

3.3.6 Self-report measures - Questionnaires

Addiction-Engagement Questionnaire (AEQ)

The AEQ is a 24-item self-report assessment of the severity of problematic internet use and consists of positive and negative statements. Respondents rate each item on a 7-point scale (1 "completely agree" to 7 "completely disagree"). The AEQ consists of two factors: addiction and engagement with scores ranging from 12 to a maximum 84 for each factor. The addiction factor consists of 12 items, seven of which relate to what have been termed to be the "core" criteria of addiction (behavioural salience-2 items, conflict-3 items, relapse and reinstatement-1 item, and withdrawal symptoms-1 item) and similarly, the engagement factor consists of 12 items, two of which relate to what have been termed "peripheral" criteria of addiction (cognitive salience-1 item, euphoria-1 item). The presence or absence of core and peripheral criteria are indicative for the categorization of problematic and non-problematic users.

The AEQ was initially developed to distinguish between problematic and high engagement in association with computer and online gaming use based on Brown's (1991, 1993) proposed criteria for behavioural addictions (Charlton, 2002; Charlton and Danforth, 2007, 2010). Carlton (2002) argued that different sets of the proposed criteria associated with problematic (core criteria of addiction) and high engagement (peripheral criteria of addiction) respectively. Charlton's argument developed through the observation that for some individuals even though they spent a lot of time on computer activities, their lives did not suffer negative consequences. He suggested that the negative consequences were a hallmark for distinguishing between high engagement and problematic behaviour.

In this present study the latest version of the scale which previously had been used to assess behavioural patterns of a specific type of Massively Multiplayer Online Role-Playing Game: Asheron's Call, was adapted and each item reworded with a reference to the internet (see Appendix III for details). For example, a statement such as "Arguments have sometimes arisen at home because of the time I spend on Asheron's Call" was reworded to "Arguments have sometimes arisen at home because of the time I spend on the internet". Moreover, the severity of problematic internet use in relation to specific online applications such as social networking sites (SNS) and online gaming was assessed. Thus, two more versions of the AEQ were included and adapted accordingly. For example, all the items of the questionnaire were reworded with reference to SNS and online gaming. Therefore a statement such as "Arguments have sometimes arisen at home because of the time I spend on the internet" was reworded to "Arguments have sometimes arisen at home because of the time I spend on SNS" and "Arguments have sometimes arisen at home because of the time I spend on online gaming".

In order to classify participants based on their responses in relation to core and peripheral criteria on the AEQ, a polythetic approach and classification system was adapted similar to Charlton and Danforth (2007, 2010) and Metcalf and Pammer's (2011) methodology. Moreover, responses to items associated with the core and peripheral criteria of addiction were dichotomised and mid-range responses were discarded. For the classification of problematic internet use, participants had to respond positively in at least 4 out of the 7 core criteria related to the addiction factor. Also, for the classification of high engagement, participants had to respond positively to 1 or 2 of the peripheral criteria related to the engagement factor and to 3 or less of the core criteria related to the addiction factor. The non-problematic internet users had to have negative responses in all of the 7 core and the 2 peripheral criteria. Moreover, from the initial phase where patterns of internet use were assessed, a high proportion of individuals who did not satisfy any of the criteria of the aforementioned groups were identified. Previous research (Charlton and Danforth, 2007, 2010; Metcalf & Pammer, 2011) has not made any reference to individuals that belong to this newly identified group. The participants belonging to this group either responded positively to 3 or less of the core criteria of addiction and negatively in the peripheral criteria or positively in 1 of the peripheral criteria and negatively to all core criteria. This group was termed the moderate internet users and they were included in the second phase of the experiment in order to assess whether they had similar characteristics to the non-problematic group. The Cronbach's alpha coefficient for the addiction factor was 0.91 and for the high engagement factor 0.83 for the general internet use, 0.92 and 0.92 for the online gaming and 0.92 and 0.91 for social networking sites respectively.

Internet Addiction Test (IAT)

The Cronbach's alpha coefficient was 0.93 for the whole scale and 0.89 (withdrawal and social problems), 0.85 (time management and performance) and 0.70 (reality substitute).

Problematic Internet Use Questionnaire (PIUQ)

The Cronbach's alpha coefficient sample was 0.94 for the whole scale and 0.91 (obsession), 0.84 (neglect) and 0.89 (control disorder).

In order to accommodate for the discrepancies in relation to assessment criteria and diagnosis for problematic internet use, in this study problematic internet use was assessed based on three different well established and validated questionnaires (the AEQ, the IAT and the PIUQ).The goal was to assess relationships between these questionnaires with their factors and thus provide; 1) a better understanding of the different components of problematic internet use, 2) relationships between the different assessment criteria and 3) validate whether or not there were qualitative differences between problematic, high engager, moderate and non-problematic internet users.

Brief Symptom Inventory (BSI-53)

The Cronbach's alpha coefficient was 0.97 for the whole scale and 0.85 (somatization), 0.84 (obsession-compulsion), 0.88 (interpersonal sensitivity), 0.86 (depression), 0.87 (anxiety), 0.85 (hostility), 0.86 (phobic anxiety), 0.84 (paranoid ideation), and, 0.84 (psychoticism). All raw scores were converted to T-scores using adult non-patient norms for each gender (Derogatis, 1993).

Barratt Impulsiveness Scale version 11 (BIS)

The Cronbach's alpha coefficient was 0.82 for the whole scale and 0.72 (non-planning), 0.70 (motor) and 0.71 (cognitive).

The BSI-53 and BIS-11 were used in order to assess whether there were qualitative differences between groups of problematic internet users in relation to psychopathological and personality constructs.

Questionnaire on internet use urges (QIUU)

The QIUU is a 10-item self-report questionnaire assessing severity of urges to be online. Respondents rate each item on a 7-point scale (1 "completely disagree" to 7 "completely agree").The QIUU was adapted from the original Questionnaire on Smoking Urges-Brief (Cox, Tiffany, & Christen, 2001; Tiffany & Drobes, 1991). In order to assess levels of urges to be online each item was reworded with a reference to online activity. For example a statement such as “I have the desire for a cigarette right now” was reworded to “I have the desire to be online right now”. The Cronbach’s alpha coefficient was 0.94.

The QIUU was used to assess whether increase urges to be online correlate with attentional bias for internet-related stimuli.

3.3.7 Procedure

On first contact, participants were given information in relation to the study’s aims and procedures and were provided with the opportunity to ask any questions that they might have had. Once they agreed to take part they completed a battery of questionnaires comprising the AEQ, IAT, PIUQ, BIS-11 and BSI-53 on an online data collection website (Bristol Online Survey). Based on the selection criteria outlined above (subsection 3.3.1), a sample of internet users were invited to participate in the second phase of the experiment which took place in the Department of Psychology Laboratories. Upon arrival, participants were given information in relation to the experimental procedures, they provided informed consent and asked any questions they had. Next the participants sat comfortably in a chair at a 70cm distance (approximately) from a computer display where they performed the two computer based tasks. At the beginning of the testing procedure eye tracker calibration was conducted. The participants then completed the Dot-Probe task and were explicitly instructed to try to stay as still as possible throughout the experiment, to fixate on the cross at the start of each trial when it appeared on the screen and to try not to blink while they viewed the cross and the pair of pictures. Then they completed the Pleasantness Rating task and a battery of questionnaires comprising the QIUU and AEQ for specific online applications namely; social networking sites and online gaming. After the completion of the questionnaires, participants were fully debriefed and received a payment of £10. The total participation time took approximately thirty minutes. Those participants who filled in the online questionnaires but were not selected for the second phase of the experiment had the opportunity to win a £50 Amazon voucher in a prize draw.

3.3.8 Preparation of eye movement data

Eye movements were only analysed for the 60 critical trials where internet-related images were paired with controls. The criteria for initial fixation was based on Field, Mogg, & Bradley's (2004b) methodology, which required that 1) participants fixated on the cross before the pair of pictures appeared on the screen, 2) any eye movement had to occur 100ms after the visual stimuli presentation and before the pictures offset 3) participants fixated on one of the pictures rather than the central area during the presentation of the experimental stimuli. An initial fixation was made on either the internet or control related images in 90.86% of the trials. For 5.70% of the trials, participants did not fixate on the cross before the pictures offset and for 3.44% of trials they fixated on the central area rather than the stimuli.

Dwell time was calculated based on the amount of time participants spent fixating (summing the duration of each fixation) on both images and the central location (between the images area) for each critical trial. First, the average time participants spent looking at these three areas altogether were analysed and trials where there were excessive missing data (no recording eye movements-fixations were more than 3 *SD*s above the sample mean) were excluded. The 3 *SD*s is a cut-off point which has been consistently applied in research conducted with eye movements (Field, Mogg, & Bradley, 2004b; Mogg et al., 2005). A fixation was made on any of the three aforementioned areas at 84% of the time of image presentation. The remaining 16% of the time where no fixation was recorded was attributed to saccade eye movement, eye blinks, and failure of the system to record eye movements. Of the recorded fixation time 87.85% related to fixations made to one of the regions containing the images with the remaining 12.15% made to the central location (i.e. where the cross was presented between the images area).

3.3.9 Statistical Analysis

All statistical analyses were conducted using SPSS 20 software.

The analysis related to the Dot-Probe task was based on a similar methodological approach to that used in the field of addiction (Field, Mogg, & Bradley, 2004b; Mogg et al., 2003). The dependent variables for eye movements in the Visual Dot-Probe task were the direction of the initial fixation in relation to internet-related images and the time spent fixating (the dwell time) on internet-related and control images. Moreover, in the Dot-Probe task reaction times related to responses to probes replacing internet or control related visual stimuli were assessed and analysed. The probe position had two levels; congruent when the probe replaced internet-related images and incongruent when the probe replaced control images. Mixed-way ANOVAs, paired and independent t-tests were used to assess group differences for the time spent fixating on each image as well as for the RTs in relation to congruent-incongruent trials. Moreover, in order to identify which type of stimuli (image) each group preferred to look at first, we compared the percentage in which they looked at internet-related images against the 50% which indicated no bias. One-way ANOVAs (post-hoc comparisons) assessed group differences in the percentage of initial direction of gaze in our sample. Similarly, mixed-way ANOVAs, paired and independent t-tests were conducted to assess group differences in relation to pleasantness ratings for internet and control images. Additionally, supplementary analyses were conducted for all the aforementioned variables for the two experimental conditions: the computer condition, where internet-related images were matched with computer images and the non-computer condition, where internet-related and logo-related images were matched with non-computer images and symbols.

In addition, Pearson correlation coefficients and partial correlations were conducted to assess the relationship between biases (cognitive, evaluative) with internet variables (severity of problematic internet use and urges to be online). Based on the findings, all the aforementioned analysis were conducted with the inclusion of another factor that of levels of urges to be online (this included internet users with higher levels and internet users with lower levels of urges to be online).

Finally, whether the individuals with problematic internet use for specific internet application (such as social networking sites) showed an attentional bias for general internet stimuli was investigated. For this reason all the aforementioned analyses were run with the one difference, namely, that the groups of internet users reported either generic or/and specific problematic internet use.

3.4 Results

3.4.1 Group characteristics (see Tables 3.1 and 3.2)

Initially, based on Charlton and Danford's (2007, 2010) model assessment was made regarding whether differences between groups of internet users would be evident in: 1) severity of problematic internet use, 2) motivational states, 3) psychopathological constructs, and, 4) personality traits. One-way ANOVAs were performed on key self-report measures. Where significant group effects were found, Tukey HSD or Games-Howell tests depending whether Levene's test of homogeneity of variance was significant or not, were performed.

From Table 3.1, it can be seen that overall, the problematic internet users group had significantly higher scores compared to high engagers, moderate and non-problematic internet users on the AEQ addiction scale, IAT total (including withdrawal and social problems subscale) and PIUQ total scores (including obsession, neglect and control disorder subscales). Additionally, the problematic internet users had significantly higher scores compared to non-problematic internet users on the AEQ high engagement scale. Moreover, the problematic internet users had significantly higher scores compared to non-problematic and moderate internet users on the IAT subscales (time management and performance and reality substitute subscales). Finally, this group of problematic internet users had higher scores on the QIUU compared to moderate and non-problematic internet users.

Table 3.1- Characteristics of internet use groups. Values are means (standard deviation in brackets)

	Problematic internet users (PIU) (n=17)	High engagers internet users (HE) (n=14)	Moderate internet users (MIU) (n=20)	Non-problematic internet users (NPIU) (n=17)	Anova F Values	Post-hoc comparisons (Tukey HSD and Games-Howell)
Age (years)	22.9 (3.4)	27.34 (8.71)	28.30 (9.2)	28.41 (9.91)		
Gender (M/F)	5M/12F	4M/10F	5M/15F	3M/14F		
AEQ addiction	58.24 (9.79)	38.29 (11.45)	33.70 (12.35)	22.06 (5.99)	37.01 **	PIU>HE,NPIU,MIU;HE> NPIU; MIU>NPIU
AEQ high engagement	62.12 (11.29)	62.86 (11.35)	53.35 (11.76)	47.00 (7.92)	8.16**	PIU>NPIU; HE>NPIU
IAT total	56.35 (13.85)	42.64 (11.91)	41.75 (12.54)	32.24 (5.94)	12.67**	PIU>HE,NPIU,MIU
IAT withdrawal and social problems	21.06 (7.60)	13.43 (4.52)	14.05 (5.01)	10.94 (2.38)	11.60**	PIU>HE,NPIU,MIU
IAT time management and performance	20.06 (4.16)	16.36 (5.02)	15.90 (5.20)	12.24 (3.36)	8.57**	PIU>NPIU,MIU
IAT reality substitute	8.29 (2.36)	6.21 (3.19)	6.10 (2.65)	4.18 (1.07)	8.23**	PIU> NPIU,MIU; MIU>NPIU
PIUQ total	54.94 (11.66)	40.00 (10.03)	40.45 (13.40)	29.94 (4.78)	15.85**	PIU>HE,NPIU,MIU; HE>NPIU; MIU>NPIU
PIUQ obsession	16.06 (4.21)	11.43 (4.22)	11.85 (5.19)	8.47 (1.58)	9.93**	PIU>HE,NPIU,MIU; MIU>NPIU
PIUQ neglect	19.41 (4.03)	14.43 (4.40)	14.20 (4.82)	11.06 (2.43)	12.39**	PIU>HE,NPIU,MIU
PIUQ control disorder	19.47 (4.90)	14.14 (3.51)	14.40 (5.24)	10.41 (2.34)	13.03**	PIU>HE, RIU,NPIU; HE>NPIU; MIU>NPIU
QIUU	36.47 (14.46)	30.36 (11.00)	26.60 (12.25)	19.59 (7.61)	6.23**	PIU> NPIU,MIU

Note. AEQ = *Engagement and Addiction Questionnaire with subscales*, IAT = *Internet Addiction Test with subscales*; PIUQ = *Problematic Internet Use Questionnaire with subscales,* QIUU = *Questionnaire on internet use urges. PIU = four or more addiction criteria, HE = three or less addiction criteria and one or two peripheral criteria, MIU = three or less addiction criteria or one peripheral criteria, NPIU = none of the addiction or peripheral criteria.*

Additionally, problematic internet users had higher scores compared to the other internet users on the BSI Positive symptom distress index which is an overall assessment of the severity of distress individuals are experiencing. Also, they had significantly higher scores compared to non-problematic internet users on the BSI subscale: global severity index, positive symptom total, obsession-compulsion, interpersonal sensitivity, depression, hostility, paranoid ideation and psychoticism (Table 3.2).

In relation to personality trait characteristics the problematic internet users had higher scores on the BIS attention subscale compared to high engagers and non-problematic internet users (Table 3.2).

Overall, the data provided support for qualitative differences between internet use groups (problematic, high engagers, moderate and non-problematic internet users) based on the AEQ proposed criteria, as there were significant differences between these groups in relation to severity of problematic internet use, psychopathology and personality characteristics.

Table 3.2-Psychopathological and personality characteristics of internet use groups.

	Problematic internet users (PIU) (n=17)	High engagers internet users (HE) (n=14)	Moderate internet users (MIU) (n=20)	Non-problematic internet users (NPIU) (n=17)	Anova F Values	Post-hoc comparisons (Tukey HSD and Games-Howell)
BSI grand total	62.35 (43.69)	31.14 (25.84)	33.45 (31.41)	16.47 (11.27)	6.67**	PIU> NPIU
BSI global severity index	64.94 (10.93)	55.85 (12.70)	55.85 (12.70)	48.88 (7.95)	6.34**	PIU> NPIU
BSI positive symptom total	64.29 (10.69)	56.29 (10.94)	55.05 (13.23)	151.76 (8.28)	3.96*	PIU> NPIU
BSI positive symptom distress index	64.64 (5.68)	57.35 (7.17)	58.95 (9.82)	49.53 (5.19)	12.29**	PIU>HE ,NPIU; HE>NPIU;MIU>NPIU
BSI somatization	57.41 (11.8)	52.07 (10.01)	50.9 (9.98)	50.41 (6.46)	1.90	
BSI obsession-compulsion	71.00 (6.54)	64.50 (11.58)	57.15 (12.41)	55.64 (8.68)	8.50**	PIU> RIU, NPIU
BSI interpersonal sensitivity	64.83 (9.66)	55.85 (11.92)	57.8 (11.73)	50.53 (7.76)	5.47*	PIU> NPIU
BSI depression	63.29 (10.44)	57.50 (8.69)	56.65 (12.22)	51.47 (7.45)	3.92*	PIU> NPIU
BSI anxiety	55.88 (13.68)	47.71 (12.06)	53.4 (10.54)	47.85 (8.28)	1.84	
BSI hostility	63.53 (12.72)	49.57 (11.68)	56.00 (11.03)	50.17 (8.81)	5.56**	PIU> HE,NPIU
BSI phobic anxiety	59.29 (11.21)	52.64 (10.16)	53.10 (10.10)	50.88 (7.68)	2.34	
BSI paranoid ideation	64.23 (10.59)	55.92 (10.25)	53.40 (12.86)	50.64 (7.98)	5.17*	PIU> MIU,NPIU
BSI psychoticism	67.00 (11.63)	59.42 (9.48)	61.45 (12.91)	52.41 (8.19)	5.20**	PIU> NPIU
BIS total	65.94 (8.55)	63.00 (12.30)	62.35 (9.78)	61.12 (11.37)	0.65	
BIS attention	19.35 (3.33)	15.43 (4.68)	16.90 (3.07)	15.71 (3.87)	3.79*	PIU> HE,NPIU
BIS motor	21.59 (3.26)	23.07 (5.55)	22.85 (5.48)	21.88 (4.10)	0.39	
BIS non-planning	25.00 (4.91)	24.50 (6.16)	22.60 (4.54)	23.53 (5.03)	0.78	

Note, BSI = Brief Symptom Inventory with subscales; BIS = Barratt Impulsivity Scale with subscales. PIU = four or more addiction criteria, HE = three or less addiction criteria and one or two peripheral criteria, MIU = three or less addiction criteria or one peripheral criteria, NPIU = none of the addiction or peripheral criteria. $p < .01^{**}$, $p < .05^{*}$

3.4.2 Dot-probe task performance *(All the raw data are presented in Table 3.3)*

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

Fixation Duration

The mean amount of time (fixation duration) participants spent fixating on each image (internet-related versus control) was calculated during critical trials. A 2 x 4 mixed-way ANOVA with image type (internet versus control) as a within factor and group (problematic, high engagers, moderate and non-problematic internet users) as a between factor was performed. Overall, the results revealed no significant main effect of image type, $F(1, 64) = 1.19$, $p = .28$, group effect, $F(3, 64) = 0.20$, $p = .89$, or interaction between picture type and group, $F(3, 64) = 0.81$, $p = .49$. The data suggest that all groups of internet users spent equal amount of time fixating on both types of images (Figure 3.5).

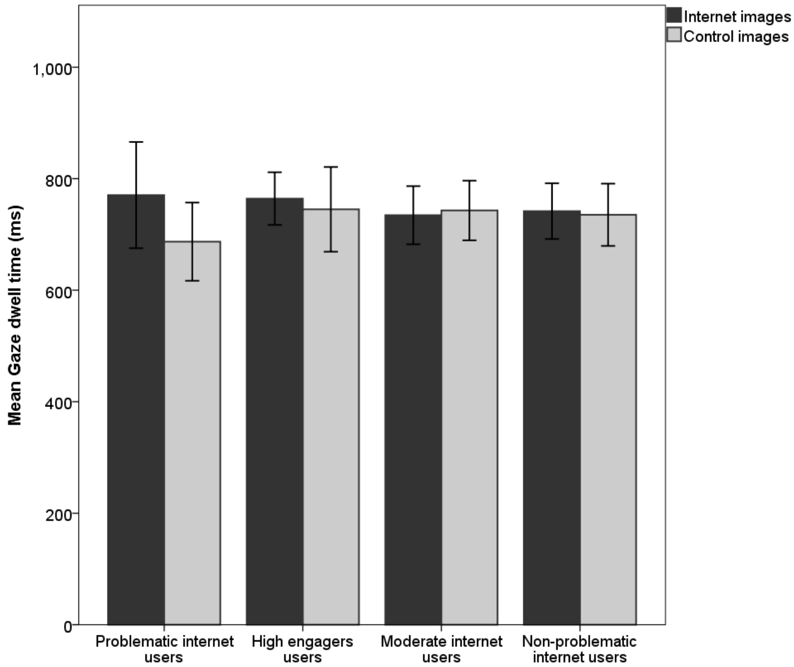

Figure 3.5 Mean gaze dwell time (in milliseconds) on internet and control images, shown separately for problematic, high engagers, moderate and non-problematic internet users. Error bars represent standard error of the means.

Direction of initial fixation

The direction of initial fixation was calculated by assessing the percentage of the trials where the initial fixation was made on internet-related images. It has been suggested that scores greater than 50% (which indicates no bias) reflected bias for internet images (Mogg et al., 2005). Problematic internet users made their first fixation on internet-related images in 47.8% of the trials (*SD* = 5.17), high engagers in 52.6% of the trials (*SD* = 6.58), moderate internet users in 47.5% of the trials (*SD* = 6.02) and non-problematic in 50.5% of the trials (*SD* = 7.51) which were not significantly greater than 50%, *t*(16) = 1.72, *p* = .104; *t*(13) = -1.46, *p* = .168; *t*(19) = 1.87, *p* = .076; *t*(16) = -.25, *p* = .802, respectively. Moreover, a one-way ANOVA revealed no differences between groups in percentages of initial fixations made on internet-related images, *F*(3, 67) = 2.27, *p* = .089. Overall results revealed no direction of initial fixation bias in any of the internet use groups.

Attentional bias as assessed with manual reaction times to probes

Reaction times (RTs) were only analysed for critical trials. Trials with errors (1%) and outliers (RTs more than 3*SD* above the sample mean, 2.5%) were excluded from the analysis. Moreover, the data from one participant were missing due to technical difficulties.

Mean RTs in response to the probe replacing each image (internet versus control) during critical trials was calculated. A 2 x 4 mixed-way ANOVA with probe condition (probe in the same congruent versus different incongruent location with internet-related images) as a within factor and group (problematic, high engagers, moderate and non-problematic internet users) as the between factor was performed. Overall, the results revealed no significant main effect of probe condition, *F*(1, 63) = 2.93, *p* = .09, group effect, *F*(3, 63) = 1.58, *p* = .204, or interaction between probe condition and group, *F*(3, 63) = 0.78, *p* = .51.

3.4.3 Pleasantness rating task: stimulus valence measures

Mean pleasantness ratings for the internet and control images was calculated. A 2 x 4 mixed-way ANOVA with image type (internet versus control) as a within factor and group (problematic, high engagers, moderate and non-problematic internet users) as the between factor was performed. There was a significant main effect of image type, *F*(1, 64) = 104.60, *p* = .0001, ηp^2 = .62, and group with images type interaction, *F*(3, 64) = 4.54, *p* = .006, ηp^2 = .18. However, the group effect was not significant, *F*(1, 64) = 1.70, *p* = .175. Overall, participants rated internet images as more pleasant than control images, *t*(67) = 9.4, *p* = .0001, *d* = 2.29, 95% CI [0.75, 1.15], and this difference reached significance for problematic internet users, $t(16) = 7.09$, $p = .0001$, $d = 3.54$, 95% CI [1.01, 1.87], high engagers, $t(13) = 5.32$, $p = .0001$, $d = 2.95$, 95% CI [0.67, 1.59], moderate internet users, $t(19) = 4.44$, $p = .0001$, $d = 2.02$, 95% CI [0.39, 1.09] and non-problematic internet users, $t(16) = 3.21$, $p = .005$, $d = 1.61$, 95% CI [0.19, 0.92]. Post-hoc Bonferroni correction tests revealed that problematic internet users rated internet images more pleasant compared to moderate internet users, $t(35) = 2.89$; $p = .007$, $d = .97$, 95% CI [0.16, 0.96], and non-problematic internet users, $t(32) = 4.33$; $p = .0001$, $d = 1.53$, 95% CI [0.45, 1.25] (Figure 3.6).

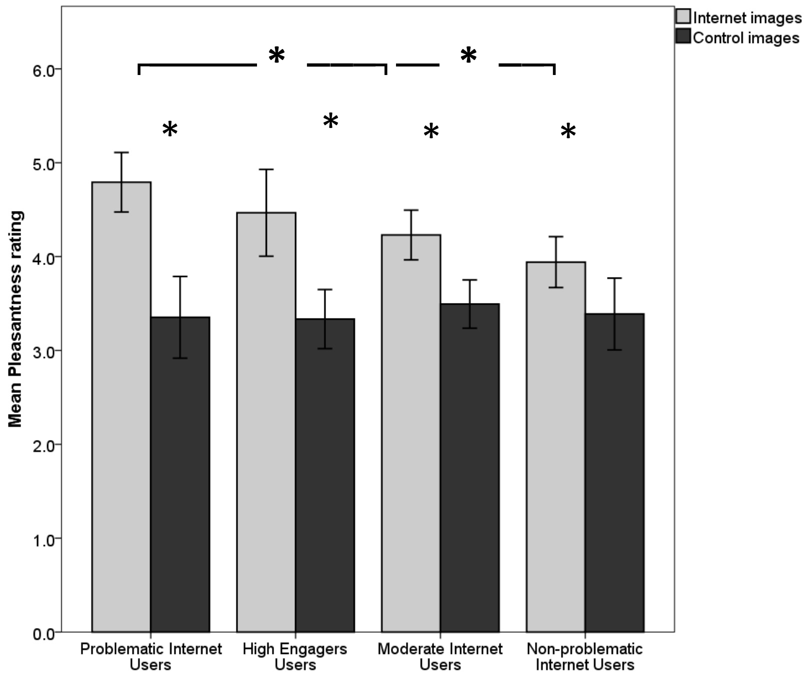

Figure 3.6 Mean pleasantness rating for internet and control images, shown separately for problematic, high engagers, moderate and non-problematic internet users. Error bars represent standard error of the means.

Overall, the results did not reveal any difference in attentional processes between the groups of internet users. Moreover, further analysis was conducted separately for trials where internet images were matched with control-computer related images and for trials where they were matched with non-computer related images. Supplementary analysis was conducted in order to assess whether there were differences in behavioural outcomes related to each type of control stimuli.

3.4.4 Supplementary analysis for computer condition *(All the raw data are presented in Table 3.3)*

Dot-probe task performance

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

<u>Fixation Duration</u>

There was a significant main effect of image type, $F(1, 64) = 5.48$, $p = .022$, $\eta_p^2 = .08$. Overall, results revealed that participants fixated longer on control-computer images compared to internet images, $t(67) = -2.39$, $p = .02$, $d = .58$, 95% CI [-131.92, -11.92], however, this difference reached significance only for the non-problematic internet users, $t(16) = -2.43$, $p = .027$, $d = 1.21$, 95% CI [-252.16, -17.25], (Figure 3.7). The main effect of group, $F(3, 64) = 0.42$, $p = .74$, and the interaction between image type and group, $F(3, 64) = 0.76$, $p = .52$, were not significant.

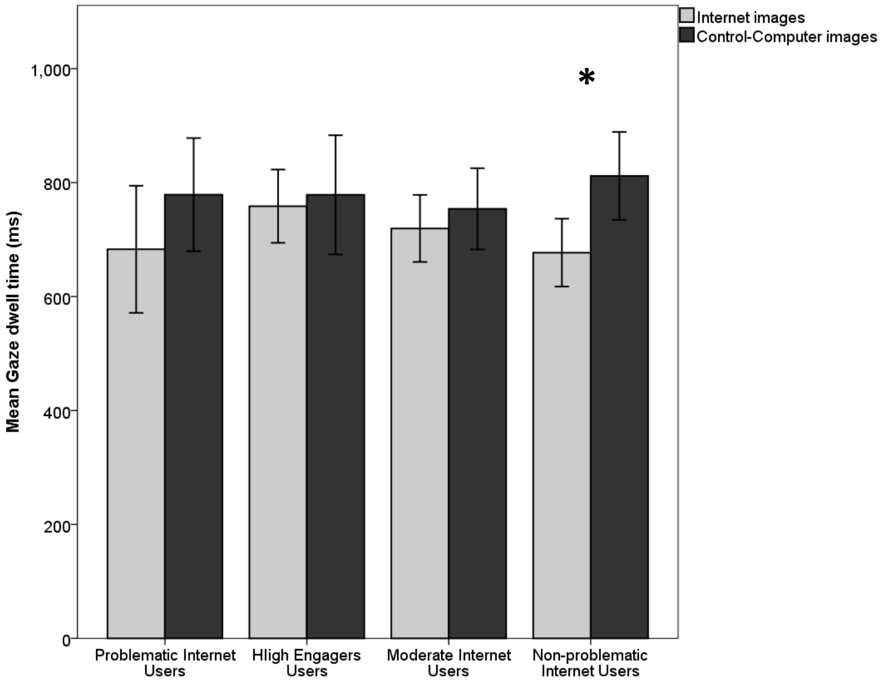

Figure 3.7 Mean gaze dwell time (in milliseconds)on internet and control-computer images, shown separately for problematic, high engagers, moderate and non-problematic internet users. Error bars represent standard error of the means.

<u>Direction of initial fixation</u>

Problematic internet users made their first fixation on internet-related images on 42.1% of trials (*SD* = 8.35), high engagers on 45.2% of the trials (*SD* = 6.84), moderate internet users on 44.8% of the trials (*SD* = 10.51) and non-problematic on 44.5% of the trials (*SD*= 10.43) which were significantly smaller than 50%, $t(16) = -3.91$, $p = .001$, $d = -2.17$, 95% CI [-12.23, -3.64]; $t(13) = -2.63$, $p = .021$, $d = -1.46$, 95% CI [-8.76, -0.86]; $t(19) = -2.21$, $p = .036$, $d = -1.06$, 95% CI [-10.12, -0.29]; $t(16) = -2.18$, $p = .044$, ; $d = -1.09$, 95% CI [-10.88, -0.15], respectively. Moreover, the one-way ANOVA revealed no differences between groups in percentages of initial fixations made on internet-related images, $F(1, 64) = .38$, $p = .77$. Overall results suggested that all internet users had a direction of initial fixation bias on control-computer images (Figure 3.8).

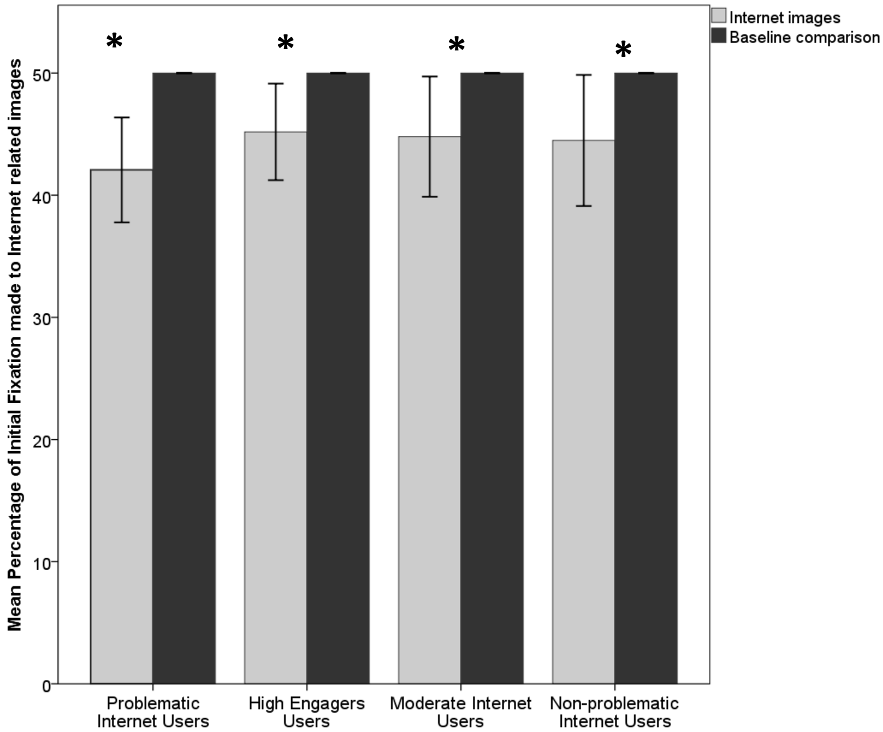

Figure 3.8 Mean percentage of direction of initial fixation on internet-related images (in trials where controls were computer related images) against 50% which indicates no bias, shown separately for problematic, high engagers, moderate and non-problematic internet users. Error bars represent standard error of the means.

<u>*Attentional bias as assessed with manual reaction times to probes*</u>

There was a significant main effect of probe condition $F(1, 63) = 5.94$, $p = .018$, $\eta p^2 = .09$. Overall, the results revealed that participants were quicker to respond to probes replacing internet images compared to probes replacing control-computer images, $t(66) = -2.64$, p = .01, $d = .64$, 95% CI [-22.77, -3.16]. The main effect of group, $F(3, 63) = 1.44$, $p = .24$, and the interaction between probe condition and group, $F(3, 63) = 0.47$, $p = .702$, were not significant.

3.4.5 Supplementary analysis for non-computer condition *(All the raw data are presented in Table 3.3)*

Dot-probe task performance

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

Fixation Duration

There was a significant main effect of image type, $F(1, 64) = 6.95$, $p = .011$, $\eta_p^2 = .10$. Overall, results revealed that participants fixated longer on internet images compared to control non-computer images $t(67) = 2.52$, $p = .014$, $d = .62$, 95% CI [13.78, 118.13]. However, this difference reached significance only for problematic internet users, $t(16) = 2.12$, $p = .05$, $d = 1.06$, 95% CI [0.29, 290.89] and approached significance for the high engagers, $t(13) = 2.13$, $p = .053$, $d = 1.17$, 95% CI [-0.867, 112.29]. Similarly there was a strong trend for non-problematic internet users to fixate more on internet compared to the control images, $t(16) = 1.95$, $p = .069$, 95% CI [-6.85, 167.70] (Figure 3.9). The main effect of group, $F(3, 64) = 0.42$, $p = .74$, and the interaction between image type and group, $F(3, 64) = 0.76$, $p = .52$, were not significant.

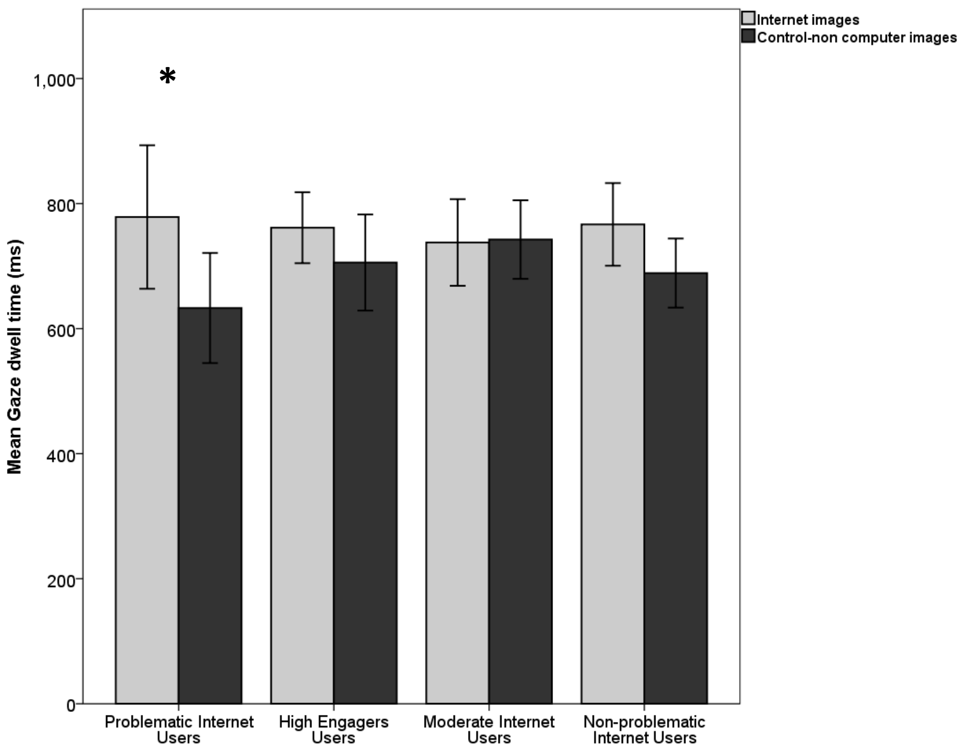

Figure 3.9 Mean gaze dwell time (in milliseconds) on internet and control non-computer

images, shown separately for problematic, high engagers, moderate and non-problematic internet users. Error bars represent standard error of the means.

Direction of initial fixation

Problematic internet users made their first fixation on internet-related images in 47.3% of the trials (*SD* = 12.58), high engagers in 47.9% of the trials (*SD* = 7.57), moderate internet users in 48.54% of the trials (*SD* = 12.48) and non-problematic in 49.4% of the trials (*SD* = 10.45) which were not significantly greater than 50% which indicate no bias, $t(16) = 0.89$, $p = .38$; $t(13) = 1.04$, $p = .317$; $t(19) = 0.52$, $p = .608$; $t(16) = .23$, $p = .82$, respectively. Moreover, a one-way ANOVA revealed no differences between groups in percentages of initial fixations made on internet-related images, $F(3, 67) = 0.11$, $p = .95$. Overall results revealed no direction of initial fixation bias in any of the internet use groups.

Attentional bias as assessed with manual reaction times to probes

There were not significant main effects of probe condition, $F(1, 63) = 0.002$, $p = .97$ or group, $F(3, 63) = 1.59$, $p = .20$, and the interaction between probe condition and group, $F(3, 63) = 1.60$, $p = .20$, was also not significant.

Table 3.3-Mean and standard deviations for RTs, direction of initial fixation, dwell gaze time and pleasantness ratings for all trials, trials where control images were computer and non-computer for problematic, high engagers, moderate and non-problematic internet users.

Internet use group	Problematic internet users	High engagers	Moderate users	Non-problematic internet users
Behavioural Performance	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
RT congruent all trials	519.08 (75.13)	475.44 (79.16)	471.62 (77.44)	487.02 (67.04)
RT incongruent all trials	529.60 (78.06)	478.42 (82.14)	474.65 (82.41)	487.37 (67.67)
RT congruent computer trials	523.79 (79.82)	478.19 (80.26)	465.31 (94.54)	484.50 (78.22)
RT incongruent computer trials	532.29 (77.99)	483.30 (91.20)	485.71 (87.44)	499.39 (68.90)
RT congruent non-computer trials	516.94 (74.43)	473.83 (79.58)	475.47 (74.60)	488.62 (63.51)
RT incongruent non-computer trials	528.32 (80.47)	476.33 (79.73)	469.55 (83.50)	481.22 (68.07)
Direction of initial fixation all trials	47.83 (5.173)	52.56 (6.58)	47.47 (6.01)	50.46 (7.50)
Direction of initial fixation computer trials	42.06 (8.353)	45.18 (6.84)	44.79 (10.51)	44.489 (10.43)
Direction of initial fixation non-computer trials	47.26 (12.57)	47.89 (7.57)	48.54 (12.48)	49.40 (10.44)
Dwell gaze time internet all trials	770.58 (196.13)	764.28 (88.29)	734.50 (116.68)	741.76 (103.03)
Dwell gaze control all trials	687.05 (144.55)	745.00 (142.11)	743.00 (119.56)	735.29 (115.11)
Dwell gaze time internet computer trials	682.94 (217.01)	758.57 (111.41)	719.50 (125.67)	677.05 (115.74)
Dwell gaze time control computer trials	778.82 (193.06)	778.57 (181.10)	754.00 (152.39)	811.76 (150.21)
Dwell gaze time internet non-computer trials	778.52 (223.18)	761.42 (98.32)	737.75 (147.92)	766.76 (128.56)
Dwell gaze time control non-computer trials	632.94 (171.20)	705.71 (133.21)	742.50 (134.32)	688.82 (107.40)
Pleasantness rating of internet images all trials	4.79 (0.61)	4.46 (0.80)	4.23 (0.56)	3.94 (0.52)
Pleasantness rating of control images all trials	3.35(0.84)	3.33 (0.54)	3.49 (0.54)	3.38 (0.74)

3.4.6 Relationships between cognitive and evaluative biases with internet-related variables

Following the suggestion from the field of addictions which implies that not only trait (dependence) but also state characteristics such as craving levels are associated with attentional and evaluative biases, correlational analysis was conducted in order to assess the relationships between the severity of problematic internet use, urges to be online, evaluative bias and cognitive biases as assessed with the gaze dwell time, and direction of initial fixation, as well as reaction times in response to probes. In order to conduct correlational analysis the following were calculated: 1) direction of initial fixation scores as measured by the percentage of the first eye movement made on internet images (as mentioned in subsection 3.3.9), 2) the gaze dwell time; for this the mean dwell time spent on control images was subtracted from the mean dwell time spent on internet images, and thus positive scores indicated a bias for internet images, 3) RTs; for calculating this, the mean RTs to probes replacing internet images was subtracted from the RTs regarding probes replacing control images and thus positive scores reflected an attentional bias for internet images and finally 4) evaluative bias; for calculating this the mean pleasantness ratings for control images was subtracted from mean pleasantness ratings for internet images and thus positive scores reflected a higher pleasantness score for internet images.

<u>Correlations between cognitive, evaluative biases with internet variables</u>

Table 3.4 revealed that there were significant positive correlations between the severity of problematic internet use as assessed with the AEQ addiction subscale with urges to be online, r = .66, p = .001; with gaze dwell time, r = .29, p = .015; and evaluative bias, r = .41, p = .001. Moreover, urges to be online were also positively correlated with gaze dwell time, r = .39, p = .001; and evaluative bias, r = .43, p = .001. There were also inter-correlations between RTs with evaluative bias, r = .27, p = .03 and gaze dwell time with evaluative bias, r = .45, p = .001. No other correlations were found.

Table 3.4- Correlations (Pearson) of AEQ, dwell time, reaction time, pleasatness rating, direction of initial fixation and urges to be online.

	AEQ addiction	Dwell time	Reaction time	Pleasatness rating	Direction of initial fixation	Urges to be online
AEQ addiction	**1**	**.29****	.15	**.41****	.13	**.66****
Dwell time	**.29****	**1**	.21	**.43****	.23	**.39***
Reaction time	.15	.21	**1**	**.27****	-.17	.14
Pleasatness rating	**.41****	**.43****	**.27****	**1**	-.03	**.43****
Direction of initial fixation	.13	**1**	-.17	-.03	**1**	.09
Urges to be online	**.66****	**.39****	.14	**.43****	.09	**1**

Note. Values are correlation coefficients; bold coefficients are statistically significant (two-tailed). *AEQ: Addition and Engagement Questionnaire.* $p < .05^{*}; p < .01^{**}$

The two variables, the severity of problematic internet use and urges to be online which previously have been tentatively associated with attentional and evaluative bias and, as a consequence with internet use were highly correlated. Thus, correlations (controlling for each variable) were performed partially in order to assess whether their relationships with the cognitive and evaluative biases were influenced by the other variable. Partial correlation, when controlling for the urges to be online variable, revealed that the correlation between the severity of problematic internet use with gaze dwell time $r = .05$, $p = .68$, and with evaluative bias, $r = .18$, $p = .14$ was no significant. On the other hand, when controlling for severity of problematic internet use, urges to be online were still significantly correlated with gaze dwell time, $r = .27$, $p = .03$ and approached significance with evaluative bias, $r = .23$, $p = .06$.

These data suggest that urges to be online mediated the relationship between the severity of problematic internet use with attentional and evaluative bias. Thus, further analysis was performed with levels of urges to be online as an additional factor (two levels based on a median split scores on the QIUU; internet users with higher levels of urges to be online and internet users with lower levels of urges to be online) and assessed attentional and evaluative bias in groups of internet users (problematic, high engagers, moderate and non-problematic internet users).

Frequency analysis revealed that 62% of internet users with higher levels of urges to be online belonged to problematic and high engagers internet users and 38% to moderate and non-problematic internet users, whereas 29% of the internet users with lower levels of urges to be online belonged to the problematic and high engagers internet users and 71% to moderate and the non-problematic internet users (see also Table 3.4).

Table 3.5- Total percentages for each internet use group split by levels of urges to be online group (high and low).

Internet use group	Problematic internet users		High engagers internet users		Moderate internet users		Non-problematic internet users	
Levels of urges to be online	High	Low	High	Low	High	Low	High	Low
Percentages	70.6%	29.4%	64.3%	35.7%	45%	55%	23.5%	76.5%

3.4.7 Dot-probe task performance split by levels of urges to be online and internet use groups (All the raw data are presented in Table 3.6)

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

Fixation Duration

A 2 x 4 x 2 mixed-way ANOVA with image type (internet versus control) as a within factor and internet use group (problematic, high engagers, moderate and non-problematic internet users) and levels of urges to be online (internet users with higher levels of urges to be online, internet users with lower levels of urges to be online) as between factors was performed. There were significant interactions between image type and levels of urges to be online, *F*(1, 60) = 7.51, *p* = .008, η_p^2 = .11, and internet use group with levels of urges to be online, *F*(3, 60) = 3.46, *p* = .022, η_p^2 = .15. The main effects of image, *F*(1, 60) = 1.44, *p* = .41, internet use group, *F*(3, 60) = 1.21, *p* = .31, levels of urges to be online group, *F*(1, 60) = 0.14, *p* = .71 and the interactions between image type and internet use group, *F*(3, 60) = 0.21, *p* = .89 and image type, internet use group and levels of urges to be online group, *F*(3, 60) = 0.48, *p* = .70 were not significant.

In order to investigate the significant interaction between image type and levels of urges to be online a 2 x 2 mixed-way ANOVA was performed with image type (internet versus control) as a within factor and levels of urges to be online (internet users with higher levels of urges to be online, internet users with lower levels of urges to be online) as a between factor. There was a significant interaction between image type and levels of urges to be online, *F*(1, 66) = 9.31, *p* = .003; η_p^2 = .12. However, the main effect of image type was not significant, *F*(1, 66) = 1.24, *p* = .27. The group of internet users with higher levels of urges to be online spent significantly more time fixating on the internet compared to the control images, *t*(33) = 2.46, *p* = .019, *d* = .86, 95% CI [15.55, 163.85]. The group of internet users with lower levels of urges to be online spent more time fixating on the control compared to the internet images and this difference approached significance, *t*(33) = -1.8, *p* = .078, *d* = .63, 95% CI [-88.55, 5.02]. Group comparisons revealed that internet users with higher levels of urges to be online spent significantly more time fixating on the internet images compared to internet users with lower levels urges to be online, *t*(66) = -2.51, *p* = .0015, *d* = .62, 95% CI [30.74, 15.67]. Moreover, internet users with lower levels of urges to be online showed a tendency of fixating more on the control images compared to internet users with higher levels of urges to be online, *t*(66) = -1.76, *p* =.082, *d* = .43, 95% CI [-116.01, 7.19] (Figure 6).

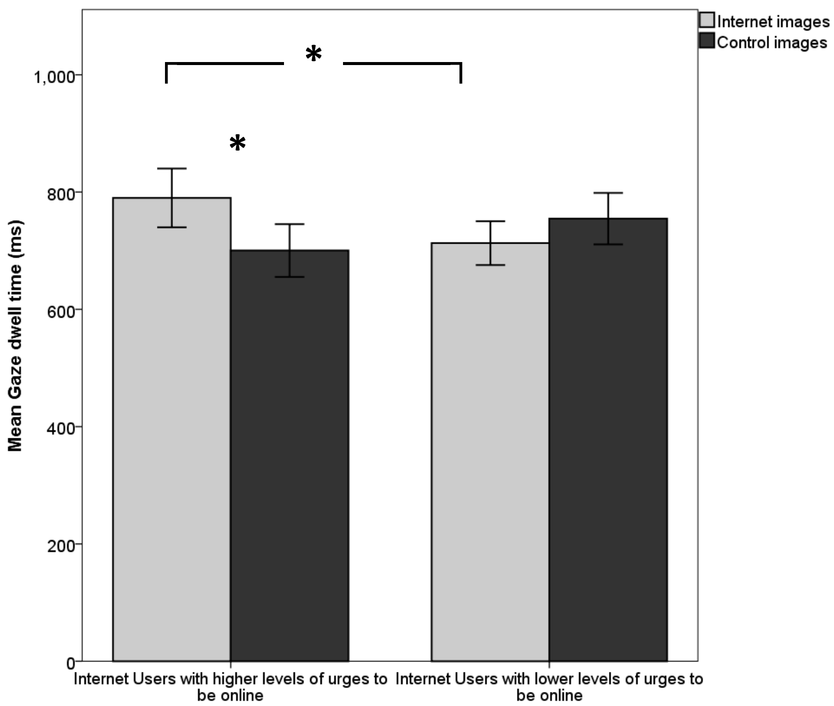

Figure 3.10 Mean gaze dwell time (in milliseconds) on internet and control images, shown separately for internet users with higher and lower levels of urges to be online. Error bars represent standard error of the means.

Furthermore, in order to investigate the significant interaction between internet use groups and levels of urges to be online a 2 x 2 mixed-way ANOVA was performed with image type (internet versus control) as a within factor and levels of urges to be online (internet users with higher levels of urges to be online, internet users with lower levels of urges to be online) as a between factor, for each internet users group (problematic, high engagers, moderate and non-problematic internet users). For the problematic internet users there was a significant effect of levels of urges to be online, $F(1, 15) = 5.78$, $p = .03$; $\eta p^2 = .28$. The problematic internet users with higher levels of urges to be online fixated significantly longer on the internet images compared to problematic internet users with lower levels of urges to be online, $t(15) = 2.65$, $p = .018$, $d = 1.37$, 95% CI [88.99, 46.30]. Moreover, there was a trend for problematic internet users with higher levels of urges to be online to fixate more on the internet compared to control images, although this difference failed to reached significance, $t(11) = 1.82$, $p = .096$. However, the main effect of image type, $F(1, 15)$

= .29, *p* = .60, and the interaction with image type and levels of urges to be online group *F*(1, 15) = .29, *p* = .60, were not significant as well as the main effects and interactions for the high engagers, moderate and non-problematic internet users (Figure 3.11).

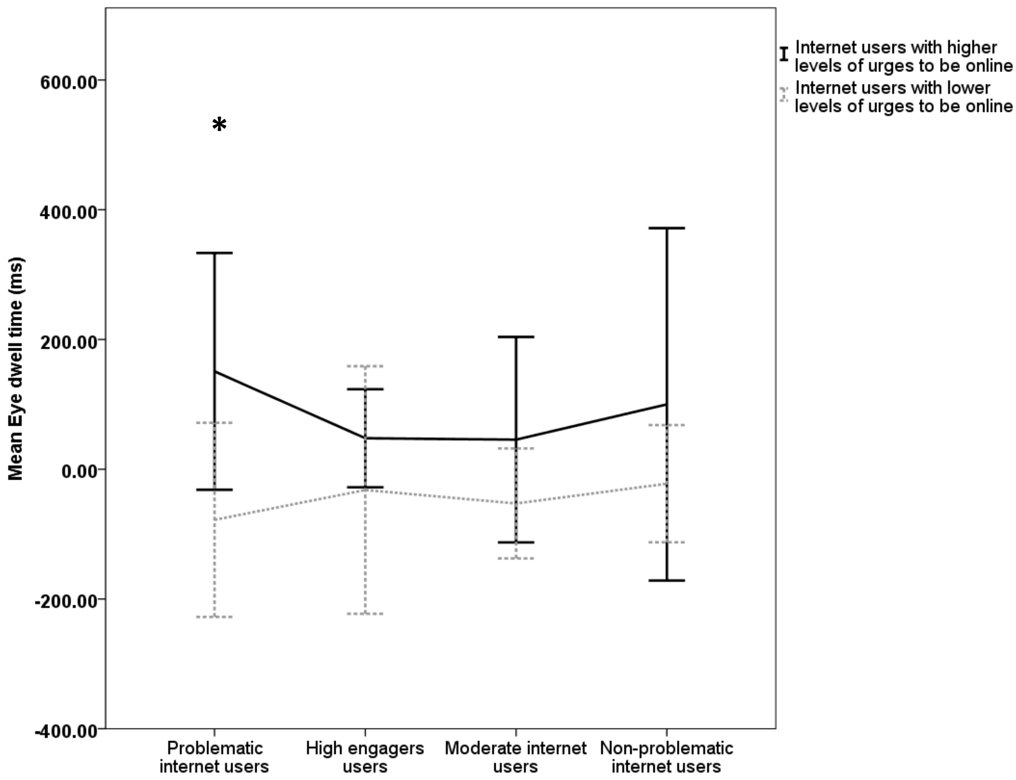

Figure 3.11 Mean gaze dwell time on internet images, shown separately for internet users with higher and lower levels of urges to be online for each internet use group (problematic, high engagers, moderate and non-problematic internet users) with CI error bars.

<u>*Direction of initial fixation*</u>

Overall, the results revealed no direction of initial fixation bias for internet users with higher levels of urges to be online, *t*(32) = -.06, *p* = .948, or for internet users with lower levels of urges to be online, *t*(33) = -1.04, *p* = .306.

<u>*Attentional bias as assessed with manual reaction times to probes*</u>

A 2 x 2 x 4 mixed-way ANOVA was performed with probe condition (probe in the same congruent versus different incongruent location with internet images) as a within factor and internet use groups (problematic, high engagers, moderate and non-problematic internet users) and levels of urges to be online (internet users with higher levels of urges to be online, internet users with lower levels of urges to be online) as between factors. The main effects probe condition, $F(1, 59) = 2.03$, $p = .16$, internet use group, $F(3, 59) = 0.91$, $p = .44$, levels of urges to be online group, $F(1, 59) = 2.3$, $p = .13$ and the interactions between probe condition and internet use group, $F(3, 59) = 0.72$, $p = .55$, probe condition and levels of urges to be online group, $F(3, 59) = 0.58$, $p = .45$, and probe condition, internet use group and levels of urges to be online group, $F(3, 59) = 0.52$, $p = .67$ were not significant.

3.4.8 Pleasantness rating task: stimulus valence measures

A 2 x 2 x 4 mixed-way ANOVA was conducted with image type (internet versus control) as a within factor and internet use groups (problematic, high engagers, moderate and non-problematic internet users) and levels of urges to be online (internet users with higher levels of urges to be online, internet users with lower levels of urges to be online) as between factors. There was a significant main effect of image type, $F(1, 60) = 84.45$, $p = .001$, $\eta_p^2 = .58$, and internet use group with image type interaction, $F(3, 60) = 2.82$, $p = .046$, $\eta_p^2 =.12$. Overall, the participants rated internet images as more pleasant than control images, t(67) = 9.4, p = .0001, d = 2.29, 95% CI [0.75, 1.15]. See section 3.4.3 for further analysis. The main effects of internet use group, $F(3, 60) = 1.04$, $p = .38$, levels of urges to be online group, $F(1, 60) = .63$, $p = .43$ and the interactions between image type and levels of urges to be online group, $F(3, 60) = 0.78$, $p = .38$, image type, internet use group and levels of urges to be online group, $F(3, 60) = 0.20$, $p = .99$, and internet use group and levels of urges to be online group, $F(3, 60) = 2.17$, $p = .101$ were not significant.

3.4.9 Supplementary analysis for computer condition split by levels of urges to be online and internet use groups *(All the raw data are presented in Table 3.6)*

Dot-probe task performance

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

<u>*Fixation Duration*</u>

The results showed significant main effect of image type, *F*(1, 60) = 6.47, *p* =.014, ηp^2 = .10 and internet use group with levels of urges to be online interaction, *F*(3, 60) = 2.9, *p* =.042; ηp^2 = .13. Overall, it was found that participants fixated longer on control-computer images compared to internet images *t*(67) = -2.39, *p* = .02, *d* =2.37, 95% CI [-131.30, -11.92]. The main effects of internet use group, *F*(3, 60) = 1.39, *p* = .25, levels of urges to be online group, *F*(1, 60) = 0.25, *p* = .62 and the interactions between image type and internet use group, *F*(3, 60) = 0.73, *p* = .54, image type and levels of urges to be online group, *F*(3, 60) = 1.85, *p* = .18 and image type, internet use group and levels of urges to be online group, *F*(3, 60) = 0.35, *p* = .79 were not significant.

Moreover, further investigation assessing the interaction between internet use group with levels of urges to be online revealed that for the problematic internet users there was a significant effect of levels of urges to be online, *F*(1, 15) = 4.53, *p* = .05, ηp^2 = .23. The problematic internet users with higher levels of urges to be online fixated longer on the internet images compared to problematic internet users with lower levels of urges to be online and this difference approached significance, *t*(15) = 1.98; *p* = .06, *d* =1.02, 95% CI [106.1, -15.23]. Also, the problematic internet users with lower levels of urges to be online fixated more on control-computer than internet images, *t*(4) = -3.39, *p* = .027, *d* =.86, 95% CI [-392.6, -39.39], (Figure 3.12). Moreover, for the non-problematic internet users the image type effect approached significance, *F*(1, 15) = 3.99, *p* = .06, ηp^2 = .21. Non-problematic internet users fixated on the control-computer images significantly more than the internet images, *t*(16) = -2.43, *p* = .027, *d* =1.21, 95% CI [-252.16, -17.25]. There were no other significant main effects or interactions.

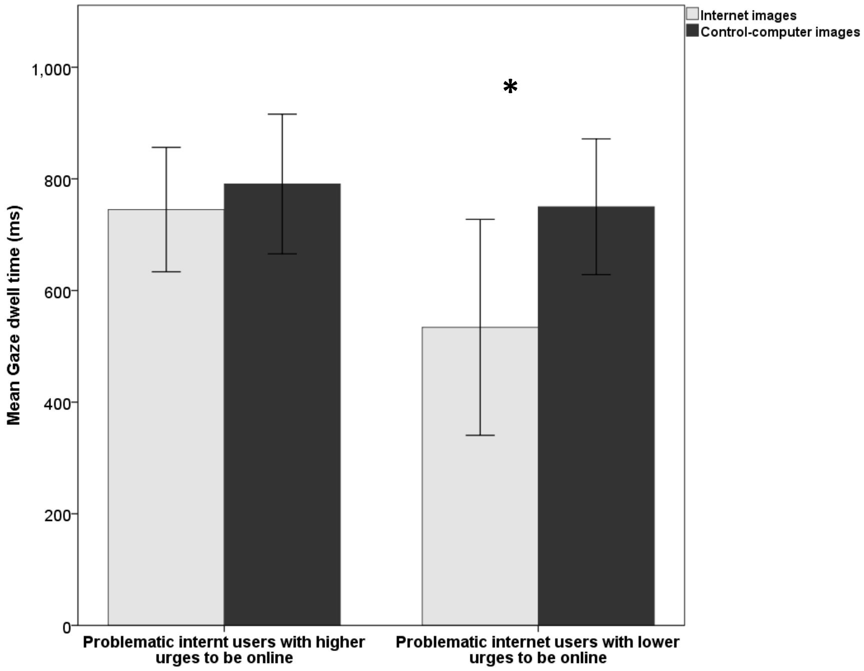

Figure 3.12 Mean gaze dwell time (in milliseconds)on internet and control-computer images, shown separately for problematic internet users with lower and higher levels of urges to be online. Error bars represent standard error of the means.

<u>*Direction of initial fixation*</u>

Internet users with higher levels of urges to be online made their first fixation on internet-related pictures in 44.1% of the trials (*SD* = 8.17) and internet users with lower levels of urges to be online in 44.1% of the trials (*SD* = 10.23),which was significantly smaller than 50% which indicated no bias, *t*(33) = -4.18, *p* = .0001, *d* = 1.45, 95% CI [-8.71,-3.00]; *t*(33) = -3.36, *p* = .002, *d* = 1.17, 95% CI [-9.47, -2.33], respectively. Overall results revealed direction of initial fixation bias for control computer images.

<u>*Attentional bias as assessed with manual reaction times to probes*</u>

There was a significant main effect of probe condition, *F*(1, 59) = 4.81, *p* = .032, ηp^2 = .07. Overall, the results revealed that participants were quicker to respond to a probe replacing internet images compared to control-computer images, *t*(66) = -2.64, p = .01, *d* =.64, 95% CI [-22.77, -3.16]. The main effects of internet use group, *F*(3, 59) = 0.86, *p* =

.47, levels of urges to be online group, *F*(1, 59) = 1.86, *p* = .18 and the interactions between levels of urges to be online group and internet use group, *F*(3, 59) = 1.74, *p* = .17, between probe condition and internet use group, *F*(3, 59) = 0.50, *p* = .68, probe condition and levels of urges to be online group, *F*(3, 59) = 0.09, *p* = .76, and probe condition, internet use group and levels of urges to be online group, *F*(3, 59) = 0.87, *p* = .46 were not significant.

3.4.10 Supplementary analysis for non-computer condition split by levels of urges to be online and internet use groups *(All the raw data are presented in Table 3.6)*

Dot-probe task performance

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

Fixation Duration

There was a significant main effect of image type *F*(1, 60) = 6.18, *p* = .016; $\eta p^2 = .09$. Overall, the results revealed that participants fixated longer on internet compared to the control non-computer images, *t*(67) = 2.52; *p* = .014, *d* = .62, 95% CI [13.78, 118.13]. However, this difference reached significance only for the problematic internet users with higher levels of urges to be online, *t*(11) = 2.61, *p* = .024, *d =1*.6, 95% CI [34.93, 410.01], and high engagers with higher levels of urges to be online, *t*(8) = 2.41, *p* = .043, *d =1*.7, 95% CI [2.88, 134.89], (Figure 3.13). Even though we can see from Figure 3.13 that non-problematic internet users showed a similar trend this difference failed to reached significance *p* = .126 which could be due to the small number in the group (n = 4) and large *SD*. Moreover there was a significant interaction between image type with levels of urges to be online, *F*(1, 60) = 8.28, *p* =.006, $\eta p^2 = .12$. The main effects of internet use group, *F*(3, 60) = 1.03, *p* = .38, levels of urges to be online group, *F*(1, 60) = 0.03, *p* = .86 and the interactions between levels of urges to be online group and internet use group, *F*(3, 60) = 2.06, *p* = .11, between image type and internet use group, *F*(3, 60) = 1.03, *p* = .39, and image type, internet use group and levels of urges to be online group, *F*(3, 60) = 0.69, *p* = .56 were not significant.

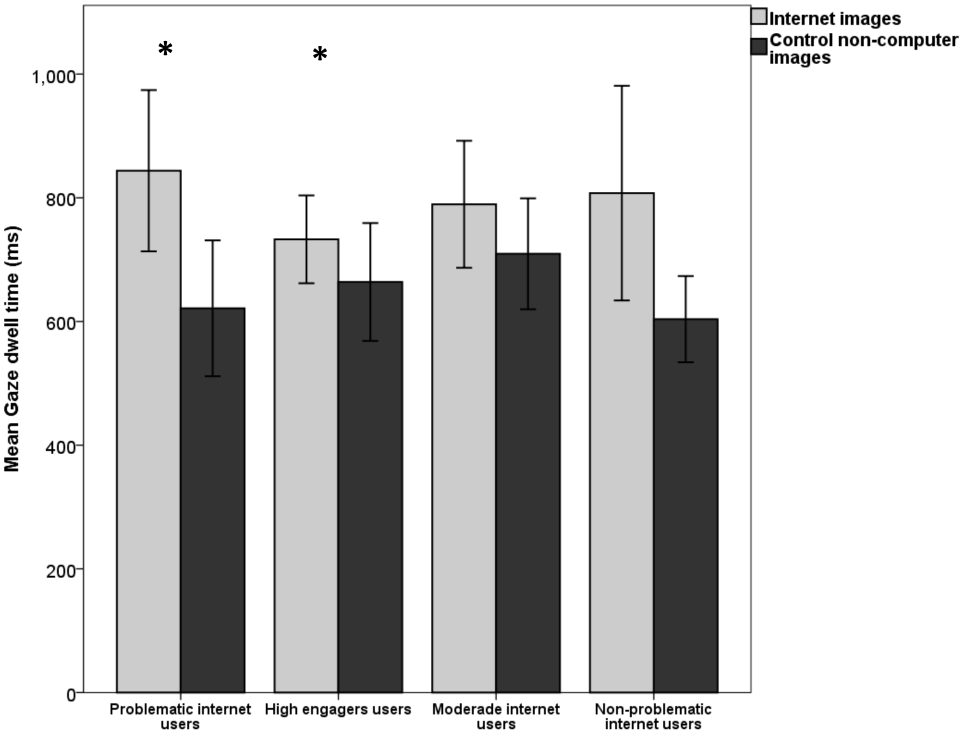

Figure 3.13 Mean gaze dwell time (in milliseconds)on internet and control non-computer images, shown for internet users with higher levels of urges to be online for each internet use group (problematic, high engagers, moderate and non-problematic internet users). Error bars represent standard error of the means.

In order to investigate the significant interaction between image type with levels of urges to be online, a 2 x 2 mixed-way ANOVA was performed with image type (internet versus control non-computer) as a within factor and levels of urges to be online (internet users with higher levels of urges to be online, internet users with lower levels of urges to be online) as a between factor. There was a significant main effect of image type, $F(1, 66) = 7.17$, $p = .009$, $\eta p^2 = .09$ and image type with group interaction, $F(1, 66) = 9.51$, $p = .003$; $\eta p^2 = .13$. The main effect of levels of urges to be online group was not significant, $F(1, 66) = 0.034$, $p = .85$. The group of internet users with higher levels of urges to be online spent significantly more time fixating on internet images compared to the control non-computer ones, $t(33) = 3.5$, $p = .001$, $d = 1.21$, 95% CI [59.29, 224.52]. Group comparisons revealed that internet users with higher levels of urges to be online spent more time fixating on the internet images compared to internet users with lower levels of urges to be online and this difference approached significance, $t(66) = 1.93$, $p = .058$, $d = .67$, 95% CI [-2.47, 145.12]. Moreover, internet users with lower levels of urges to be online spent significantly more time fixating on the control non-computer images compared to internet users with higher levels of urges to be online, $t(66) = -2.43$, $p = .018$, $d = .85$, 95% CI [-116.68, -14.49], (Figure 3.14).

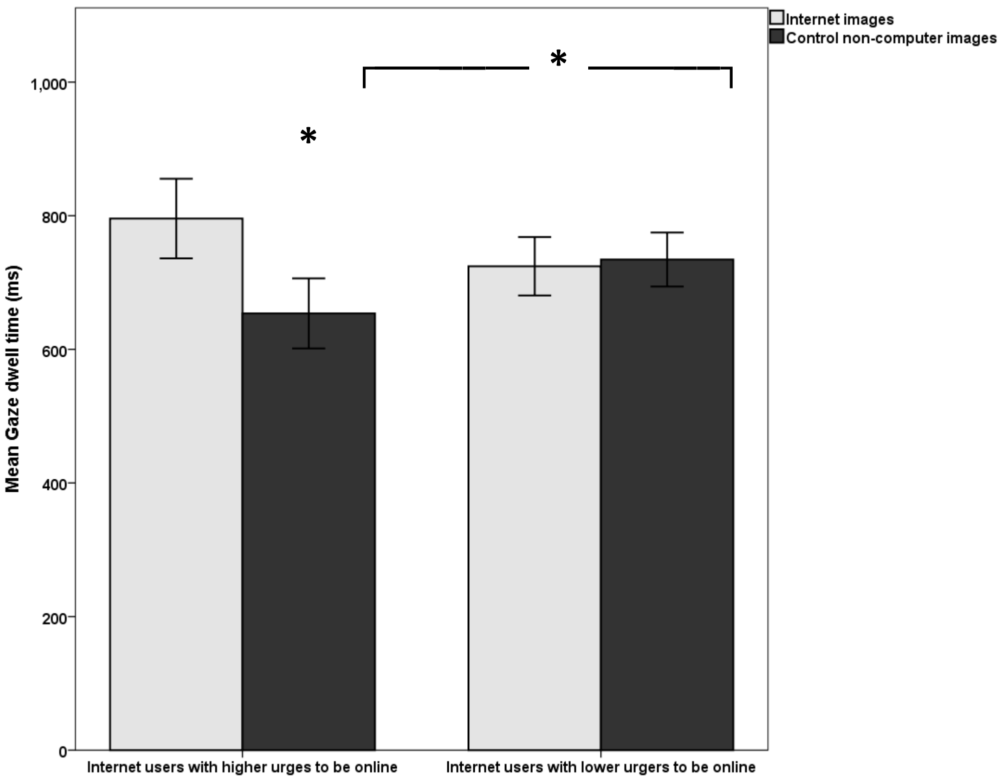

Figure 3.14 Mean gaze dwell time (in milliseconds)on internet and control non-computer images, shown separately for internet users with higher and lower levels of urges to be online. Error bars represent standard error of the means.

<u>*Direction of initial fixation*</u>

Internet users with higher levels of urges to be online made their first fixation on internet-related pictures in 47.56% of the trials ($SD = 10.79$) and internet users with lower levels of urges to be online in 49.06% of the trials ($SD = 11.21$), which was not significantly different than 50% which indicated no bias, $t(33) = -1.32$, $p = .19$; $t(33) = -0.49$, $p = .63$, respectively. Overall results revealed direction of initial fixation bias for control non-computer images.

<u>*Attentional bias as assessed with manual reaction times to probes*</u>

The main effects of probe condition, $F(3, 59) = 0.002$, $p = .96$, of internet use group, $F(3, 59) = 0.89$, $p = .45$, levels of urges to be online group, $F(1, 59) = 2.5$, $p = .12$ and the interactions between levels of urges to be online group and internet use group, $F(3, 59) = 1.83$, $p = .15$, between probe condition and internet use group, $F(3, 59) = 1.53$, $p = .22$, probe condition and levels of urges to be online group, $F(3, 59) = 0.98$, $p = .33$, and probe condition, internet use group and levels of urges to be online group, $F(3, 59) = 0.25$, $p = .86$ were not significant.

Table 3.6-Mean and standard deviations for RTs, direction of initial fixations and dwell gaze time for all trials, trials where control were computer and non-computer images, for problematic, high engagers, moderate and non-problematic internet users with higher and lower levels of urges to be online and separately for all internet users with higher and lower levels of urges to be online.

Internet use group	Problematic internet users		High engagers		Moderate users		Non-problematic internet users		Internet users with higher urges to be online	Internet users with lower urges to be online
Levels of urges to be online	High	Low	High	Low	High	Low	High	Low		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
RT congruent all trials	544.02 (69.16)	464.21 (61.14)	469.29 (76.33)	486.51 (92.07)	467.90 (63.34)	474.66 (90.34)	542.47 (39.84)	469.96 (65.24)	502.69 (74.45)	473.07 (74.46)
RT incongruent all trials	556.11 (70.58)	471.30 (64.95)	467.80 (82.20)	497.53 (87.77)	470.75 (60.71)	477.83 (99.65)	536.17 (48.43)	472.35 (66.94)	506.33 (78.25)	477.67 (78.49)
RT congruent computer trials	548.79 (76.04)	468.79 (62.78)	473.18 (78.21)	487.21 (92.44)	449.23 (64.92)	478.46 (114.83)	538.96 (53.49)	467.74 (78.42)	499.82 (81.20)	474.23 (88.31)
RT incongruent computer trials	560.28 (67.01)	470.70 (68.46)	473.30 (87.24)	501.30 (105.74)	484.76 (70.27)	486.50 (102.83)	546.27 (53.36)	484.96 (68.26)	514.26 (79.87)	485.77 (83.02)
RT congruent non-computer trials	541.90 (68.06)	462.03 (60.91)	467.11 (76.64)	485.92 (92.48)	477.32 (64.31)	473.95 (85.21)	543.86 (33.55)	471.62 (61.37)	504.13 (73.01)	473.07 (71.42)
RT incongruent non-computer trials	554.10 (75.22)	471.59 (65.45)	465.28 (81.33)	496.21 (81.61)	463.82 (58.59)	474.25 (102.21)	531.32 (51.10)	465.81 (66.57)	502.50 (79.71)	473.86 (78.78)
Direction of initial fixation all trials	49.14 (4.25)	44.69 (6.30)	53.06 (6.32)	51.66 (7.69)	46.57 (6.34)	48.21 (5.94)	52.75 (9.36)	49.75 (7.13)	49.92 (6.35)	48.79 (6.74)
Direction of initial fixation computer trials	44.87 (6.73)	35.33 (8.60)	44.11 (6.52)	47.11 (7.73)	41.33 (9.41)	47.62 (10.92)	48.28 (13.05)	43.30 (9.80)	44.13 (8.17)	44.09 (10.23)
Direction of initial fixation non-computer trials	50.82 (12.67)	38.73 (7.89)	47.37 (8.47)	48.82 (6.39)	42.71 (8.82)	53.31 (13.35)	49.07 (13.29)	49.50 (10.06)	47.55 (10.79)	49.05 (11.21)
Dwell gaze time internet all trials	840.00 (177.76)	604.00 (133.90)	746.66 (95.78)	796.00 (70.92)	774.44 (132.8)	701.81 (95.58)	772.50 (151.29)	732.30 (89.55)	790.00 (143.67)	712.94 (107.23)
Dwell gaze control all trials	689.16 (153.82)	682.00 (135.90)	698.88 (148.78)	828.00 (89.27)	728.88 (103.3)	754.54 (135.23)	672.50 (63.96)	754.61 (122.17)	700.29 (128.75)	754.70 (125.65)
Dwell gaze time internet computer trials	745.00 (192.89)	534.00 (216.28)	755.55 (122.17)	764.00 (102.12)	750.00 (129.2)	694.54 (122.99)	657.50 (159.45)	683.07 (106.48)	738.82 (152.66)	676.76 (141.43)
Dwell gaze time control computer trials	790.83 (216.68)	750.00 (136.01)	723.33 (190.59)	878.00 (121.32)	758.88 (139.5)	750.00 (168.81)	792.50 (102.10)	817.69 (165.28)	764.70 (175.91)	794.70 (157.56)
Dwell gaze time internet non-computer trials	843.75 (225.92)	622.00 (124.47)	732.77 (106.56)	813.00 (59.43)	789.44 (153.9)	695.45 (135.10)	807.50 (173.61)	754.23 (117.38)	795.73 (173.77)	724.41 (127.49)
Dwell gaze time control non-computer trials	621.25 (190.14)	661.00 (128.17)	663.88 (142.91)	781.00 (76.19)	709.44 (134.5)	769.54 (134.17)	603.75 (69.68)	715.00 (104.94)	653.82 (152.96)	734.41 (117.72)

Further analysis was conducted aiming to investigate whether individuals with problematic internet use for specific internet applications, such as social networking sites (SNS) and online gaming would show an attentional bias for generic internet-related stimuli. It was assessed whether or not individuals who reported generic problematic internet use in the initial assessment also reported problematic SNS and online gaming use. From the seventeen general problematic internet users twelve also reported problematic SNS with the remaining five reporting only general problematic internet use (Table 3.7). Moreover, in the sample there were eight individuals with problematic SNS but not general problematic internet use (Table 3.7). Similarly, from the seventeen general problematic internet users only one also reported problematic online gaming with the remaining sixteen reporting only general problematic internet use. Further, in the sample there were three individuals with problematic online gaming but not general problematic internet use. Thus, due to the limited number of individuals who reported problematic online gaming use the analysis was focused only on SNS problematic internet use. Participants were divided in to three groups; 1) individuals who disclosed both general and SNS problematic internet use, 2) individuals with general problematic internet use, and, 3) individuals with SNS problematic internet use.

Table 3.7-Total number of participants in each group of internet users.

Internet use group	General and SNS problematic internet users	SNS problematic internet users	General problematic internet users
Total Number	12	8	5

3.4.11 Dot-probe task performance split by subgroups of problematic internet use *(All the raw data are presented in Table 3.8)*

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

Fixation Duration

A 2 x 3 mixed-way ANOVA was performed with image type (internet versus control) as a within factor and group (general problematic internet users, SNS problematic internet users and, general and SNS problematic internet users) as a between factor. Overall, results revealed a significant main effect of image type, $F(1, 22) = 4.95$, $p = .037$; $\eta p^2 = .02$, with internet-related images fixated on more than the control ones. Although this was more evident for general problematic internet users as revealed with a trend, $t(4) = 1.96$, $p = .121$, 95% CI [-107.39, -627.39], it failed to reach significance due to the small sample and large standard deviation (Figure 3.15). Similarly, the interaction between image type and group approach significance, $F(2, 22) = 2.35$, $p = 0.118$, $\eta p^2 = 0.18$. Group comparisons revealed that the general problematic internet use group spent significantly less time fixating on control images compared to the general and SNS problematic internet use group, $t(15) = 2.59$, $p = .02$, $d = 1.34$, 95% CI [30.84, 312.15], and SNS problematic internet use group, $t(11) = 1.88$, $p = .048$, $d = 1.34$, 95% CI [1.95, 311.04], (Figure 3.15). Finally, the main effect of group was not significant, $F(2, 22) = 0.35$, $p = .71$.

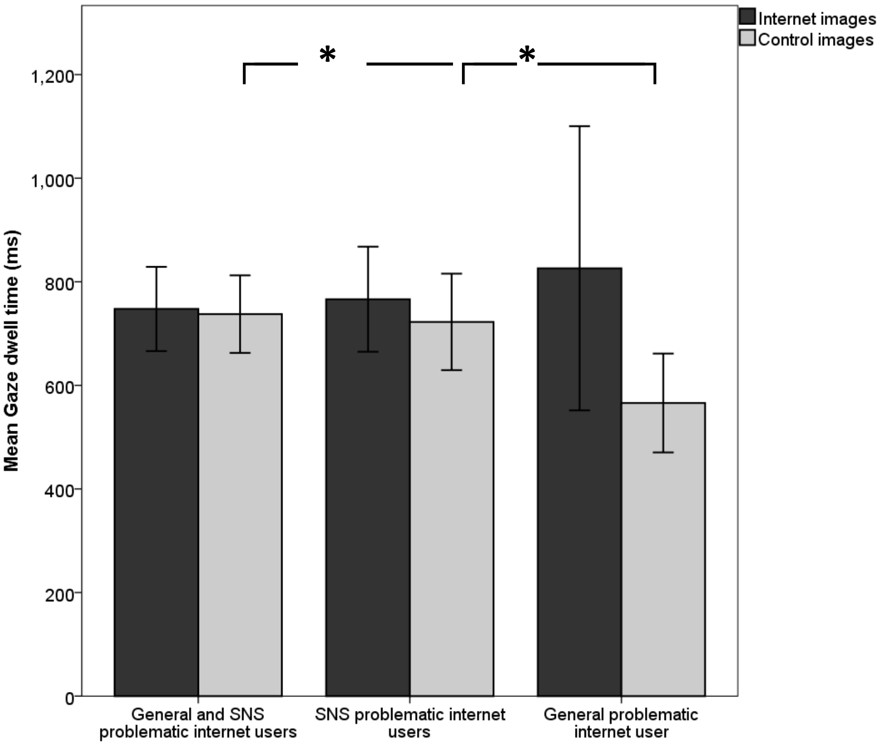

Figure 3.15 Mean gaze dwell time (in milliseconds) on internet and control-computer images, shown separately for general problematic internet users, SNS problematic internet users and, general and SNS problematic internet users. Error bars represent standard error of the means.

<u>*Direction of initial fixation*</u>

General and SNS problematic internet users made their first fixation on internet-related images in 49.14% of the trials (*SD* = 4.19), SNS problematic internet users 50.79% of the trials (*SD* = 8.21), and general problematic internet users 44.71% of the trials (*SD* = 6.44), which was not significantly different than 50% which indicated no bias, $t(11) = -0.71$, $p = .49$; $t(7) = 0.27$, $p = .79$, $t(4) = -1.84$, $p = .14$, respectively. Overall results revealed direction of initial fixation bias for internet images.

<u>*Attentional bias as assessed with manual reaction times to probes*</u>

The main effects of probe condition, $F(1, 21) = 2.32$, $p = .14$, of group, $F(2, 21) = 1.36$, $p = .28$, and the interaction between probe condition and group, $F(2, 21) = 1.08$, $p = .36$, were not significant.

3.4.12 Pleasantness rating task: stimulus valence measures

A 2 x 3 mixed-way ANOVA was performed with images type (internet versus control) as a within factor and group (general problematic internet users, SNS problematic internet users and, general and SNS problematic internet users) as a between factor. There was a significant main effect of image type, $F(1, 22) = 55.53$, $p = .001$, $\eta p^2 = .72$. There was a trend for group with images type interaction, $F(2, 22) = 2.18$, $p = .14$, $\eta p^2 = .17$, and group effect, $F(2, 22) = 1.82$, $p = .18$, $\eta p^2 = .14$. Overall, participants rated internet images as more pleasant compared to the controls and this difference reached significance for general and SNS problematic internet users, $t(11) = 5.24$, $p = .001$, $d = 3.16$, 95% CI [0.743, 1.82], SNS problematic internet users, $t(7) = 2.85$, $p = .025$, $d = 2.15$, 95% CI [0.143, 1.53], and general problematic internet users, $t(4) = 5.36$, $p = .006$, $d = 5.36$, 95% CI [0.875, 2.76]. Moreover, between group comparisons revealed that both general and SNS problematic internet users and general problematic internet users rated internet images as more pleasant compared to the SNS problematic internet users, $t(18) = 2.17$, $p = .044$, $d = 1.02$, 95% CI [0.02, 1.3], $t(11) = -2.47$, $p = .031$, $d = 1.5$, 95% CI [-1.85, -.11], respectively (Figure 3.16).

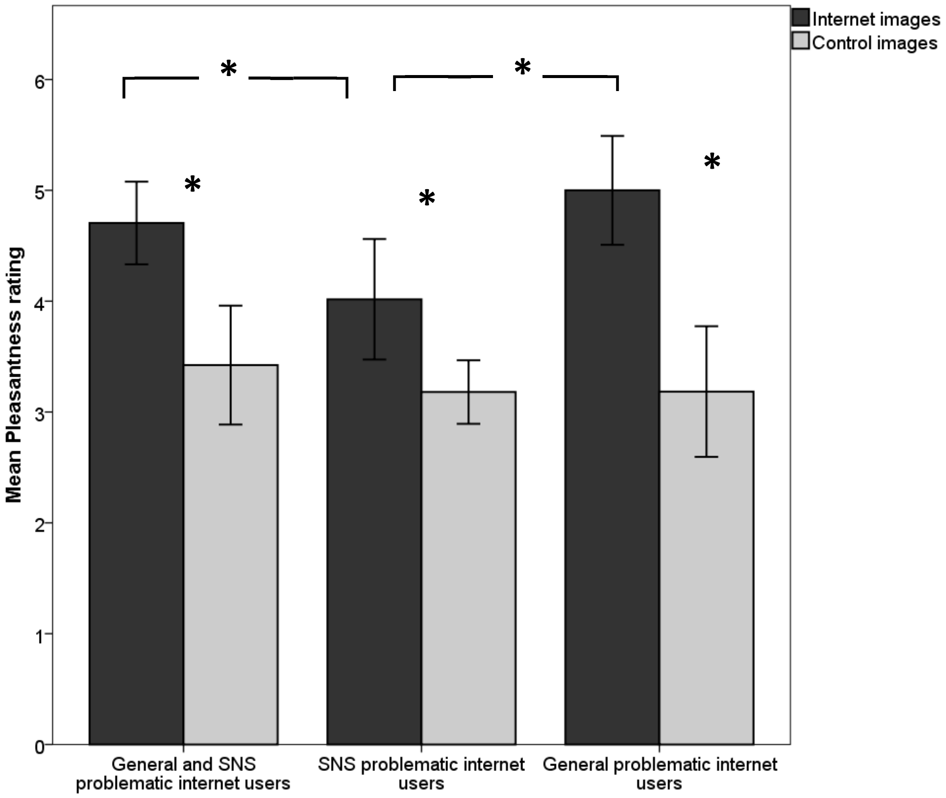

Figure 3.16 Mean pleasantness rating for internet and control images, shown separately for general problematic internet users, SNS problematic internet users and, general and SNS problematic internet users. Error bars represent standard error of the means.

3.4.13 Supplementary analysis for computer condition split by groups of specific and/or general problematic internet use *(All the raw data are presented in Table 3.8)*

Dot-probe task performance

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

<u>Fixation Duration</u>

Overall, results revealed no significant main effects of image type $F(1, 22) = 0.41$, $p = .528$, or group effect, $F(1, 22) = 0.91$, $p = .42$. Although there was a trend for interaction between image type and group, this difference did not reach significance, *F*(2, 22) = 1.82, *p* = .185, ηp^2 = .14. Group comparisons revealed that general and SNS problematic internet users spent more time fixating on the control images compared to the general problematic internet users, *t*(15) = 2.31, *p* = .035, *d* = 1.2, 95% CI [16.63, 405.03], (Figure 3.17). Moreover, general and SNS problematic internet users spent more time fixating on control-computer images compared to the internet images and this difference approached significance, *t*(11) = -1.99, *p* = .072, 95% CI [-363.17, 18.17].

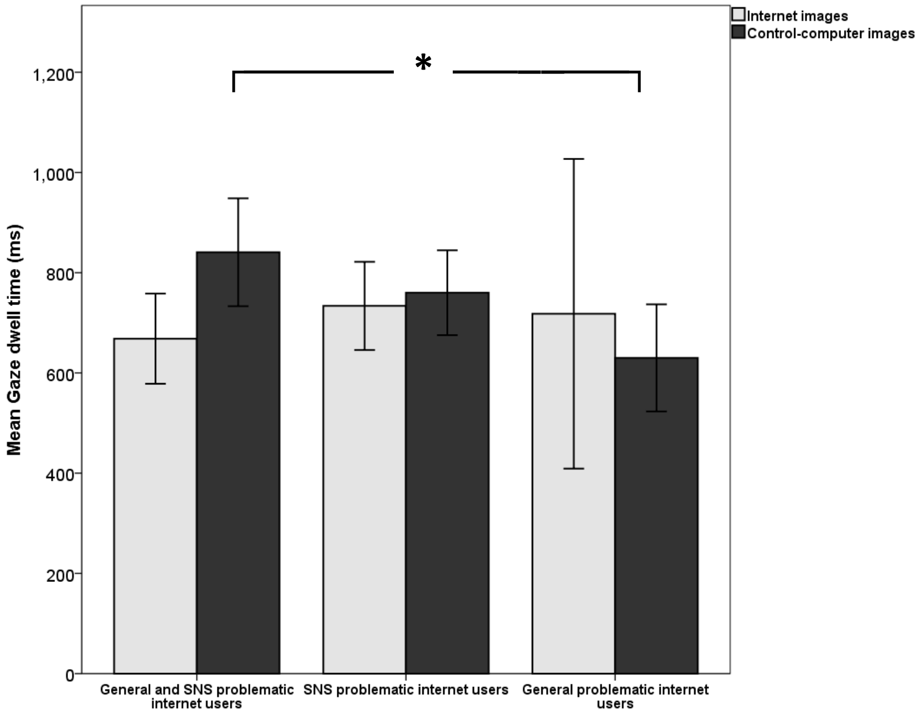

Figure 3.17 Mean gaze dwell time (in milliseconds) on internet and control-computer images, shown separately for general problematic internet users, SNS problematic internet users and, general and SNS problematic internet users. Error bars represent standard error of the means.

<u>*Direction of initial fixation*</u>

Only general and SNS problematic internet users made their first fixation on internet images in 41.7 % of trials (*SD* = 9.13) which was significantly smaller than against the 50%

and which indicated no bias, *t*(11) = -3.142; *p* = .009, *d* = 1.89, 95% CI [-14.09, -2.48]. SNS problematic internet users made their first fixation on internet images on 49.7% of the trials (*SD* = 9.68), and general problematic internet users 42.92% of the trials (*SD* = 6.95), which was not significantly different than 50% which revealed no bias, *t*(7) = -0.10, *p* = .93; *t*(4) = -2.28, *p* = .08, respectively and indicated no bias for initial fixation for internet related images.

Attentional bias as assessed with manual reaction times to probes

The main effects of probe condition, *F*(1, 21) = 0.91, *p* = .35, of group, *F*(2, 21) = 0.01, *p* = .99, and the interaction between probe condition and group, *F*(2, 21) = 1.35, *p* = .28, were not significant.

3.4.14 Supplementary analysis for non-computer condition split by subgroups of problematic internet use *(All the raw data are presented in Table 3.8)*

Dot-probe task performance

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

Fixation Duration

Overall, the results revealed a significant main effect of image type, *F*(1, 22) = 10.76, *p* = .003, ηp^2 = .33, with internet images fixated on more than the control non-computer images. This difference approached significance for the general problematic internet users, *t*(4) = 2.57, *p* = .062, *d* =2.57, 95% CI [-29.38, 771.38]. Moreover, there was a significant interaction between image type with group, *F*(2, 22) = 3.80, *p* = .038, ηp^2 = 0.26. Group comparisons revealed that the general problematic internet use group spent significantly less time fixating on control non-computer images compared to the SNS problematic internet use group, *t*(11) = 2.33, *p* = .04, *d* =1.4, 95% CI [10.04, 363.95], and general and SNS problematic internet use group, however this difference failed to approach significance, *t*(15)

= 1.83, *p* = .09; *d* =.95, 95% CI [-25.63, 337.13], (Figure 3.16). Finally, the group effect, *F*(1, 22) = 0.16, *p* = .85 was not significant.

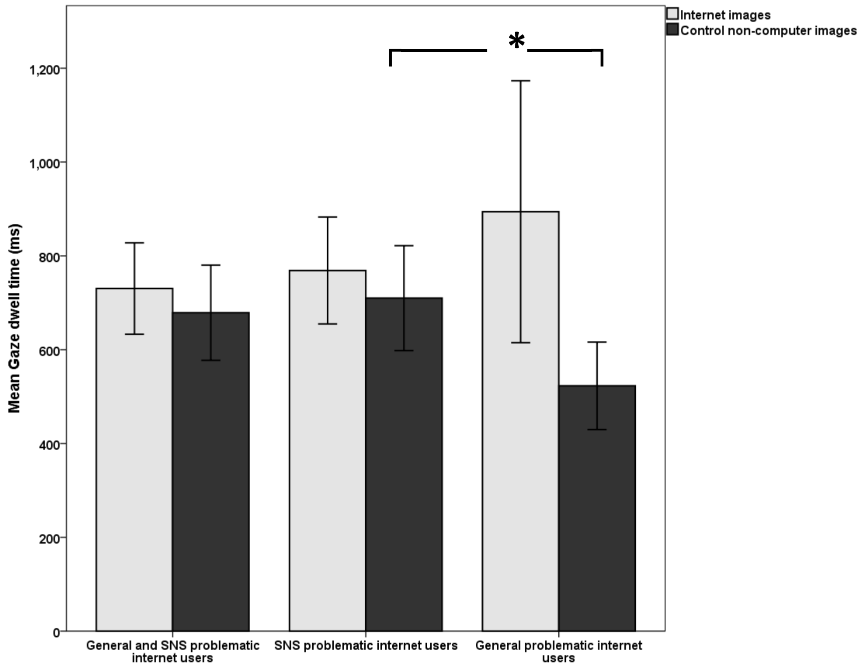

Figure 3.18 Mean gaze dwell time (in milliseconds)on internet and control non-computer images, shown separately for general problematic internet users, SNS problematic internet users and, general and SNS problematic internet users. Error bars represent standard error of the means.

<u>*Direction of initial fixation*</u>

General and SNS problematic internet users made their first fixation on internet images in 45.87% of trials (*SD* = 11.61), SNS problematic internet users 46.80% of the trials (*SD* = 8.19), and general problematic internet users 50.63% of the trials (*SD* = 15.56), which was not significantly different than 50% which indicated no bias, *t*(11) = -1.23, *p* = .24; *t*(7) = -1.11, *p* = .31; *t*(4) = .09, *p* = .93, respectively. Overall the results revealed no direction of initial fixation bias in any of the groups.

<u>*Attentional bias as assessed with manual reaction times to probes*</u>

The main effects of probe condition, $F(1, 21) = 1.53$, $p = .23$, of group, $F(2, 21) = 1.34$, $p = .28$, and the interaction between probe condition and group, $F(2, 21) = 1.54$, $p = .24$, were not significant.

Table 3.8-Mean and standard deviations for RTs, direction of initial fixations, dwell gaze time and pleasantness ratings for all trials, trials where controls were computer and non-computer for general and SNS problematic internet users, SNS problematic internet users and general problematic internet users.

Internet use group	General and SNS problematic internet users	SNS problematic internet users	General problematic internet users
Behavioural Performance	Mean (SD)	Mean (SD)	Mean (SD)
RT congruent all trials	515.67 (75.92)	471.95 (76.13)	526.59 (81.59)
RT incongruent all trials	522.55 (78.76)	470.27 (76.017)	545.13 (83.10)
RT congruent computer trials	518.01 (78.26)	471.20 (68.09)	536.50 (91.04)
RT incongruent computer trials	526.70 (72.78)	478.02 (86.30)	544.58 (96.39)
RT congruent non-computer trials	514.59 (75.91)	472.26 (80.70)	522.12 (79.48)
RT incongruent non-computer trials	520.50 (83.46)	466.34 (74.20)	545.52 (79.54)
Direction of initial fixation all trials	49.14 (4.18)	50.79 (8.21)	44.70 (6.44)
Direction of initial fixation computer trials	41.71 (9.13)	49.66 (9.67)	42.92 (6.94)
Direction of initial fixation non-computer trials	45.86 (11.60)	46.79 (8.19)	50.63 (15.56)
Dwell gaze time internet all trials	747.50 (140.72)	766.25 (143.52)	826.00 (306.72)
Dwell gaze control all trials	737.50 (129.69)	722.50 (131.66)	566.00 (106.67)
Dwell gaze time internet computer trials	668.33 (155.96)	733.75 (124.54)	718.00 (345.42)
Dwell gaze time control computer trials	840.83 (186.47)	760.00 (119.64)	630.00 (119.37)
Dwell gaze time internet non-computer trials	730.41 (168.67)	768.75 (161.08)	894.00 (312.07)
Dwell gaze time control non-computer trials	678.75 (175.77)	710.00 (158.22)	523.00 (104.31)
Pleasantness rating of internet images all trials	4.70 (0.64)	4.01 (0.76)	5.00 (0.54)
Pleasantness rating of control images all trials	3.42 (0.92)	3.18 (0.40)	3.18 (0.65)

3.5 Discussion

This study revealed that problematic internet users did not show an attentional bias for internet-related images. However, assessment of motivational states (levels of urges to be online) showed that this factor mediated the relationship between the severity of problematic internet use and attentional bias. More specifically, it was found that not only those internet users who had higher levels of urges to be online showed an attentional bias for internet-related images compared to internet users with lower levels of urges to be online, but this was also evident for problematic internet users with higher levels of urges to be online compared to problematic internet users with lower levels of urges to be online. However, levels of urges to be online did not have any effect regarding attentional processes in the other internet use groups (high engagers, moderate users and non-problematic internet users). This is in accordance with the finding showing that problematic internet users had significantly higher scores on the questionnaire assessing urges to be online, which was also confirmed with the high proportion of problematic internet users belonging to the group of internet users with higher levels of urges to be online. Overall, the data suggest that problematic internet users showed an attentional bias for internet-related images only when they had higher levels of urges to be online. Additionally, problematic internet users rated internet images as more pleasant compared to moderate and non-problematic internet users. Thus, it can be argued that trait characteristics (problematic use) were associated with evaluative bias; whereas state characteristics (urges to be online) with attentional bias and most importantly, state variables mediated the relationship between trait characteristics and attentional bias. However, these findings should be interpreted cautiously, because when each group of internet users was divided into subgroups, based on their levels of urges to be online, the sample size was small. Moreover, problematic internet users with higher levels of urges to be online showed only a trend for fixating more on internet images compared to the control images. Bearing these limitations in mind, the implications of the aforementioned findings are more deeply explored in the following paragraphs.

Attentional bias was only evident for the gaze dwell time measure, whereas direction of initial fixation and RTs did not reveal such a bias. This is in accordance with the suggestion that each attentional bias measure reflects different attentional processes which are mediated by separate cognitive mechanisms (LaBerge, 1995). More specifically, research from the field of addictions has revealed that the gaze dwell time measure of attentional bias, which reflects maintenance of attention, was particularly susceptible to state characteristics of addicted individuals (such as craving levels), whereas RTs and direction of initial fixation were associated with trait characteristics, such as dependence (Chanon, Sours, & Boettiger, 2010; Cousijn et al., 2013; Field, Mogg, & Bradley, 2004a, 2004b; Franken, Kroon, Wier, & Jansen, 2000; Mogg et al., 2005; Noel et al., 2006; Stormark et al. 1997; Townshend & Duka, 2001, 2007; Vollstädt-Klein, Loeber, von der Goltz, Mann, & Kiefer, 2009). For example, Field, Mogg and Bradley (2004b) compared attentional processes in smokers who were either deprived or non-deprived. They found that smokers who were deprived spent more time looking at smoking related images compared to non-deprived ones, which concurs with the view that gaze fixation duration is more susceptible to motivational states. Moreover, both groups of smokers (deprived and non-deprived) showed a bias as assessed with RTs and direction of initial fixation for smoking related images, which is also supportive insomuch as these attentional measures are associated with trait characteristics (dependence). Similarly, in this present study only state variables (levels of urges to be online) were indicative of attentional bias, which is why only the gaze dwell time measure of attentional bias was evident.

Overall, this present study further supported the relationship between attentional bias and motivational states (Field et al., 2009). Moreover, is in line with research from the field of addictions which has suggested that motivational levels are associated with attentional bias (Field, Mogg, & Bradley, 2004b; Field et al. 2005, 2013; Franken et al., 2000, Mogg et al., 2005). More specifically, this study is similar to that of Field, Mogg, and Bradley (2004a), who found attentional bias for cannabis stimuli to be evident only in cannabis users with increased levels of craving. Similarly, it is compatible with research which has revealed an attentional bias for alcoholic stimuli in social drinkers and abstinent alcoholics only when they had increased levels cravings (Field et al., 2005, 2013). Additionally, it is in line with Franken et al.'s (2000) work which also reported an attentional bias in cocaine and heroin abstinent dependent individuals for cocaine and heroin related words, respectively, to be associated with increased levels of cravings. Thus, overall this study has illustrated further that commonalities exist regarding the mechanisms which previously have been implicated in the development and maintenance of substance-related and addictive disorders as well as with problematic internet use.

The results from this study are in accordance with certain aspects of the incentive-sensitization model of addiction (Robinson & Berridge, 1993, 2001). More specifically, this model posits that motivational components (such as increased levels of urges to be online) as well as cognitive processes (e.g. attentional bias) reflect incidence of incentive salience mechanisms, which is why these two constructs were associated in this study. Additionally, there were positive correlations amongst attentional bias, perceived attractiveness of internet-related images and levels of urges to be online, which is also in line with the aforementioned assumption of the model (Robinson & Berridge, 1993, 2001). Although, there were no clear trait bias characteristics, when these were combined with state characteristics (motivational levels) attentional bias was evidenced. However, these findings are also compatible with Tiffany's (1990) habit theory of drug addiction, which predicts an attentional bias when levels of cravings are high. Nevertheless, it is difficult to deduce which theory best would account for the data as the levels of urges to be online were not manipulated experimentally. Thus, future research should assess whether there might be differences in attentional processes in individuals with problematic internet use before and after experimentally controlling for internet use by asking participants to minimize their internet use for few days, which arguably will be associated with increased levels of urges to be online. The incentive sensitization theory predicts that after deprivation from online activities there will be an increase in attentional bias for problematic internet users, however this bias will also be evident before deprivation. On the other hand, the habit theory of addiction predicts that this bias will only be evident when urges to be online are high (after deprivation-limited access regarding the internet) whereas when access is not disrupted this bias will not be prominent. This type of research would enrich our knowledge of the theoretical background of problematic internet use.

However, before reflecting on the implications of the aforementioned findings, it is necessary to integrate the data from the supplementary analyses related to the two experimental conditions; computer and non-computer ones. This will allow us to investigate the effect that each type of control image had on attentional processes, which can be very informative regarding the overall behavioural outcome in the task.

On the whole, dwell time measures of attentional bias revealed that in the computer condition, the problematic internet users with lower levels of urges to be online and non-problematic internet users showed an attentional bias for control-computer images. By contrast problematic internet users as well as the ones with higher levels of urges to be online showed no preference. This evidence is in accordance with the suggestion that control-computer images might fail to capture attentional bias as computers are the common medium to be online and, as such, they are associated with online activities. Moreover, the opposite pattern was found for the non-computer condition. More specifically, problematic internet users as well as those with higher urges to be online showed an attentional bias for internet images compared to the control non-computer images. This was also evident for high engagers and for internet users with higher levels of urges to be online, whereas problematic internet users with lower levels of urges to be online and non-problematic internet users did not show such a preference. Thus, it can be argued that problematic internet users with lower levels of urges to be online and non-problematic internet users showed similar cognitive processes (no attentional bias). Additionally, these cognitive processes differed from the ones of problematic internet users with higher levels of urges to be online. Overall, the supplementary analyses revealed that each type of control image was associated with attentional processes which were group and motivational level specific. Thus, from the aforementioned findings, it can be argued that the control non-computer and symbol images might be the best candidates for the assessment of attentional processes in problematic internet users, because they capture attentional bias which associates with both trait (problematic internet use) and state (levels of urge to be online) characteristics. The main message that needs to be taken away is that it is the levels of urges to be online which played a significant role in the underlying cognitive mechanisms in problematic internet users and high engagers, but this did not apply to moderate or non-problematic internet users.

There were also some unexpected findings associated with the aforementioned analyses. More specifically, in the computer condition, all internet users showed a bias as assessed for direction of initial fixation for computer images. Initial fixation of attentional allocation has been associated with trait characteristics of addiction (Field & Cox, 2008). However, considering that all internet users showed this bias, it may be suggested that it might be the perceptual characteristics of control-computer images which attracted attention. Computer images were generated in order to be perceptually similar to the internet-related ones in a way that they imitated them but without their online characteristics. This might have made them perceptually more attractive or interesting compared to more familiar internet images and this could explain why they attracted attention. However, for problematic internet users this was only evidenced for the direction of initial fixation whereas for the total time spent fixating at each image there was no difference which was suggestive that the internet images attracted attention as well. It should be noted that non-problematic internet users showed a preference for the computer images as revealed with both the initial fixation and the time spent looking at these images.

The lack of clear trait specific (problematic internet use) bias, as well as the lack of in-between groups (problematic versus non-problematic internet users) differences in attentional processes, are in opposition to research in the field of addictions (see Field & Cox, 2008 for review; alcohol e.g. Field et al., 2011, 2013; Ryan, 2002; Duka & Townshend, 2004; Weafer & Fillmore 2012, nicotine e.g. Bradley et al., 2003; Dickter & Forestell, 2012; Kang et al., 2012, opiate addiction e.g. Lubman et al., 2000, 2009, cannabis use/dependence e.g. Cousijn et al., 2013, Field, Mogg, & Bradley, 2004a, pathological gambling e.g. Boyer & Dickerson, 2003; Brevers, Cleeremans, & Bechara et al., 2011; Honsi et al., 2013; see van Holst et al., 2010 for review). However, internet use has some characteristics that distinguish it from other addictive behaviours which can be very informative for shedding light on the aforementioned discrepancies. For example, a person who is addicted to a substance can try (if they choose) to abstain/keep away from this substance in a similar way to a person who has never used a substance of abuse. Nevertheless, the same cannot apply to internet usage, as many of our everyday activities rely heavily on internet use and in many circumstances, they are reinforced by our environment (for example, using emails in the work environment, using the internet for learning resources at university, conversing through SNS). Research when assessing attentional processes in addictive behaviour compares individuals who use/abuse a substance with individuals who do not. In the field of problematic internet use the same comparisons are based on people who use the internet but differ in the level of their problematic use (problematic versus non-problematic internet use), which is why there might be discrepancies between these types of behaviours.

Moreover, unlike substance use and abuse, which in many circumstances is an illegal activity, internet use is not illegal and is not perceived as a negative stigmatized behaviour (i.e. it is sociably acceptable). In addition, far less awareness and knowledge exists in relation to the addictive potential of internet use compared to that of substance use and abuse. These differences can shape the way individuals perceive each type of behaviour. The best illustration of how social acceptability shapes individuals' perceptions comes from research conducted with regards to using two substances, alcohol and tobacco which were either perceived as socially acceptable or not. Smoking is a negatively stigmatized behaviour and with respect to this, research has shown that non-smokers perceived smoking stimuli more negatively compared to smokers. This difference supports the negative emotional valence that these stimuli have for non-smokers, whereas the opposite was evident for smokers (Mogg et al., 2003). By way of contrast research conducted with alcohol has revealed no differences in groups of social drinkers (light versus heavy) in the way they perceived alcohol related stimuli (Cox et al., 1999; Townshend & Duka, 2007; Vollstädt-Klein et al., 2009). Alcohol use is perceived as sociably acceptable behaviour especially in the context of social drinking. These studies highlight how social acceptability shapes individuals' perceptions in either negative or positive ways. Similarly, in this present study it could be argued that the lack of differences between the groups in attentional processes could reflect the social acceptability effect of internet use. This assumption has been supported with the finding that that all the internet users perceived the internet images as more pleasant than the control ones.

It could be argued that the lack of differences between groups in attentional processes can also reflect a familiarity effect regarding those stimuli. Support for such an assumption comes from a study which compared attentional processes for alcoholic stimuli in a group of detoxified alcohol patients and a control group that consisted of individuals who were staff members of the detoxing clinic, with the presumption being that the latter were very familiar with alcohol stimuli due to the nature of their employment (Ryan, 2002). The research found no differences in attentional processes between these groups. This suggests that the familiarity effect of alcoholic stimuli in both groups had, as a consequence, similar behavioural outcomes. In a similar way it can be argued that because the internet is an inevitable part of our everyday lives and the majority of individuals are familiar with internet-related paraphernalia there is a lack of between group differences in internet users. To sum up, all the aforementioned evidence justify the assumption that social acceptability, familiarity effect, lack of knowledge with respect to the addictive potential of internet use and encouragement of internet usage coming from different mediums, might account for the lack of clear difference in attentional bias between the different groups of internet users.

Moreover, research from the field of addictions, which has indexed attentional bias with eye movement measures, has shown that consideration of the within group differences is a validated approach for the assessment of attentional bias. For example, Brevers et al. (2011) found that pathological gamblers showed an attentional bias for gambling related stimuli using the Flicker task. This bias was indexed with a higher proportion of fixation counts and fixation length on gambling stimuli compared to neutral stimuli for pathological gamblers, whereas normal controls did not show such a difference. Most importantly, there were no differences in the fixation counts and fixation length for gambling and neutral stimuli between the groups. Similar evidence has been found for cannabis users and smokers (Mogg et al., 2003). More specifically, both groups of substance users showed a preference for stimuli related to their substance of abuse which was revealed through longer fixation duration regarding those particular stimuli as compared to neutral ones. However, neither group of substance users showed a difference in the time spent fixating on either type of stimuli (substance-related versus neutral) compared to normal control groups. All this evidence as well as the findings from this study validate the suggestion that within group differences are an indication of attentional bias when indexed with eye movement measures.

Another objective of this study was to assess whether there were qualitative differences between the groups of internet users not only concerning attentional processes but also measures assessing psychopathological and personality constructs. Accordingly, from the research in the field, in this study it was found that problematic internet users had significantly higher levels of psychopathology (as assessed with various psychopathological constructs) compared to non-problematic internet users (Cheung & Wong, 2011; Dong, Lu et al., 2011; Fu et al., 2010; Jang et al., 2008; Kelleci & Inal, 2010; Kormas et al., 2011). This evidence points to the clinical nature of problematic internet use; however it cannot be concluded whether or not psychopathology is the cause or consequence of problematic internet use. Moreover, problematic internet users scored higher on the cognitive subscale of impulsivity, which reflects a tendency to make rapid decisions, compared to non-problematic internet users. Although this is in accordance with evidence suggesting that higher levels of impulsive behaviour is associated with problematic internet use (Cao et al., 2007; Dong et al., 2010; Mottram & Fleming, 2009; Zhou et al., 2010), there was no difference in the overall scores of trait impulsivity between the groups. However, impulsivity is a multi-faceted construct (Barratt & Patton, 1983) and as such, it can be assessed with various behavioural and self-report measures. Considering that in this study only a self-report assessment of impulsivity was obtained, which arguably is susceptible to a social desirability bias, future research should assess other facets of impulsivity combining both behavioural and self-report assessments in order to provide a more coherent understanding of the role of impulsivity in problematic internet use. Overall, the findings of this study validated the assessment of problematic and non-problematic internet use based on Charlton and Danforth’s (2007, 2010) model, for there were qualitative differences between these not only on the psychopathological level but on the cognitive level as well. In addition, there were many similarities between moderate and non-problematic internet users regarding psychopathological and cognitive behavioural outcomes, which suggest that the two behaviours reflect similar patterns of internet use.

Another objective of this study was to validate whether there were qualitative differences between problematic internet users and high engagers. Charlton and Danforth (2007, 2010) argued that even though both groups spent significant amounts of time engaging with online activities, only problematic internet users experienced negative repercussions due to internet use in their lives. This present study found many similarities in psychopathological and personality constructs between the two groups. However, on a behavioural level, only problematic internet users with high levels of urges to be online showed an attentional bias for internet-related images, whereas high engagers, irespective of trait (status) and state (motivational factors – levels of urges to be online) did not show such a bias. This evidence is suggestive of a qualitative difference between the two groups of internet users which is in accordance with Charlton and Danforth's (2007, 2010) stance. To the contrary, the similarities between them in relation to psychopathological and personality constructs could imply that these factors are associated with increased levels of internet use, considering that both groups of internet users spent significant amounts of time online. This argument has been validated from research which has shown that individuals with depression, anxiety, social phobias, loneliness etc. frequently use the internet as a coping or escape mechanism for the distress they experience (Campbell et al., 2006; Caplan, 2002; Cheung & Wong, 2011; Hetzel-Riggin & Pritchard, 2011; Morahan-Martin, 1999). The finding that high engagers had similar psychopathology as well as similar amounts of time online as the problematic internet users poses the question as to whether this group of internet users might have unique characteristics which makes them resistant to developing problematic internet use. One of the main differences between the two groups was that problematic internet users experienced higher levels of distress as a consequence of psychopathology compared to the high engagers. Thus, it can be argued that this factor might make high engagers resilient to problematic internet use. On the other hand, the evidence can also point to the argument that high engagers are individuals at risk of developing problematic internet use. These assumptions need to be further explored with a longitudinal study in order to better understand the relationship between these two types of behaviour. This form of research will also help in identifying those factors which make high engagers resilient or vulnerable to developing problematic internet use, in turn, can be very informative for the shaping of prevention and intervention strategies for individuals at risk.

The final objective of this study was to assess whether individuals with problematic behaviour for a specific online application (SNS), showed an attentional bias for internet stimuli. Overall the SNS problematic internet users did not show a bias for internet images. This supports the assumption that cognitive bias might be activity specific in a similar way to that which has been reliably demonstrated for online gaming (Lorenz et al., 2013; Metcalf & Pammer, 2011; van Holst et al., 2012). More specifically, it is in accordance with research regarding pathological gambling where attentional bias was particularly evident for the specific type of gambling activity for which the pathological gamblers showed a preference for (McCusker & Getting, 1997). This evidence also suggests that problematic internet use might consist of different subtypes (Young, 1999). However, in order for firmer conclusions to be made, future research needs to verify whether SNS problematic internet users show a bias for stimuli related to their preferred online activity, that is, SNS-related stimuli. In addition, the results from this analysis should be interpreted cautiously, as the sample size for each group of problematic online users was small and, as such, it warrants further confirmation.

When the proportion of individuals who reported problematic internet use for generic and specific online applications was assessed, unexpectedly a number of internet users who reported both general and SNS problematic internet use was revealed. Moreover, this group of internet users showed, overall, no bias for internet stimuli which was similar to the SNS problematic internet users' behaviour, whereas the group of general problematic internet users was the only group that showed a tendency to spend more time looking at the internet images compared to the control ones. It can be argued that individuals with general and SNS problematic internet use might have referred to their SNS activities when they were assessed in relation to their general internet use. This suggestion is supported by the behavioural similarities between this group and the SNS problematic internet users. Thus, for future research it would be very informative to pay specific attention to the initial assessment. This would control for the possibility that internet users might refer to specific rather than generic activities, and thus allow for firmer conclusions to be made in relation to cognitive processes in problematic internet use. Moreover, another reason why there was no clear trait related attentional bias in our sample of internet users could be due to the heterogeneity of our sample in terms of their problematic behaviour, consisting of those users with general as well as SNS problematic use.

Overall, the findings from this study are not only indicative of the underlying mechanisms associated with problematic internet use but they also have important clinical implications. Research from the field of addictions suggests that there is a strong link between attentional bias and craving levels with substance seeking behaviour (Field & Eastwood, 2005; Field, Mogg, & Bradley, 2004a, 2004b, 2005; Marhe et al., 2013; Waters et al., 2012). This has led to the development of interventions aiming to alter attentional bias processes and subsequent assessment of their effects on craving and substance seeking behaviour (Fedardi & Cox, 2009; Field & Eastwood, 2005; Field et al., 2007; Kerst & Waters, 2014; Schoenmakers et al., 2010; Wiers & Stacy 2006). This evidence is quite promising as it has been proven that direct manipulation of attentional bias can influence both behavioural and motivational outcomes. Thus, in an analogous way it could be argued that with appropriate training problematic internet users can reduce and control their internet use in such ways that it does not interfere with their everyday lives. One possibility for future research could be to train problematic internet users (Fedardi & Cox, 2009; Field & Eastwood, 2005; Wiers & Stacy 2006), to avoid internet stimuli and assess whether this has an effect upon levels of urges to be online as well as upon their overall amount of internet use.

In conclusion, the results from this study revealed that problematic internet users with higher levels of urges to be online showed an attentional bias for internet-related images compared to problematic internet users with lower levels of urges to be online. This suggests the underlying mechanisms which have been implicated in the development and maintenance of substance-related and addictive disorders may share commonalities with those pertaining to problematic internet use. However considering the limitations of this study, future research is needed that places an emphasis on attentional bias processes for specific potential subtypes of problematic internet use. This will impact favourably upon our understanding as to whether or not this bias is particularly evident for stimuli related to those online activities for which internet users show a preference.

Chapter Four

Study 3: Attentional bias in problematic Social Networking Sites internet users

4.1 Abstract

Rationale: The evidence from the field of substance-related and addictive disorders suggests that attentional bias for stimuli related to substance or an activity (gambling) of abuse, is a marker of addictive behaviour. Additionally this bias has been argued to be substance or activity (gambling) specific. In the field of problematic internet use this bias has been illustrated for generic and for a specific potential subtype, online gaming. However, online gaming can arguably be executed in the offline environment as well, and as such, its reliability and validity in regard to online activities has been questioned.

Objective: To validate whether cognitive bias which is found in the field of substance-related and addictive disorders is evident in a potential subtype of problematic internet use, Social Networking Sites (SNS) which contains activities which are predominantly pursued online.

Methods: Eighty five participants performed the Visual Dot-Probe task containing SNS related images while recording eye movements which provides a direct measure of the allocation of attention. In addition a Pleasantness Rating task provided an index of the perceived pleasantness of each image presented in the Visual Dot-Probe task.

Results: Overall problematic SNS internet users and SNS internet users with higher levels of urges to be online showed a preference for SNS images compared to the control images. This was not evident for generic problematic internet users.

Conclusions: It is indicative that problematic internet use consists of different subtypes, which although they have similar generic cognitive processes (attentional bias) these are related to the online activities with which each subtype is associated.

4.2 Introduction

This study aimed to expand upon the assumptions and evidence from Chapter three (Study two) that problematic internet use might consist of different subtypes which although they might share general characteristics might show differences which are specific to each subtype. The focus of this study was based on a specific online application; Social Networking Sites (SNS). SNS consist of various online applications (Facebook, Twitter, and LinkedIn etc.) which aim to provide a platform for social interactions amongst their users. SNS allow people to communicate their thoughts, meet new people, maintain old friendships and in general, they provide a useful tool for any kind of social interaction (Caers et al., 2013). However, there is increased concern that this type of social interaction can lead to various negative outcomes in the users' lives; for example, it has been suggested that they are associated with family conflicts, increased risk of developing problematic SNS use and threaten offline friendships due to a preference for socializing on SNS in lieu of offline interactions, all of which in the long-term can lead to increased feelings of loneliness etc. (Baek, Bae, & Jang, 2013; Clerkin, Smith, & Hames, 2013; Kittinger et al., 2012; Kuo & Tang, 2014; Shapiro & Margolin, 2014). Although a lot of research in the field has been devoted to identifying patterns of usage and trait characteristics of SNS users, as yet there is little insight into the behavioural characteristics of individuals who lose control over their SNS use and develop problematic SNS use. Research into problematic internet use suggests that over usage of SNS constitutes one of the subtypes of this problematic behaviour which has been referred to as the *"cyber-relationships"* subtype (Young, 1998b). However, very little is known about this potential type of problematic internet use particularly regarding whether or not is it similar or different in nature to other subtypes of problematic internet use (for example online gaming and problematic internet use regarding generic online activities) and if so, what are the characteristics of this. Thus, the aim of this study was to answer some of the aforementioned questions which will impact favourably upon our understanding of this potential subtype of problematic internet use.

A prominent theory about the different subtypes of problematic internet use has been developed by Davis (2001), who proposed two distinct forms of problematic internet use; specific and generalized. Specific problematic internet use involves engagement with specific internet applications such as online gambling, online gaming etc., whereas generalized pathological internet use involves a more global/generic set of behaviours. Davis' argument was that specific subtypes constitute those online activities which predominantly substitute for offline ones and as such, the internet represents a medium through which to execute already malfunctioning behaviour. However, some of the proposed specific subtypes such as SNS are associated only with online activities (Young, 1999), which makes Davis' argument partially invalid. Understanding the mechanisms related to each type of behaviour (general versus specific) is of vital importanc in light of the debate as to whether people display problematic behaviour *to* or *on* the internet (Griffiths, 1999, 2010). Thus, in Chapter three (Study two) I researched cognitive processes (attentional bias) in problematic internet users for generic internet applications (generalized). The evidence was suggestive of similarities in the underlying cognitive mechanisms between general problematic internet use with substance-related and addictive disorders. In order to further validate whether the internet is not just the platform to display another problematic behaviour as well as the argument that it consists of different subtypes, there is a necessity to illustrate that similar mechanisms are associated with specific subtypes of problematic internet use. Research has shown that similar mechanisms are evident for one specific online application, online gaming (Lorenz et al., 2013; Metcalf & Pammer, 2011; van Holst et al., 2012). However, online gaming can be performed both in the online and offline environment, and thus, it can be argued that it is not representative of purely online behaviours. Therefore, in this present study attentional processes in problematic internet users for SNS were assessed, which arguably involves sets of activities which can only be pursued online. SNS involves online socially related activities which have some unique characteristics compared to offline ones. For example, people can present themselves the way they like, including the creation of false self-representations. In offline social interaction this is more difficult to achieve. Also, there is a lack of face-to-face communication and can be a relaxing medium for social interaction especially for some individuals who have social anxiety problems. Nevertheless, this type of communication hides any of the emotional cues which are evident when face-to-face communications take place and which make social interaction easier. Moreover, online social interaction allows for communication with multiple people at the same time which is not so easy in the offline environment. Finally, it does necessitate the use of media such as the internet or mobile phones.

Assessing similarities and differences between generalized and specific online problematic internet use can also provide a better understanding of each type of behaviour, assuming that certain subtypes of problematic internet use might actually exist (Young, 1998b). Similarly, research from pathological gambling has revealed differences in various cognitive processes between different subtypes of pathological gamblers (such as slot machine users, casino gamblers or racing gamblers). For example, McCusker and Getting (1997) found a specific gambling activity interference effect when they assessed attentional bias with the addiction Stroop task. More specifically, poker gamblers had increased reaction times to poker related words compared to racing related words and the opposite effect was evident for racing gamblers. Moreover, Goudriaan et al. (2005) found differences in a playing cards task performance between gamblers whose primary gambling activity was either slot or casino machines. More specifically, they found that slot machine gamblers had a better performance on the task, which was attributed to their increased sensitivity to punishment, whereas casino gamblers had more impaired performance on the task, which was attributed to increase reward seeking or decreased sensitivity to punishment. The aforementioned studies have important implications as they suggest that within a clinical homogeneous group of pathological gamblers there can be differences in cognitive as well as motivational processes. Most importantly, they highlight that these differences are related with the activity for which each group of gamblers showed preference. Overall, it can be argued that failure to make this distinction between different subgroups, for example of gamblers, could have important implications for intervention outcomes.

With respect to interventions, some have been developed to focus on altering attentional bias processes in substance dependent individuals for stimuli related to their substance of abuse, with the aim of minimizing substance seeking behaviour (Fedardi & Cox, 2009; Field & Eastwood, 2005; Field et al., 2007; Kerst & Waters, 2014; Schoenmakers et al., 2010; Wiers & Stacy 2006). This type of intervention was developed based on the assumption that attentional bias is causing or underling the processes that cause substance dependence (Robbins & Ehrman, 2004). Thus, there must be a high inter-correlation between the two constructs and as such, by altering attentional bias processes it was expected that changes in substance seeking behaviour would result as well. Similar mechanisms have been implicated with pathological gambling (Honsi et al., 2013). Thus, if researchers develop such interventions for pathological gamblers with stimuli related to generic gambling activities whilst failing to identify specific subgroups of gamblers, then this form of intervention might fail to deliver the desired outcomes. This is because it has been found that gamblers tend to show attentional bias for their preferred gambling activity. In a similar way, in Goudriaan et al.'s (2005) study the differences in task performance between gamblers were attributed to different motivational processes underlying gambling behaviour. For example, it has been argued that slot machine gamblers gamble in order to avoid/escape negative situations, such as stress in their lives, which is in the opposite to the reward seeking hypothesis generally advanced regarding pathological gamblers (Blaszczynski & Nower, 2002; Ledgerwood & Petry, 2006). Thus, if treatment interventions have the target of altering or controlling reward seeking behaviour, for example with the implementation of cognitive behavioural therapy, then this option will not be optimal for slot machine gamblers, whose motive underlying their gambling is punishment aversion. All the aforementioned evidence highlights the importance of identifying subgroup specific characteristics which might be part of a more generic set of behaviours.

In a similar way it can be argued that although problematic internet users have overt behavioural similarities (such as continuing to use the internet despite the rise of negative consequences of its use in everyday life or experiencing a feeling of excitement when online etc.), there might be specific characteristics which might be related to each potential subtype of online behaviour. For example, substantial sources of evidence suggest that individuals who play online games have better performance on tasks capturing response inhibition and attentional processes (Boot et al., 2008; Green & Bavelier, 2008; Sun et al., 2010). This suggests that individuals with problematic online gaming might have superior performance compared for example, to individuals with generic problematic internet use. Thus, understanding the mechanisms which relate to each potential subgroup of online users is of great importance for a better understanding of the different components of problematic internet use.

In Chapter three (Study two) it was found that problematic internet users for generic internet applications (with higher levels of urges to be online) such as web browsing, YouTube activities, reading and composing emails, characterized by Davis (2001) as generalized problematic internet use, showed an attentional bias for images containing generic internet activities. However, this bias was not evident for problematic internet users for specific online applications (SNS). This evidence points to the existence of sub-groups of problematic internet users. However, in order to validate such an assumption this work has been followed up by designing a more bespoke study. In this I specifically targeted individuals with problematic SNS internet use in order to assess whether attentional bias will be evident for these online applications and be activity specific in a similar way to that found in the research on pathological gambling. If problematic internet users for a specific online application (SNS) show an attentional bias for their preferred online applications then this will support the hypothesis that there are sub-groups of problematic internet users who only show addiction-like tendencies towards their preferred specific applications and not generically to online applications. This type of investigation can be very informative for enhancing our understanding of the potential different sub-groups of problematic internet use.

Building upon the hypotheses from Chapter three (Study two) and based on the same methodological assumptions, in this study it was hypothesized that individuals with problematic SNS internet use would show an attentional bias for SNS related images, and this bias would be evident for both initiation and maintenance of attention. Further, following the principles of incentive sensitization theory, it was hypothesized that individuals with problematic SNS internet use would also perceive SNS related images as being more attractive, what has been termed, evaluative bias, compared to neutral-control images (which serve as comparison against SNS images). Also, the role of craving (levels of urges to be online) was investigated further by assessing the relationship between attentional and evaluative biases, levels of urges to be online, and the severity of SNS problematic internet use. Moreover, based on Charlton and Danforth’s (2007, 2010) model it was hypothesized that there will be qualitative differences between individuals with and without problematic SNS internet use (high engagers, moderate and problematic SNS internet users) in relation to certain psychopathological and personality constructs. A final objective of this study was to assess problematic internet use not only for specific (SNS) but also for generic internet applications and to investigate whether there were differences in cognitive processes between them. It was hypothesized that if subtypes of problematic internet use exist, then only problematic internet users for the specific online application SNS would show an attentional and evaluative bias for SNS images, which would be supportive of the claim that addiction-like cognitive bias is related to the specific online applications that individuals show a preference for.

4.3 Method

4.3.1 Participants

The participants were recruited through advertisements placed within the University of Bath. In the initial phase of the experiment an online questionnaire assessing their SNS internet use was administered (a modified Addiction-Engagement Questionnaire-AEQ: the same as used in Study two). From a total number of 163, 85 were contacted for further testing (phase two) based on their scores on the modified AEQ for assessing SNS internet use. Efforts were made to recruit equal numbers of participants who fulfilled the criteria for problematic, high engagement and non-problematic SNS internet use. The mean age was 22.51 years (*S.D* = 6.58) and there were 51 females. All participants in the second phase of the study had normal or corrected-to-normal vision. There was an imbalance in the male-to-female ratio in this study. The number of participants that conducted the second phase of testing reflected the ratio of males and females that initially showed an interest in participating in the study (initial stage ratio, 1:1.6; second stage ratio, 1:1.5). Such an inconsistency has been noted within several articles related to this field of research with many researchers surmising that this discrepancy might reflect the greater willingness of female participants to disclose personal information compared to male participants (Young, 1998a). For extensive argument see Chapter two (Study one, subsection 2.3.1). However, the gender ratio between groups in this study did not differ significantly for males $x^2 = 3.18$, $p = .365$, females $x^2 = 1.18$, $p = .765$.

4.3.2 Pictorial stimuli

SNS related stimuli consisted of pictorial colour images containing general SNS related activities (Facebook, Twitter and Google^{+} websites etc.) and SNS related logos (Facebook, Twitter and LinkedIn logos etc.) which were retrieved from the Google image search database (see Appendix IV for examples of the images). In order to obtain the most relevant images to serve as sample stimuli a total of 40 SNS related images (pictures) were retrieved. Twenty individuals (who did not participate in the study) rated all images on a 10-point scale according to their relatedness to the SNS (ranging from 1 “not at all related” to 10 “very related”). From the 40 images, 15 were selected as the most relevant SNS images based on the highest scores allocated. Each SNS image was matched with a control image. Visual characteristics such as colour, brightness, size etc. of each image were manipulated with an Adobe Photoshop (www.adobe.com) in order to attain visual similarity between pairs of images, thus, following similar procedures to those used in the field of addiction (Field, Mogg, & Bradley, 2004b; Mogg et al., 2005). Similar, to the previous study, where attentional bias for general internet-related images was assessed, I generated two types of control images. One type referred to as the control-computer related images, were generated using Microsoft Office Word or Powerpoint (see Figure 4.2) and were visually very similar to SNS related images. These control-computer images related to the offline environment (common visual images you seen when working with the computer offline). The other type of control images shared similar lower visual information with SNS-related and SNS logo-related images. However, they had no visual reference to the online environment or computer characteristics, and were termed control non-computer images. These types of images were generated in order to control for the possibility that individuals who might show an attentional bias for SNS related stimuli might also show a bias for computer related stimuli, as computers are commonly used as a medium for being online. Examples of the stimuli are presented in Figures 4.1, 4.2, and 4.3.

Figure 4.1: Presentation of SNS related stimulus (logo) on the left, matched with control stimulus on the right.

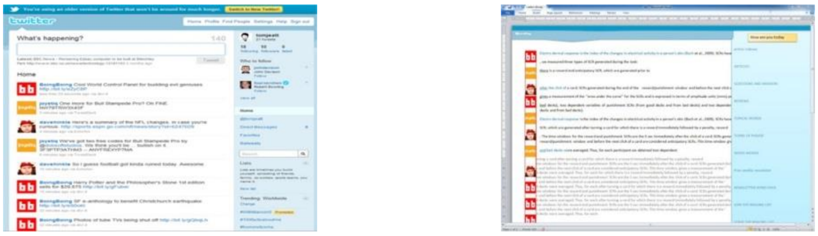

Figure 4.2: Presentation of SNS related stimulus (Twitter website) on the left, matched with control-computer related stimulus on the right (PowerPoint generated image).

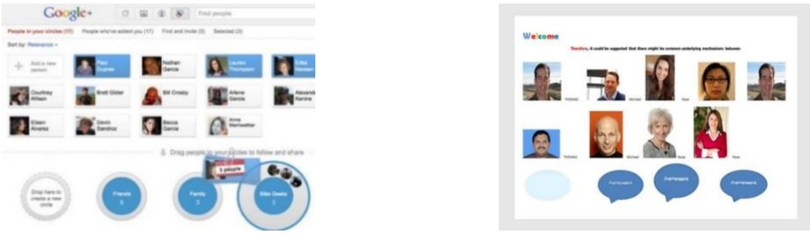

Figure 4.3: Presentation of SNS related stimulus (Google+ website) on the left, matched with control non-computer related stimulus on the right.

Six of the SNS stimuli were logo related images and were paired with visually similar symbols (see Figure 4.1). The remaining nine SNS images containing general SNS online activities were matched in half of the trials with control-computer related images (see Figure 4.2) and in the remaining half with control-non computer related images (see Figure 4.3). Thus, there were two experimental conditions. One consisting of SNS-related images matched with control-computer images (the computer condition) and the other where SNS-related and SNS-logo related images were matched with control non-computer images and symbols (the non-computer condition). Additionally, 45 neutral pictures were taken from the International Affective Picture System (IAPS) database (Lang, & Bradley, 2007) and used in fillers and practice trials. Neutral pictures contained images of everyday objects such as a lamb, fork, book, landscapes etc. (mean arousal = 5.65, *SD* = 1.10; mean range = 3.82). The size of the pictures was 5.5cm wide and 11cm high and the distance between the inner edges of each picture in each pair was 3cm (visual angle of 1^{o} between the fixation position and the inner edge of each picture).

4.3.3 Visual Dot-Probe Task - Pleasantness rating task- Eye tracking

The same as Chapter three (Study two).

4.3.4 Self-report measures-Questionnaires

See Chapter three (Study two) for details as to the structure of the following measures. The Cronbach's alpha for each measure for this particular study are included to evidence the validity of their usage for this study.

Addiction-Engagement Questionnaire (AEQ)

The Cronbach's alpha coefficient for the addiction factor was .90 for the high engagement factor .84 for the generalized internet use, .92 and 0.89 for SNS use.

Internet Addiction Test (IAT)

The Cronbach's alpha coefficient was .93 for the whole scale .87 (withdrawal and social problems), .86 (time management and performance) and .74 (reality substitute).

Problematic Internet Use Questionnaire (PIUQ)

The Cronbach's alpha coefficient was .94 for the whole scale .91 (obsession), .81 (neglect) and .84 (control disorder).

Brief Symptom Inventory (BSI-53)

BSI has good internal consistency with a range of .71 to .85 and test-retest reliability with a range of .68 to .91 (Derogatis et al., 1983). The Cronbach's alpha coefficient was .96 for the whole scale and: .75 (somatization), .85 (obsession-compulsion), .87 (interpersonal sensitivity), .88 (depression), .85 (anxiety), .72 (hostility), .65 (phobic anxiety), .80 (paranoid ideation), .69 (psychoticism). All raw scores were converted to T-scores using adult non-patient norms for each gender (Derogatis, 1993).

Barratt Impulsiveness Scale version 11 (BIS)

The Cronbach's alpha coefficient was .87 for the whole scale .61 (non-planning), .62 (motor) and .66 (cognitive).

Questionnaire on internet use urges (QIUU)

The Cronbach's alpha coefficient was .94.

4.3.4 Procedure

The same as Chapter three (Study two).

3.3.5 Preparation of eye movement data

Eye movements were only analysed for the 60 critical trials where SNS images were paired with control images. The criteria for initial fixation was based on Field, Mogg, and Bradley's (2004b) methodology, which required that 1) participants fixated on the cross before the pair of pictures appeared on the screen, 2) any eye movement had to occur 100ms after the visual stimuli presentation and before the pictures offset 3) participants fixated on one of the pictures rather than the central area during the presentation of the experimental stimuli. An initial fixation was made on either the SNS or control related images in 89.1% of the trials. For 3.8% of the trials participants did not fixate on the cross before pictures offset and for 7.1% of trials they fixated on the central area rather than the stimuli.

Dwell time was calculated based on the amount of time participants spent fixating (summing the duration of each fixation) on both images and the central location (between the images area) for each trial. The average time participants spent looking at these three areas altogether was analysed first and trials excluded where there were excessive missing data (no recording eye movements-fixations were more than 3 *SD*s above the sample mean). The 3 *SD*s is a cut-off point which has been consistently applied in research conducted with eye movements (Field, Mogg, & Bradley, 2004b; Mogg et al., 2005). A fixation was made on any of the three aforementioned areas for 82% of the time of image presentation. The remaining 18% of the time where no fixation was recorded was attributed to saccade eye movement, eye blinks, and failure of the system to record eye movements. Of the recorded fixation time 75.6% related to fixations made to one of the regions containing the images with the remaining 22.4% made to the central location (i.e. where the cross was presented, between the images area).

4.3.6 Statistical Analysis

All statistical analyses were conducted in the same way as in Chapter three (Study two).

4.4 Results

4.4.1 Group characteristics *(see Tables 4.1 and 4.2)*

Initially, based on Charlton and Danforth's (2007, 2010) model assessments were made to see whether differences between groups of SNS internet users would be evident in: 1) the severity of problematic internet use, 2) motivational states, 3) psychopathological constructs and, 4) personality traits. One-way ANOVAs were performed on key self-report measures. Where significant group effects were found, Tukey HSD or Games-Howell tests depending whether Levene's test of homogeneity of variance was significant or not, were performed.

From Table 4.1, we can see that, overall, the problematic SNS internet users group had significantly higher scores compared to high engagers, moderate and non-problematic SNS internet users on the AEQ addiction scale. Moreover, they had significantly higher scores compared to moderate and non-problematic SNS internet users on the AEQ high engagement scale, IAT total (including the withdrawal and social problems and reality substitute subscales) and PIUQ's obsession subscale. Also, they had significantly higher scores compared to non-problematic SNS internet users on the PIUQ total and neglect and control disorder subscales and the IAT's time management and performance subscale. Similarly, high engagers had higher scores compared to moderate and non-problematic SNS internet users on the AEQ addiction and high engagement scales, IAT withdrawal and social problems and reality substitute subscales and PIUQ obsession subscale. Moreover, they had significantly higher scores compared to non-problematic SNS internet users on the PIUQ total and neglect and control disorder subscales and the IAT total and time management and performance subscale. Finally, problematic and high engagers SNS internet users had higher scores on the QIUU compared to non-problematic SNS internet users.

Table 4.1- Characteristics of internet SNS use groups. Values are means (standard deviation in brackets)

	Problematic SNS internet users (PSIU) (n=16)	High engagers SNS users (HESU) (n=25)	Moderate SNS users (MSU) (n=20)	Non-problematic SNS internet users (NPSIU) (n=24)	Anova F Values	Post-hoc comparisons (Tukey HSD and Games-Howell)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)		
Age (years)	19.25 (1.39)	21.96 (4.51)	22.15 (6.73)	25.54 (8.97)		
Gender (M/F)	4M/12F	10M/15F	10M/10F	10M/14F		
AEQ addiction	56.13 (10.92)	39.20 (7.30)	30.50 (7.86)	18.62 (6.39)	74.95**	PSIU>HESU,NPSIU,MSU;HESU>NPSIU,MSU; MSU>NPSIU
AEQ high engagement	60.25 (10.61)	56.88 (8.99)	46.20 (6.85)	37.21 (10.66)	26.68**	PSIU>NPSIU,MSU;HESU>NPSIU,MSU; MSU>NPSIU
IAT total	46.88 (14.84)	43.88 (13.15)	35.70 (9.85)	27.33 (7.26)	12.73**	PSIU>NPSIU,MSU; HESU>NPSIU
IAT withdrawal and social problems	16.19 (6.10)	15.84 (5.92)	11.75 (3.43)	10.25 (2.93)	8.37**	PSIU>NPSIU,MSU; HESU>NPSIU,MSU
IAT time management and performance	18.00 (5.93)	15.64 (4.07)	14.40 (4.70)	9.37 (3.00)	14.58**	PSIU>NPSIU;HESU>NPSIU;RSU>NPSIU
IAT reality substitute	7.06 (2.51)	6.76 (3.11)	4.45 (1.84)	3.83 (1.55)	10.08**	PSIU>MSU, NPSIU; HESU>MSU, NPSIU
PIUQ total	47.56 (13.56)	47.16 (10.05)	37.65 (9.65)	28.08 (9.04)	17.41**	PSIU>NPSIU;HESU>NPSIU, MSU;MSU>NPSIU
PIUQ obsession	13.81 (5.20)	14.32 (4.84)	9.50 (3.28)	8.67 (4.07)	9.66**	PSIU>NPSIU, MSU;HESU>NPSIU, MSU
PIUQ neglect	16.63 (3.96)	16.72 (3.69)	14.15 (3.70)	10.04 (3.30)	16.78**	PSIU>NPSIU;HESU>NPSIU;MSU>NPSIU
PIUQ control disorder	17.13 (5.31)	16.12 (3.20)	14.00 (3.81)	9.38 (2.44)	19.45**	PSIU>NPSIU;HESU>NPSIU;MSU>NPSIU
QIUU	31.00 (12.55)	31.68 (13.02)	25.55 (10.66)	19.88 (12.08)	4.65**	PSIU>NPSIU;HESU>NPSIU

*Note. AEQ = Engagement and Addiction Questionnaire with subscales, IAT = Internet Addiction Test with subscales; PIUQ = Problematic Internet Use Questionnaire with subscales, QIUU = Questionnaire on internet use urges.PSIU = four or more addiction criteria, HESU = three or less addiction criteria and one or two peripheral criteria, MSU = three or less addiction criteria or one peripheral criteria, NPSIU = none of the addiction or peripheral criteria. p < .01***

In addition, the problematic SNS internet users group had significantly higher scores compared to non-problematic SNS internet users on the subscales somatization, obsession-compulsion, interpersonal sensitivity, hostility, paranoid ideation, psychoticism, global severity, positive symptoms and positive symptom distress index. Moreover, the high engagers SNS internet users group had significantly higher scores compared to the non-problematic SNS internet users on the subscales of somatization, obsession-compulsion, depression, interpersonal sensitivity, psychoticism, global severity, positive symptoms and positive symptom distress index (Table 4.2).

In relation to personality trait characteristics there were no differences between SNS internet users (Table 4.2).

Overall, the data provided support for there being qualitative differences between SNS internet use groups (problematic, high engagers, moderate and non-problematic SNS internet users) based on the AEQ proposed criteria, as there were significant differences between these groups in relation to the severity of problematic internet use and psychopathology.

Table 4.2-Psychopathological and personality characteristics of internet SNS use groups.

	Problematic SNS internet users (PSIU) (n=16)	High engagers SNS users (HESU) (n=25)	Moderate SNS users (MSU) (n=20)	Non-problematic SNS internet users (NPSIU) (n=24)	Anova F Values	Post-hoc comparisons (Tukey HSD and Games-Howell)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)		
BSI grand total	51.19 (35.62)	42.68 (28.84)	31.25 (24.73)	19.96 (23.26)	4.86**	PSIU>NPSIU;HESU>NPSIU
BSI global severity index	63.81 (11.54)	62.32 (8.27)	57.35 (12.16)	51.33 (10.41)	6.25**	PSIU>NPSIU;HESU>NPSIU
BSI positive symptom total	63.19 (11.49)	61.76 (8.47)	56.20 (9.71)	52.88 (9.91)	5.13**	PSIU>NPSIU;HESU>NPSIU
BSI positive symptom distress index	59.18 (8.86)	58.84 (6.95)	55.40 (9.80)	50.37 (8.93)	5.05**	PSIU>NPSIU;HESU>NPSIU
BSI somatization	56.37 (10.83)	55.40 (8.10)	52.05 (9.16)	45.87 (7.47)	6.48**	PSIU>NPSIU;HESU>NPSIU
BSI obsession-compulsion	63.81 (10.82)	62.44 (8.58)	60.00 (11.73)	53.45 (10.27)	4.39**	PSIU>NPSIU;HESU>NPSIU
BSI interpersonal sensitivity	67.37 (11.11)	66.96 (8.62)	62.60 (9.56)	57.58 (7.98)	5.50**	PSIU>NPSIU;HESU>NPSIU
BSI depression	63.81 (13.19)	61.88 (9.89)	58.55 (9.43)	54.45 (8.93)	3.38**	HESU>NPSIU
BSI anxiety	54.62 (17.78)	53.12 (9.58)	48.65 (9.91)	47.50 (10.42)	1.72	
BSI hostility	53.75 (14.41)	49.92 (12.05)	48.70 (12.53)	42.29 (7.32)	3.51**	PSIU>NPSIU
BSI phobic anxiety	55.75 (10.77)	56.92 (9.36)	55.15 (9.65)	50.25 (8.00)	2.33	
BSI paranoid ideation	61.25 (10.70)	59.12 (11.17)	53.40 (10.14)	51.37 (9.71)	4.07**	PSIU>NPSIU
BSI psychoticism	64.43 (12.25)	64.52 (9.81)	57.20 (11.50)	53.29 (9.02)	6.18**	PSIU>NPSIU;HESU>NPSIU
BIS total	60.94 (9.99)	60.96 (7.08)	61.45 (9.15)	60.67 (10.05)	0.02	
BIS attention	16.94 (3.92)	16.12 (2.53)	16.20 (3.70)	15.25 (3.75)	0.78	
BIS motor	20.31 (2.91)	20.68 (3.01)	21.35 (4.67)	21.42 (5.04)	0.33	
BIS non-planning	23.69 (5.17)	24.16 (4.31)	23.90 (4.48)	24.00 (3.67)	0.04	
QIUU	31.00 (12.55)	31.68 (13.02)	25.55 (10.66)	19.88 (12.08)	4.65**	PSIU>NPSIU;HESU>NPSIU

Note, BSI = Brief Symptom Inventory with subscales; BIS = Barratt Impulsivity Scale with subscales. PSIU = four or more addiction criteria, HESU = three or less addiction criteria and one or two peripheral criteria, MSU =three or less addiction criteria or one peripheral criteria, NPSIU = none of the addiction or peripheral criteria. $p < .01^{**}$

4.4.2 Dot-probe task performance

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation), (For all raw data see Table 4.3).

<u>*Fixation Duration*</u>

The mean amount of time (fixation duration) participants spent fixating on each image (SNS versus control) during critical trials was calculated. A 2 x 4 mixed ANOVA was performed with image type (SNS versus control) as a within factor and group (problematic, high engagers, moderate and non-problematic SNS internet users) as the between factor. Overall, the results revealed a significant main effect of image type, $F(1, 81) = 4.73$, $p = .033$, $\eta p^2 = 0.05$ and interaction between image type with group, $F(3, 81) = 2.73$, $p = .049$, $\eta p^2 = 0.09$. The group effect was non significant, $F(3, 81) = 0.67$, $p = .57$. Moreover, post-hoc tests revealed that problematic SNS internet users spent more time looking at the SNS compared to the control images $t(15) = 2.28$, $p = .038$, $d = 1.17$, 95% CI [6.80, 126.20]. Finally, Bonferroni correction revealed that they also fixated on control related images less compared to moderate SNS internet users, $t(20.531) = -3.01$, $p = .007$, $d = 1.32$, 95% CI [-155.22, -28.33], (Figure 4.4).

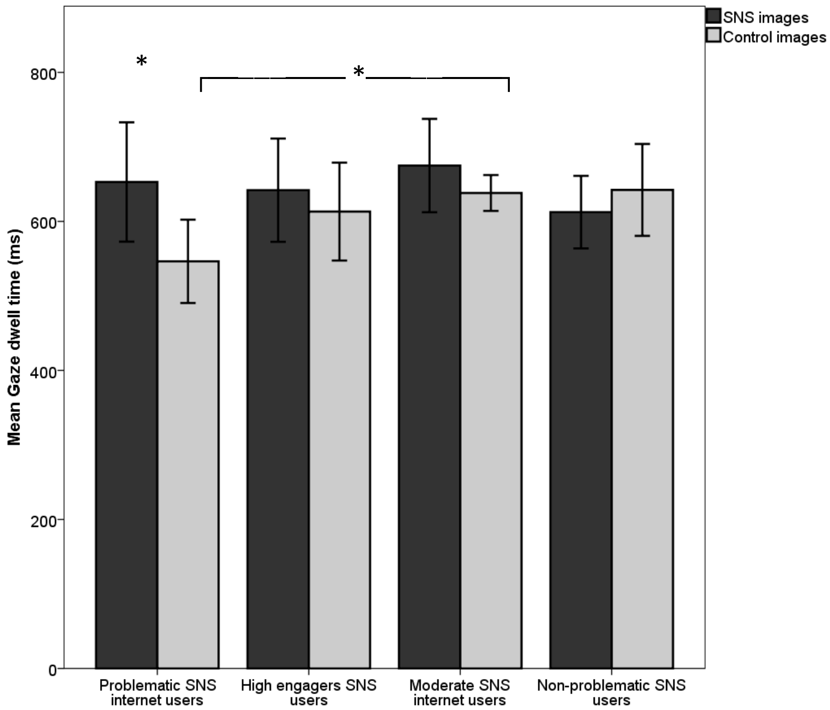

Figure 4.4 Mean gaze dwell time (in milliseconds) on SNS and control images, shown separately for problematic, high engagers, moderate and non-problematic SNS internet users. Error bars represent standard error of the means.

<u>*Direction of initial fixation*</u>

The direction of initial fixation bias was calculated by assessing the percentage of the trials where the initial fixation was made on SNS images. It has been suggested that scores greater than 50% (which revealed no bias) reflected bias for SNS images (for a similar argument see Mogg et al., 2005). Problematic SNS internet users made their first fixation on SNS images in 50% of the trials (*SD* = 15.24), high engagers 47.42% of the trials (*SD* = 13.33) and moderate SNS internet users 50.7% of the trials (*SD* = 5.81), which were not significantly greater than 50%, $t(15) = 0.01$, $p = .992$; $t(24) = -0.96$, $p = .344$; $t(19) = 0.52$, $p = .611$, respectively. Finally, the non-problematic SNS internet users made their first fixation on SNS images in 40.9% of the trials (*SD* = 15.94), which was significantly smaller than 50%, $t(23) = -2.788$, $p = .01$, $d = -1.16$, 95% CI [-15.81, -2.34] (Figure 4.5). One-way Anova reveled no difference between the groups of SNS internet users, $F(3, 81) = 2.47$, $p = .07$.

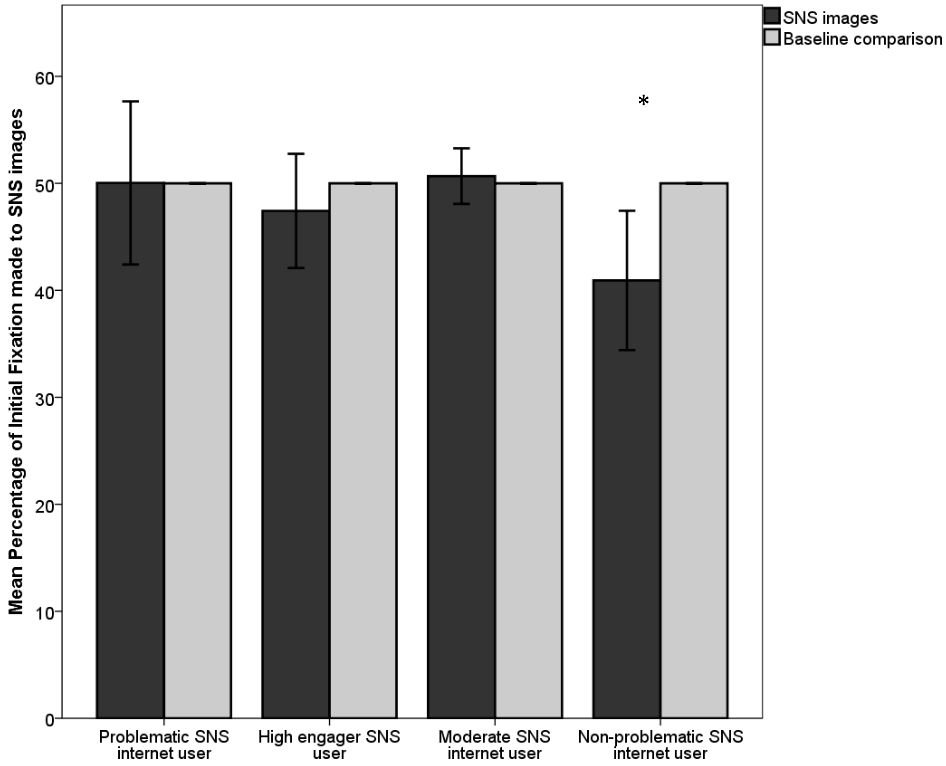

Figure 4.5 Mean percentage of direction of initial fixation on SNS images against 50% which indicate no bias, shown separately for problematic, high engagers, moderate and non-problematic SNS internet users. Error bars represent standard error of the means.

<u>*Attentional bias as assessed with manual reaction times to probes*</u>

The mean reaction times (RTs) were only analysed for critical trials. Trials with errors (0.65%) and outliers (RTs more than 3*SD* above the sample mean, 3.72%) were excluded from the analysis.

Mean RTs in response to the probe replacing each image (SNS versus control) was calculated. A 2 x 4 mixed ANOVA was performed with probe condition (probe in the same congruent versus different incongruent location with SNS images) as a within factor and group (problematic, high engagers, moderate and non-problematic SNS internet users) as the between factor. Overall, the results revealed no significant main effects of probe condition, $F(1, 81) = 1.06$, $p = .31$, group effect, $F(3, 81) = 2.03$, $p = .12$, or interaction between probe condition and group, $F(3, 81) = 1.46$, $p = .23$.

4.4.3 Pleasantness Rating task: stimulus valence measures

The mean pleasantness ratings for the SNS and control images was calculated. A 2 x 4 mixed ANOVA was performed with images type (SNS versus control) as a within factor and group (problematic, high engagers, moderate and non-problematic SNS internet users) as the between factor. Overall, the results revealed no significant main effects of image type, $F(1, 81) = 0.61$, $p = .44$, group effect, $F(3, 81) = 0.69$, $p = .56$, or interaction between image type and group, $F(3, 81) = 1.52$, $p = .93$.

Overall, the results revealed differences in attentional processes in the groups of SNS internet users. Moreover, similarly to Chapter three (Study two), further analyses were conducted for trials where SNS images were matched with control-computer related images and for trials where they were matched with non-computer related images. The supplementary analysis was conducted in order to assess whether there were differences in behavioural outcomes related to each type of control stimuli.

4.4.4 Supplementary analysis for computer condition *(For all raw data see Table 4.3).*

Dot-probe task performance

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation).

<u>*Fixation Duration*</u>

Overall, the results revealed no significant main effects of image type, $F(1, 81) = 0.47$, $p = .49$, group effect, $F(3, 81) = 1.39$, $p = .25$, or interaction between image type and group, $F(3, 81) = 0.50$, $p = .68$.

<u>*Direction of initial fixation*</u>

Problematic SNS internet users made their first fixation on SNS-related images on 47.5% of trials ($SD = 20.14$), high SNS engagers on 44.24% of the trials ($SD = 15.91$), moderate

SNS internet users on 49.32% of the trials (*SD* = 14.67) which were not significantly different than 50% which indicated no bias, $t(15) = -0.50$, $p = .63$; $t(24) = -1.81$, $p = .08$; $t(19) = -0.21$, $p = .84$. Overall, results revealed no direction of initial fixation bias in problematic, high engagers and moderate SNS internet users. However the non-problematic SNS internet users made their first fixation on SNS images in 38.3% of trials (*SD* = 19.84), which was significantly smaller than 50%, $t(23) = -2.89$, $p < .001$, $d = 1.20$, 95% CI [-20.08, -3.32].). One-way Anova reveled no difference between the groups of SNS internet users, $F(3, 81) = 1.64$, $p = .19$.

<u>Attentional bias as assessed with manual reaction times to probes</u>

The probe condition effect approached significance, $F(1, 81) = 3.74$, $p = .057$, $\eta_p^2 = 0.04$, with participants responding more quickly to a probe replacing SNS images compared to control-computer images. The main effect of group effect, $F(3, 81) = 1.61$, $p = .19$, or interaction between probe condition and group, $F(3, 81) = 1.54$, $p = .21$ were not significant.

4.4.5 Supplementary analysis for non-computer condition *(For all raw data see Table 4.3).*

Dot-probe task performance

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

<u>Fixation Duration</u>

Overall, the results revealed a significant main effect of image type, $F(1, 81) = 10.88$, $p = .001$, $\eta_p^2 = 0.12$ and interaction between image type with group, $F(3, 81) = 3.16$, $p = .029$; $\eta_p^2 = 0.11$. The group effect was not significant, $F(3, 81) = 0.61$, $p = .61$. Post-hoc tests revealed that problematic SNS internet users spent more time looking at the SNS compared to control-non computer images, $t(15) = 2.82$, $p = .013$, $d = 1.45$. 95% CI [34.33, 247.74] and this was also evident for high SNS engagers, $t(24) = 2.20$, $p = .037$, $d = 0.89$, 95% CI [4.13, 126.52]. Finally, Bonferroni correction revealed that problematic SNS internet users fixated on the control related images less compared to the moderate SNS internet users, *t*(22.575) = -3.04, *p* = .006, *d* =1.04, 95% CI [-175.44, -33.18], (Figure 4.6).

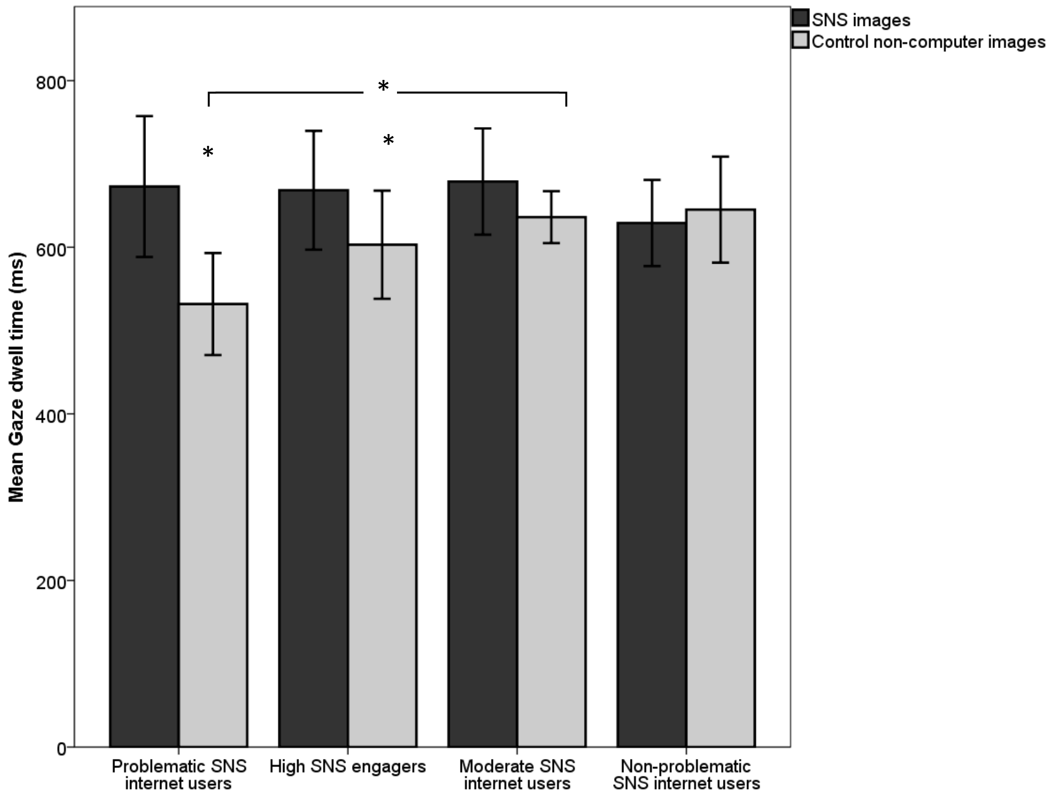

Figure 4.6 Mean gaze dwell time (in milliseconds)on SNS and control non-computer images, shown separately for problematic, high engagers, moderate and non-problematic SNS internet users. Error bars represent standard error of the means.

<u>*Direction of initial fixation*</u>

Problematic SNS internet users made their first fixation on SNS-related images on 50.67% of trials (*SD* = 15.03), high SNS engagers on 48.98% of the trials (*SD* = 15.11), moderate SNS internet users on 51.82% of the trials (*SD* = 4.74) which were not significantly different than 50% which indicated no bias, *t*(15) = -0.18, *p* = .86; *t*(24) = -

0.34, *p* = .74; *t*(19) = 1.72, *p* = .102. Overall, the results revealed no direction of initial fixation bias for problematic, high engagers and moderate SNS internet users. However, the non-problematic SNS internet users made their first fixation on SNS related images in 42% of trials (*SD* = 16.78), which was significantly smaller than 50%, *t*(23) = -2.79, *p* < .001; *d* = 1.16, 95% CI [-15.81, -0.90]. Finally, one-way Anova reveled no difference between the groups of SNS internet users, *F*(3, 81) = 2.21, *p* = .09.

Attentional bias as assessed with manual reaction times to probes

Overall, the results revealed no significant main effects of probe condition, *F*(1, 81) = 0.01, *p* = .93, group effect, *F*(3, 81) = 2.02, *p* = .07, or interaction between probe condition and group, *F*(3, 81) = 1.11, *p* = .36.

Table 4.3-Mean and standard deviations for RTs, direction of initial fixation, dwell gaze time and pleasantness ratings for all trials, trials where controls were computer and non-computer for problematic, high engagers, moderate and non-problematic SNS internet users.

SNS internet use group	Problematic SNS internet users	High engagers SNS internet users	Moderate SNS internet users	Non-problematic SNS internet users
Behavioural Performance	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
RT congruent all trials	422.14 (55.33)	468.34 (83.76)	432.12 (52.87)	472.20 (66.83)
RT incongruent all trials	430.62 (66.89)	464.01 (85.65)	442.10 (59.71)	470.50 (71.19)
RT congruent computer trials	424.60 (57.29)	474.13 (85.44)	437.07 (59.82)	473.58 (68.78)
RT incongruent computer trials	445.16 (73.98)	468.54 (82.86)	455.19 (70.19)	478.83 (73.76)
RT congruent non-computer trials	423.53 (59.30)	468.41 (86.86)	432.13 (53.06)	473.21 (67.15)
RT incongruent non-computer trials	427.13 (64.23)	461.65 (87.04)	438.94 (59.39)	468.38 (72.63)
Direction of initial fixation all trials	50.03 (15.24)	47.42 (13.33)	50.67 (5.81)	40.92 (15.94)
Direction of initial fixation computer trials	47.49 (20.13)	44.24 (15.91)	49.32 (14.67)	38.29 (19.84)
Direction of initial fixation non-computer trials	50.67 (15.032)	48.97 (15.10)	51.82 (4.73)	42.00 (16.78)
Dwell gaze time SNS internet all trials	652.88 (160.15)	641.88 (173.31)	674.95 (140.13)	612.42 (119.24)
Dwell gaze control all trials	546.38 (111.91)	613.16 (164.24)	638.15 (53.92)	642.25 (151.06)
Dwell gaze time SNS internet computer trials	573.00 (192.23)	583.44 (192.12)	665.55 (167.04)	561.75 (162.56)
Dwell gaze time control computer trials	582.13 (145.33)	603.48 (204.22)	643.95 (102.36)	622.58 (169.13)
Dwell gaze time SNS internet non-computer trials	672.84 (169.08)	668.38 (178.23)	678.88 (142.77)	629.08 (126.67)
Dwell gaze time control non-computer trials	531.81 (122.45)	603.04 (162.22)	636.12 (69.64)	645.13 (155.94)
Pleasantness rating of SNS internet images all trials	3.80 (.48)	3.58 (.56)	3.62 (.60)	3.52 (.60)
Pleasantness rating of control images all trials	3.74 (.44)	3.56 (.58)	3.62 (.63)	3.51 (.58)

4.4.6 Relationships between cognitive and evaluative biases with SNS internet-related variables

Following the suggestion from the field of substance-related and addictive disorders which implies that not only trait (dependence) but also state characteristics such as craving levels associate with attentional and evaluative biases, correlational analysis was conducted in order to assess the relationships between the severity of problematic SNS internet use, levels of urges to be online, evaluative and cognitive biases as assessed with gaze dwell time, direction of initial fixation, and reaction times in response to probes. In order to conduct correlational analysis, the following calculations were made: 1) the directions of initial fixation scores were measured by the percentage of the first eye movement made on SNS images (as mentioned above), 2) for the gaze dwell time the mean dwell time spent on control images was subtracted from the mean dwell time spent on SNS images, and thus positive scores indicated a bias for SNS images, 3) for RTs, the mean RTs to probes replacing SNS images was subtracted from probes replacing control images and thus positive scores reflected an attentional bias for SNS images and, finally 4) for the evaluative bias, the mean pleasantness ratings for the controls was subtracted from mean pleasantness ratings for SNS images and thus positive scores reflected an evaluative bias for SNS images.

Correlations between cognitive, evaluative biases and SNS internet variables

Table 4.4 revealed that there were significant positive correlations between severity of problematic SNS internet use as assessed with the AEQ addiction subscale with urges to be online, r = .31, p = .004; and with gaze dwell time, r = .22, p = .045. Moreover, urges to be online were positively associated with gaze dwell time, r = .36, p = .001; and RTs, r = .23, p = .031. Also, RTs were associated with gaze dwell time, r = .42, p = .001. No other correlations were found.

Table 4.4- Correlations (Pearson) of AEQ, dwell time, reaction time, pleasatness rating, direction of initial fixation and urges to be online.

	AEQ addiction	Dwell time	Reaction time	Pleasatness rating	Direction of initial fixation	Urges to be online
AEQ addiction	**1**	**.22****	.40	.11	.14	**.31****
Dwell time	**.22****	**1**	**.43****	-.05	.12	**.36****
Reaction time	.04	**.42****	**1**	.03	-.04	**.23***
Pleasatness rating	.11	-.05	.03	**1**	-.09	-.07
Direction of initial fixation	.14	.12	-.04	-.09	**1**	.13
Urges to be online	**.31****	**.36****	**.23***	-.07	.13	**1**

Note. Values are correlation coefficients; bold coefficients are statistically significant (two-tailed). *AEQ: Addition and Engagement Questionnaire.* $p < .05^{*}$; $p < .01^{**}$

The two variables (the severity of problematic SNS internet use and urges to be online) which it has been suggested associate with attentional bias, and as a consequence, with SNS internet use were highly correlated. Thus, partial correlations (controlling for each variable) was performed in order to assess whether their relationships with the cognitive bias were influenced by the other variable. Partial correlation, when controlling for the urges to be online variable, revealed that the correlation between the severity of problematic SNS internet use and gaze dwell time was non significant $r = .21$, $p = .28$. On the other hand, when the severity of problematic SNS internet use was introduced as a covariate, the levels of urge to be online were still significantly correlated with gaze dwell time, $r = .31$, $p = .004$ and RTs, $r = .23$, $p = .033$.

These data suggest that the urge to be online mediated the relationship between the severity of problematic SNS internet use with attentional bias. Thus, further analysis was performed by splitting each SNS internet use group into two levels (SNS internet users with higher levels of urges to be online and SNS internet users with lower levels of urges to be online) and cognitive bias assessed for the SNS internet users (problematic, high engagers, moderate and non-problematic SNS internet users).

Frequency analysis revealed that 65.1% of SNS internet users with higher levels of urges to be online belonged to problematic and high engagers SNS internet user groups and 34.9% to moderate and non-problematic SNS internet user groups. In addition 30% of the SNS internet user groups with lower levels of urges to be online belonged to problematic and high engagers SNS internet user groups and 70% to moderate and non-problematic SNS internet user groups (see Table 4.4).

Table 4.5-Total percentages for each SNS internet use group split by levels of urges to be online (high and low).

SNS internet use group	Problematic SNS internet users		High engagers SNS internet users		Moderate SNS internet users		Non-problematic SNS internet users	
Levels of urges to be online	High	Low	High	Low	High	Low	High	Low
Percentages	62.5%	37.5%	72%	28%	50%	50%	20.8%	79.02%

4.4.7 Dot-probe task performance split by levels of urges to be online and SNS groups *(For all raw data see Table 4.6).*

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

<u>*Fixation Duration*</u>

The mean amount of time (fixation duration) participants spent fixating on each image (SNS versus control) during critical trials was calculated. A 2 x 2 x 4 mixed ANOVA was conducted with image type (SNS versus control) as a within factor and SNS internet use group (problematic, high engagers, moderate and non-problematic SNS internet users) and levels of urges to be online (SNS internet users with higher urges to be online, SNS internet users with lower urge to be online) as the between factors. There was a significant main effect of image type, $F(1, 77) = 5.70$, $p = .019$, $\eta p^2 = 0.07$ and interaction between image type with levels of urges to be online, $F(3, 77) = 14.22$, $p = .001$, $\eta p^2 = 0.16$. The main effects of SNS group, $F(3, 77) = 0.96$, $p = .42$, levels of urges to be online group, $F(1, 77) = 1.60$, $p = .21$ and the interactions between image type and SNS group, $F(3, 77) = 0.71$, $p = .55$, SNS group and levels of urges to be online group, $F(3, 77) = 0.63$, $p = .59$, and image type, SNS group and levels of urges to be online group, $F(3, 77) = 1.72$, $p = .17$ were not significant.

In order to investigate further the significant interaction between image type and levels of urges to be online a 2 x 2 mixed ANOVA was performed with image type (SNS versus control) as a within factor and levels of urges to be online (SNS internet users with higher levels of urges to be online, SNS internet users with lower levels of urges to be online) as a between factor. There was a significant interaction between image type with levels of urges to be online, $F(1, 83) = 16.51$, $p = .001$; $\eta_p^2 = 0.17$. However, the main effect of image type was not significant, $F(1, 83) = 3.37$, $p = .07$ and neither was the SNS group effect, $F(1, 83) = 1.06$, $p = .31$. The group of SNS internet users with higher levels of urges to be online spent significantly more time fixating on the SNS images compared to control images, $t(42) = 3.65$, $p < .05$, $d = 1.25$, 95% CI [40.17, 139.69] and they also spent significantly more time fixating on the SNS images compared to the SNS internet users with lower levels of urges to be online, $t(83) = 2.87$, $p = .005$, $d = 0.63$, 95% CI [27.09, 150.01], (Figure 4.7). Finally, SNS internet users with lower levels of urges to be online spent more time fixating on control images compared to SNS images, and this difference approached significance, $t(41) = -1.91$, $p = .063$, $d = 0.59$, 95% CI [-69.72, 1.86].

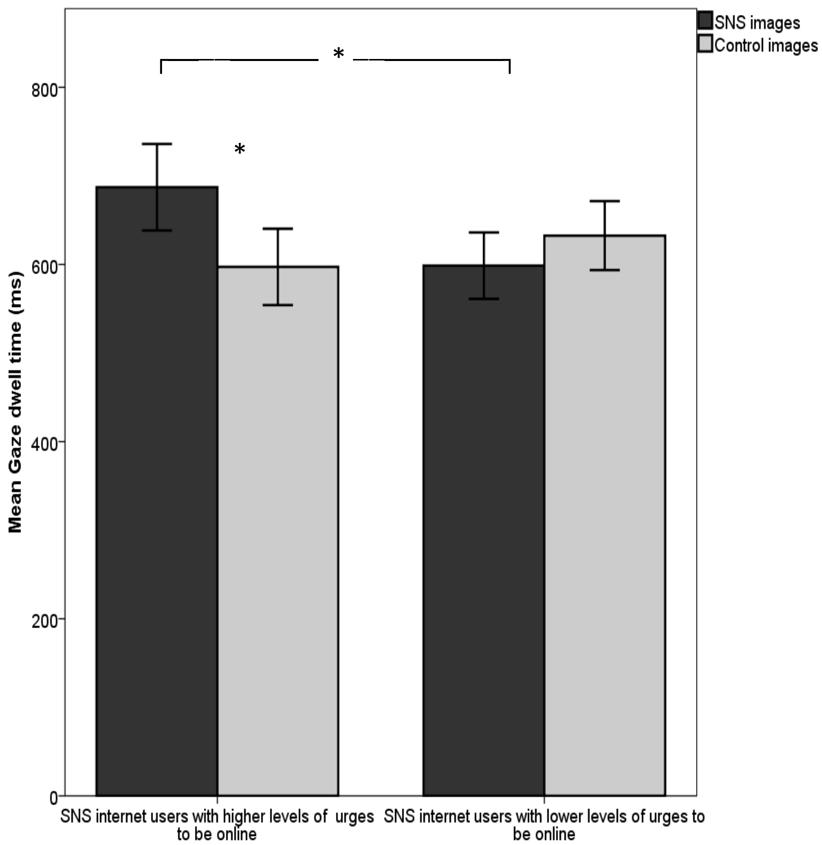

Figure 4.7 Mean gaze dwell time (in milliseconds) on SNS and control images, shown separately for SNS internet users with higher and lower levels of urges to be online. Error

bars represent standard error of the means.

Moreover, post-hoc tests revealed that the problematic SNS internet users with higher levels of urges to be online fixated significantly longer on the SNS images compared to the problematic SNS internet users with lower levels of urges to be online, $t(14) = 3.09$, $p = .008$, $d = 1.65$, 95% CI [65.55, 345.58] and they also fixated more on the SNS images compared to control ones, $t(9) = 3.16$, $p = .012$, $d = 2.1$, 95% CI [52.27, 316.73]. This was also evident for the non-problematic SNS internet users with higher levels of urges to be online, $t(4) = 5.17$, $p = .007$, $d = 5.1$, 95% CI [38.96, 129.44]. However, the non-problematic SNS internet users with lower urges to be online fixated less on the SNS images compared to the control ones, $t(18) = -2.14$, $p = .046$, $d = 1.1$, 95% CI [-118.48, -1.20].

<u>*Direction of initial fixation*</u>

The direction of initial fixation for SNS internet users based on their levels of urges to be online was analysed. Overall the results revealed no direction of initial fixation bias in SNS internet users with higher levels of urges to be online, 48.9% ($SD = 13.8$), $t(42) = 0.49$, $p = .63$, whereas for SNS internet users with lower levels of urges to be online 44.66% ($SD = 13.2$),, direction bias was significantly smaller than 50%, $t(44) = -2.62$, $p < .001$, $d = 0.81$, 95% CI [-9.453, -1.22].

<u>*Attentional bias as assessed with manual reaction times to probes*</u>

A 2 x 2 x 4 mixed ANOVA was performed with probe condition (probe in the same congruent versus different incongruent location with SNS images) as a within factor and SNS internet use groups (problematic, high engagers, moderate and non-problematic SNS internet users) and levels of urges to be online (SNS internet users with higher levels of urges to be online, SNS internet users with lower levels of urges to be online) as the between factors. There were significant interactions between the probe condition and levels of urges to be online, $F(1, 77) = 5.82$, $p = .018$, $\eta_p^2 = .07$. There were no other significant main effects or interactions. The main effects of probe condition, $F(1, 77) = 1.23$, $p = .27$, SNS group, $F(3, 77) = 1.15$, $p = .33$, levels of urges to be online group, $F(1, 77) = 0.36$, $p = .55$ and the interactions between probe condition and SNS group, $F(3, 77) = 1.4$, $p = .24$, SNS group and levels of urges to be online group, $F(3, 77) = 0.91$, $p = .44$, and probe condition, SNS group and levels of urges to be online group, $F(3, 77) = 0.59$, $p = .32$ were not significant.

In order to investigate further the significant interaction between image type and levels of urges to be online a 2 x 2 mixed ANOVA was performed with probe condition (probe in the same congruent versus different incongruent location with SNS images) as a within factor and levels of urges to be online (SNS internet users with higher levels of urges to be online, SNS internet users with lower levels of urges to be online) as the between factor. There was a significant interaction between the probe condition and levels of urges to be online, $F(1, 83) = 4.38$, $p = .039$, $\eta p^2 = 0.05$. The group of SNS internet users with higher levels of urges to be online were quicker responding to probes replacing SNS images than probes replacing control images and this difference approached significance, $t(42) = -1.99$, $p = .053$, $d = 0.61$, 95% CI [-16.64, 0.13]. However, the main effect of probe condition was not significant, $F(1, 83) = 0.52$, $p = .47$ and neither was the SNS group effect, $F(1, 83) = 0.08$, $p = .77$.

4.4.8 Pleasantness rating task: stimulus valence measures

The mean pleasantness ratings for the SNS and control images were calculated. A 2 x 2 x 4 mixed ANOVA was performed with image type (SNS versus control) as a within factor and SNS internet use groups (problematic, high engagers, moderate and non-problematic SNS internet users) and levels of urges to be online (SNS internet users with higher levels of urges to be online, SNS internet users with lower levels of urges to be online) as the between factors. There was a significant main effect of levels of urges to be online, $F(1, 77) = 11.24$, $p = .001$, $\eta p^2 = 0.13$. However, the main effects of image type, $F(1, 77) = 0.81$, $p = .37$, levels of urges to be online group, $F(1, 77) = 0.95$, $p = .42$ and the interactions between image type and SNS group, $F(3, 77) = 0.30$, $p = .82$, image type and levels of urges to be online group, $F(1, 77) = 2.29$, $p = .13$, SNS group and levels of urges to be online group, $F(3, 77) = 1.02$, $p = .39$, and image type, SNS group and levels of urges to be online group, $F(3, 77) = 0.64$, $p = .59$ were not significant. Further analysis revealed that the group of SNS internet users with higher levels of urges to be online rated SNS images and control ones as more pleasant compared to the group of SNS internet users with lower levels of urges to be online, *t* (83) = 3.10, *p* =.003, *d* = 0.68, 95% CI [0.13, 0.66]; *t* (83) = 3.84, *p* < .001, *d* = 0.85, 95% CI [0.21, 0.67].

4.4.9 Supplementary analysis for computer condition for SNS users split by levels of urges to be online and SNS groups *(For all raw data see Table 4.6).*

Dot-probe task performance

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

<u>Fixation Duration</u>

There was a significant interaction between image type and levels of urges to be online, *F(*1, 77) = 10.02, *p* = .002, ηp^2 = 0.115. The main effects of image type *F*(1, 77) = 0.71, *p* = .40, SNS group, *F*(3, 77) = 1.64, *p* = .19, levels of urges to be online group, *F*(1, 77) = 1.33, *p* = .25 and the interactions between image type and SNS group, *F*(3, 77) = 0.39, *p* = .75, SNS group and levels of urges to be online group, *F*(3, 77) = 0.47, *p* = .71, and image type, SNS group and levels of urges to be online group, *F*(3, 77) = 0.26, *p* = .86 were not significant.

In order to investigate further the significant interaction a 2 x 2 mixed ANOVA was performed with image type (SNS versus control) as a within factor and levels of urges to be online (SNS internet users with higher levels of urges to be online, SNS internet users with lower levels of urges to be online) as the between factor. There was a significant interaction between image type and levels of urges to be online, *F(*1, 83) = 10.40, *p* = .002, ηp^2 = 0.11. However, the main effect of image type was not significant, *F*(1, 83) = 0.79, *p* = .37 and neither was the SNS group effect, *F*(1, 83) = 0.95, *p* = .33. Further analysis revealed that the group of SNS internet users with lower levels of urges to be online spent more time fixating on the control computer images compared to the SNS ones, *t*(41) = -2.78, *p* = .008, *d* = 0.71, 95% CI [-163.95, -26.00] and they also spent significantly less time fixating on

SNS images compared to the group of SNS internet users with higher levels of urges to be online, *t*(83) = 2.71, *p* = .008, *d* = 0.69, 95% CI [27.05, 176.61], (Figure 4.8).

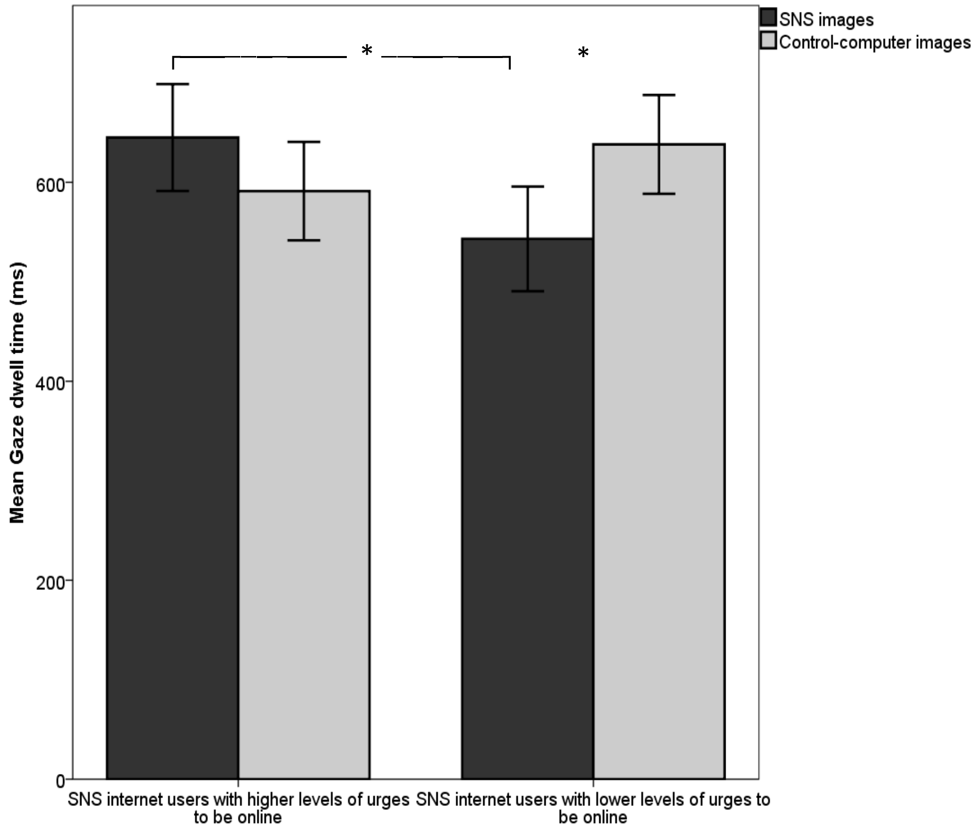

Figure 4.8 Mean gaze dwell time (in milliseconds) on SNS and control-computer images, shown separately for SNS internet users with higher and lower levels of urges to be online. Error bars represent standard error of the means.

Furthermore, the problematic SNS internet users with higher levels of urges to be online fixated significantly more on SNS images compared to the problematic SNS internet users with lower levels of urges to be online, *t*(14) = 2.60, *p* = .021, *d* = 1.39, 95% CI [38.515, 400.42].

Direction of initial fixation

Overall results revealed no direction bias for SNS internet users with higher levels of urges to be online, 48.5% (*SD* = 17.5*),* *t*(42) = 0.58=, *p* = .57, whereas for SNS internet users with lower levels of urges to be online 40.18% (*SD* = 17.5*),* direction bias was significantly smaller than 50%, *t*(41) = -3.64, *p* < .001; *d* = 1.36, 95% CI [-15.26, -4.36].

Attentional bias as assessed with manual reaction times to probes

The main effects of probe condition, *F*(1, 77) = 3.62, *p* = .06, SNS group, *F*(3, 77) = 0.90, *p* = .44, levels of urges to be online group, *F*(1, 77) = 0.59, *p* = .45 and the interactions between probe condition and SNS group, *F*(3, 77) = 2.4, *p* = .08, probe condition and levels of urges to be online group, *F*(1, 77) = 3.5, *p* = .06, SNS group and levels of urges to be online group, *F*(3, 77) = 1.1, *p* = .36, and probe condition, SNS group and levels of urges to be online group, *F*(3, 77) = 1.8, *p* = .16 were not significant.

4.4.10 Supplementary analysis for non-computer condition for SNS users split by levels of urges to be online and SNS groups *(For all raw data see Table 4.6).*

Dot-probe task performance

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

Fixation Duration

There was a significant main effect of image type, *F(*1, 77) = 12.17, *p* = .001, $\eta p^2 = 0.136$ and interaction between image type and levels of urges to be online, *F(*1, 77) = 11.24, *p* = .001, $\eta p^2 = 0.13$. However, the main effects of SNS group, *F*(3, 77) = 0.91, *p* = .44, levels of urges to be online group, *F*(1, 77) = 1.62, *p* = .21 and the interactions between image type and SNS group, *F*(3, 77) = 1.02, *p* = .39, SNS group and levels of urges to be online group, *F*(3, 77) = 0.75, *p* = .53, and image type, SNS group and levels of urges to be online group, *F*(3, 77) = 1.5, *p* = .23 were not significant.

In order to investigate further the significant interaction a 2 x 2 mixed ANOVA was performed with image type (SNS versus control-non computer) as a within factor and levels of urges to be online (SNS internet users with higher levels of urges to be online, SNS internet users with lower levels of urges to be online) as the between factor. There was a significant main effect of image type, $F(1, 83) = 9.14$, $p = .003$, $\eta p^2 = 0.10$, and interaction between image type with levels of urges to be online, $F(1, 83) = 14.92$, $p = .001$, $\eta p^2 = 0.15$. However, the main effect of levels of urges to be online group was not significant, $F(1, 83) = 0.98$, $p = .32$. The group of SNS internet users with higher levels of urges to be online spent more time fixating on the SNS images compared to control non-computer images, $t(42) = 4.28$, $p = .001$, $d = 1.34$, 95% CI [60.90, 169.33] and they fixated on SNS images significantly more compared to the group of SNS internet users with lower levels of urges to be online, $t(83) = 2.83$, $p = .006$, $d = 0.62$, 95% CI [26.99, 154.34], (Figure 4.9).

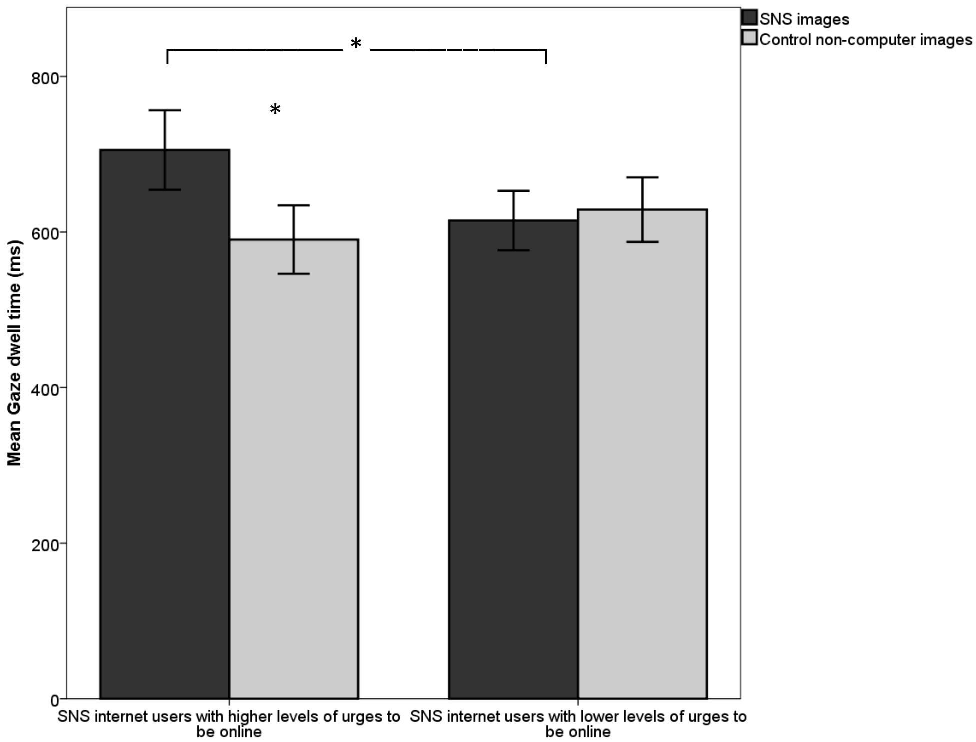

Figure 4.9 Mean gaze dwell time (in milliseconds) on SNS and control non-computer images, shown separately for SNS internet users with higher and lower levels of urges to be

online. Error bars represent standard error of the means.

Furthermore, the problematic SNS internet users with higher levels of urges to be online fixated significantly longer on the SNS images compared to the problematic SNS internet users with lower levels of urges to be online, $t(14) = 2.91$, $p = .01$, $d = 1.55$, 95% CI [54.61, 360.62] and compared to control non-computer images, $t(9) = 3.28$, $p = .009$, $d = 2.1$, 95% CI [67.19, 364.81].

Direction of initial fixation

Overall results revealed no directional bias for SNS internet users with higher levels of urges to be online, 49.34% ($SD = 14.1$), $t(42) = -.31$=, $p = .76$, and for SNS internet users with lower levels of urges to be online 46.62% ($SD = 14.47$), $t(41) = -0.13$, $p = .89$.

Attentional bias as assessed with manual reaction times to probes

There were significant interactions between the probe condition and levels of urges to be online, $F(1, 77) = 4.03$, $p = .048$, $\eta_p^2 = 0.05$. However, the main effects of probe condition, $F(3, 77) = 0.004$, $p = .95$, SNS group, $F(3, 77) = 1.1$, $p = .34$, levels of urges to be online group, $F(1, 77) = 0.32$, $p = .58$ and the interactions between probe condition and SNS group, $F(3, 77) = 0.79$, $p = .50$, SNS group and levels of urges to be online group, $F(3, 77) = 0.82$, $p = .48$, and probe condition, SNS group and levels of urges to be online group, $F(3, 77) = 0.47$, $p = .71$ were not significant.

In order to investigate further the significant interaction a 2 x 2 mixed ANOVA was performed with probe condition (probe in the same congruent versus different incongruent location with SNS images) as a within factor and levels of urges to be online (SNS internet users with higher levels of urges to be online, SNS internet users with lower levels of urges to be online) as the between factor. The main effects of probe condition, $F(3, 83) = 0.13$, $p = .71$, levels of urges to be online group, $F(1, 83) = 0.06$, $p = .81$ and the interactions between probe condition and levels of urges to be online group, $F(1, 83) = 3.1$, $p = .08$ were not significant.

Table 4.6 Mean and standard deviations for RTs, direction of initial fixations and dwell gaze time for all trials, trials where controls were computer and non-computer for problematic, high engagers, moderate and non-problematic SNS internet users with higher and lower levels of urges to be online and separately for all SNS internet users with higher and lower levels of urges to be online.

	Problematic SNS internet users		High engagers SNS internet users		Moderate SNS internet users		Non-problematic SNS internet users		SNS internet users with high urges to be online	SNS internet users with low urges to be online
Levels of urges to be online	High	Low	High	Low	High	Low	High	Low		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
RT congruent all trials	429.10 (64.92)	410.54 (36.59)	475.66 (91.89)	449.53 (59.70)	439.15 (60.37)	425.08 (46.33)	432.74 (79.73)	482.58 (61.22)	451.35 (78.45)	453.09 (60.52)
RT incongruent all trials	446.18 (76.25)	404.67 (40.81)	474.38 (94.12)	437.35 (55.61)	451.11 (70.13)	433.10 (49.30)	450.30 (83.37)	475.82 (69.20)	459.61 (81.92)	449.07 (63.22)
RT congruent computer trials	432.85 (68.93)	410.85 (30.56)	477.69 (93.77)	464.95 (64.41)	456.25 (68.22)	417.90 (45.65)	424.97 (66.13)	486.37 (65.15	456.15 (80.22)	455.71 (64.30)
RT incongruent computer trials	461.82 (81.05)	417.40 (55.79)	481.69 (90.94)	434.73 (46.67)	465.10 (81.22)	445.28 (59.89)	462.54 (87.82)	483.11 (71.73)	470.99 (83.60)	456.65 (66.39)
RT congruent non-computer trials	429.73 (66.88)	413.19 (47.90)	477.51 (94.77)	445.01 (61.99)	434.99 (60.44)	429.27 (47.67)	437.82 (86.83)	482.52 (60.40)	451.90 (81.14)	453.69 (61.04)
RT incongruent non-computer trials	442.04 (72.63)	402.28 (41.15)	471.21 (95.88)	437.07 (57.25)	447.89 (70.15)	429.99 (48.45)	447.33 (83.72)	473.92 (70.90)	456.23 (82.12)	447.09 (64.22)
Direction of initial fixation all trials	48.59 (19.44)	52.44 (2.35)	47.41 (14.33)	47.44 (11.36)	52.78 (5.81)	48.56 (5.25)	47.75 (12.29)	39.12 (16.58)	48.97 (13.80)	44.66 (13.20)
Direction of initial fixation computer trials	45.05 (23.88)	51.56 (12.59)	47.87 (16.96)	34.89 (7.46)	51.03(14. 30)	47.61 (15.59)	52.23 (13.47)	34.62 (19.86)	48.46 (17.49)	40.18 (17.48)
Direction of initial fixation non-computer trials	49.69 (18.83)	52.30 (5.87)	47.44 (14.46)	52.92 (17.15)	53.53 (4.91)	50.10 (4.07)	47.09 (16.48)	40.66 (17.04)	49.34 (14.07)	46.61 (14.46)
Dwell gaze time SNS internet all trials	729.40 (127.94)	525.33 (127.45	647.89 (189.65)	626.43 (133.64)	730.50 (145.97)	619.40 (115.29)	657.40 (120.55)	600.58 (119.29)	687.16 (160.17)	598.62 (121.59)
Dwell gaze control all trials	544.90 (112.56)	548.83 (121.47)	617.28 (192.22)	602.57 (54.99)	625.50 (45.44)	650.80 (60.97)	573.20 (92.31)	660.42 (159.97)	597.23 (141.45)	632.55 (126.15)
Dwell gaze time SNS internet computer trials	655.30 (170.31)	435.83 (150.09)	608.61 (203.46)	518.71 (153.49)	720.00 (146.55)	611.10 (175.61)	605.40 (118.58)	550.26 (173.13)	645.00 (176.15)	543.14 (170.47)
Dwell gaze time control computer trials	571.60 (87.09)	599.67 (221.62)	592.61 (230.84)	631.43 (120.76)	625.10 (73.94)	662.80 (125.94)	557.40 (123.53)	639.74 (177.96)	591.19 (162.23)	638.12 (160.88)
Dwell gaze time SNS internet non-computer trials	750.70 (136.15)	543.08 (141.66)	672.19 (195.74)	658.57 (135.47)	735.20 (150.96)	622.55 (114.85)	674.70 (161.01)	617.08 (118.36)	705.40 (167.68)	614.73 (123.60)
Dwell gaze time control non-computer trials	534.70 (132.92)	527.00 (114.63)	606.89 (190.27)	593.14 (50.37)	625.35 (54.90)	646.90 (83.47)	571.50 (78.73)	664.50 (166.71)	590.28 (144.44)	628.77 (134.57)

Further analysis was conducted in order to investigate whether or not individuals with problematic internet use for generic online activities would show an attentional bias for SNS stimuli. The number of individuals who reported problematic SNS internet use in the initial screening was assessed to elicit whether or not they also reported problematic internet use for generic online applications. From the sixteen problematic SNS internet users twelve also reported problematic internet use for generic online applications with the remaining four reporting only SNS problematic internet use (Table 4.7). Moreover, in the sample, there were eight individuals with problematic internet use for generic online applications but not SNS problematic internet use (Table 4.7). Participants were divided in three groups; 1) individuals who disclosed both general and SNS problematic internet use, 2) individuals with general problematic internet use and 3) individuals with SNS problematic internet use.

Table 4.7-Total number of participants in each group of internet users.

Internet use group	General and SNS problematic internet users	SNS problematic internet users	General problematic internet users
Total Number	12	4	8

4.4.11 Dot-probe task performance split by groups of SNS and/or generic problematic internet users *(For all raw data see Table 4.8).*

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

Fixation Duration

A 2 x 3 mixed ANOVA was performed with image type (SNS versus control) as a within factor and group (general problematic internet users, SNS problematic internet users and, general and SNS problematic internet users) as the between factor. Overall, the results revealed no significant main effects of image type, $F(1, 21) = 1.96$, $p = .18$, group effect, $F(2, 21) = 0.65$, $p = .53$, or interaction between image type and group, $F(1, 21) = 1.24$, $p = .31$. However, post-hoc tests revealed that only general and SNS problematic internet users spent more time fixating on the SNS images compared to the control ones, $t(11) = 2.49$, $p = .03$, $d = 1.5$, 95% CI [16.77, -270.89], (Figure 4.10).

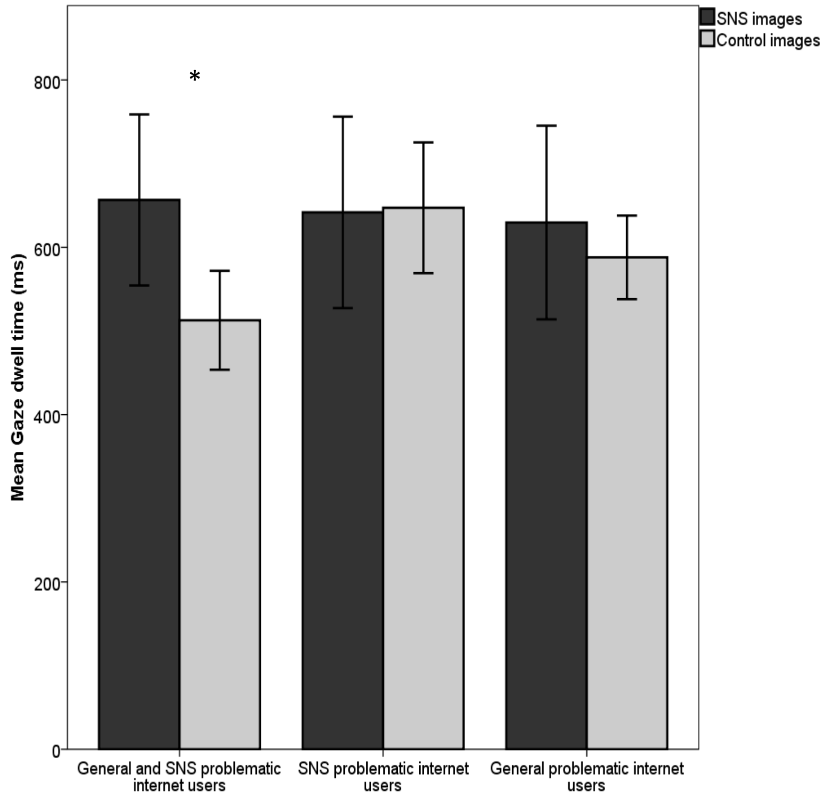

Figure 4.10 Mean gaze dwell time (in milliseconds) on SNS and control images, shown separately for general problematic internet users, SNS problematic internet users and, general and SNS problematic internet users. Error bars represent standard error of the means.

<u>Direction of initial fixation</u>

General and SNS problematic internet users made their first fixation on SNS-related images in 50.14% of the trials (*SD* = 17.6), SNS problematic internet users 49.73% of the trials (*SD* = 5.121), and general problematic internet users 53.58% of the trials (*SD* = 6.85), which was not significantly different than 50% which indicated no bias, $t(11) = 0.028$, $p = .98$; $t(3) = -.11$, $p = .92$, $t(7) = 1.5$, $p = .18$, respectively. Overall results revealed direction of initial fixation bias for SNS images.

Attentional bias as assessed with manual reaction times to probes

Overall, the results revealed no significant main effects of probe condition, $F(1, 21) = 0.001$, $p = .99$, group effect, $F(2, 21) = 2.6$, $p = .09$, or interaction between probe condition and group, $F(2, 21) = 1.42$, $p = .27$.

4.4.12 Pleasantness rating task: stimulus valence measures

The mean pleasantness ratings for the SNS related and control images were calculated. A 2 x 3 mixed ANOVA was performed with images type (SNS versus control) as a within factor and group (general problematic internet users, SNS problematic internet users and, general and SNS problematic internet users) as the between factor. Overall, the results revealed no significant main effects of image type, $F(1, 21) = 1.5$, $p = .23$, group effect, $F(2, 21) = 0.18$, $p = .84$, or interaction between image type and group, $F(2, 21) = 0.05$, $p = .95$.

4.4.13 Supplementary analysis for computer condition split by groups of SNS and/or generic problematic internet users *(For all raw data see Table 4.8).*

Dot-probe task performance

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

Fixation Duration

Overall, the results revealed no significant main effects of image type, $F(1, 21) = 015$, $p = .67$, group effect, $F(2, 21) = 1.17$, $p = .33$, or interaction between image type and group, $F(2, 21) = 0.04$, $p = .96$.

Direction of initial fixation

General and SNS problematic internet users made their first fixation on SNS-related images in 47.55% of the trials ($SD = 22.12$), SNS problematic internet users 47.32% of the trials ($SD = 15.25$), and general problematic internet users 49.20% of the trials ($SD = 15.18$), which was not significantly different than 50% which indicated no bias, $t(11) = -0.38$, $p =$

.71; $t(3) = -0.35$, $p = .75$, $t(7) = -0.15$, $p = .89$, respectively. Overall results revealed direction of initial fixation bias for SNS images.

Attentional bias as assessed with manual reaction times to probes

Overall, the results revealed no significant main effects of probe condition, $F(1, 21) = 0.53$, $p = .47$, group effect, $F(2, 21) = 2.27$, $p = .13$, or interaction between probe condition and group, $F(2, 21) = 0.88$, $p = .43$.

4.4.14 Supplementary analysis for non-computer condition split by groups of SNS and/or generic problematic internet users *(For all raw data see Table 4.9).*

Dot-probe task performance

Attentional bias as assessed with eye movement data (fixation duration-direction of initial fixation)

Fixation Duration

Overall results revealed that the main effect of image type approached significance, $F(1, 21) = 3.32$, $p = .082$, $\eta p^2 = 0.14$. However, the main effect of group, $F(1, 21) = 0.46$, $p = .64$, and interaction between image type and group, $F(2, 21) = 1.78$, $p = .19$ were not significant. Post-hoc tests showed that the general and the SNS images problematic internet users spent more time fixating on SNS compared to control images, $t(11) = 3.15$, $p = .009$; $d = 1.9$, 95% CI [56.76, 319.82], (Figure 4.11).

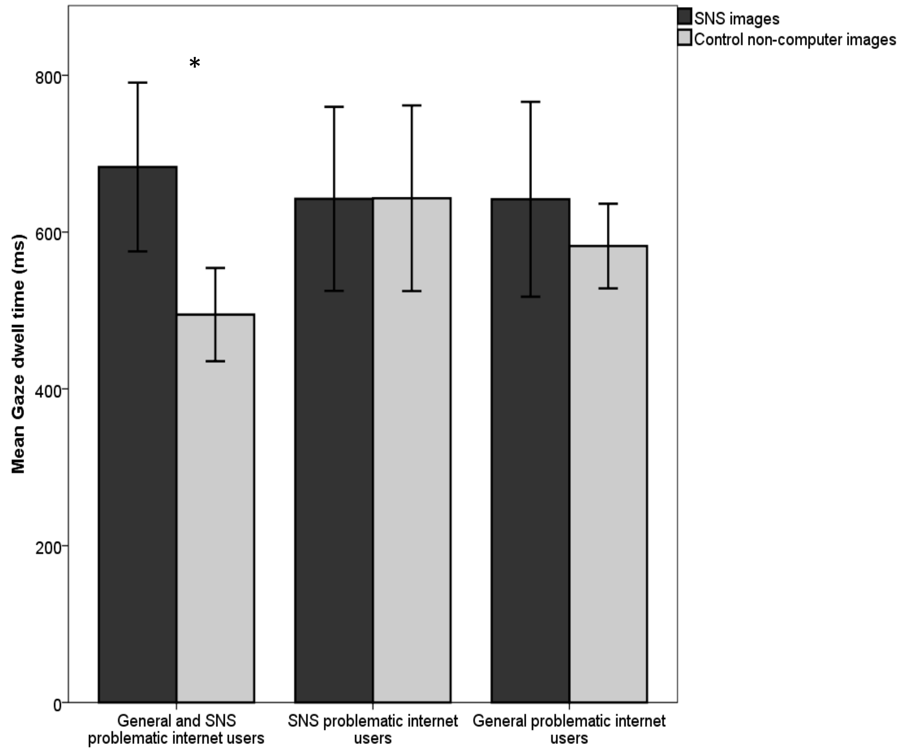

Figure 4.11 Mean gaze dwell time (in milliseconds) on SNS and control non-computer images, shown separately for general problematic internet users, SNS problematic internet users and, general and SNS problematic internet users. Error bars represent standard error of the means.

<u>*Direction of initial fixation*</u>

General and SNS problematic internet users made their first fixation on SNS-related images in 50.81% of the trials (*SD* = 17.35), SNS problematic internet users 50.25% of the trials (*SD* = 5.02), and general problematic internet users 57.01% of the trials (*SD* = 11.52), which was not significantly different than 50% which indicated no bias, $t(11) = 0.16$, $p = .87$; $t(3) = 0.10$, $p = .93$, $t(7) = 1.7$, $p = .13$, respectively. Overall results revealed direction of initial fixation bias for SNS images.

<u>*Attentional bias as assessed with manual reaction times to probes*</u>

Overall, the results revealed no significant main effects of probe condition, $F(1, 21) = 0.38$, $p = .54$, group effect, $F(2, 21) = 2.5$, $p = .10$, or interaction between probe condition and group, $F(2, 21) = 1.12$, $p = .35$.

Table 4.8-Mean and standard deviations for RTs, direction of initial fixations, dwell gaze time and pleasantness ratings for all trials, trials where controls were computer and non-computer for general and SNS problematic internet users, SNS problematic internet users and general problematic internet users.

Internet use group	Problematic SNS and general internet users	SNS problematic internet users	Problematic general internet users
Behavioural Performance	Mean (SD)	Mean (SD)	Mean (SD)
RT congruent all trials	427.24 (61.13)	406.86 (34.52)	484.41 (67.38)
RT incongruent all trials	441.94 (72.10)	396.65 (35.56)	480.13 (66.92)
RT congruent computer trials	429.72 (64.76)	409.25 (24.80)	484.47 (63.07)
RT incongruent computer trials	458.26 (77.03)	405.85 (53.49)	485.76 (77.04)
RT congruent non-computer trials	428.69 (64.21)	408.05 (45.18)	486.44 (72.66)
RT incongruent non-computer trials	437.71 (69.72)	395.40 (31.81)	476.39 (65.10)
Direction of initial fixation all trials	50.14 (17.60)	49.72 (5.12)	53.58 (6.85)
Direction of initial fixation computer trials	47.55 (22.12)	47.32 (15.25)	49.20 (15.18)
Direction of initial fixation non-computer trials	50.80 (17.35)	50.25 (5.02)	57.01 (11.52)
Dwell gaze time SNS internet all trials	656.58 (177.05)	641.75 (114.38)	629.63 (163.65)
Dwell gaze control all trials	512.75 (102.37)	647.25 (78.13)	588.00 (70.63)
Dwell gaze time SNS internet computer trials	552.50 (213.44)	634.50 (104.85)	573.63 (149.90)
Dwell gaze time control computer trials	556.83 (158.75)	658.00 (54.36)	608.50 (104.28)
Dwell gaze time SNS internet non-computer trials	683.00 (186.48)	642.38 (117.36)	641.81 (175.79)
Dwell gaze time control non-computer trials	494.71 (103.03)	643.13 (118.42)	582.19 (76.36)
Pleasantness rating of SNS internet images all trials	3.80 (.49)	3.78 (.53)	3.68 (.62)
Pleasantness rating of control images all trials	3.759 (.48)	3.71 (.36)	3.59 (.63)

4.5 Discussion

This study revealed that individuals with problematic SNS internet use did show an attentional bias for SNS related images compared to control images. These findings provided further support for the hypothesis that problematic internet use consists of different subtypes (Davis, 2001; Young, 1998b). Moreover, they suggest that although there seem to be similarities in the cognitive processes (attentional bias) between generalized and specific (SNS) problematic internet use, these are related to their preferred online activities/activity. Similarly, research conducted regarding online gaming, which has been suggested as forming another subtype of problematic internet use, has demonstrated that individuals with problematic online gaming showed a bias for online related gaming stimuli such as words and images (Lorenz et al., 2013; Metcalf & Pammer, 2011; van Holst et al., 2012). However, neither of the aforementioned studies assessed whether problematic online gamers showed an attentional bias for generic internet-related stimuli which is not specific to their preferred activity, and as such, it is debatable as to whether this bias is activity specific. With respect to this, the evidence from Chapter three (Study two, where no bias for generic internet stimuli was found) and this study (bias for SNS stimuli) provided a better understanding of the cognitive processes related to a certain subtype of problematic internet as namely SNS, which has important implications that are discussed in the following paragraphs.

With respect to attentional bias was only evident for the gaze dwell duration measure, whereas the RTs did not reveal such a bias. However, when the differences between the SNS internet users in terms of levels of urges to be online were analysed, both the gaze dwell duration and the RTs indicated a bias for SNS related images in the SNS internet users with higher levels of urges to be online. It has been suggested that assessing attentional bias with eye movements has an effect size twice as big as compared to that of RTs (Miller & Fillmore, 2010). Considering that the effect size of gaze dwell duration was smaller in problematic SNS internet users compared to SNS internet users with higher levels of urges to be online there was an absence of RTs difference in problematic SNS internet users. Although a counter argument might suggest that the gaze dwell duration measure of attentional bias can provide false positive indications of bias, there is more evidence which indicates that it is more robust compared to RTs. For example, it has been found that gaze dwell duration was a sensitive measure for assessing the relationship between the magnitude of attentional bias and participants' drinking habits (units of consumption, days drinking and being drunk), as well as for the measuring of subjective craving for a drug, whereas the RTs either did not account for or they were less sensitive with respect to capturing such a relationship (Field et al., 2009; Miller & Fillmor, 2010). This was also evident in this present study where gaze dwell duration was found to associate with the severity of problematic SNS internet use as well as with urges to be online. Moreover, even though RTs were associated with urges to be online their effect size was smaller compared to the effect size of the gaze dwell duration measures. Once again these data highlight the advantage of using eye movement recordings measures for assessing attentional bias.

Problematic SNS internet users did not show a direction of initial fixation bias for SNS related images, which is in opposition to the outcomes of research in the field of addiction which suggests that this measure of bias is associated with trait characteristics such as dependency status (Field et al., 2004b). However, in this present study, it was revealed that state characteristics such as urges to be online mediated the relationship between the severity of problematic SNS internet use and attentional bias. As state characteristics are best captured with measures of the maintenance of attentional bias, which is indicated with dwell gaze duration (Field et al., 2004b; Mogg et al., 2005), this may account for why there was no evidence of direction of initial fixation bias in the problematic SNS internet users. On the contrary, the group of non-problematic SNS internet users showed a preference for the control images as they made their first fixation on these significantly more frequently than on the SNS related images. Thus, it can be argued that problematic SNS internet use was associated with maintenance of attention as was evident with dwell gaze duration bias for SNS-related images. On the contrary, non-problematic SNS internet use was associated with initiation of attention as it was suggestive of avoidance bias in the direction of initial fixation for SNS-related images (LaBerge, 1995).

Similar to Chapter three (Study two), levels of urges to be online did have an effect regarding attentional processes. More specifically, they mediated the relationship between the severity of problematic SNS internet use and attentional bias. It was found that not only the SNS internet users with higher levels of urges to be online showed a bias for SNS stimuli compared to SNS internet users with lower levels of urges to be online, but this was also evident for problematic SNS internet users with higher levels of urges to be online compared to problematic SNS internet users with lower levels of urges to be online. In addition, an unexpected finding was that non-problematic SNS internet users with higher levels of urges to be online showed a bias for SNS stimuli. This is in opposition to the theories of addiction which suggest craving levels have an effect in attentional processes, prominently in addicted individuals (Field et al., 2009; Franken, 2003; Robinson & Berridge, 1993; 2001). However, there were some limitations which could account for these findings. For example, in the present study there was a small number of non-problematic SNS internet users with higher levels of urges to be online (n = 4), and owing to this, the evidence can only be suggestive of such tendencies. Moreover, there were no differences in attentional processes between the non-problematic SNS internet users with higher and lower levels of urges to be online as was evident in the other SNS internet use groups. Thus, this evidence warrants further research taking into account the aforementioned limitations, in order for firmer conclusions to be made with respect to attentional processes in SNS internet use groups with different levels of urges to be online.

Similar to Chapter three (Study two), the data from the supplementary analyses was integrated in order to investigate the effect that each type of control image had on attentional processes, which can be very informative in terms of the overall behavioural outcome in the task. Overall, no bias was found for the group of problematic SNS internet users in the computer condition. These findings validate the assumption that control-computer images are capturing attention in a similar way to that hypothesized for SNS related images because computers are deployed as the common medium to be online, and as such, they are associated with online activities. In contrast, in the non-computer condition, analysis revealed an overall preference for SNS related images as was shown by problematic SNS internet users, problematic SNS internet users with higher levels of urges to be online and SNS internet users with higher levels of urges to be online. Therefore, it could be argued that control non-computer and symbol images are the best candidates for use in future research probing attentional bias in SNS internet use which is both trait (problematic SNS internet use groups) and state (levels of urges to be online) specific.

Overall, these findings have important implications as they support the claim of the existence of generalized and specific subtypes of problematic internet use (Davis, 2001; Young, 1999). Moreover, the assessment of a subtype of problematic internet use which can only be pursued online (SNS), has provided further validation of the construct of problematic internet use. Previous research with online gaming has questioned the validity of the construct of problematic internet use, as it was argued that the internet can be the platform to execute an already existing problematic behaviour. Thus, the present study provided evidence to counter this assumption. It has also highlighted the importance for future research of identifying certain subtypes of problematic internet use in order to tackle subtype specific characteristics.

The findings from the present study are in accordance with theories pertaining to substance-related and addictive disorders which have been introduced to provide a better understanding of their development and maintenance. More specifically, according to incentive-sensitization models of addiction (Franken, 2003; Robinson & Berridge, 1993, 2001) it has been posited that incentive salience processes (e.g. attentional bias) were associated with the severity of problematic behaviour (SNS) and levels of urges to be online. However, contrary to the assumptions of the theory, problematic SNS internet users did not perceive SNS images as being more pleasant ("attractive"). In this study, participants were explicitly asked to rate the attractiveness of SNS and control images and this might have given rise to social desirability effects, especially for those who reported problematic SNS internet behaviour. Thus, future research should assess the implicit attitudes surrounding these stimuli. This can provide a better indication of how the perceived attractiveness of the stimuli can have an effect on overt behaviour as carried out in research from the field of addiction assessed with the Implicit Association Task and the Stimulus Response Compatibility Task (Field et al., 2005). However, the findings from this study can also be viewed according to Tiffany's (1990) habit theory of drug addiction which does not make predictions for evaluative bias (perceived attractiveness of SNS stimuli). Tiffany's theory suggests that drug addiction is driven by habit. However, when drug seeking behaviour is obscured then there is an increase in craving levels which is associated with an attentional bias for drug related stimuli. The findings from the present study accord with the assumptions of this theory but the levels of urges to be online were not manipulated experimentally and thus we cannot make inference regarding which theory best can account for our data. Similar to the suggestions offered in Chapter three (Study two), future research should assess attentional processes in SNS problematic internet users before and after experimentally controlling for SNS internet use by asking participants to minimize their SNS internet use for few days prior to the assessment which arguably would be associated with increased levels of urges to be online. Although both theories predict alterations in attentional processes after experimentally controlling for urges to be online, Tiffany's theory when compared to the incentive-sensitization theory, predicts that these differences will be more robust. This type of research would enrich our knowledge on the mechanisms related to problematic SNS internet use. Nonetheless, the findings from this study have provided further support of the commonalities between substance-related and addictive disorders with (subtypes of) problematic internet use.

Another objective was to validate whether there were qualitative differences between SNS internet users with an emphasis given to certain psychopathological and personality constructs. It was revealed that problematic SNS internet users had higher levels of psychopathology compared to the non-problematic SNS internet users. This is keeping with established literature which has found higher levels of psychopathology are associated with problematic internet use, but without clarifying whether this reflects preferences for generic or specific online applications (Cheung & Wong, 2011; Dong, Zhou et al., 2011; Fu et al., 2010; Jang et al., 2008; Kelleci & Inal, 2010; Kormas et al., 2011). However, the findings from this present study offer validation to this being evident for a potential specific subtype of problematic internet use, SNS. Thus, it can be argued that the differences between problematic and non-problematic SNS internet users were evident not only on a behavioural but on a psychopathological level as well, which validates the distinction of the two groups based on Charlton and Danforth's (2007, 2010) model. Moreover, assessment of the relationship between the problematic SNS internet users and high engagers revealed that although on a behavioural level there were qualitative differences, with only the problematic SNS internet users showing a bias for SNS related images, on a psychopathological level no differences between the groups were evident. Similar to the argument made in Chapter three (Study two) this suggests that high engagers might represent individuals that are either at risk of or resilient to developing problematic SNS internet use. These assumptions need to be explored further with a longitudinal study in order to better understand the relationship of these two types of behaviour. This type of research will also help in identifying the factors which make high engagers resilient or vulnerable regarding problematic SNS internet use. Finally, similar to the findings from Chapter three (Study two) no differences were found in personality traits related to impulsivity between the groups of SNS internet users. However, considering that only a self-report assessment of impulsivity was obtained, it is necessary to conduct further research with an emphasis on behavioural assessments of impulsivity in order for provide a better understanding of the relationship between impulsivity and problematic SNS internet use.

The final objective of this study was to identify whether the expected bias for SNS images would also be evident not only for individuals with problematic SNS internet use but also for individuals with generalized problematic internet behaviour. Overall, individuals with problematic behaviour for generic internet activities did not show any preference for SNS images. In Chapter three (Study two) this group of internet users was found to prefer to attenuate images with generic internet activities. As suggested by Davis (2001), generalized problematic internet use reflects an occupation with more global internet activities and as such, this might be another subtype of problematic internet behaviour. Thus, failure to show a bias in this study might reflect preference of this internet use group for generic internet activities and not only specific SNS online applications. This supports the assumption that cognitive bias might only be evident when it relates to the specific activity/activities concerning which the individuals display problematic behaviour, as reliably shown in a similar way for online gaming and gambling (Lorenz et al., 2013; Metcalf & Pammer, 2011; McCusker & Getting, 1997; van Holst et al., 2012).

When the proportion of individuals who reported problematic internet use for generic and specific online applications was assessed, a high number of internet users who reported both general and SNS problematic internet use was found. More interestingly, this group did show a bias for SNS images, whereas the group of problematic SNS users did not show any such a bias. This could be a reflection of the small number of individuals who reported only problematic SNS internet use (n = 4). However, as was argued in the previous study, when assessing problematic internet use for generic and specific applications (SNS), individuals might have referred to their SNS activities as generic internet use and this could explain why in our sample the majority of problematic SNS internet users also reported problematic generic internet use. To the best of our knowledge studies conducted in the field have either assessed problematic internet use for generic or for specific applications (online gaming, SNS) but none have assessed both (generic and specific) together. Thus, the evidence from my previous and this present study highlights the importance of placing an emphasis on the specific online applications (generic versus specific) to which the investigation relates in order to control for misinterpretation. This is the reason why an emphasis in this study was also focused on the assessment of problematic internet use for generic online activities. In future, researchers need to be explicit about which online activities they are referring to for this will result in a better understanding of the characteristics of each type of problematic internet use and as a consequence, assist in the development of efficacious interventions.

Overall, this study has shown that attentional bias is associated with a specific online activity and that individuals display problematic behaviour in a similar way to that reliably shown for online gaming (Lorenz et al., 2013; Metcalf & Pammer, 2011; van Holst et al., 2012). The evidence is suggestive not only of the underlying mechanisms related to problematic SNS internet use but also it has important clinical implications. As with the argument in Chapter three (Study two) and similarly drawing on evidence from research in the field of addictions which has shown that interventions which aim to alter attentional bias processes in substance users and abusers can have an effect in substance behaviour (Fedardi & Cox, 2009; Field & Eastwood, 2005; Schoenmakers et al., 2010; Wiers & Stacy, 2006), future research should investigate whether such interventions could be applied for problematic SNS internet users. For example, problematic SNS internet users could be trained to avoid SNS stimuli so as to assess whether this will reduce attentional bias to these stimuli as well as their overall amount of SNS internet use.

In conclusion, the results from the present study revealed that problematic SNS internet users showed an attentional bias for SNS related images, which is in accordance with theories from the field of addiction and as such supports the suggestion that there are similarities between them in the mechanisms related to their development and maintenance. Moreover, it supports the argument that the construct of problematic internet use is real and consists of different subtypes, which even though they have similar generic cognitive processes are activity specific.

Chapter Five

Study 4: Inhibitory control in generic and SNS problematic internet users

5.1 Abstract

Rationale: Recent theories of addiction suggest that it is not only the power that substances and substance-related stimuli have in "highjacking" behaviour and eliciting automatic responses but also deficits in inhibitory control which fail to take control over these automatic responses that are associated with cycles of substance seeking and taking behaviour. Evidence from Chapters three and four suggested that stimuli related to those online activities that problematic internet users show a preference for had the power to influence behaviour, as revealed with an attentional bias. There is a lack of studies assessing whether this also reflects an inability to inhibit these processes and gain control over such automatic responses.

Objective: To assess generic and SNS problematic internet users and to investigate whether or not deficits in inhibitory control were particularly evident in the presence of stimuli related to the online activities for which problematic internet users showed a preference.

Methods: One hundred and one participants performed the Internet Shifting and SNS Shifting tasks. These tasks assess the power that emotional stimuli has upon inhibitory control.

Results: Overall generic and SNS problematic internet users did not show any difference in their inhibitory control as assessed with disinhibition and discrimination rates for both

generic and SNS related stimuli when compared to the other groups of internet users.

Conclusions: It is suggested that the inhibition impairment which is a marker of substance-related and addictive disorders is not evident for problematic internet use. However, further research is warranted in order to draw firmer conclusions with respect to associate with inhibitory control processes.

5.2 Introduction

Chapters three and four revealed that online stimuli had the power to influence behaviour. This was evidenced with an attentional bias for stimuli related to the online activities for which problematic internet users showed a preference. Researchers from the field of substance-related and addictive disorders have argued that this bias is either causing or indexing the underlying mechanisms related to substance seeking behaviour (Robbins & Ehrman, 2004). However, recent theories of addiction suggest that it is not only the power that substances and substance-related stimuli have in “highjacking” behaviour and eliciting automatic responses but also deficits in inhibitory control which fail to take control over these automatic responses, that are associated with cycles of substance seeking and taking behaviour. Thus, the focus of this study was to assess cognitive processes related to inhibitory control in individuals with elevated levels of problematic internet use, as impaired inhibitory control has been implicated as a vulnerability factor for both the initiation as well as continuation of substance-related and addictive behaviours (Noel, Bechara, Brevers, Verbanck, & Campanella, 2010). Researching the area will enhance our understanding of the addictive potential as well as the underlying mechanisms related to problematic internet use. This will ultimately impact favourably upon our knowledge as to whether or not problematic internet use is another type of behavioural addiction (Griffiths et al., 2000; Hinic et al., 2010; Shapira et al., 2000; Treuer et al., 2001; Weistein & Lejoyeux, 2010; Young, 1996, 1999).

Prominent theories of addiction have conceptualized substance seeking behaviour as a consequence of incentive sensitization processes (Franken, 2003; Robinson & Berridge, 1993; 2001). According to these theories, addictive drugs can cause neuroadaptations in neural and brain systems that are normally involved in the process of incentive motivation and reward. These neuroadaptations cause these systems to become hypersensitive to substances and substance associated stimuli and it is the incentive salience motivation properties of substances to which addicted individuals become hypersensitive (Robinson & Berridge, 2001). Dopamine levels in the mesolimbic dopamine system mediate the incentive salience mechanism process (Robinson & Berridge, 1993). Through the processes of classical conditioning, stimuli related to substances of abuse are associated with the incentive motivation of substances and thus elicit conditioning responses (increased dopamine release). Whenever such stimuli are encountered, they elicit an automatic approach behaviour which results in increased craving and substance seeking behaviour (Robinson & Berridge, 1993; 2003). Initially, incentive sensitization theory was developed in order to account for the development and maintenance of stimulant drugs of abuse such as cocaine and amphetamine. However, research has shown that it is also applicable to behavioural addictions such as pathological gambling (Honsi et al., 2013) which do not involve the digestion of substances and thus it can also be applicable to problematic internet use.

One of the main criticism of the incentive sensitization view of addiction is that even though it has been widely validated (Field & Cox, 2008; Honsi et al., 2013), it has not accounted for processes related to deliberate cognitive control. For example, although substances and substance-related cues might elicit automatic approach behaviour, it is also the individual's ability to control and reflect upon such behaviour that can result in a more adaptive behaviour (to abstain or control substance use or abuse). Recent models of addiction have incorporated this view under dual process models (Wiers & Stacy 2006; Wiers et al., 2007), and suggest that the loss of willpower to control or abstain from substances of abuse (Noel et al., 2010) reflects an imbalance between two systems; the appetitive and the reflective. More specifically, the former is associated with automatic responses related to the motivational valence of substances and substance-related stimuli whereas the latter is associated with cognitive control and incorporates processes such as inhibitory control, monitoring, planning etc. (Bechara, 2005; Wiers & Stacy, 2006; Wiers et al., 2007). In addition, it also moderates the automatic system. According to the dual process theory, due to the incentive motivational valence which substances and substance-related stimuli elicit when substance dependent individuals encounter them, they engage in automatic approach behaviour. Moreover, because cognitive control processes are elevated in substance dependent individuals this has as the consequence of them being unable to control and inhibit these automatic responses and as such substance seeking behaviour is maintained.

The accumulating evidence from the field of substance-related and addictive disorders is supportive of the dual process theories, as it has been shown that substances as well as non-substances (gambling) related stimuli have the power to elicit automatic responses such as attentional bias or approach behaviours (see Field & Cox, 2008 for review; alcohol e.g. Boyer and Dickerson, 2003; Field et al., 2011, 2013; Ryan, 2002; Duka & Townshend, 2004; Weafer & Fillmore 2012, nicotine e.g. Bradley et al., 2003; Dickter & Forestell, 2012; Kang et al., 2012, opiate addiction e.g. Lubman, Peters, Mogg, Bradley, & Deaakin, 2000, cannabis use/dependence e.g. Cousijn et al., 2013; Field, Mogg, & Bradley, 2004a; pathological gambling e.g. Brevers, Cleeremans, & Bechara et al., 2011; Fleming & Bartholow 2014; Honsi et al., 2013; see van Holst et al., 2010 for review). Moreover, evidence is suggestive that addicted individuals are also impaired in processes related to cognitive control, especially in the presence of stimuli related to their chosen substance of abuse (Adams et al., 2012; Noel et al., 2005, 2007). Cognitive control relates to a set of deliberate behaviours and actions which aim to regulate emotions and feeling as well as the execution of certain behaviours (Noel et al., 2010). A hallmark of cognitive control is the ability to inhibit an automatic triggered behaviour which is initiated by the appetitive-impulsive system in order to regulate behaviour according to specific goals. Inability to implement such control has been characterized as a deficit in inhibitory control and this type of behaviour has been suggested as a marker of addictive behaviours (Noel et al., 2010), as demonstrated in studies capturing the behavioural aspects of inhibitory control (alcohol; Kreusch et al., 2013; Lopez-Caneda et al., 2014; pathological gambling; Fuentes et al., 2006; Goudriaan et al., 2005; Kertzman et al., 2008; nicotine; Billieux et al., 2010; polysubstance users; Verdejo-Garcia et al., 2010). Moreover, there is accumulating evidence which points to there being abnormalities both structurally and functionally in brain areas which have been implicated in inhibitory control in addicted individuals (Cavedini et al., 2001; Feil et al., 2010; Franken et al., 2007; Fu et al., 2010; Hester & Garavan, 2004; Jentsch & Pennington, 2014; Kamarajan et al., 2004; Li & Sinha, 2008; Li et al., 2010; Luijten et al., 2013; Nigg et al., 2006; Schulte et al., 2012). Thus, it could be argued that deficits in the regulatory systems can lead to the maintenance of the addiction cycle (Goldstein & Volkow, 2002) through a mechanism that weakens the willpower of addicted individuals to make decisions and adjust behaviour accordingly to meet long-term beneficial outcomes (Bechara, 2005; Field, Wiers, Christiansen, Fillmore, & Verster, 2010; Noel et al., 2010).

Inhibitory control is a behavioural component of impulsivity. The construct of impulsivity is multidimensional and is broadly characterized by a tendency to react fast without thinking and planning, as well as a tendency to make decisions based on immediate outcomes without considering future consequences (Moeller et al., 2001). As a multifaceted construct, it has been proposed that impulsivity can be captured with both self-report as well as with behavioural assessments in tasks geared towards assessing the ability to make appropriate responses after processing all information, the ability to update current responses in relation to current changes as well as the ability to withhold responses in the face of distracting information (Moeller et al., 2001). Moreover, it has been suggested that self-report and behavioural assessments of impulsivity not only capture different aspects of the construct, but are also not related to each other (Cheng et al., 2012; Lorains et al., 2014). In the field of problematic internet use there is growing evidence which suggests there is a strong link between impulsivity and problematic internet use as assessed with self-report questionnaires (Billieux & Van der Linden, 2012; Cao et al., 2007; Choi et al., 2014; Kim et al., 2008; Lee et al., 2012; Mottranet & Fleming, 2009; Park et al., 2013). Additionally, there is some evidence demonstrating generic deficits regarding inhibitory control in problematic internet users (Cao et al., 2007; Choi et al., 2014; Dong, Zhou, & Zhao, 2010, 2011). However, to the best of our knowledge, there is only one study which has assessed whether deficits in inhibitory control are particularly evident in the presence of online stimuli, and this has been conducted with respect to a specific subtype of problematic internet use; online gaming. Therefore, in this study the proposal is to investigate whether inhibitory control deficits are evident in other proposed subtypes of problematic internet use and assess whether these are particularly prominent in the presence of online stimuli related to the activities for which online users show a preference. Researching the area will further our understanding of the similarities and differences between the different subtypes of problematic internet use as well as the underlying mechanisms associated with processes which account for their initiation and maintenance.

A task that has been widely used in the field of addictions in order to assess inhibitory control is the Go/No-Go task, where participants are instructed to respond as quickly and as accurately as possible to a series of stimuli that are associated with a "go" response while at the same time withhold their responses to stimuli that have been denoted as a "no-go" response. Inability to withold responses to no-go stimuli, referred to as commission errors, and failure to respond to go stimuli, termed omission errors are assessing various aspects of inhibitory control (behavioural inhi bition, attention, behavioural execution). In the field of addictions there is substantial evidence of impaired inhibitory control in addicted individuals as assessed with the Go/No-Go task (Cheng et al., 2012; Constantinou et al., 2010; Fillmore & Rush, 2002; Fleming & Bartholow, 2014; Kozink et al., 2010; Pike et al., 2013; Verdejo-Garcia et al., 2012). Similar deficits in inhibitory control have been found in problematic internet users (Zhou et al., 2010).

The Go/No-Go task has also incorporated emotional stimuli in order to assess the effects of emotional processing in inhibitory control in various clinical and non-clinical populations and this accounts for why it is appropriate for application in this present study (emotional stimuli in non-clinical populations- Schulz et al., 2007; alcohol stimuli in light and heavy drinkers; addicted individuals- Adams et al., 2012 Noel et al., 2005, 2007; cocaine stimuli for addicted individuals- Fillmore and Rush, 2002; emotional stimuli for worry prone individuals- Gole, Köchel, Schäfer, & Schienle, 2012; emotional stimuli for bipolar individuals- Murphy et al., 1999; emotional stimuli for anxious children- Waters & Valvoi, 2009). Validation of the emotional Go/No-Go task captures inhibitory control comes from a study where it was found to function as the original and emotional versions of Go/No-Go task in a sample of college students (Schulz et al., 2007). Moreover, based on the dual process theories of addiction, which implicate both cognitive bias as well as impaired inhibitory control with the addiction cycle, Noel et al. (2005) developed a revised version of the original Go/No-Go task called the Alcohol-Shifting task in order to assess how these two mechanisms interact. They incorporated both neutral and emotional stimuli related to alcohol in order to assess general response inhibition and shifting of attention as well as the influence of the emotional (alcohol) stimuli upon these functions in a sample comprising detoxified polysubstance abusers suffering with alcoholism and normal controls. An important element of this revised Go/No-Go task was that there was a shift in instructions related to the Go/No-Go responses between blocks and thus the task required high executive processes not only regarding inhibitory control but also in relation to the ability to shift from one set of instructions to the other; termed mental flexibility (Noel et al., 2005). The idea was that because emotional stimuli are capturing attention and elicit strong approach behaviour due to their strong emotional valences this will have a direct effect on inhibitory and shifting control processes. This type of task has been used with various addictive behaviours (Adams et al., 2012; Brevers, Cleeremans, Verbruggen, et al., 2012; Fleming & Batholow, 2014; Kreusch et al., 2013; Noel et al., 2005, 2007; Pike et al., 2013; Rose & Duka, 2008; Weafer & Fillmore 2012). It has been argued that inhibition and shifting executive processes are substantial mechanisms that need to be preserved when an addict wants to stop their thoughts and actions related to the substance of abuse so as to be able to change to non-substance activity (Noel et al., 2005).

Using two versions of the emotional shifting task, Decker and Gay (2011) assessed inhibitory control in online gamers. More specifically, one version of the task was related to specific Multiplayer Online Role Playing Games (MMORPGs); World of Warcraft (WoW), and the other was related to common positive and negative English words. Overall, they found a bias for WoW words as revealed by quicker reaction times, higher discrimination and disinhibition rates for problematic online gamers. They concluded that problematic gamers showed an overall superior performance compared to non-gamers. These findings were in accordance with Sun et al.'s (2010) study which found problematic internet user showed a better performance in the original version of the Go/No-Go task. In Sun et al.'s (2010) work the online activity on which the problematic internet users spent most of their time was online gaming and it was argued that superior performance in the task was due to gaming training. It has been found that gaming can improve various cognitive processes (Aguilera & Mendiz, 2003; Boot et al., 2008; Green & Bavelier, 2006; Sun et al., 2010). However, building upon the assumptions from Chapters three and four, where it was argued that online gaming is an activity which can also be pursed offline and thus might not be representative of online behaviour (Griffiths, 1999, 2010; Stern, 1999), the focus of this study was to assess inhibitory control in a sample of problematic internet users for generic and specific (SNS) applications which are activities that can predominately be executed online. Following the assumptions underpinning dual process theory as well as the evidence from Chapters three and four where automatic processes (attentional bias) were revealed to be activity specific, this study assessed whether the same holds true for inhibitory control. Thus, two emotional versions of the Go/No-Go task were used; one version contained generic internet-related stimuli and the other SNS related stimuli in order to assess whether interference effects would be specific to the stimuli that online users showed a preference for.

Moreover, whether or not elevated levels of impulsivity, as assessed with self-report questionnaires, were associated with problematic internet use were investigated. This can enhance our understanding of the relation between problematic internet use with the different facets of impulsivity. In addition, building upon the findings from Chapters three and four where it was reported that levels of urges to be online were associated with attentional bias, in this study and in line with evidence from the field of addiction which has implicated increased craving levels in further diminishing inhibitory control (Kozink et al., 2010), it was assessed whether inhibitory control was more impaired in internet users with increased levels of urges to online than in their counterparts. A final objective of this study based on the assumptions in Chapters three and four regarding the classification of problematic internet use was to validate whether there were qualitative differences between problematic internet use and non-problematic internet use not only with respect to inhibitory control but also levels of psychopathology. This was undertaken in order to further validate further Charlton and Danforth's (2007, 2010) model of problematic internet use.

To sum up, the focus of the present study was to investigate inhibitory control processes in individuals with generic and specific (SNS) problematic internet use. Deficits in inhibitory control are evident in addicted individuals and have been implicated as playing a role in the development and maintenance of the addiction cycle. Researching whether the same holds true for problematic internet use will enhance our understanding of its addictive potential as well as provide us with a better understanding of the mechanisms associated with it. This will impact positively upon the development of efficacious intervention and prevention strategies. More specifically, it was hypothesized that individuals with problematic internet use would show an impaired inhibitory and shifting control, as assessed with reaction times as well as disinhibition and discrimination rates which combine both commission and omission errors in the emotional shifting tasks. Moreover, it was hypothesized that these deficits will be particularly evident when processing and controlling for emotional (generic and specific) internet-related information. Furthermore, it was hypothesized that these deficits will relate to the specific online applications regarding which the individuals display problematic behaviour. That is for generic problematic internet users this will be evident in the task where generic internet stimuli are encountered whereas for specific (SNS) problematic internet users this will be evident for the task where SNS internet stimuli are encountered. Furthermore, another objective of this study was to assess whether these deficits will be more evident in problematic internet users with high levels of urges to be online. Finally, based on Charlton and Danforth's (2007, 2010) model, it was hypothesized that there would be qualitative differences between individuals with and without problematic internet use (high engagers, moderate and non-problematic internet users), for generic as well as specific (SNS) online activity in relation not only to inhibitory and shifting control processes but also with respect to psychopathological and personality constructs.

5.3 Methods

5.3.1 Participants

The participants were recruited through advertisements placed within the University of Bath. In the initial phase of the experiment, an online questionnaire assessing the participants' generic as well as SNS internet use was administered (the modified Addiction-Engagement Questionnaire (AEQ): the same as used Study two (Chapter three). From a total number of 250, 101 individuals were contacted for further testing (phase two) based on their scores on the modified AEQ regarding for assessing generic and SNS internet use. Efforts were made to recruit equal numbers of participants who fulfilled the criteria for problematic, high engagement, moderate and non-problematic for generic and SNS internet use. The mean age was 21.96 years (*S.D* = 4.8) and there were 59 females. Review of the gender differences between these groups revealed no differences in the male ratio, x^2 = 2.38, p = .497, and similarly for females, x^2 = 2.22, p = .528 for generic problematic internet use. Similarly, for SNS internet users, the female ratio did not differ between groups, x^2 = 6.15, p = .104. However, the male difference, x^2 = 21.23, p = .01 differed significantly between the groups with a higher proportion of male participants in the moderate and non-problematic SNS groups compared to a lower number of male participants in the problematic and high engagers groups. This difference fits with the established literature which suggests that females are using the internet for socializing more than males (Weiser, 2000; Whang et al., 2003; Young, 1998b).

5.3.2 Pictorial stimuli for Internet and SNS Shifting tasks

The internet-related stimuli consisted of pictorial colour images containing generic internet-related activities (Google search websites, email websites etc.) and internet-related logos (Internet Explorer logo, eBay logo etc.) which were retrieved from the Google image search. The total number of internet-related stimuli was 30. The 15 images that were used in Study two (Chapter three) which had been rated as being the most internet-related ones along with 15 additional images which were similar in content to these previously assessed were employed (see Appendix V for examples of the images). The additional images were included in order to control for possible familiarity effect caused by repetition of images based on the structure of the task. Similarly, this procedure was followed for collecting the SNS related images (see Appendix V for examples of the images). That is, the 15 images used in Study three (Chapter four) which had been rated as being the most SNS related ones along with 15 additional images were gathered. Moreover, there were 80 images of houses which were used as the neutral control category and 20 images of animals which were used in the practice trials. The size of the pictures was 5.5cm wide and 11cm high. In keeping with the argument put forward in our previous studies as to which type of images can constitute the best candidates for control images, a similar category (images of landscape and building) was chosen to the one that was used in a study conducted on online gaming that assessed attentional processes by comparing complex online gaming and neutral control images (Lorenz et al., 2013). It was decided not to use the neutral images included in the previous studies because they were perceptually very similar to online images. This might have caused interference effects and masked any possible differences in inhibitory control processes between the groups due to the nature of the Go/No-Go task. In this way, this study has expanded upon previous research where landscape and building images have been used and validated as an appropriate control category that is able to capture differences in attentional processes in groups of problematic and non-problematic online gamers (Lorenz et al., 2013).

5.3.3 Internet and SNS Shifting tasks

This task has been adapted from the pictorial Alcohol-Shifting task (Noel et al., 2007). Two versions have been created; one where generic internet images were matched with house images and another where SNS related images were matched with house images. Each task contained ten blocks with the first two related to practice trials blocks and the remaining eight being the experimental blocks. Each block contained 20 stimuli, 15 (75%) of which were go and 5 (25%) no-go cues which were randomized between the blocks. Each trial started with the presentation of a stimulus which was presented centrally on a computer screen for a period of 500ms, followed by an inter-stimulus interval of 900, 1250 or 1500ms which were randomized across the trials in order to control for anticipatory responses. The participants were given specific instructions at the beginning of each block as to which category stimuli were the target for that block and as such, for which a response was required, and the same time, which category was the non-target and required no response (see Appendix II for detailed instructions). For example, in block four, the instructions would have told the participants: "when you see internet-related images press the spacebar but when you see house images do not press anything". The instructions could change or stay the same between blocks. Participants were required to respond as quickly and as accurately as possibly to the target category while trying to ignore the non-target stimuli. Whenever they made a wrong response, such as pressing the space bar when a non-target stimuli was displayed, (a commission error), a 500ms 900Hz tone was given as a negative feedback. No such feedback was given when they failed to make a response for a target category, in other words, when they failed to press the spacebar within the timeframe of the target stimuli presentation of 500ms when it was required (an omission error). The targets were presented in order: either PPIIHHIIHH or PPHHIIHHII (P= practice, I= internet-related images, H= house images). The order in which the targets were presented was counterbalanced between participants. This target presentation arrangement resulted in four “shift” and four “non-shift” blocks. In the shift blocks, the target category was different from the previous block whereas in the non-shift blocks, it was the same as for previous block. The same procedure was followed with the SNS version of the shifting task with the difference being that instead of the images being generic internet one, the images were SNS related. The order in which the two tasks were completed was counterbalanced between participants in order to account for practice effects. Both tasks were generated with E-prime 2.0 Professional software (Psychology Software Tools, Pittsburgh, PA) and were presented on a 19inch monitor screen.

5.3.4 Self-report measures- Questionnaires

See Study two (Chapter three) for details as to the structure of the following measures. The Cronbach's alpha for each measure used is included to give evidence of the validity of its application in this present study.

Addiction-Engagement Questionnaire (AEQ)

The Cronbach's alpha coefficient for the addiction factor was .83, for the high engagement factor .80 for the generalized internet use and .90 and .88 for SNS use.

Internet Addiction Test (IAT)

The Cronbach's alpha coefficient was .87 for the whole scale and for the subscales: .77 (withdrawal and social problems), .81 (time management and performance) and .54 (reality substitute).

Problematic Internet Use Questionnaire (PIUQ)

The Cronbach's alpha coefficient was .91 for the whole scale and for the subscales: .84 (obsession), .76 (neglect) and .81 (control disorder).

Brief Symptom Inventory (BSI-53)

The Cronbach's alpha coefficient was .96 for the whole scale and for the subscales: .81 (somatization), .78 (obsession-compulsion), .91 (interpersonal sensitivity), .87 (depression), .73 (anxiety), .77 (hostility), .71 (phobic anxiety), .77 (paranoid ideation) and, .73 (psychoticism). All raw scores were converted to T-scores using adult non-patient norms for each gender (Derogatis, 1993).

Barratt Impulsiveness Scale version 11 (BIS)

The Cronbach's alpha coefficient was .78 for the whole scale and for the subscales .70 (non-planning), .55 (motor) and .70 (cognitive).

Questionnaire on internet use urges (QIUU)

The Cronbach's alpha coefficient was .93.

5.3.5 Procedure

On the initial contact, the participants were given information in relation to the study's aims and procedures and were provided with the opportunity to ask any questions. Once they agreed to take part in the study, the participants completed a battery of questionnaires comprising the AEQ, IAT, PIUQ, BIS-11 and BSI-53 on an online data collection website (Bristol Online Survey). Based on the selection criteria outlined above, a sample of internet users were invited to participate in the second phase of the experiment which took place in the Department of Psychology Laboratories. Upon arrival, participants were given information pertaining to the experimental procedures, provided their informed consent and were given the opportunity to ask any questions. Next, participants sat comfortably in a chair at approximately 70cm distance from a computer display where they performed the two computer based tasks. Then they completed a final questionnaire, the QIUU. After the completion of the questionnaires, participants were fully debriefed and received a payment of £5. The total participation time was approximately thirty minutes. Participants who filled in the initial online questionnaires but were not selected for the second phase of the experiment had the opportunity to win in a prize draw (£30 Amazon voucher).

5.3.6 Statistical Analysis

All statistical analyses were conducted using SPSS 20 software.

Reaction time (RT) was used as a dependent variable. RTs less than 100ms were excluded as it has been suggested that these capture anticipatory responses (Noel et al., 2005, 2007). Snodgrass and Corwin's (1988) signal detection analysis was used in order to assess discrimination (d') and disinhibition (C) which gives a better indication of overall inhibitory control because it combines both the number of false alarms as well as the responses to targets. It has been argued that assessing the number of false alarms (responses to non-targets) is not the best indicator for inhibitory control (Noel et al., 2005, 2007). According to signal detection analysis, poor discrimination (d') is indicated with a value of 0 or less. A low value indicates that there is a high response to non-targets (i.e. responding to distracters) as well as a low number of hits (responding to targets). By contrast a high value for d' indicates a good ability to withhold responses to non-targets and respond to target stimuli. Similarly, disinhibition (C) takes into account both responses to target and non-target stimuli and a value below 0 is an indication of high disinhibition (high rates of responses to both target and non-target stimuli). For each participant, the following were recorded: the number of hits, false alarms, correct withholdings and misses for each block and for each task (internet and SNS tasks) and the mean RTs was calculated. Then the calculations for the signal detection analysis were conducted (see Appendix VI for details). A series of ANOVAs were performed in order to assess the differences between the group of internet users for each of the three dependent variables; RTs, d' and C for each task (internet shifting and SNS shifting tasks). Moreover, task order (shifting internet first versus shifting SNS first) and target order (internet versus house first and SNS and house first) were introduced as covariates for all the dependent variable analysis. However, they did not interact significantly with any of the dependent variables and thus were excluded from further analysis. Moreover, whether levels of urges to be online had an effect on inhibitory control was assessed with series of ANOVAs on the aforementioned dependent variables, for each emotional shifting task.

5.4 Results

5.4.1 Group characteristics for generic problematic internet users *(see Tables 5.1 and 5.2)*

Initially, based on Charlton and Danford's (2007, 2010) model, assessment was made as to whether differences between the groups of internet users would be evident in: 1) the severity of problematic internet use; 2) psychopathological constructs; 3) personality traits and, 4) motivational states. One-way ANOVAs were performed on key self-report measures. Where significant group effects were found, Tukey HSD or Games-Howell tests depending whether Levene's test of homogeneity of variance was significant or not were performed.

From Table 5.1, we can see that overall, the problematic internet users group had significantly higher scores compared to high engagers, moderate and non-problematic internet users on the AEQ addiction scale. Moreover, problematic internet users had significantly higher scores compared to non-problematic and moderate internet users for the IAT total (including the withdrawal and social problems and time management and performance subscales) and PIUQ total scores (including neglect subscale). Additionally, the problematic internet users had significantly higher scores compared to non-problematic internet users on the AEQ high engagement scale, the IAT (the reality substitute subscale) and the PIUQ (the obsession and control subscales). Moreover, high engagers and moderate internet users had significantly higher scores compared to non-problematic internet users on the AEQ addiction and high engagement scales, the IAT total (the reality substitute and time management and performance subscales) and the PIUQ total (the neglect and control subscales). Finally, problematic internet users, high engagers and moderate internet users had higher scores on the QIUU compared to non-problematic internet users.

Table 5.1- Characteristics of internet use groups. Values are means (standard deviation in brackets)

	Problematic internet users (PIU) (n=28)	High engagers internet users (HE) (n=24)	Moderate internet users (MIU) (n=29)	Non-problematic internet users (NPIU) (n=20)	Anova F Values	Post-hoc comparisons (Tukey HSD and Games-Howell)
Age (years)	21.64 (4.16)	20.63 (2.53)	21.86 (5.83)	24.15 (5.57)		
Gender (M/F)	11/17	7/17	14/15	10/10		
AEQ addiction	53.04 (7.13)	39.33 (8.22)	37.03 (8.66)	21.15 (5.48)	69.32**	PIU>HE,NPIU,MIU; HE>NPIU; MIU>NPIU
AEQ high engagement	57.57 (12.92)	58.00 (6.65)	55.59 (6.31)	44.95 (9.77)	9.24**	PIU>NPIU;HE>NPIU; MIU>NPIU
IAT total	44.96 (7.71)	40.00 (9.33)	34.55 (6.03)	27.95 (9.18)	19.66**	PIU>NPIU,MIU; HE>NPIU; MIU>NPIU
IAT withdrawal and social problems	15.5 (4.47)	13.96 (4.45)	11.62 (2.46)	10.30 (2.77)	9.83**	PIU>NPIU,MIU; HE>NPIU
IAT time management and performance	17.36 (3.15)	14.71 (3.62)	13.07 (3.55)	9.55 (4.65)	18.14**	PIU>NPIU,MIU; HE>NPIU; MIU>NPIU
IAT reality substitute	6.43 (2.35)	5.58 (2.26)	5.07 (1.62)	3.80 (1.40)	7.09**	PIU>NPIU; HE>NPIU; MIU>NPIU
PIUQ total	41.93 (9.83)	40.00 (8.93)	34.48 (7.89)	26.15 (9.79)	13.61**	PIU>NPIU,MIU; HE>NPIU; MIU>NPIU
PIUQ obsession	11.68 (4.28)	11.88 (4.10)	9.38 (3.09)	7.65 (2.35)	7.17**	PIU>NPIU; HE>NPIU
PIUQ neglect	15.11 (3.57)	14.04 (3.28)	12.62 (3.10)	9.00 (3.728)	13.63**	PIU>NPIU,MIU; HE>NPIU; MIU>NPIU
PIUQ control disorder	15.14 (4.55)	14.08 (3.57)	12.48 (3.05)	9.50 (4.36)	8.97**	PIU>NPIU; HE>NPIU; MIU>NPIU
QIUU	34.04 (14.51)	31.21 (11.06)	27.48 (13.33)	17.55 (9.53)	7.35**	PIU>NPIU; HE>NPIU; MIU>NPIU

Note. AEQ = *Engagement and Addiction Questionnaire with subscales*, IAT = *Internet Addiction Test with subscales*; PIUQ = *Problematic Internet Use Questionnaire with subscales*, QIUU = *Questionnaire on internet use urges*.PIU = four or more addiction criteria, HE = three or less addiction criteria and one or two peripheral criteria, MIU = three or less addiction criteria or one peripheral criteria, NPIU = none of the addiction or peripheral criteria. $p < .01^{**}$

In addition problematic internet users had higher scores compared non-problematic internet users on BSI subscales: the global severity index, positive symptom total, obsession-compulsion, anxiety, hostility and psychoticism. Moreover, high engagers had higher scores compared to non-problematic internet users for the global severity index, positive symptom total and obsession-compulsion subscales (Table 5.2).

In relation to personality trait characteristics there were no differences between internet users (Table 5.2).

Overall the data provided support for there being qualitative differences between internet use groups (problematic, high engagers, moderate and non-problematic internet users) based on AEQ proposed criteria, as there were significant differences between these groups in relation to the severity of problematic internet use and levels of psychopathology.

Table 5.2-Psychopathological and personality characteristics of internet use groups.

	Problematic internet users (PIU) (n=28)	High engagers internet users (HE) (n=24)	Moderate internet users (MIU) (n=29)	Non-problematic internet users (NPIU) (n=20)	Anova F Values	Post-hoc comparisons (Tukey HSD and Games-Howell)
BSI grand total	42.79 (33.24)	34.42 (26.30)	32.93 (26.54)	19.45 (24.43)	2.69 *	PIU>NPIU
BSI global severity index	61.46 (9.75)	58.83 (9.01)	58.24 (9.18)	50.70 (13.15)	4.54 **	PIU>NPIU; HE>NPIU
BSI positive symptom total	59.79 (10.37)	57.83 (8.86)	58.07 (9.97)	49.15 (11.92)	4.75 **	PIU>NPIU; HE>NPIU; MIU>NPIU
BSI positive symptom distress index	60.68 (7.23)	56.83 (7.57)	56.21 (7.93)	51.45 (10.08)	5.04 **	PIU>NPIU
BSI somatization	54.82 (10.62)	52.83 (7.67)	50.31 (10.42)	47.45 (8.81)	2.61	
BSI obsession-compulsion	64.07 (9.59)	60.62 (9.22)	59.38 (9.43)	52.60 (11.03)	5.48 **	PIU>NPIU; HE>NPIU
BSI interpersonal sensitivity	62.46 (12.11)	59.92 (11.46)	59.65 (11.78)	53.45 (12.94)	2.25	
BSI depression	60.82 (9.77)	57.42 (10.27)	60.34 (9.82)	53.65 (11.97)	2.32	
BSI anxiety	56.61 (9.55)	54.71 (8.62)	53.83 (6.89)	49.45 (11.60)	2.47	PIU>NPIU
BSI hostility	56.57 (10.95)	54.50 (9.82)	52.10 (10.78)	47.75 (9.46)	3.06 *	PIU>NPIU
BSI phobic anxiety	56.61 (10.04)	55.67 (9.43)	54.31 (10.22)	51.45 (8.20)	1.22	
BSI paranoid ideation	59.18 (11.39)	56.54 (11.09)	55.27 (10.97)	50.55 (11.26)	2.38	
BSI psychoticism	64.25 (10.35)	61.00 (10.75)	62.48 (10.63)	55.45 (10.92)	2.90 *	PIU>NPIU
BIS total	64.54 (8.47)	64.13 (7.92)	62.31 (7.56)	61.65 (9.89)	0.67	
BIS attention	16.93 (3.08)	16.29 (4.28)	15.17 (2.61)	15.05 (4.26)	1.68	
BIS motor	22 (4.44)	22.42 (3.79)	21.34 (3.19)	22.00 (3.71)	0.36	
BIS non-planning	25.61 (4.122)	25.42 (3.02)	25.79 (4.14)	24.60 (3.87)	0.42	

Note, BSI = Brief SYmptom Inventory with subscales; BIS = Barratt Impulsivity Scale with subscales. PIU = four or more addiction criteria, HE = three or less addiction criteria and one or two peripheral criteria, MIU = three or less addiction criteria or one peripheral criteria, NPIU = none of the addiction or peripheral criteria. $p < .01^{**}$, $p < .05^{*}$

5.4.2 Internet shifting task performance for generic internet users (All the raw data are presented in Table 5.3)

<u>Reaction time</u>

The mean amount of time (RTs) participants spent to respond to targets was calculated. A three way mixed ANOVA was performed with the target image type (internet versus houses) and condition (shift versus non-shift blocks) as within factors and group (problematic, high engagers, moderate and non-problematic internet users) as the between factor. Overall, the results revealed a significant effect of target image type, $F(1, 97) = 216.88$, $p = .001$, $\eta_p^2 = .69$. The participants responded quicker when the targets were house images ($M = 339.89$, $SD = 29.73$) than internet images ($M = 353.01$, $SD = 29.11$), $t(100) = 7.30$, $p = .001$, $d = 1.46$, 95% CI [9.55, 16.68]. However, the main effects of condition, F(1,

97) = 0.001, p = .98, group, F(3, 97) = 0.17, p = .92 and interactions between target image type type with group, F(3, 97) = 0.99, p = .40, condition with group, F(3, 97) = 0.72, p = .54, target image type and condition, F(1, 97) =1.06, p = .31 and target image type, condition and group, F(3, 97) = 0.25, p = .86 were not significant.

Discrimination (d')

Initially an assessment was made as to whether there was a difference in the overall hit and false alarm rates between the groups of internet users. Overall, there were no significant differences between them. Furthermore, a three-way ANOVA was performed with target image type (internet versus houses) and condition (shift versus non-shift blocks) as within factors and group (problematic, high engagers, moderate and non-problematic internet users) as the between factor. The main effects of target image type, F(1, 97) = 0.001, p = .98, condition, F(1, 97) = 0.004, p = .78, group, F(3, 97) = 0.51, p = .67 and interactions between target image type with group, F(3, 97) = 0.36, p = .78, condition with group, F(3, 97) = 1.73, p = .17, target image type and condition, F(1, 97) = 0.035, p = .85 and target image type, condition and group, F(3, 97) = 1.22, p = .31 were not significant.

Disinhibition (C)

A three-way ANOVA with target image type (internet versus houses) and condition (shift versus non-shift blocks) as within factors and group (problematic, high engagers, moderate and non-problematic internet users) as the between factor revealed a target image type, group and condition interaction, F(3, 97) = 3.75, p = .013, ηp^2 = .10 (Figure 5.1). However, the main effects of target image type, F(1, 97) = 0.06, p = .80, condition, F(1, 97) = 0.05, p = .83, group, F(3, 97) = 0.50, p = .68 and interactions between target image type with group, F(3, 97) = 1.9, p = .13, condition with group, F(3, 97) = 1.25, p = .30, target image type and condition, F(1, 97) = 0.04, p = .83 were not significant. For the interaction of target image type, group and condition, simple effect analyses were conducted for each group of internet users separately. For the non-problematic internet users there was a significant target and condition interaction, F (1, 19) = 5.92, p = .025, ηp^2 = .24. They had greater disinhibition rates on shift blocks where the targets were houses (M = -.07, SD = .51) than on shift blocks where the targets were internet images (M = .16, SD = .65), t(19) = 2.09, p = .05, d =0.78, 95% CI [.001, .47], (Figure 5.1). There was no other significant effect or interaction.

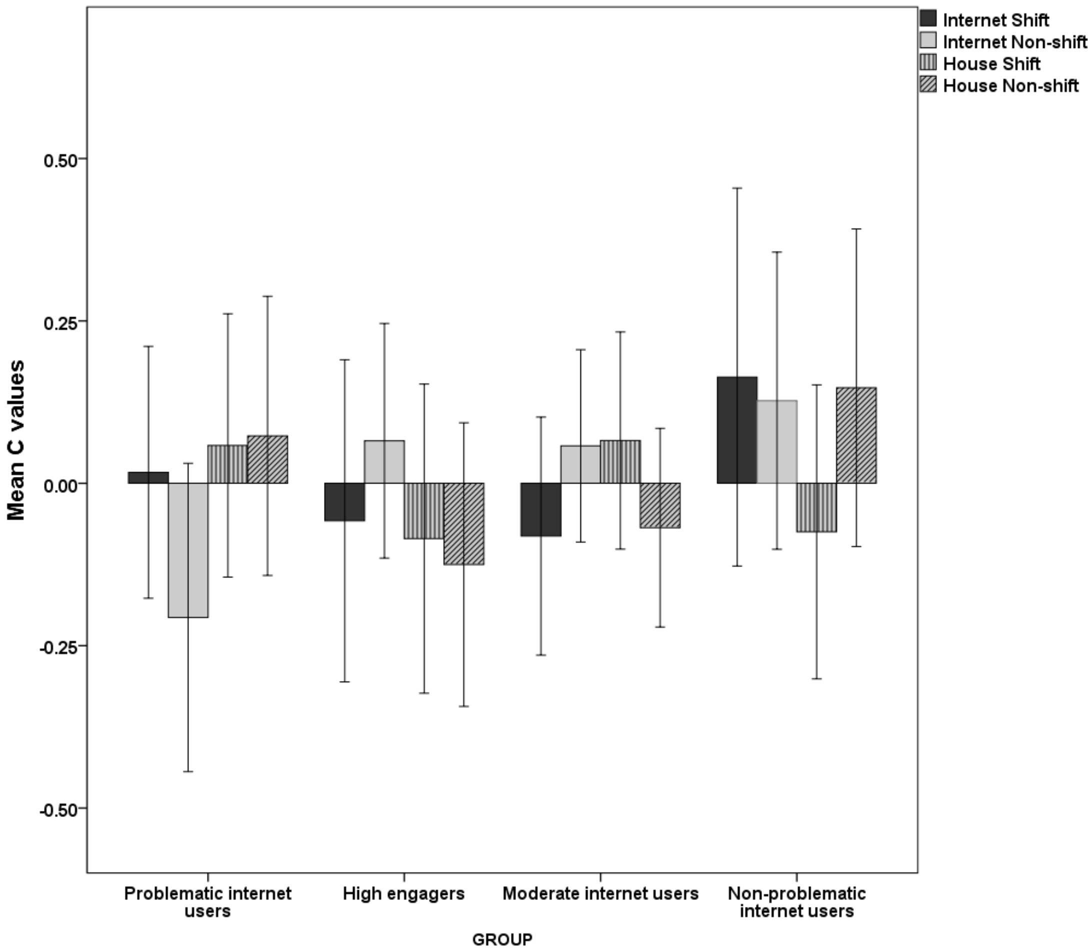

Figure 5.1 Disinhibition rates (C value) for each internet use group (problematic, high engagers, moderate, non-problematic) in trials where targets were internet images and the blocks were shift and non-shift blocks and where targets were house images and the blocks were shift and non-shift blocks. CI error bars.

5.4.3 SNS shifting task performance for generic internet users (*All the raw data are presented in Table 5.3)*

<u>Reaction time</u>

The mean amount of time (RTs) participants spent to respond to targets was calculated. A three way mixed ANOVA was performed with target image type (SNS versus houses) and condition (shift versus non-shift blocks) as a within factor and group (problematic, high engagers, moderate and non-problematic internet users) as the between factor. Overall, results revealed a significant effect of target image type, $F(1, 97) = 189.36$, $p = .001$, $\eta p^2 = .66$. Participants responded quicker when the targets were house images ($M = 339.77$, $SD = 32.85$) than SNS images ($M = 354.76$, $SD = 27.17$), $t(100) = 7.16$, $p = .001$, d =1.43, 95% CI [10.83, 19.14]. However, the main effects of condition, $F(1, 97) = 1.54$, $p = .22$, group, $F(3, 97) = 0.13$, $p = .95$ and interactions between target image type type with group, $F(3, 97) = 0.16$, $p = .92$, condition with group, $F(3, 97) = 0.42$, $p = .74$, target image type and condition, $F(1, 97) = 2.01$, $p = .16$ and target image type, condition and group, $F(3, 97) = 0.39$, $p = .76$ were not significant.

Discrimination (d')

A three-way ANOVA with target image type (SNS versus houses) and condition (shift versus non-shift blocks) as within factors and group (problematic, high engagers, moderate and non-problematic internet users) as the between factor revealed the main effects of target image type, $F(1, 97) = 0.02$, $p = .90$, condition, $F(1, 97) = 0.001$, $p = .97$, group, $F(3, 97) = 0.99$, $p = .40$ and interactions between target image type with group, $F(3, 97) = 0.33$, $p = .80$, condition with group, $F(3, 97) = 0.06$, $p = .98$, target image type and condition, $F(1, 97) = 0.002$, $p = .96$ and target image type, condition and group, $F(3, 97) = 0.17$, $p = .91$ were not significant.

Disinhibition (C)

A three-way ANOVA with target image type (SNS versus houses) and condition (shift versus non-shift blocks) as within factors and group (problematic, high engagers, moderate and non-problematic internet users) as a between factor revealed no significant main effects of target image type, $F(1, 97) = 0.02$, $p = .88$, condition, $F(1, 97) = 0.01$, $p = .91$, group, $F(3, 97) = 0.54$, $p = .65$ and interactions between target image type with group, $F(3, 97) = 0.49$, $p = .69$, condition with group, $F(3, 97) = 0.48$, $p = .70$, target image type and condition, $F(1, 97) = 0.01$, $p = .94$ and target image type, condition and group, $F(3, 97) = 1.37$, $p = .94$.

Table 5.3-Mean and standard deviations for RTs, d' and C, for generic problematic, high engagers, moderate and non-problematic internet users on internet and SNS shifting task

.		Problematic internet users		High engagers		Moderate users		Non-problematic internet users	
Shifting Tasks		Internet	SNS	Internet	SNS	Internet	SNS	Internet	SNS
RT Condition		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
	Non-shift	342.48 (26.91)	345.42 (32.33)	347.22 (24.76)	349.44 (25.13)	349.77 (26.01)	352.00 (27.13)	347.84 (35.64)	348.41 (33.01)
	Shift	343.19 (29.68)	346.19 (33.01)	348.61 (28.48)	345.35 (25.97)	346.88 (27.91)	348.48 (24.19)	346.23 (36.34)	341.25 (36.14)
Type of target									
	House	337.26 (28.93)	338.97 (36.55)	340.47 (26.65)	341.51 (31.36)	339.68 (27.73)	341.33 (30.715)	343.18 (38.02)	336.54 (34.36)
	Internet/SNS	348.41 (29.02)	352.64 (31.00)	355.36 (26.40)	353.28 (24.07)	356.97 (27.88)	359.15 (22.04)	350.89 (34.71)	353.12 (32.54)
D Condition	Non-shift	-0.21 (0.90)	-0.12 (0.82)	0.13 (0.78)	-0.04 (0.96)	0.13 (0.93)	0.18 (1.02)	-0.04 (0.81)	-0.03 (0.72)
	Shift	0.07 (0.81)	-0.13 (0.93)	-0.23 (1.04)	-0.16 (0.83)	0.17 (0.79)	0.14 (0.82)	-0.08 (1.06)	0.17 (0.73)
Type of target									
	House	-0.15 (0.97)	-0.14 (0.86)	-0.01 (0.74)	-0.07 (0.96)	0.19 (0.81)	0.09 (0.90)	-0.05 (1.01)	0.15 (0.93)
	Internet/SNS	0.02 (0.76)	-0.11 (0.94)	-0.09 (1.14)	-0.14 (0.90)	0.10 (0.93)	0.23 (0.97)	-0.07 (1.02)	-0.01 (0.76)
C Condition									
	Non-shift	-0.04 (0.54)	0.04 (0.51)	-0.05 (0.40)	-0.05 (0.46)	-0.02 (0.29)	0.06 (0.27)	0.15 (0.50)	-0.08 (0.43)
	Shift	0.01 (0.31)	0.01 (0.52)	-0.05 (0.53)	-0.11 (0.48)	0.01 (0.40)	0.02 (0.41)	0.03 (0.50)	0.08 (0.35)
Type of target									
	House	0.06 (0.44)	-0.01 (0.47)	-0.11 (0.48)	-0.08 (0.41)	-0.01 (0.37)	0.04 (0.43)	0.04 (0.49)	0.05 (0.34)
	Internet/SNS	-0.09 (0.50)	0.07 (0.61)	0.01 (0.46)	-0.08 (0.50)	-0.01 (0.37)	0.04 (0.29)	0.14 (0.55)	-0.05 (0.48)

5.4.4 Group characteristics of SNS internet users (*see Tables 5.4 and 5.5)*

Based on Charlton and Danford's (2007, 2010) model, an assessment was made as to whether differences between groups of the SNS internet users would be evident in: 1) the severity of problematic internet use; 2) psychopathological constructs; 3) personality traits and 4) motivational states. One-way ANOVAs were performed on key self-report measures. Where significant group effects were found, Tukey HSD or Games-Howell tests, depending whether Levene's test of homogeneity of variance was significant or not, were performed.

From Table 5.4, we can see that overall, the problematic SNS internet users group had significantly higher scores compared to high engagers, moderate and non-problematic SNS internet users on the AEQ addiction scale. Additionally, the problematic SNS internet users had significantly higher scores compared to moderate and non-problematic SNS internet users on the AEQ high engagement scale, the IAT total (including time management and performance and reality substitute subscales) and the PIUQ total scores (including obsession and control subscales). Moreover, the problematic SNS internet users had significantly higher scores compared to non-problematic users on the PIUQ (including neglect and withdrawal and social problems subscales).

Similarly, the high SNS engagers had significantly higher scores compared to non-problematic SNS internet users for the AEQ addiction and high engagement scales, the IAT Total (including time management and performance and reality substitute, withdrawal and social problems subscales), as well as the PIUQ total (including neglect and control subscales). Finally, problematic, high engagers and moderate SNS internet users had higher scores on the QIUU compared to non-problematic internet users.

Table 5.4-Characteristics of SNS internet use groups. Values are means (standard deviation in brackets)

	Problematic SNS internet users (PSIU) (n=25)	High engagers SNS internet users (HESU) (n=13)	Moderate SNS internet users (MSU) (n=38)	Non-problematic SNS internet users (NPSIU) (n=29)	Anova F Values	Post-hoc comparisons (Tukey HSD and Games-Howell)
Age (years)	21.12 (2.9)	21.15 (2.9)	20.9 (4.6)	24.24 (6.2)		
Gender (M/F)	3/22	3/10	18/16	18/11		
AEQ addiction	54.32 (6.51)	38.38 (6.83)	29.44 (9.86)	17.10 (5.79)	110.09**	PISU>HESU,NPSIU,MSU ; HESU>NPSIU,MSU;MRSU>NPSIU
AEQ high engagement	57.96 (7.38)	56.77 (8.14)	44.12 (12.49)	35.83 (9.76)	26.51**	PSIU>NPSIU,MSU; HESU>NPSIU,MSU; MSU>NPSIU
IAT total	44.76 (6.22)	41.62 (10.61)	35.68 (9.93)	31.28 (7.78)	12.39**	PSIU>NPSIU,MSU; HESU>NPSIU
IAT withdrawal and social problems	14.84 (4.10)	14.62 (4.13)	12.62 (4.19)	11.10 (3.22)	4.98**	PSIU>NPSIU; HESU>NPSIU
IAT time management and performance	17.32 (2.89)	15.77 (5.10)	13.18 (4.46)	11.14 (3.45)	12.37**	PSIU>NPSIU,MSU; HESU>NPSIU
IAT reality substitute	6.68 (2.17)	5.92 (1.89)	5.06 (2.18)	4.17 (1.49)	7.85**	PSIU>NPSIU,MSU; HESU>NPSIU
PIUQ total	43.72 (8.29)	41.15 (10.71)	34.18 (9.98)	29.90 (8.52)	11.69**	PSIU>NPSIU,MSU; HESU>NPSIU
PIUQ obsession	12.40 (3.50)	11.85 (3.78)	9.03 (3.44)	9.17 (3.96)	5.81**	PSIU>NPSIU,MSU
PIUQ neglect	15.24 (3.08)	14.23 (4.14)	12.79 (4.16)	10.52 (3.08)	8.24**	PSIU>NPSIU; HESU>NPSIU
PIUQ control disorder	16.08 (3.16)	15.08 (4.66)	12.35 (4.18)	10.21 (3.12)	12.77**	PSIU>NPSIU,MSU; HESU>NPSIU
QIUU	36.6 (13.12)	32.77 (9.30)	27.97 (14.67)	19.24 (8.48)	9.87**	PSIU>NPSIU; HESU>NPSIU; MSU>NPSIU

Note. AEQ = *Engagement and Addiction Questionnaire for SNS with subscales*, IAT = *Internet Addiction Test with subscales*; PIUQ = *Problematic Internet Use Questionnaire with subscales*, QIUU = *Questionnaire on internet use urges.PSIU = four or more addiction criteria, HESU = three or less addiction criteria and one or two peripheral criteria, MSU = three or less addiction criteria or one peripheral criteria, NPSIU = none of the addiction or peripheral criteria.* $p < .01^{**}$

In addition, from Table 5.5 we can see that problematic SNS internet users had higher scores compared to moderate and non-problematic SNS internet users on the BIS total, BSI positive symptom distress index (which is an overall assessment of the severity of the distress individuals are experiencing), hostility, phobic anxiety and paranoid ideation subscales. Moreover, problematic SNS internet users had higher scores compared to non-problematic SNS internet users on somatization, obsession-compulsion and psychoticism subscales of BSI.

In relation to personality trait characteristics there were no differences between the SNS internet users.

Overall the data provided support for there being qualitative differences between SNS internet use groups (problematic, high engagers, moderate and non-problematic internet users) based on the AEQ proposed criteria, as there were significant differences between these groups in relation to the severity of problematic internet use and psychopathology characteristics.

Table 5.5-Psychopathological and personality characteristics of SNS internet use groups.

	Problematic SNS internet users (PSIU) (n=25)	High engagers SNS internet users (HESU) (n=13)	Moderate SNS internet users (MSU) (n=38)	Non-problematic SNS internet users (NPSIU) (n=29)	Anova F Values	Post-hoc comparisons (Tukey HSD and Games-Howell)
BSI grand total	54.60 (37.61)	31.31 (24.01)	26.24 (19.45)	24.28 (22.65)	7.377^{**}	PSIU>NPSIU,MRSU
BSI global severity index	62.92 (10.05)	57.61 (8.55)	56.35 (10.10)	55.10 (11.78)	2.87^{*}	PSIU>NPSIU
BSI positive symptom total	63.04 (11.31)	56.76 (7.21)	55.11 (9.46)	53.13 (11.23)	4.62^{**}	PSIU>NPSIU,MSU
BSI positive symptom distress index	60.40 (8.63)	55.61 (7.58)	55.58 (7.71)	55.13 (9.47)	2.18	
BSI somatization	56.56 (10.33)	52.53 (8.83)	51.64 (10.16)	46.82 (7.13)	4.99^{**}	PSIU>NPSIU
BSI obsession-compulsion	64.60 (9.57)	60.46 (9.77)	57.94 (10.56)	56.96 (10.09)	3.04^{*}	PSIU>NPSIU
BSI interpersonal sensitivity	64.08 (12.30)	58.69 (10.41)	58.38 (11.32)	56.41 (13.38)	1.92	
BSI depression	63.28 (9.96)	55.92 (9.74)	57.00 (9.24)	57.13 (12.01)	2.45	
BSI anxiety	56.52 (9.95)	53.53 (9.66)	53.64 (7.47)	52.24 (10.49)	0.97	
BSI hostility	59.96 (9.94)	52.38 (8.05)	51.29 (10.24)	49.44 (10.52)	5.59^{**}	PSIU>NPSIU,MSU
BSI phobic anxiety	59.64 (9.57)	55.61 (10.72)	52.38 (8.74)	52.75 (9.05)	3.51^{**}	PSIU>NPSIU,MSU
BSI paranoid ideation	61.92 (11.13)	54.61 (9.74)	54.05 (10.21)	52.82 (12.15)	3.63^{**}	PSIU>NPSIU,MSU
BSI psychoticism	66.32 (9.96)	61.15 (10.23)	59.55 (10.33)	58.82 (11.50)	2.71^{*}	PSIU>NPSIU
BIS total	65.24 (8.23)	64.54 (8.25)	63.18 (7.09)	60.97 (9.64)	1.31	
BIS attention	17.24 (3.66)	16.08 (4.03)	15.59 (3.22)	15.03 (3.52)	1.88	
BIS motor	22.24 (3.8)	22.23 (2.97)	21.91 (4.01)	21.48 (3.92)	0.21	
BIS non-planning	25.76 (3.95)	26.23 (3.41)	25.68 (3.15)	24.45 (4.50)	0.94	

Note, BSI = Brief Symptom Inventory with subscales; BIS = Barratt Impulsivity Scale with subscales. PSIU = four or more addiction criteria, HESU = three or less addiction criteria and one or two peripheral criteria, MSU = three or less addiction criteria or one peripheral criteria, NPSIU = none of the addiction or peripheral criteria. $p < .01$**, $p < .05$

5.4.5 Internet shifting task performance for SNS internet users *(All the raw data are presented in Table 5.6)*

<u>*Reaction time*</u>

Overall, results revealed a significant effect of target image type, *F*(1, 97) = 197.50, *p* = .001, ηp^2 = .67. The participants responded quicker to house images (*M* = 339.89, *SD* =29.73) than to internet images (*M* = 353.01, *SD* =29.11), *t*(100) = 7.30, *p* = .001, *d* =1.46, 95% CI [9.55, 16.68]. However, the main effects of condition, *F*(1, 97) = 0.22, *p* = .64, group, *F*(3, 97) = 1.35, *p* = .26 and interactions between target image type type with group, *F*(3, 97) = 0.39, *p* = .76, condition with group, *F*(3, 97) = 1.16, *p* = .33, target image type and condition, *F*(1, 97) = 1.03, *p* = .31 and target image type, condition and group, *F*(3, 97) = 1.43, *p* = .24 were not significant.

<u>*Discrimination (d')*</u>

Assessment was made to ascertain whether there was a difference in the overall hit and false alarm rates between the groups of SNS internet users. Overall, there were no significant differences between the groups. This evidence was also verified with a three-way ANOVA with target image type (internet versus houses) and condition (shift versus non-shift blocks) as within factors and group (problematic, high engagers, moderate and non-problematic SNS internet users) as the between factor. The main effects of target image type, *F*(1, 97) = 0.29, *p* = .59, condition, *F*(1, 97) = 0.09, *p* = .76, group, *F*(3, 97) = 1.4, *p* = .25 and interactions between target image type with group, *F*(3, 97) = 2.11, *p* = .10, condition with group, *F*(3, 97) = 1.17, *p* = .33, target image type and condition, *F*(1, 97) = 0.005, *p* = .94 and target image type, condition and group, *F*(3, 97) = 0.80, *p* = .50 were not significant.

<u>*Disinhibition (C)*</u>

A three-way ANOVA with target image type (internet versus houses) and condition (shift versus non-shift blocks) as within factors and group (problematic, high engagers, moderate and non-problematic SNS internet users) as the between factor revealed a target, group and condition interaction *F*(3, 97) = 2.75, *p* = .047, ηp^2 = .08. However, the main effects of target image type, *F*(1, 97) = 0.06, *p* = .81, of condition, *F*(1, 97) = 0.34, *p* = .56, group, *F*(3,

97) = 2.51, p = .063 and interactions between target image type type with group, F(3, 97) = 1.13, p = .34, condition with group, F(3, 97) = 1.47, p = .23, target image type and condition, F(1, 97) = 0.65, p = .42 were not significant. For the interaction of target, group and condition, simple effect analyses were conducted for each group of SNS internet users separately. The results showed a marginal main effect of condition, F(1, 12) = 4.48, p = .056, ηp^2 = .27 in high engager SNS internet users. More specifically, high engagers had greater disinhibition rates on non-shift blocks where the targets were internet images (M = 0.05, SD = 0.63) than on shift blocks where the targets were internet images (M = 0.45, SD = 0.63), t(12) = 2.65, p = .021, d = 1.5, 95% CI [.07, .71].

5.4.6 SNS shifting task performance for SNS internet users *(All the raw data are presented in Table 5.6)*

Reaction time

Overall the results revealed a significant effect of target image type F(1, 97) = 165.10, p = .001, ηp^2 = .63. The participants responded quicker to house images (M = 339.77, SD = 32.85) than to SNS images (M = 354.76, SD = 27.17), t(100) = 7.16, p = .001, d =1.43, 95% CI [10.83, 19.14]. However, the main effects of condition, F(1, 97) = 2.11, p = .15, group, F(3, 97) = 0.92, p = .44 and interactions between target image type type with group, F(3, 97) = 0.29, p = .84, condition with group, F(3, 97) = 0.40, p = .75, target image type and condition, F(1, 97) = 2.85, p = .095 and target image type, condition and group, F(3, 97) = 0.54, p = .66 were not significant.

Discrimination (d')

Overall, the main effects of target image type, F(1, 97) = 0.001, p = .97, condition, F(1, 97) = 0.23, p = .64, group, F(3, 97) = 0.57, p = .64 and interactions between target image type with group, F(3, 97) = 0.38, p = .77, condition with group, F(3, 97) = 0.79, p = .50, target image type and condition, F(1, 97) = 0.11, p = .74 and target image type, condition and group, F(3, 97) = 0.35, p = .79 were not significant. However when order effect was controlled, it was found that the order of task interacted with target and condition F(1, 95) = 4.31, p = .041, ηp^2 = .043. Further analysis revealed that participants who did the internet shifting task first had significantly lower discrimination scores (M = -0.26, SD = 1.38) in shift blocks where targets related to house images compared to the participants who did the SNS shifting task first (*M* = 0.36, *SD* = 0.89), *t*(99) = -2.56, *p* = .012, *d* = 0.5, 95% CI [-1.11, -0.14] which could reflect fatigue effects.

Disinhibition (C)

Overall, the main effects of target image type, *F*(1, 97) = 0.33, *p* = .57, condition, *F*(1, 97) = 0.01, *p* = .93, group, *F*(3, 97) = 1.65, *p* = .18 and interactions between target image type with group, *F*(3, 97) = 1.11, *p* = .35, condition with group, *F*(3, 97) = 0.35, *p* = .79, target image type and condition, *F*(1, 97) = 0.41, *p* = .53 and target image type, condition and group, *F*(3, 97) = 1.86, *p* = .14 were not significant.

Table 5.6-Mean and standard deviations for RTs, d' and C, for problematic, high engagers, moderate and non-problematic SNS internet users on the internet and SNS Shifting task

Internet use group		Problematic SNS internet users		High SNS engagers		Moderate SNS users		Non-problematic SNS internet users	
Shifting Tasks RT		Internet	SNS	Internet	SNS	Internet	SNS	Internet	SNS
Condition		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
	Non-shift	342.06 (21.48)	346.14 (27.17)	360.34 (20.39)	355.60 (23.31)	343.20 (27.54)	343.97 (27.71)	348.90 (34.291)	353.91 (34.22)
	Shift	343.75 (24.29)	343.12 (28.28)	360.29 (24.94)	356.38 (21.35)	341.28 (28.94)	341.38 (28.54)	347.56 (36.29)	348.10 (34.21)
Type of target									
	House	337.76 (23.07)	338.10 (29.82)	352.46 (23.95)	351.69 (32.62)	334.80 (30.66)	334.07 (31.48)	342.06 (35.09)	342.54 (36.77)
	Internet/ SNS	348.04 (23.57)	351.16 (27.48)	368.17 (24.94)	360.29 (18.81)	349.69 (25.62)	351.28 (25.22)	354.40 (36.93)	359.46 (31.99)
D									
Condition									
	Non-shift	-0.01 (1.01)	0.13 (0.89)	-0.32 (1.01)	-0.08 (0.75)	0.10 (0.73)	0.06 (0.93)	0.04 (0.80)	-0.14 (0.94)
	Shift	0.15 (0.91)	0.15 (0.86)	-0.45 (1.04)	-0.11 (0.52)	0.10 (0.84)	-0.02 (0.82)	-0.05 (0.93)	-0.06 (0.97)
Type of target									
	House	0.01 (1.04)	0.15 (0.97)	-0.205 (0.89)	-0.10 (0.69)	-0.03 (0.76)	-0.05 (0.85)	0.12 (0.87)	-0.03 (1.03)
	Internet/ SNS	(0.12) (0.86)	0.13 (0.83)	-0.56 (1.02)	-0.09 (0.92)	0.24 (0.89)	0.09 (0.89)	-0.13 (0.98)	-0.18 (0.98)
C									
Condition									
	Non-shift	-0.12 (0.44)	-0.06 (0.41)	0.11 (0.39)	0.01 (0.31)	-0.04 (0.37)	-0.01 (0.44)	0.10 (0.53)	0.06 (0.47)
	Shift	-0.11 (0.33)	-0.13 (0.46)	0.29 (0.42)	0.05 (0.45)	-0.07 (0.36)	-0.07 (0.39)	0.04 (0.53)	0.17 (0.47)
Type of target									
	House	-0.07 (0.42)	-0.08 (0.42)	0.15 (0.35)	0.12 (0.41)	-0.03 (0.38)	-0.06 (0.45)	0.02 (0.55)	0.08 (0.38)
	Internet/ SNS	-0.16 (0.37)	-0.11 (0.43)	0.25 (0.52)	-0.07 (0.32)	-0.08 (0.34)	-0.03 (0.43)	0.12 (0.58)	0.16 (0.60)

5.4.7 Internet and SNS shifting tasks performance for generic internet users split by levels of urges to be online

Empirical evidence has shown that levels of cravings have an effect on inhibitory control processes in addicted individuals (Constantinou et al., 2010). Moreover, in Chapters three and four (Studies two and three) it was also found that levels of urges to be online did have an effect on attentional bias processes. Thus, in this study further analysis was performed with levels of urges to be online (two levels based on a median split scores on the QIUU; internet users with higher levels of urges to be online and internet users with lower levels of urges to be online) and their role upon inhibitory control processes was assessed.

A series of 4 way ANOVAs were performed with target image type (internet versus houses) and condition (shift versus non-shift blocks) as within factors and group (problematic, high engagers, moderate and non-problematic internet users) and levels of urges to be online (internet users with higher levels of urges to be online versus internet users with lower levels of urges to be online) as between factors for RTs, d’ and C for each task (internet shifting and SNS shifting tasks). A significant interaction between target, condition, levels of urges to be online and internet use group for the RT value in the SNS shifting task was found, $F(3, 93) = 7.17$, $p = .001$, $\eta p^2 = .19$ as well as a significant interaction between target, levels of urges to be online and internet use group for the C value in the internet shifting task, $F(3, 93) = 5.97$, $p = .001$, $\eta p^2 = .16$. For the above interactions, simple effect analyses were conducted to investigate the effect of the levels of urges to be online separately for each internet use group; there was no significant effect of levels of urges to be online. These results imply that levels of urges to be online did not have any effect on task performance on the SNS or internet shifting task for the generic internet users.

5.4.8 Internet and SNS shifting tasks performance for SNS internet users split by levels of urge to be online

A series of 4 way ANOVAs were performed with target image type (SNS versus houses) and condition (shift versus non-shift blocks) as within factors and group (problematic, high engagers, moderate and non-problematic SNS internet users) and levels of urges to be online (SNS internet users with higher levels of urges to be online versus SNS internet users with lower levels of urges to be online) as the between factors for RTs, d' and C for each task (internet shifting and SNS shifting task). A significant interaction between target, condition, levels of urges to be online and SNS internet use group for the C value in the SNS shifting task was found, $F(3, 93) = 3.34$, $p = .023$, $\eta p^2 = .10$. For the above interaction, simple effect analyses were conducted to investigate the effect of the levels of urges to be online separately for each SNS internet use group. However, there was no significant effect of levels of urges to be online. Overall, these results imply that levels of urges to be online did not have any effect on task performance on the SNS or internet shifting task for the SNS internet users.

5.5 Discussion

This study assessed cognitive functioning related to executive processes in a sample of internet users whose online behaviour ranged from non-problematic to problematic and this was related to either generic or specific (SNS) online applications. Overall, there were no differences in executive processes (inhibition and mental flexibility) between the groups of internet users as assessed with the emotional Go/No-Go tasks and evidenced with RTs, discrimination (d) and disinhibition (C) rates. Additionally, there was no evidence that cognitive bias for emotional stimuli (generic internet versus SNS images) influenced executive function processes, particularly those of problematic internet users.

However, one interesting finding was that all internet users processed generic and SNS internet-related stimuli more slowly compared to control/house stimuli when these were the target category. In order to comprehend why this might have happened we need to understand the principles underlying the emotional Go/No-Go task. This task was developed in order to assess whether emotional stimuli can affect inhibitory control processes (Noel et al., 2005). The idea was that because emotional stimuli elicit automatic responses, these would interfere with inhibitory control processes. This has been found to be particularly evident in individuals with elevated levels of inhibitory control for whom the emotional stimuli are notably salient (Adams et al., 2012; Decker & Gay, 2011; Noel et al., 2005). Thus, fast responses in the emotional Go/No-Go task can be considered to be another indication of deficient inhibitory control (Adams et al., 2012; Decker & Gay, 2011; Noel et al., 2005). This claim has been supported by Noel et al.'s (2007) study in which it was discovered that compared to detoxified alcoholics, social drinkers were quicker to respond to alcohol related stimuli and had higher commission errors (i.e. they pressed the go button when a no-go target was presented) for alcohol distracter words. Field and Cole (2007) in a complimentary response to Noel et al.'s (2007) work study argued that detoxified alcoholics had fewer commission errors compared to social drinkers because they processed the alcohol relevant information slower. Further, Noel et al. (2005) have also found that polysubstance alcoholics were, overall, slower to process alcohol and neutral stimuli compared to the normal controls. However, the former did have faster reactions for alcohol compared to neutral stimuli which was associated with higher rates of disinhibition and discrimination errors for those stimuli. Moreover, Rose and Duka (2008) conducted a study in order to assess the effect of alcohol intoxication on inhibitory control in a group of social drinkers. They found that social drinkers showed increased RTs to alcohol compared to neutral stimuli, regardless of the condition to which participants were assigned (primed with alcohol versus placebo). They suggested that because alcohol stimuli were more salient for social drinkers, they attracted a greater amount of attention which resulted in a prolonged processing time. Also, this processing was associated with an intact inhibitory control. Thus, following these suggestions it could be argued that slower processing time for online stimuli in this present study was another indication of intact inhibitory control which was also evidenced with discrimination and disinhibition rates.

The prolonged processing which was associated with online stimuli was evident in all internet users. This is contrary to studies which have found differences in processing times between groups, for example, of alcohol users (Adams et al., 2012; Noel et al., 2005, 2007). Referring to the argument put forward in Studies two and three (Chapters three and four), it could be argued that this might reflect some of the unique characteristics of online behaviour. More specifically, it has been suggested that compared to other addictive behaviours not only is there far less knowledge or awareness of the addictive potential of online behaviour but there is also an increased level of reinforcement from our contemporary environment to use the internet (for example, using emails in the work environment, using the internet for learning in educational institutions and socializing through social networking sites). This reflects the positive beliefs and attitudes people hold regarding internet usage which is in opposition to the negative ones commonly associated with other addictive behaviours. These beliefs and attitudes can influence the way we process information associated with each type of behaviour (Cox et al., 1999; Mogg et al. 2003; Townshend & Duka, 2007; Vollstädt-Klein et al., 2009). Thus, in this study the preference for generic and SNS online stimuli, as revealed with prolonged processing time might be the outcome of the positive beliefs and attitudes that all internet users have regarding online behaviour.

Overall, the lack of differences in inhibitory control processes amongst the groups of internet users was in opposition to the dual process theories of addiction which imply that deficits in the reflective processes are a marker of addictive behaviour (Bechara & Damasio, 2005; Wiers & Stacy, 2006; Wiers et al., 2007). However, similar outcomes were reported in Rose and Duka's (2008) study. One of the similarities between the present work and this scholars' study is that both used a pictorial version of the emotional Go/No-Go task. It has been suggested that pictorial images constitute a better ecological stimuli compared to lexical ones for the assessment of various cognitive processes in addicted individuals (Townshend & Duka, 2001). Additionally, based on the evidence from Studies two and three (Chapters three and four) where attentional bias was evident in generic and SNS problematic internet users from the assessment of using pictorial stimuli, in this study the same kind of images were selected in order to investigate further their role regarding executive control processes (inhibitory and mental flexibility). However, it could be argued that in both studies, the lack of observable deficits in reflective processes could be due to the type of stimuli used. This suggestion is grounded in evidence which has shown inhibitory control impairments from the field of addiction to be prominent under the lexical version of the emotional Go/No-Go task (Adams et al., 2012; Decker & Gay, 2011; Noel et al., 2005; 2007). Further support for this has come from a study which has assessed the effects of alcohol consumption upon inhibitory control in a group of light and heavy social drinkers that employed assessment using both lexical and pictorial version of the Alcohol Shifting task (Adams et al., 2012). More specifically, Adams et al. found greater levels of disinhibition was associated with alcohol distracters in all social drinkers primed with different doses of alcohol in the lexical version of the task. However, this was not evident for the pictorial version, where an opposite pattern was found. In this version higher levels of disinhibition were associated with the neutral distracters. Adams et al. argued that these differences in task performance between the two versions of the task might reflect the different neural regions that each type of stimuli engage with linked to inhibitory control processes. Thus, before firmer conclusions with respect to inhibitory control can be made concerning generic and SNS problematic internet users, further research should be conducted with a lexical version of the emotional Go/No-Go task. This will elucidate whether or not Adams et al.'s argument is valid and evident in the field of problematic internet use.

Similar to the findings for Studies two and three (Chapters three and four), in this study no difference in the self-report assessments of trait impulsivity between the groups of internet users was found. Low levels of impulsivity in the previous experiments did not seem to have affected the cognitive processes related to attentional bias. However, the findings from this study imply that this might not hold true for inhibitory control. This suggestion has also been validated by Lorains et al.'s (2014) study which assessed different facets of impulsivity (self-report and behavioural measures; the Stop Signal task, and the Stroop task) in problem gamblers. Although pathological gambling was conceived as being an impulse control disorder (APA-IV-TR, 2003), Lorains et al. failed to find a strong indication of impulsive behaviour as assessed with self-report and behavioural measures. They suggested that impulsive behaviour might not be a central marker of pathological gambling and it might be specific to certain subtypes. Their research was guided by evidence which has revealed differences between subgroups of pathological gamblers in terms of the motivation behind gambling, attentional processes, and inhibitory control etc. (Blaszczynski & Nower, 2002; Goudriaan et al., 2005; Grant, Odlaug, Chamberlain, & Schreiber, 2012). Similarly, Billieux, Lagrange, Van der Linden, Lançon, Adida, and Jeanningros (2012), found great heterogeneity in a group of pathological gamblers in relation to self-report assessments of impulsivity as well as behavioural assessments of inhibitory control, with some gamblers showing no deficits and others showing impairments in both facets of impulsivity. In the field of problematic internet use the evidence suggests that such claims seem to be applicable as findings are indicative of an association between trait impulsivity and inhibitory control (Cao et al., 2007; Choi et al., 2014; Dong et al., 2010; Dong, Devito, Du, & Cui, 2012; Zhou et al., 2010). Additionally, the findings from the present work and Zhou et al.'s study also indicate that such a claim is valid especially for the Go/No-Go task, as it appears that performance on the task is susceptible to levels of trait impulsivity. More specifically, low levels of self-report assessment of impulsivity were associated with intact performance in this study whereas the opposite was true for Zhou et al.'s study. However, no evidence exists regarding whether the same holds true for other behavioural tasks which assess different facets of inhibitory control in problematic internet users. For example, it has been found that high levels of trait impulsivity are associated with deficits in inhibitory control, as assessed with the Stroop and Stop Signal Task (SST), (Cao et al., 2007; Choi et al., 2014).These tasks capture the facets of inhibitory control which are related to conflict resolution and response inhibition to a preponent go signal respectively. However, to the best of our knowledge there is no study showing whether low levels of trait impulsivity associate with intact performance in these tasks. Thus, further research is required to clarify whether inhibitory control deficits reflect individual differences on trait impulsivity or whether these might also be associated with certain tasks which capture specific facets of inhibitory control. Support for the last suggestion has come from Rose and Duka's (2008) study where, for a sample of social drinkers, they found that alcohol priming affected performance on the classical and emotional Stroop task whereas it had no effect on the emotional Go/No-Go task. This indicates that it is certain aspects of inhibitory control which associate with conflict resolution, and are captured with the Stroop task, that are affected by alcohol consumption. Similarly, and based on the aforementioned argument, it could be suggested that for some internet users with low levels of trait impulsivity it might be other aspects of inhibitory control that are elevated.

A finding that is worthy of attention has come from two studies which have assessed the relationship between brain activation and inhibitory control processes using the Go/No-Go and Stroop tasks (Dong et al., 2010; 2012). Both studies reported no evidence of impairment in task performance in problematic internet users. However, in Dong et al.'s (2010) study it was found that problematic internet users had decreased and increased brain activity in areas that associate with conflict monitoring, response evaluation and inhibitory control processes respectively (lower no-go/N2 amplitude, higher no-go/P3 amplitude and higher no-go/P3 peak latency). Dong et al. (2010) interpreted these findings as reflecting compensatory effort made in order to overcome impairments in cognitive control. Similarly, Dong et al. (2012) in an fMRI study found that there was greater activity in brain areas which have been associated with inhibitory control processes, such as the anterior and posterior cingulate cortices, which was suggestive of diminished efficacy of response inhibition in problematic internet users. However, none of these studies assessed the levels of trait impulsivity and thus no inference in relation to the argument which has been put forward that low levels of trait impulsivity are associated with intact inhibitory control performance can be made. Further, even if it is hypothesized that this might be the case the findings then raise the question of why the underlying mechanisms show signs of impairments. It can be argued that brain activation studies can show meaningful differences in cognitive processes which are not yet subtle to produce robust behavioural effects. This has also been documented in the field of addictions (de Ruiter et al., 2012; Filbey & Yezhuvath, 2013). Following the same line of argument, it can be suggested that this might also reflect some of the characteristics of internet use. For example, computing has been argued to increase certain cognitive processes including inhibitory control, predominantly for online gamers (Aguilera & Mendiz, 2003; Boot et al., 2008; Decker & Gay; 2011; Green & Bavelier, 2008; Sun et al., 2010). In the present study, although our sample comprised generic and SNS internet users this does not mean that they do not play online games as well for this terminology simply implies that online gaming is not their predominant online activity. Thus, an argument which can be put forward is that even though problematic internet use might associate with deficits in inhibitory control processes, computer training might have remedied these deficits. This can be evidenced an intact behavioural performance and alterations in the underlying mechanisms associated with their function.

Problematic internet use has been conceived as a type of behavioural addiction which does not involve the chemical intoxication that is normally associated with substance abuse. Chemical intoxication has been suggested as causing or worsening inhibitory control processes in addicted population due to neurotoxicity in the brain areas underlying these functions that associate with substance consumption (Adams et al., 2012; Noel et al., 2007). Thus, it could be argued that in substance dependent individuals these deficits might be more prominent (Noel et al., 2005, 2007) as compared to behavioural addictions (Dong et al., 2010, 2012; Lorains et al., 2012). For this present study the design of the experiment was based on a well validated task which is also reliable in terms of the integration of emotional stimuli (Adams et al., 2012; Decker & Gay, 2011; Noel et al., 2005; 2007). However, it could be suggested that because of certain characteristics of problematic internet use, such as the fact that it does not involve chemical intoxication and the suggestion that computing training repairs possible deficits in inhibitory control, it might be that if deficits in inhibitory control are evident then these might best be captured with tasks which probably demand greater capacity of inhibitory control. One such task is the Stop Signal task which requires participants to withhold their responses to a prepotently learned go signal. The stop signal appears after the go signal has initiated a response and this requires greater capacity of inhibitory control. Evidence has shown deficits in task performance using the original version of the task (Choi et al., 2014). Thus, future research should also assess whether the emotional version of the task will show interference with inhibitory control processes. The Stop Signal task has been proposed for future research as it is the only one of the validated behavioural inhibitory control tasks which has found deficit performance in only problematic internet users. The Go/No-Go and Stroop tasks have found mixed evidence, which it has been argued, may reflect differences in trait impulsivity (Cao, 2007; Choi et al., 2014; Dong et al., 2010; 2011). Thus, assessing whether or not high levels of trait impulsivity associate with deficits or not in task performance in the stop signal task will elucidate upon the claim as to whether or not inhibitory control deficits reflect individual differences on trait impulsivity or whether these might also associate with certain tasks which capture specific facets of inhibitory control. Similar to Dong et al.'s studies, another avenue for future research will be to assess whether deficits in brain areas underlying inhibitory control will be evident in problematic internet users with intact behavioural performance and elevated levels of trait impulsivity. This will provide further validation for the claim regarding the effect of computing training upon inhibitory control.

Moreover, another objective of this study was to assess whether levels of urges to be online had an effect on inhibitory control processes. This investigation was based on evidence from Studies two and three (Chapters three and four) where levels of urges to be online were found to have an effect on attentional bias processes and drew upon the suggestion that motivational levels interfered with other cognitive processes (Franken, 2003). Considering the lack of studies in the area and the discrepancies in the findings from the field of addictions (Constantinou et al., 2010; Kozink et al., 2010; Verdejo-Garcia et al., 2012), this type of investigation was justified. Overall, no evidence was found that levels of urges to be online interfered with inhibitory control processes. Although these findings point to the different effects motivational levels have upon various cognitive processes (attentional versus inhibitory control) they do nevertheless require further validation. In light of the claims made above regarding the trait characteristics of impulsivity and the impact different behavioural tasks might have upon inhibitory control, future research could assess whether levels of urges to be online might also be susceptible to these variables. For example, research from the field of addictions has discovered no differences in task performance between opiate dependent individuals and normal controls in the Go/No-Go task, before and after experimentally manipulating induced craving levels, as reported through autobiographical craving scripts (Verdejo-Garcia et al., 2012). However, they did find increased error responses in the Stroop task for opiate dependent participants, which was mediated by individual differences in trait compulsivity (Verdejo-Garcia et al., 2012). In general, it was suggested that craving caused an interference effect on conflict resolution (which is associated with Stroop task performance) whereas it did not interfere with response inhibition (which is associated with the Go/No-Go task), (Chambers, Garavan, & Bellgrove, 2009).

Another objective was to validate whether there were qualitative differences between internet users with an emphasis given to certain psychopathological constructs. It was revealed that generic and SNS problematic internet users had higher levels of psychopathology compared to non-problematic generic and SNS internet users, which is consistent with established literature regarding generic problematic internet users (Cheung & Wong, 2011; Dong, Lu et al., 2011; Fu et al., 2010; Jang et al., 2008; Kelleci & Inal, 2010; Kormas et al., 2011). Additionally, considering the limited evidence concerning specific online applications the findings from this study have provided support that this finding also holds true for SNS problematic internet users. Thus, it can be argued that the differences between problematic and non-problematic generic and SNS users were evident on a psychopathological level, which validates the distinction made between the two groups, as based on Charlton and Danforth’s (2007; 2010) model. Moreover, assessment of the relationship between problematic generic and SNS internet users and high engagers revealed no differences between the groups on a psychopathological level. This is similar to the findings from Studies two and three (Chapters three and four) where it was argued that high engagers might represent individuals at risk or resilient in terms of developing problematic generic and SNS internet use. These claims need to be explored further with a longitudinal study in order to better understand the relationship of these two types of behaviour. This form of research will also help in identifying the factors which make high engagers resilient or vulnerable to problematic generic and SNS internet use. This would be very informative for the development of prevention and treatment options.

In conclusion, the results from the present study revealed that problematic generic and SNS internet users did not show any differences in inhibitory control processes in response to emotional stimuli compared to the other internet use groups. However, considering the multidimensional nature of impulsivity, further research is warranted that aims to capture other facets of inhibitory control in order for firmer conclusions regarding problematic internet users to be made.

Chapter Six: *General Discussion*

6.1 Review of the Experimental Aims

The main aim of this thesis was to investigate a controversial type of problematic behaviour, problematic internet use, and assess whether its characteristics resemble traditional types of addictions such as substance dependence and pathological gambling. In Chapter one the literature review evidence suggested that problematic internet use could be another type of behavioural addiction (Acier & Kern, 2011; Dong, Zhou, & Zhao, 2010, 2011; King & Delfabbro, 2013; Kuss et al., 2013; Pawlikowski et al., 2014; Ross et al., 2012; Tokunaga, 2014; Yau et al., 2013; Zhou et al., 2010). This necessitated further research with the emphasis on identifying similarities and differences in problematic internet use in relation to markers that have been reliably associated with the development and maintenance of addictive behaviours. This has important implications for the legitimacy of the construct of problematic internet use. Additionally, due to the nature of this type of problematic behaviour, researchers have questioned whether or not it is the internet *per se* or its applications that cause individuals to display problematic behaviour (Griffiths, 1999, 2010; Young, 1999). Thus, in this thesis I followed a pragmatic approach and comprehensively investigated behavioural and physiological markers of addictive behaviours in the field of problematic internet use. Moreover, emphasis was placed on assessing problematic online behaviours associated with activities which can only be pursued online, in order to elucidate upon the argument as to whether it is the internet *per se* or its applications that are the cause of problematic behaviour.

The main research questions were investigated in a sample of internet users whose internet use ranged from non-problematic to problematic and was associated either with generic or specific online applications; Social Networking Sites (SNS). The focus was placed on cognitive markers such as decision-making, attentional bias and inhibitory control processes, as these factors have been implicated as playing a major role in the initiation and maintenance of addictive behaviour. This investigation enhanced our understanding of 1) whether problematic internet use resembles other types of addictive behaviour and thus, 2) provided evidence as to whether it is a distinct psychopathological condition which would impact upon its classification as another type of behavioural addiction. Moreover, internet users whose problematic behaviours were either associated with generic or specific online applications were assessed. This was carried out in order to assess whether different potential subtypes of problematic internet use exist by investigating similarities and differences in the aforementioned cognitive processes. Finally, by focussing on a specific online application, SNS, which can only be executed in the online environment, further evidence was provided as to whether or not problematic internet use is a real psychopathological construct.

6.2 Summary of main findings

6.2.1 Decision-making processes

In Chapter two (Study one) the focus of the research was to investigate the way problematic internet users make decisions. Following and expanding upon the research within the field of substance-related and addictive disorders, it was assessed whether problematic internet users' decision-making processes are also characterized by "myopia for the future" (Bechara & Damasiom, 2002, Bechara et al., 2002; Goudriaan et al., 2006; Verdejo-Garcia & Bechara, 2009). This investigation built upon the observation that problematic internet users continue to overuse the internet despite the rise of negative consequences in their lives (e.g. loss of job, marital conflict). This is a characteristic of addictive behaviour and reflects the tendency of addicted individuals to make decisions based on immediate rewards such as to consume a drug or gamble while ignoring the long-term negative consequences of their behaviour (marital conflicts, socioeconomic problems). According to the Somatic Marker Hypothesis this inability to make choices in light of the long-term outcomes reflects a deficit in the generation of somatic markers (emotional related signals) whose role is in assisting cognitive processes to orient toward advantageous outcomes (Damasio, 1994; Verdejo-Garcıa & Bechara, 2009).

Research within the field of problematic internet use has provided contradictory evidence in relation to decision-making processes (Ko et al., 2010; Sun et al., 2009). However, the lack of assessment made regarding emotional processing assessment makes it difficult to understand whether or not these discrepancies reflect differences in the underlying mechanisms associated with cognitive processes. This argument has been validated from research in the field of substance-related and addictive disorders where differences in decision-making processes between substance dependent individuals were associated with the generation of emotional markers (Bechara & Damasio 2002, Bechara et al. 2002). Thus, in this work, emotional integration into decision-making processes was assessed in order to understand not only overt cognitive functioning but also the underlying mechanisms related to them: The Iowa Gambling Task assessed internet users' decision-making processes while the Skin Conductance Responses indexed emotional generation before and after participants made a decision with advantageous or disadvantageous outcomes. Overall, internet users with higher levels of problematic internet use made more disadvantageous choices (based their decisions on immediate rewards) and they showed a delay in acquiring a learning strategy regarding the contingencies of the decks compared to those internet users with lower levels of problematic internet use, which is in accordance with Sun et al.'s study (2009). In addition, this finding is suggestive of there being commonalities in decision-making processes with other types of addiction (Goudriaan et al., 2006; Verdejo-Garcia et al., 2007). Impairments in decision-making processes were independent of the levels of psychopathology and substance misuse history, which validates the assumption that it is a core characteristic of problematic internet use.

The major contribution of this study was the assessment of emotional integration during cognitive functioning. The evidence was indicative of differences in the mechanisms underlying this functioning in problematic internet users. More specifically, it was found that sensitivity to punishment guided decision-making processes in internet users with higher levels of problematic internet use. However, this differs from the "myopia for the future" and reward sensitivity which commonly guide the same processes in addicted individuals (Bechara & Damasio, 2002; Bechara et al., 2002; Goudriaan et al., 2006). Thus, it could be argued that the factors which might put individuals at risk of developing problematic internet use seem to be different from the ones putting them at risk of developing substance-related and addictive disorders.

This study enhanced our understanding in relation to the underlying processes associated with problematic internet use. The importance of sensitivity to punishment in online behaviour has been validated by research which suggests that personality traits, as well as psychological states in which sensitivity to negative feedback is a component such as anxiety, neuroticism and psychoticism, are vulnerability factors related to problematic internet use (Meerkerk et al., 2010; Park et al., 2013). However, a paradox emerged: if sensitivity to punishment guides decision-making processes, why then do problematic internet users continue to use the internet even though there is an increase in the negative outcomes of its use in their lives? One would expect negative outcomes (punishment) to guide internet users away from the internet. Regarding this, it could be argued that even though sensitivity to punishment initiates/motivates internet use, once online it might be the rewarding effects of the internet which reinforce such behaviour (Hinic et al., 2010), which is similar to other addictive behaviours (Bechara et al., 2002; Dawe & Loxton, 2004; Goudriaan et al., 2006; Grant et al., 2006; Reuter et al., 2005; van Holst et al., 2010; Volkow et al., 2013). This claim suggests that there are commonalities in the mechanisms related to their maintenance once they have developed, an assumption which was investigated further in the next experiment.

The findings of this study have important neurobiological implications. Deficits in performance on the Iowa Gambling Task have been suggested to underlie functional and structural alterations in the ventromedial prefrontal cortex (VMPFC) as well as the amygdala (Bechara et al., 1999). These brain areas are vital for the generation of somatic markers and they have been associated with deficits in decision-making processes in addicted populations (Bechara & Damasio, 2002; Bechara et al., 2002; Goudriaan et al., 2006). This assumption has been supported with neuroimaging studies which have revealed deficits in the function and structure in these brain areas in addicted individuals (Hommer et al., 1997; London et al., 2000; Stapleton et al., 1995). Thus, considering that internet users with higher levels of problematic internet use generated anticipatory somatic markers, it can be suggested that the VMPFC functions normally in this group. However, this group of internet users showed hypersensitivity to punishment. As the amygdala has been implicated as playing a role in responses related to punishment (Bechara et al., 1999), it can be argued that the behavioural and physiological outcomes of this group of internet users could be explained in terms of hypersensitivity of the amygdala, in such a way that it makes stimuli related to punishment magnify processing, especially in situations of risk. This evidence can have important implications with respect to the implementation of interventions aiming to help individuals at risk or those who have already developed problematic internet use.

A secondary aim of this study was to identify which online applications were associated with higher levels of problematic internet use. These were grouped into three categories. Category one was online gaming, category two was SNS and reflected activities such as meeting new online friends, updating personal homepages, communicating with online friends, and the final category covered a more generic set of online activities such as reading and posting messages on newsgroup/discussion groups, WWW-surfing, browsing and watching video content. Thus, in Chapter three (Study two), problematic online behaviour specifically related to these three categories which have been considered to constitute different subtypes of problematic internet use were assessed (Davis, 2001; Young et al., 1998b). Investigation of specific subcategory characteristics enhanced the understanding of the construct of problematic internet use as a whole. It validated its existence as a distinct psychopathological condition and has opened avenues for future research with emphasis on the assessment of specific characteristics of each subtype of online behaviour.

6.2.2 Attentional bias

In Chapter three (Study two), I expanded upon the implications of Chapter two (Study one), where it was argued that when online, problematic internet users' might find it difficult to control their behaviour. It was argued that this might reflect the power of internet stimuli to "highjack" and shape behaviour. This assumption has been well validated with studies within the field of addictions which have demonstrated that stimuli related to substances of abuse and non-substances (e.g. gambling) can influence cognitive and behavioural functioning (Field & Cox, 2008; Field et al., 2011, 2013; Honsi et al., 2013; Kang et al., 2012, Lubman et al., 2000, 2009; Robinson & Berridge, 1993, 2001). Thus, in this study, attentional bias processes as well as levels of urges to be online were assessed in a sample of internet users in order to 1) investigate whether attentional bias is evident in problematic internet users in a similar way to that reliably been found to associate with other addictive behaviour and, 2) assess the role of motivation (levels of urges to be online) regarding cognitive functioning.

Following the outcomes of the first experiment, levels of problematic internet use were assessed not only with reference to generic activities, but also for specific ones that can either be found predominately online (SNS) or offline as well (gaming). SNS involves online social related activities which have some unique characteristics compared to offline ones. For example, people can present themselves the way they like including creating false self-representations. In the offline social interaction this is more difficult to achieve. Also, in the online milieu, there is a lack of face-to-face communication and as such it can be a relaxing medium for social interaction especially for those individuals who have social anxiety problems. This type of communication hides any emotional cues which are evident when face-to-face communications take place and makes social interaction easier. In addition, online social interaction allows for communication with multiple people at the same time which is not so easy in the offline environment. Finally, it necessitates the use of media such as the internet, mobile phones etc. The aim was to identify problematic internet users for generic, SNS and online gaming applications in order to assess attentional bias for each potential subtype and assess whether attentional bias was online activity specific. This investigation was the first to directly assess similarities and differences of these potential different subtypes of problematic internet use.

It was revealed that generic problematic internet users with higher levels of urges to be online showed an increased preference for generic internet stimuli as assessed with eye tracking technology and verified with the duration of time spent looking at those images (the dwell time). The evidence pointed to similarities in the cognitive processes which have been implicated as underling initiation and maintenance of addictive behaviours (Robinson & Berridge, 1993, 2001). Additionally, when the proportion of internet users who reported either problematic SNS or online gaming was investigated it was found that 1) the number of problematic online gamers was very small so no further assessment was conducted and, 2) there was an overlap in the proportion of internet users who reported both generic and

SNS problematic internet use. Further comparisons were made on the attentional processes based on internet users who reported: only problematic generic internet use, only problematic SNS internet use and internet users who reported both generic and SNS problematic internet use. The findings show that only generic problematic internet users showed a preference for generic online stimuli. Therefore, this investigation justifies the claim that different subtypes of problematic internet use exist. Moreover, it is indicative that attentional bias is associated with the online activities for which internet users show a preference.

The high overlap between generic and SNS problematic internet use was indicative of the importance of emphasizing which particular online activities the researcher is referring to when assessing internet use so as to control for misinterpretations. If, for example, a pathological gambler who gambles online is assessed using generic questions related to online behaviour, it is highly possible that his/her profile will fit that of a problematic internet user. This has led to the debate concerning whether problematic internet use is real, as it can be argued that the problematic gambler simply uses the internet to gamble. Thus, the internet can be viewed as the medium to engage in an already existing problematic behaviour. In a similar way the same argument can be made for gaming as it is an activity that can be pursued both in an online as well as in an offline environment. These criticisms have questioned the validity of online problematic behaviour as a whole. Assessing whether addictive markers in internet users whose problematic behaviour can only be displayed online was a necessity for establishing the validity of the construct of online problematic behaviour as a whole.

Building upon the aforementioned argument and the findings from the second experiment, in Chapter four (Study three), attentional processes in internet users whose problematic behaviour was associated with SNS was assessed, which involve activities that can only be pursued online such as meeting new online friends, updating personal homepages, and communicating with online friends. The stimuli were modified and the decision was made to include SNS related images in order to assess whether attentional bias processes are related to the activities which the internet users showed a preference for. This claim has been validated in Study two as well as with those studies conducted regarding online gaming (Lorenz et al., 2013; Metcalf & Pammer, 2011; van Holst et al., 2012). The evidence was suggestive of attentional bias in problematic SNS internet users. Similarly to the Study two (Chapter three) levels of urges to be online mediated the relationship between attentional bias and severity of problematic online behaviour and the findings emphasized the role of not only trait but also state characteristics (motivational levels) regarding cognitive processes.

In order to validate that attentional bias is activity specific, generic problematic internet use in the sample of SNS internet users was assessed. Similar to Study two high levels of overlap between the two problematic behaviours were revealed. When assessing attentional bias between the groups of internet users based on generic and/or SNS classification, only the group who reported both problematic online behaviours showed a preference for the SNS stimuli. This suggests that when SNS users were assessed in terms of their generic internet use they referred to this as their SNS activities. This serves to account for why only this group showed a preference for the SNS stimuli. This finding illustrates the importance of communicating clearly the online activities to which the investigator is referring when conducting research in the area as failure to do this can result in the identification of characteristics which might not be representative of the specific subtype.

Overall, the findings suggested that different subtypes of problematic internet use exist, which although they have overt cognitive similarities such as attentional bias, these processes are specific to the stimuli associated with the preferred online activities (Studies two and three). This is in accord with research conducted with pathological gambling (McCusker & Getting, 1997). This outcome opens a new area of research where emphasis should be given to the assessment of the specific set of applications for which the internet users show a preference which can be either generic or specific (Davis, 2001). An important contribution of the two aforementioned experimental studies was that focus was given to online applications that can predominantly be pursued online which strengthens the argument of the validity of the construct of problematic internet use.

6.2.3 Inhibitory control

The final experimental study (Chapter five) was conducted based on the speculation from the field of substance-related and addictive disorders that it is not only the automatic responses that the substance and non-substance (gambling) related stimuli elicit which "highjacks" behaviour, but it must also be the inability of addicted individuals to reflect upon this behaviour and control the initiated automatic responses (Bechara & Damasio, 2005; Wiers & Stacy 2006; Wiers et al., 2007). It was argued that the combination of these two mechanisms relates to deficits in decision-making processes, in the way that addicted individuals lose their will power to control or abstain from their substance or non-substance (gambling) of abuse (Noel et al., 2010). The aforementioned experimental studies have demonstrated commonalities between problematic internet use and substance-related and addictive disorders in decision-making and attentional bias processes. Thus, the final experimental study addressed whether such similarities hold true for processes reflecting the ability to control an initiated automatic behaviour, which has been referred to as inhibitory control.

Inhibitory control processes were assessed in internet users whose problematic behaviour ranged from non-problematic to problematic and was associated with generic or specific online applications (SNS). Building upon the evidence gathered in this thesis that online stimuli have the power to grasp attention, whether or not similar interferences are evident in inhibitory control was assessed. Emotional stimuli related to substances of abuse have been demonstrated to influence inhibitory control processes in addicted sample populations (Noel et al., 2005, 2007). Two versions of the emotional Go/No-Go task were used; one containing pictorial stimuli related to generic online activities and the other containing SNS related images. The main aim was to assess whether deficits in inhibitory control processes were evident in problematic internet users. Another aim was to investigate whether these deficits were associated with the stimuli that internet users showed a preference for (generic versus SNS), in a similar way to attentional bias processes being online activity specific.

However, contrary to our hypothesis, there were no differences in executive functions (inhibitory control and mental flexibility) between the groups of internet users. Moreover, there was no evidence that deficits in inhibitory control might be prominent only when emotional stimuli related to the online activities problematic internet users showed preference for (generic versus SNS). Inhibitory control has been argued to be a central component of addictive behaviour (Billieux et al., 2010; Fuentes et al., 2006; Goudriaan et al., 2005; Kertzman et al., 2008; Kreusch et al., 2013; Lopez-Caneda et al., 2014; Verdejo-Garcia et al., 2010). However, emerging evidence now reveals that this might not be the case for addictive behaviours which do not necessitate the ingestion of chemical substances, such as pathological gambling (Lorains et al., 2014). More specifically, research has found that there is great variability between subgroups for example, of pathological gamblers in their inhibitory control (Billieux et al., 2012). Similar to the claims made in this thesis, researchers have argued that this variability might reflect individual differences in trait impulsivity. Moreover, it could be argued that inhibitory control deficits in behavioural addictions (Dong et al., 2010, 2012; Lorains et al., 2012) might not be as pervasive as in substance addiction (Noel et al., 2005, 2007) and that they might only be associated with a certain aspect of inhibitory control. A suggestion which has been put forward to account for these differences is that they might reflect the toxic effects of the substances. This assumption which has been validated with evidence that has found substances of abuse cause alterations in neural systems of the brain that underlie inhibitory control processes, and as such, cause or exaggerate inhibitory control deficits in addicted populations (Gallinat et al., 2006; Garavan, Kaufman, & Hester, 2008). Thus, similar to pathological gambling, inhibitory control deficits in problematic internet use might reflect individual differences in trait impulsivity and/or might be specific to certain aspects of inhibitory control.

Overall, considering the unique characteristics of problematic internet use and the experimental evidence presented in these sections, it can be argued that the mechanisms which have been implicated in the development and maintenance of substance-related and addictive disorders are also associated with problematic internet use. However, it can be claimed that problematic internet use resembles pathological gambling more closely. This might be because both are types of behavioural addictions, which means that they do not involve ingestion of substances. Thus, certain characteristics which are different from those pertaining to substance addictions could reflect changes in cognitive functioning caused by substance of abuse intoxication. This argument was put forward in order to explain why deficits in inhibitory control were not evident in problematic internet use.

6.3 Psychopathology and personality trait characteristics

A substantial volume of research within the field of problematic internet use has been devoted to the assessment of the emotional, psychological, functional, environmental and social problems as well as the personality characteristics of individuals whose internet use has been characterized as problematic (Tsai et al. 2009; Weinstein & Lejoyeux et al., 2010; Xiuqin et al. 2010; Yen, Ko, Yen, Chang et al., 2009). This has revealed a high co-occurrence between them, which has lead researchers to question the validity of problematic internet use (Collier, 2009; Pies, 2009; Griffiths, 2000). For example, a person with social anxiety might find the anonymity of the virtual world appealing and safe (Campbell et al., 2006) and as such uses the internet as a mechanism to ameliorate any discomfort that real world communication causes. The internet can be viewed thus as a platform to display another problematic behaviour. However, the fact that problematic internet use is associated with a variety of problematic behaviours is not on its own evidence that it is not a real psychopathological construct. This argument is too simplistic but nevertheless demands further research to elicit whether addictive markers are prominent in problematic internet use irrespective of the co-existence of other psychopathology or problematic behaviours.

Thus, a secondary aim of this thesis was to address this issue. In each experimental study that was conducted, there were batteries of questionnaires assessing levels of psychopathology (Studies one, two, three and four), history of substance misuse/family history of substance misuse or psychiatric condition (Study one) as well as assessment of personality traits (Studies one, two, three and four) which have all been implicated as associating with problematic internet use (Aboujaoude, 2010; Bernardi & Pallanti, 2009; Cao et al., 2007; Caplan, 2007, Cheung & Wong, 2011; Dong, Lu et al., 2011; Jang et al., 2008; Kelleci & Inal, 2010; Kormas et al., 2011; Mythily et al., 2008; Tsitsika et al., 2011; Weinstein & Lejoyeux et al., 2010; Yen et al., 2009; Yeon, 2009; Zboralski et al., 2009).

In Chapter two (Study one), it was found that although severity of problematic internet use was associated with elevated levels of psychopathology task performance was not. Additionally it was not associated with substance or psychiatric disorders. Different psychopathological constructs such as anxiety and depression have been implicated as affecting performance on the IGT task (Schmitt, Brinkley, & Newman, 1999). Thus, the findings in this study validate the assumption that deficits in decision-making processes are a characteristic of problematic internet use.

Elevated levels of psychopathology were also evident in problematic internet users in Studies two, three and four. However, their role in attentional bias processes (Studies two and three) was not assessed further, as there is no evidence from the field of substance-related and addictive disorders that levels of psychopathology affect attentional processes for stimuli related to substances or non-substances (gambling) of abuse. Attentional bias reflects automatic cognitive processes for stimuli which are of participants' interest/concern. Thus, if the internet was the medium to ameliorate another problematic behaviour, then no attentional bias for the internet-related stimuli would be evident (Studies two and three). Moreover, research concerning inhibitory control suggests that psychopathological constructs such as anxiety are associated with impairments in executive processes in substance dependent individuals (Karch et al., 2008). However, in study four there was no evidence of inhibitory control deficits with regards to problematic internet use. Thus, it can be argued that even though problematic internet use was associated with elevated levels of psychopathology, intact inhibitory control performance indicates that this is a characteristic of problematic internet use, which further validates its construct validity.

Trait impulsivity has been implicated as a characteristic of addictive behaviour (Dom et al., 2006; Finn, et al., 2005; Grano et al., 2004; Hair & Hampson, 2006; Treuer et al., 2001) as well as one of problematic internet use (Cao et al., 2007; Meerkerk et al., 2010; Mottram & Fleming, 2009). Thus, in this thesis the trait characteristics of impulsivity were assesssed and monitored in association with task performance, when applicable. More specifically, in

Study one, it was found that higher levels of impulsivity were associated with higher levels of problematic online behaviour. Nevertheless, similar to levels of psychopathology, impulsivity did not have any effect on task performance. This further validates the argument that a deficit in decision-making processes is a characteristic of problematic internet use. In Studies two, three and four there was no clear evidence of differences in the overall levels of impulsivity between the groups of internet users. However, the assessment criteria and stance taken in relation to the analysis was based on Charlton and Danforth's (2007, 2010) model of problematic internet use. The categorical approach of this model might have masked any trend which was evident in Study one. Therefore, further correlational analyses were conducted on the three questionnaires assessing the severity of problematic internet use (the IAT, PIUQ, AEQ - the addiction factor) regarding association to trait impulsivity. An association between the two constructs was only found in the second Study. This is suggestive that elevated levels of impulsivity might guide automatic responses (attentional bias) to substance-related stimuli (Field and Cox, 2008). However, if this suggestion was valid then it should have been applicable in Study three, which was not the case. Thus, the evidence up to now is supportive of the assumption that attentional bias is a characteristic of problematic internet use and that it is independent of impulsivity levels.

Finally, in Study four emphasis was given to the assessment of the relationship between different facets of impulsivity and problematic internet use. Overall, there was no evidence that these constructs were related. More specifically, levels of trait impulsivity and inhibitory control were similar amongst the groups of internet users. Research has demonstrated that elevated levels of trait impulsivity associates with impaired inhibitory control (Choi et al., 2014; Zhou et al., 2010). Thus, it could be suggested that the findings from this study might reflect individual differences in trait impulsivity amongst problematic internet users. For example, it could be argued that only the users with high levels of trait impulsivity also have impairment in inhibitory control. This assumption has been validated with research from the field of pathological gambling where subgroups of gamblers have been identified who differ in both trait impulsivity and inhibitory control (Billieux et al., 2012).

6.4 Assessment Criteria

As there is no official classification of problematic internet use under the DSM-5 (APA, 2013) a major problem in this field concern the inconsistencies in the ways researchers define and assess this problematic behaviour (Villella et al., 2011; Wang et al., 2011; Weinstein & Lejoyeux, 2010; Widyanto & McMurran, 2004; Widyanto et al., 2011; Young, 1996; 1998a). This has led to the debate as to whether or not researchers are communicating about the same or different constructs. In this thesis I aimed to sidestep some of the aforementioned issues by using the most validated questionnaires in the area. The aim of providing multiple assessments was to investigate the association between them and thus further validate whether or not they do measure the same characteristics of problematic internet use.

In Study one a dimensional approach for the assessment of problematic internet use, was adopted, gauginig users' problematic internet use on a range from low to high. Assessing a behaviour along a continuum is a method generally used (Helzer et al., 2006). Although the classification system employed in Studies two, three and four can be characterized as categorical, there is continuity in the categories as they span non-problematic, high engagement, moderate and problematic internet use. By so doing, my system does not apply arbitrary cut-off points defining problematic against non-problematic behaviour, but instead, assesses internet use along a continuum.

Charlton and Danforth's (2007, 2010) model for the assessment of problematic internet use (Studies two, three and four) was incorporated in order to assess not only similarities and differences between problematic and non-problematic internet use, but also high engagement. According to the assumptions of the model, although problematic and high engaging internet users spent a significant amount of their time on the internet, it is only problematic internet users who experience negative repercussions of the activity in their lives. It has been argued that it is the fact that there are negative outcomes in the person's life makes this behaviour significant. According to Charlton and Danforth (2007, 2010), a failure to make the distinction between the two can result in the overestimation of the problematic behaviour. Moreover, they posited that high engagement might represent a developmental stage of problematic use and as such, identifying its characteristics can be crucial for identifying individuals at risk of developing problematic internet use. This model has been validated with research conducted with regards to a specific online application (online gaming) and thus necessitates further validation for other potential subtypes of problematic internet use.

Overall, problematic internet users as assessed by Charlton and Danforth's (2007, 2010) model had higher scores on the two well validated assessments of problematic internet use (the IAT, PIUQ). This suggests that all these measurements assess similar characteristics of problematic internet use. In this investigation emphasis was placed not only on the qualitative differences between the groups of internet users on a behavioural level, but on the psychopathological levels as well. In Studies two and three, attentional bias was only evident in problematic internet use, which provides justification for the classification of problematic internet use according to the model. Additionally, comparisons across the three experiments in relation to psychopathological levels revealed qualitative differences between internet users. More specifically, problematic internet users scored higher on different psychopathological constructs compared to non-problematic ones. However, this was not evident when comparisons between problematic and high engager internet use groups were made. The similarities between them in relation to their levels of psychopathology could suggest that these factors are associated with increased levels of internet use, considering that both groups spent significant amounts of time online. This argument has been validated from research which has shown that individuals with depression, anxiety, social phobias and loneliness etc. frequently use the internet as a coping or escape mechanism for the distress they experience (Campbell et al., 2006; Caplan, 2002; Cheung & Wong, 2011; Hetzel-Riggin & Pritchard, 2011; Morahan-Martin, 1999). For example, socially anxious individuals perceive face-to-face interactions as highly unfavourable, whereas they typically perceive the online environment as a safer place for social interaction due to the lack of physical face-to-face encounters (Campbell et al., 2006). This preference for online interaction might make them more vulnerable to the addictive potential of internet use. However, the finding that high engagers had similar psychopathology as well as similar amounts of time online as problematic internet users poses the question as to whether this group of internet users might have unique characteristics which make them resistant to developing problematic internet use. On the contrary, the evidence can suggest that high engagers are individuals at risk of developing problematic internet use. The findings from this thesis are only indicative of the relationship between problematic and high engagement internet use and thus further research is warranted that places an emphasis on identifying the factors which make high engagers resilient or vulnerable to problematic internet use. This can be very informative for identifying individuals at risk of developing problematic internet use.

Finally, based on Metcalf and Pammer's (2011) criteria for problematic, high engagers and non-problematic online users, I found that there was a high proportion of internet users who did not fulfil any of the aforementioned proposed criteria for the three identified categories. I defined this category as moderate internet users and assessed whether they had similar characteristics as the non-problematic internet users. Evidence from the three experimental studies supported such an assumption as no overt differences between the two categories were observed.

6.5 Implications

Overall support of conceptualizing problematic internet use as another type of behavioural addiction

As discussed in Chapter one, there is increased awareness of the addictive potential of problematic internet use. However, the existence of controversies arising from experimental findings have led researchers to debate its validity as another type of addictive behaviour (Griffiths, 2000; Hinic et al., 2010; Pies, 2009; Yen et al., 2008; Young, 1996). The relatively robust findings from Chapters two, three and four suggest that cognitive markers such as decision-making and attentional bias processes function similar to other addictive behaviours. Thus, the evidence from this thesis further validates the view that problematic internet use is another type of behavioural addiction. This is the first body of evidence that has investigated simultaneously the various markers which have been implicated in the development and maintenance of substance-related and addictive disorders, and as such, it has provided a holistic understanding of problematic internet use.

Additionally, my research was based on well validated theories from the field of substance-related and addictive disorders. Considering that there is limited theoretically based research within the area of problematic internet use, a unique contribution of this thesis is that it provides a theoretical background for future research. For example, it was suggested in Chapter one, that one way to avoid confusion in the area concerning assessment criteria and definitions would be for researchers to share a common theoretical framework.

By assessing not only overt but also the underlying mechanisms related to cognitive processes, I identified unique characteristics of problematic internet use. Similarly, although overt similarities exist between different types of addictions, research indicates that there are characteristics which are unique to each of them. For example, withdrawal symptoms associated with alcohol dependence can be severe to the point of being fatal. On the other hand nicotine withdrawal is mild and has minimal adverse effects. This thesis revealed that there are differences in the underlying mechanisms associated with problematic internet use (sensitivity to punishment) in comparison to other types of addictions (sensitivity to reward), (see Chapter two). However, although these two processes might seem different they could lead to the same outcomes which is that individuals try harder to get rewards, but approach this from two different angles: loss aversion for problematic internet users and reward seeking for addicted individuals. Moreover, these findings suggest that individuals with personality traits as well as psychological states in which sensitivity to negative feedback is a component such as anxiety, neuroticism and psychoticism, might be at risk for developing problematic internet use. This has important implications for research focusing on identifying individuals at risk. Further, it establishes the foundations for research investigations which focus on treatment and prevention strategies, for understanding the different factors which are unique and associate with the specific “disorder” in question, is fundamental for the development of effective and efficient interventions.

Another difference between problematic internet use with substance-related and addictive disorders was that problematic internet users showed no sign of inhibitory control deficits as assessed with the emotional Go/No-Go task. As mentioned in the experimental aims in subsection 6.1, deficits in the emotional Go/No-Go task for individuals with substance addiction, could be associated with chemical intoxication related to the substance use. This has some important implications as it suggests that by studying behavioural addictions we can acquire a better understanding of the mechanisms associated with the development of substance addictions without the confounding impact of chemical intoxication changes which might damage certain involved mechanisms further. However, this type of research warrants further confirmation.

A substantial amount of research in the field has been conducted with online gaming which arguably is an activity that can also be found offline (Stern, 1999). In this thesis, the emphasis was on online applications which can only be pursued online and as such, provided further support that problematic internet use is real, and not just the medium employed to display another problematic behaviour (Griffiths, 2010; Young 1998b). Furthermore, the assessment of different subtypes of problematic internet use provided increased awareness of the importance of emphasizing the online activities to which the researchers are referring as there was a tendency for participants to associate their internet use with the activities for which they show a preference for. Moreover, the results presented in this thesis are the first experimental findings which have directly compared cognitive processes in different proposed subtypes of problematic internet use. It was found that attentional bias was related to the online activities that each subtype showed a preference for, which validates the suggestion that problematic internet use consists of different subtypes. Failure to identify subtypes of problematic internet use might have resulted in conflicting evidence. In this regard the findings from this thesis have opened new avenues for research with the focus on identifying the potential unique characteristics of different subtypes, in order to acquire a comprehensive understanding of problematic internet use as a whole.

6.6 Limitations

Whilst the experimental studies in this thesis have provided a better understanding of the addictive potential of problematic internet use and have increased awareness of the pitfalls of simplifying this type of behaviour by not identifying specific subtypes, there are some limitations that need to be accounted for in future research.

In the samples of internet users in all the experimental studies there were higher proportions of female participants compared to male. Although gender is a factor which can account for differences in task performance (Naglieri & Rojahn, 2001; van den Bos, Homberg, & de Visser, 2013; Yuan, He, Qinglin, Chen, & Li, 2008), the ratio of male/females overall did not differ between the groups of internet users and thus we could have confidence that any differences were not due to gender discrepancies. Moreover, these discrepancies in gender ratio are well documented in the field of problematic internet use (Campbell et al., 2006; Caplan et al., 2005; Jang et al., 2008) and have been attributed to the relatively greater willingness of female participants to disclose personal information (Young, 1998a).

When assessing online users' behavioural characteristics based on either levels of urges to be online or their problematic behaviour for both generic and specific SNS applications, subdividing the groups into subgroups resulted in a smaller sample size which could have limited the power of the analysis (Field et al., 2009). Thus, any comparisons were only suggestive. However, these type of analyses were of secondary research interest explorative in nature and warrant further validation and confirmation.

This was the first study in the field of problematic internet use where pictorial stimuli were used to assess attentional bias. As such, a major challenge was encountered regarding the development of control images which were used as comparison images against internet-related ones. Two types of control stimuli were assessed; computer and non-computer related images. With the inclusion of computer images, which appeared to be the best option for control images there was the danger that any cognitive bias differences might have been masked because the internet and computer images were perceptually very similar and, because computers are the most commonly used medium to be online. In order to account for these possibilities a second type of control images was introduced, the non-computer ones which resembled to a lesser degree the online images, but had similar content. When a secondary analysis was conducted in order to assess which of the two types of control images was better for assessing attentional bias differences, the number of the total trials were subdivided according to the type of control image they contained. It could be suggested that by reducing the number of trials there is the possibility that the power of the analysis is reduced. In order to overcome this limitation one possibility could be to increase the overall trial numbers. However, due to the technical problems associated with the eye tracker equipment the total number used in my experiment was limited. More specifically, with the specific model of eye tracker used, it emerged that recalibration was required after carrying out 60 experimental trials. This would entail stopping and restarting the experiment which could possibly interfere with the experimental findings. Considering that eye-movement assessment has been suggested to be the most robust measure of attentional bias (Field, Mogg, & Bradley, 2004b; Miller & Fillmore, 2010) it can be argued that it could counterbalance the limitation of restricted experimental trials.

For this study, the sample of internet users consisted largely of a student population. This arguably could eliminate the generality of our findings. However, one of the aims of this thesis was to assess online activities which can predominately be pursed online. It has been proposed that different subtypes of problematic internet use exist (Young et al., 1998b) and as such, it could be argued that there is high variability in relation to online activities internet users prefer. Considering that the student population uses the internet mainly for socializing (Office for National Statistics, 2014), by focusing on this particular population I could assess the activity that the majority of them prefer to undertake while online.

Moreover, it could be suggested that the lack of between group differences could reflect limitations associated with the assessment criteria or the experimental tasks employed. In relation to assessment criteria, as argued in the subsection on assessment criteria there were similarities in scores amongst the three different assessment measures that were employed. In detail, two of them comprised the most widely used and validated questionnaires and this justifies my argument that all measures assess similar aspects of problematic internet use. Also, further validation came from the psychopathological differences between the groups of internet users, as revealed through all the experimental chapters, as well as the finding that certain cognitive processes were evident only in problematic internet users (Chapters two, three and four).

In regards to the experimental tasks, the Visual Dot-Probe task was chosen as it has been well validated within the field of substance-related and addictive disorders as capturing attentional bias for emotional stimuli with eye tracker technology (Brevers, Cleeremans, & Bechara et al., 2011; Field, Eastwood, Bradly, & Mogg, 2006; Mogg et al., 2003). Variours other tasks are available for the assessment of attentional bias processes such as the Stroop, Flicker etc., but for these far more limitations have been reported than for the Visual Dot-Probe task. More specifically, the Stroop task has been criticised concerning whether interferences effects reflect not only attentional but other cognitive processes, such as the cognitive effort to suppress ongoing processes that might be caused by memories that the stimuli trigger, or general deficits in inhibitory control which can also disturb task performance (Cox et al., 2006; Field & Cox, 2008; MacLeod, 1991; Mogg et al., 2003). In addition, although this task can index allocation of attention it cannot clarify whether this reflects mechanisms related to avoidance or approach behaviour (Townshend & Duka, 2007). Similarly, the emotional Go/No-Go task was chosen based on its reliability established in the assessment of the effects of emotional stimuli upon inhibitory control with substance-related and addictive disorders (Adams et al., 2012; Noel et al., 2005, 2007). Although other tasks such as the Stop Signal, Stroop etc. have been used to assess inhibitory control processes they lack validation with emotional stimuli. Furthermore, these tasks capture different aspects of inhibitory control and they thus might not be appropriate for making comparisons with inhibitory control processes associated with the emotional Go/No-Go task.

Although attentional bias processes were suggestive of problematic internet use, there was a lack of a clear difference between the groups (Chapters three and four) which is contrary to research conducted with regards to substance-related and addictive disorders (Cousijn et al., 2013; Field & Cox, 2008; Field et al., 2011, 2013; Honsi et al., 2013; Weafer & Fillmore 2012). However, internet use has some distinct characteristics which differentiates it from any other type of addictive behaviour. For example, it has been suggested that compared to other addictive behaviours, there is not only far less knowledge and/or awareness of the addictive potential of online behaviour but there is also an increased level of reinforcement from our everyday environment to use the internet (for example, using emails in the working environment, using the internet for accessing learning resources in a university and socializing through social networking sites etc.). This reflects the positive beliefs and attitudes people have regarding internet use which is in contrast to the negative ones commonly associated with other addictive behaviours. These beliefs and attitudes can influence the way we process information pertaining to each type of behaviour (Cox et al., 1999; Mogg et al. 2003; Townshend & Duka, 2007; Vollstädt-Klein et al., 2009). Overall, it can be argued that the lack of between group differences in attentional processes could reflect the social acceptability of the internet which is unlike many people's attitudes towards substances of abuse.

6.7 Future research

The findings from this thesis have important theoretical and practical implications. However, further research is required so far more coherent conclusions can be made in relation to the various factors involved in the development and maintenance of problematic internet use. Building upon the evidence from this thesis, future research should reflect the role of motivational factors, such as sensitivity to punishment (trait characteristic) or levels of urges to be online (state characteristics). This is because these constructs have been found to associate with cognitive processes related to problematic internet use, such as decision-making and attentional bias.

More specifically, state motivational levels (levels of urges to be online) were found to mediate the relationship between the severity of problematic internet use and attentional bias. Thus their role regarding attentional processes and as a consequence, upon problematic internet use warrants further investigation. Future research should experimentally try to manipulate state motivational levels. One way to do this could be to ask problematic internet users to minimize their internet use for few day for example, by reducing this to half an hour a day and to use only basic functions, such as checking emails once a day. By so doing, we could then assess attentional bias processes before and after manipulation. This will provide a better understanding as to whether motional levels have a direct effect upon cognitive functioning in problematic internet use. Research from substance-related and addictive disorders has demonstrated increased vigilance for substance stimuli when craving levels were high (Field, Mogg, & Bradley, 2004a; Field et al., 2005; 2013; Franken et al., 2000a; Mogg et al. 2005). Moreover, this has been associated with increased relapse rates when individuals are trying to abstain from the substance. Similarly, if motivational levels are found to increase vigilance for online stimuli in problematic internet users, then this can have important implications when implementing strategies geared towards controlling problematic internet use.

In this thesis it was found that attentional bias processes were associated with the online activities for which internet users' showed a preference. This evidence provided support for the claim that problematic internet use consist of different subtypes. Thus, future research is warranted that focusses on identifying more characteristics of each subtype as well as the commonalities between them. In Study one, there was no focus on subtypes of problematic internet use. However, three groups associated with online applications which internet users spent most of their time on and which have been proposed as forming subtypes of problematic internet use were identified (Young et al., 1998b). The results from Study one indicate that sensitivity to punishment was associated with cognitive processes and reflected the motivation underlying internet use. However, considering that subgroups characteristics were not analysed and potential differences could have been masked, future research should assess the underlying mechanisms. These should be assessed with SCRs associated with decision-making processes in the three aforementioned subgroups in order to validate whether or not sensitivity to punishment guides decision-making processes in these different subtypes of problematic internet users. Understanding the mechanisms which guide decisions can have important implications for our understanding of the motives associated with online behaviour.

Finally, based on the implications for inhibitory control outcomes in respect to problematic internet use future research should focus on two areas. Firstly, the evidence from Study four was suggestive that problematic internet users did not differ in their levels of trait impulsivity from non-problematic internet users and also did not have different patterns of inhibitory control. However, future research should look into whether this does not hold true for problematic internet users with elevated levels of trait impulsivity. This will illuminate whether individual differences underlie differences in inhibitory control in problematic internet users. Moreover, it was argued that impairments in inhibitory processes might be evident in tasks capturing aspects of inhibitory control other than the ones assessed with the Go/No-Go task. Although the selection (Go/No-Go task) was based on established research from the field of substance-related and addictive disorders (Adams et al., 2012; Noel et al., 2005; 2007) due to the nature of problematic internet use more robust measures of inhibitory control might be required to captured deficits in inhibitory control. One such task is the Stop Signal task which necessitates response cancelation and thus has been said to increase inhibitory control demands. Future research should include emotional stimuli in the Stop Signal task for a group of internet users who vary in their levels of trait impulsivity. This will shed light on whether any apparent deficits in inhibitory control are evident and associated with individual differences or are task specific.

6.8 Practical implications

The findings from this thesis have some potential practical implications regarding the development of intervention strategies. For example, research from substance-related and addictive disorders has argued that attentional bias is either causing or indexing the underlying mechanisms related to substance seeking behaviour (Robbins & Ehrman, 2004). Based on this belief, researchers have developed interventions aiming to alter attentional bias processes and assess their effects on craving levels and substance seeking behaviour

(Fedardi & Cox, 2009; Field & Eastwood, 2005; Field et al., 2007; Kerst & Waters, 2014; Schoenmakers et al., 2010; Wiers & Stacy 2006). The evidence is quite promising as it indicates that direct manipulation of attentional bias can influence both behavioural and motivational outcomes. In an analogous way it can be argued that problematic internet users could be trained to avoid internet stimuli and steps taken to assess whether this will have an impact upon their internet use. This will demonstrate whether, when provided with appropriate training aiming at controlling and reducing internet use, problematic internet users can use the internet in a way that does not interfere with their everyday lives.

The finding from the decision-making experiment suggested that sensitivity to punishment reflected the motivation underlying problematic internet use. More specifically, it was argued that personality traits as well as psychological states in which sensitivity to negative feedback is a component such as anxiety, neuroticism and psychoticism are vulnerability factors related to problematic internet use (Meerkerk et al., 2010; Park et al., 2013). It has been suggested that individuals with elevated levels in the aforementioned constructs use the internet in an attempt to escape or ameliorate negative affective states associated with their everyday world interactions. Thus, future research should assess whether interventions such as motivational or cognitive behavioural therapy can alter the distorted beliefs problematic internet users have for the world, and as such, whether they have an effect in controlling and altering this problematic behaviour.

6.9 Concluding Comments

In my thesis I examined cognitive markers of addictive behaviour in a group of internet users whose internet use ranged from non-problematic to problematic. Focus was given on cognitive processes that have been robustly associated with addictive behaviour such as decision-making, attentional bias and inhibitory control. Emphasis was placed upon both behavioural as well as physiological assessments of cognitive processes. Overall, the evidence was suggestive of similarities between problematic internet use and established addictions. However, problematic internet use appears to have some unique characteristics that differentiate it from other types of addictions. Moreover, subtype specific characteristics were revealed, which is evidence that warrants further investigation. On a theoretical level, this thesis has important implications as it has enhanced our understanding of the factors associated with the development and maintenance of problematic internet use.

In conclusion, the evidence from this thesis indicates the addictive potential of problematic internet use. This thesis provided an insight into key changes related to everyday cognitive processes which have been associated with problematic internet use while incorporating its unique characteristics. However, considering that internet use has become in the last few years an inevitable part of our lives, more time and effort are required in order to identify further potential negative outcomes which might become evident with long-term internet use.

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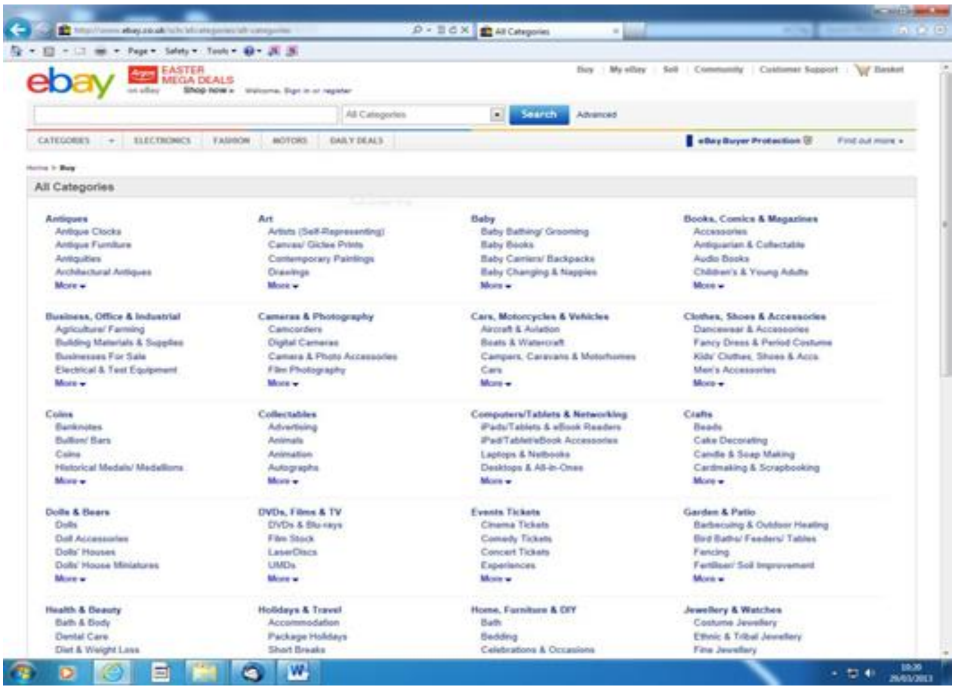
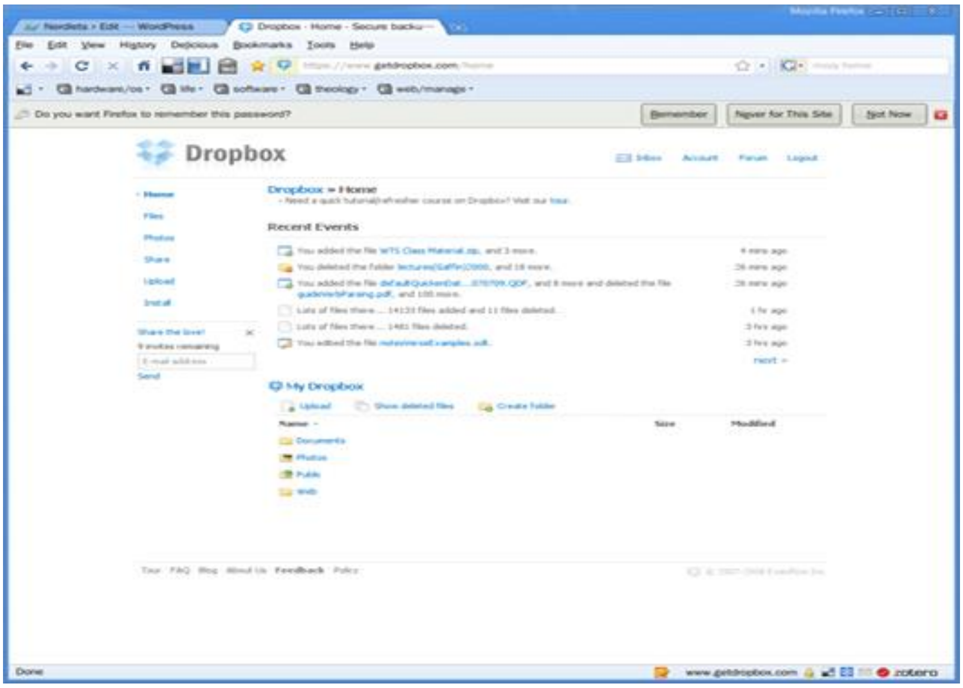
Appendix I

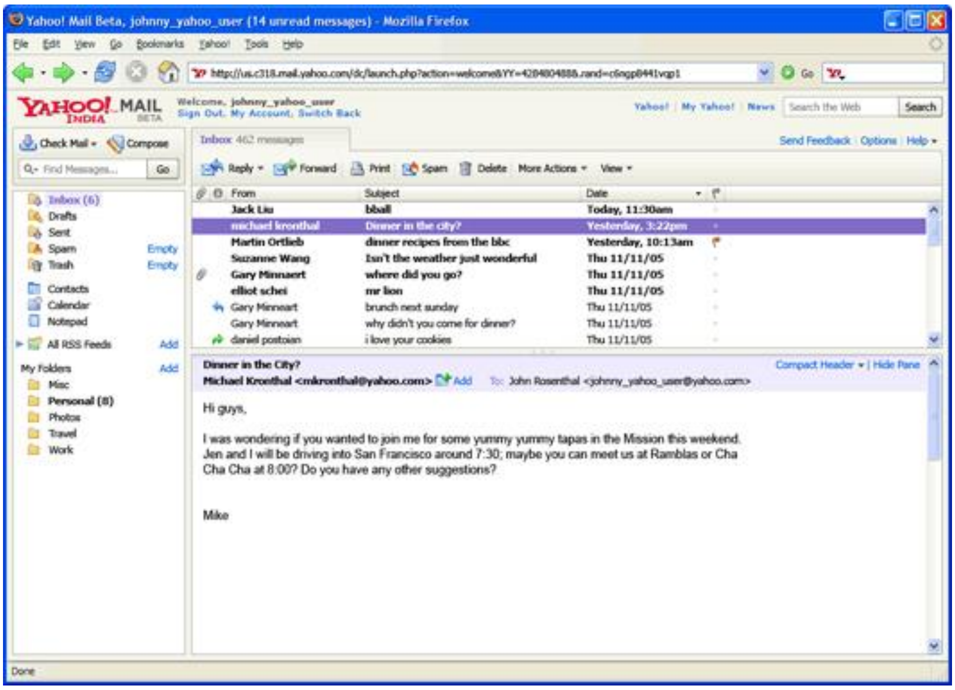
Images used in study 2

Generic Internet

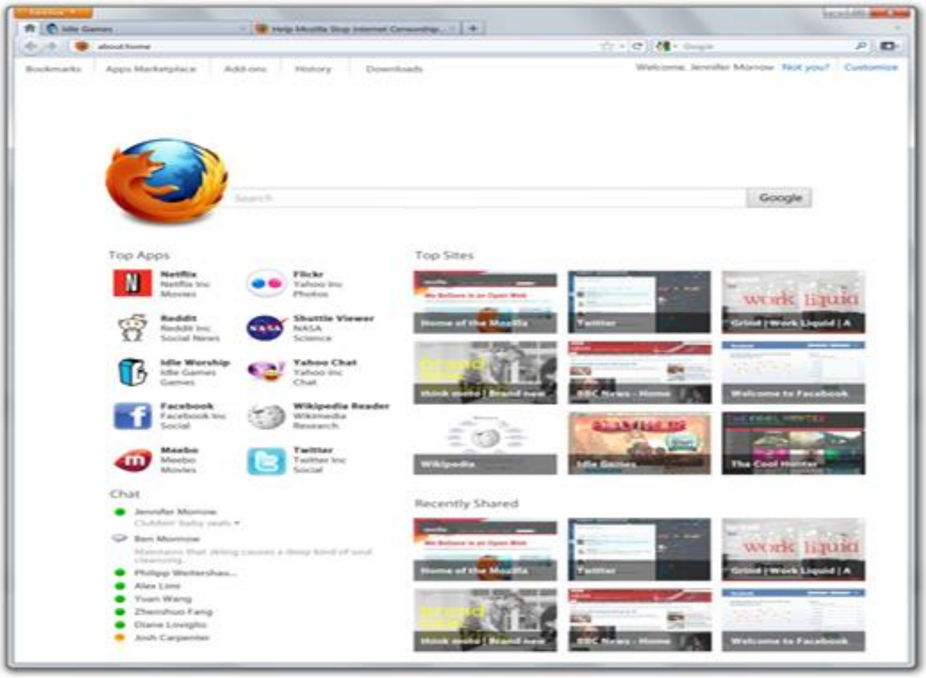




Do you want Firefox to remember this password?
Remember
Never for This Site
Not Now
Dropbox
Dropbox » Home
Recent Events
My Dropbox

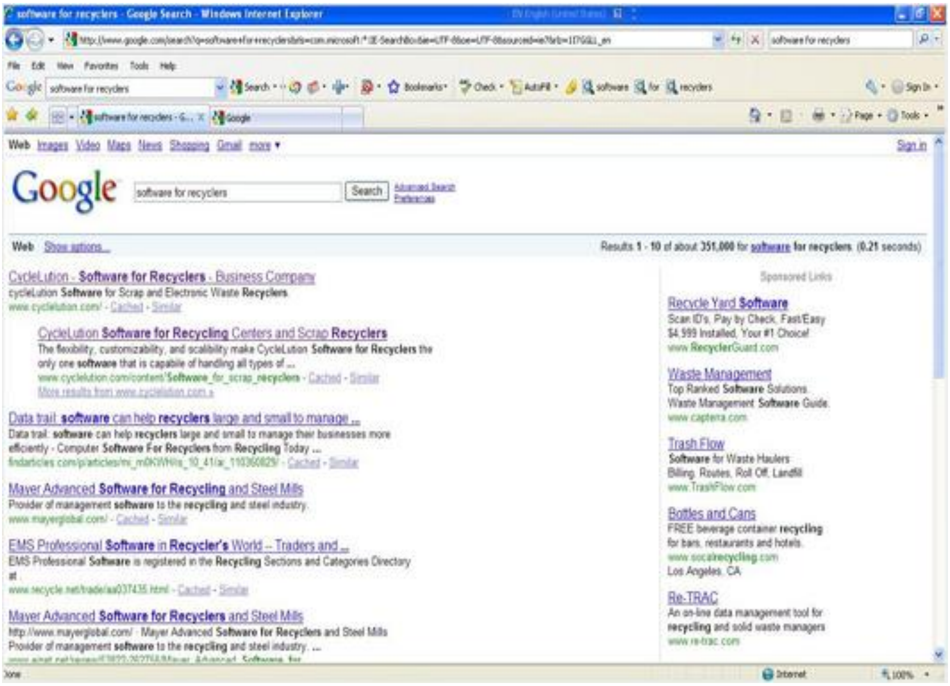


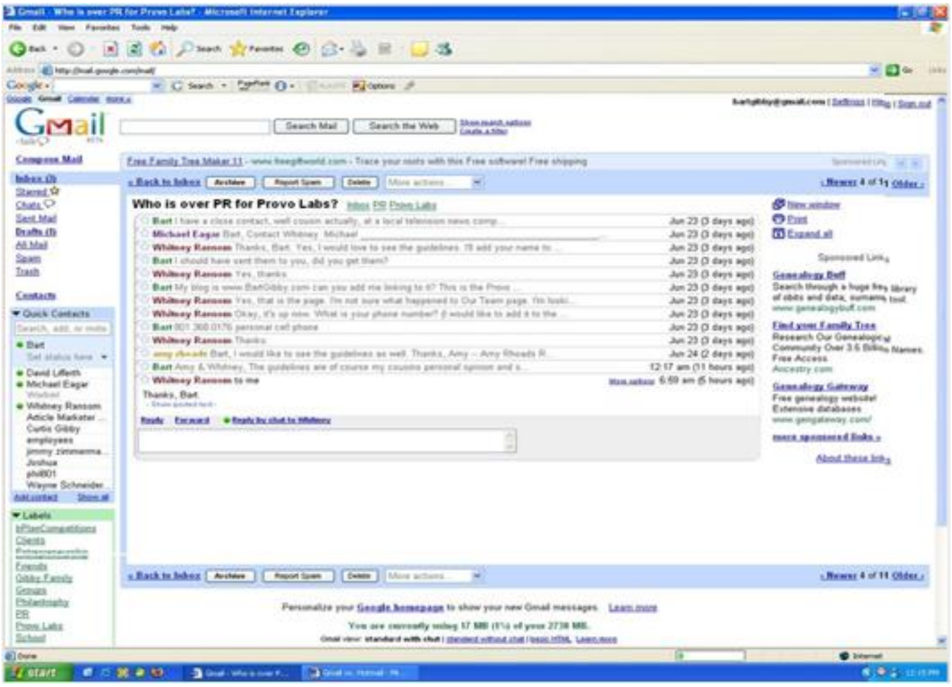
Yahoo! Mail Beta, johnny_yahoo_user (14 unread messages) - Mozilla Firefox
Welcome, johnny_yahoo_user
Sign Out, My Account, Switch Back
Check Mail
Compose
Inbox 462 messages
Reply
Forward
Print
Spam
Delete
More Actions
View
Inbox (6)
Drafts
Sent
Spam
Trash
Contacts
Calendar
Notepad
All RSS Feeds
My Folders
Misc
Personal (8)
Photos
Travel
Work
From
Subject
Date
Jack Liu
bball
Today, 11:30am
michael kronthal
Dinner in the city?
Yesterday, 3:22pm
Martin Ortlieb
dinner recipes from the bbc
Yesterday, 10:13am
Suzanne Wang
Isn't the weather just wonderful
Thu 11/11/05
Gary Minnaert
where did you go?
Thu 11/11/05
elliot schei
mr lion
Thu 11/11/05
Gary Minnaert
brunch next sunday
Thu 11/11/05
Gary Minnaert
why didn't you come for dinner?
Thu 11/11/05
daniel postoian
i love your cookies
Thu 11/11/05
Dinner in the City?
Michael Kronthal <mkronthal@yahoo.com>
To: John Rosenthal <johnny_yahoo_user@yahoo.com>
Hi guys,
I was wondering if you wanted to join me for some yummy yummy tapas in the Mission this weekend. Jen and I will be driving into San Francisco around 7:30; maybe you can meet us at Ramblas or Cha Cha Cha at 8:00? Do you have any other suggestions?
Mike

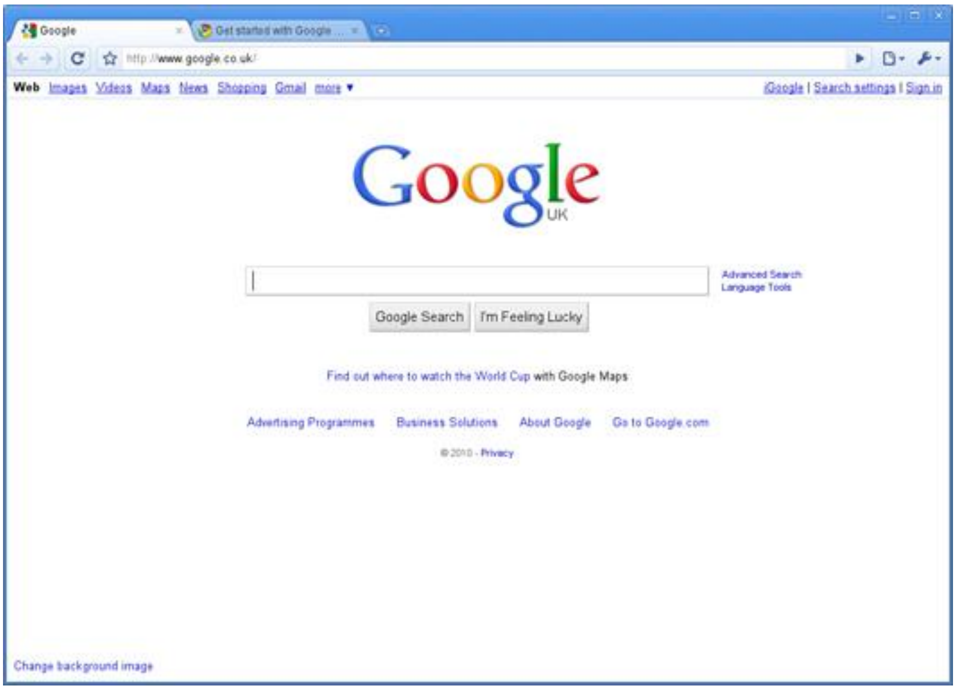


Google
Top Apps
Netflix
Flickr
Reddit
Shuttle Viewer
Idle Worship
Yahoo Chat
Facebook
Wikipedia Reader
Meebo
Twitter
Chat
Top Sites
Recently Shared
work liquid

BBC NEWS | News Front Page - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://news.bbc.co.uk/
BBC NEWS | News Front Page
Science News - The New York Times
BBC
Low graphics Help
Search
Explore the BBC
NEWS
Watch ONE-MINUTE WORLD NEWS
Notice anything different? Find out about changes to the BBC News website
News Front Page
Page last updated at 12:19 GMT, Thursday, 25 June 2009 13:19 UK
News Feeds
LATEST: Al-Qaeda's North African branch say they _
'Severe curbs' on Iran's Mousavi
Iran's protest leader Mir Hossein Mousavi complains about "complete" restrictions on him and a crackdown on his media.
Poll row set to rage on
Video map of Tehran protests
Jeremy Bowen in Tehran
OTHER TOP STORIES
Politkovskaya case to be retried
African al-Qaeda 'killed' US man
'Shift needed' in Afghan combat
US governor admits having affair
New cancer drug 'shows promise'
Many sharks 'facing extinction'
SPECIAL REPORT: TALIBAN CONFLICT
A very strange funeral
Burying the Pakistani tribal chief who broke from Taliban
Risk factor
Voices from the 'danger zone'
Africa
Americas
Asia-Pacific
Europe
Middle East
South Asia
UK
Business
Health
Science & Environment
Technology
Entertainment
Also in the news
Video and Audio
Have Your Say
In Pictures
Google access disrupted in China
Access to Google has been disrupted in parts of China, amid a row over what internet users can view and pornography.
Oscars expand best film category
The best picture shortlist at the 2010 Academy Awards will be doubled to 10 films, it is announced.
VIDEO AND AUDIO NEWS
Could there be life on
Iran films reflect social
ALSO IN THE NEWS
Stoned wallabies 'make crop
Done


software for recyclers - Google Search - Windows Internet Explorer
Web Images Video Maps News Shopping Gmail more
Sign in
Google
software for recyclers
Search
Advanced Search
Preferences
Web Show options...
Results 1 - 10 of about 351,000 for software for recyclers. (0.21 seconds)
CycleLution - Software for Recyclers - Business Company
cycleLution Software for Scrap and Electronic Waste Recyclers.
CycleLution Software for Recycling Centers and Scrap Recyclers
Data trail: software can help recyclers large and small to manage ...
Mayer Advanced Software for Recycling and Steel Mills
Provider of management software to the recycling and steel industry.
EMS Professional Software in Recycler's World -- Traders and ...
EMS Professional Software is registered in the Recycling Sections and Categories Directory
Mayer Advanced Software for Recyclers and Steel Mills
Sponsored Links
Recycle Yard Software
Scan ID's, Pay by Check, Fast/Easy
$4,999 Installed, Your #1 Choice!
www.RecyclerGuard.com
Waste Management
Top Ranked Software Solutions.
Waste Management Software Guide.
www.capterra.com
Trash Flow
Software for Waste Haulers
Billing, Routes, Roll Off, Landfill
www.TrashFlow.com
Bottles and Cans
FREE beverage container recycling
for bars, restaurants and hotels.
www.socalrecycling.com
Los Angeles, CA
Re-TRAC
An on-line data management tool for
recycling and solid waste managers
www.re-trac.com

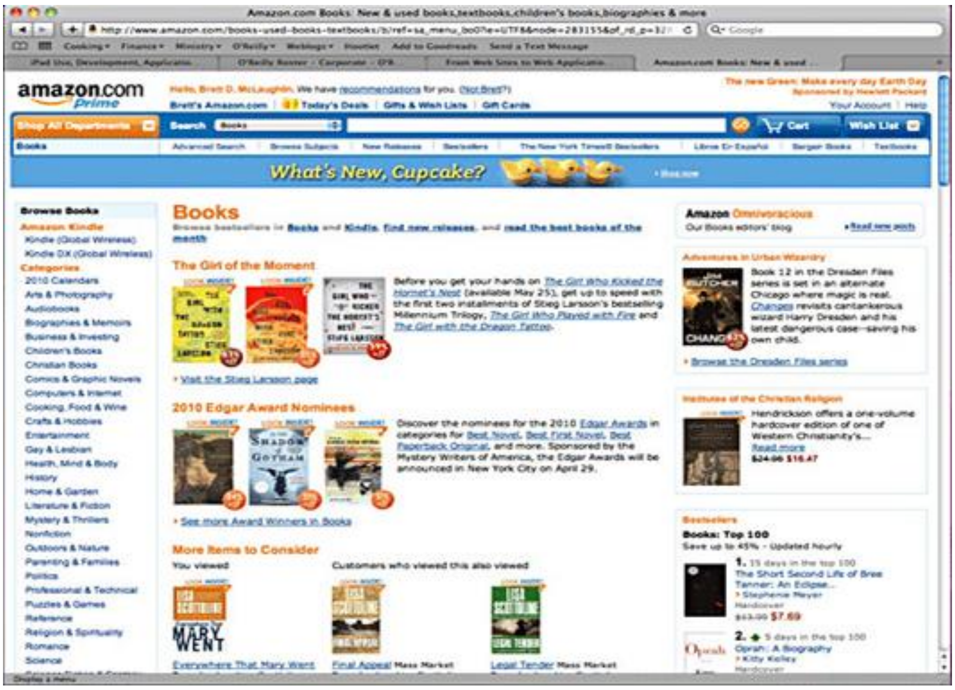

Gmail
Search Mail
Search the Web
Compose Mail
Who is over PR for Provo Labs?
Sponsored Links
Genealogy Buff
Find your Family Tree
Genealogy Gateway

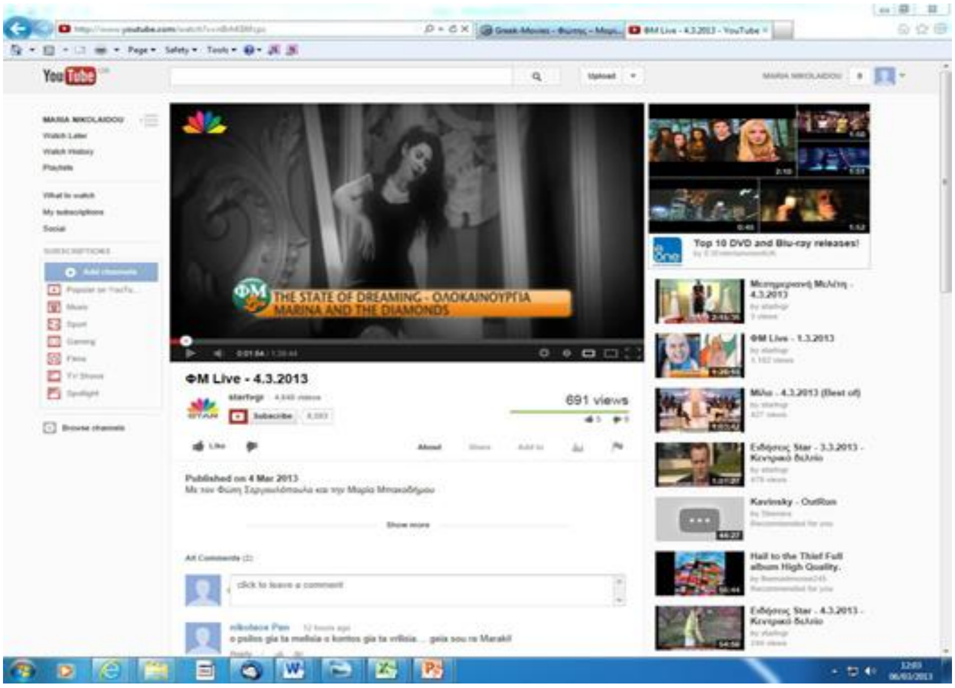


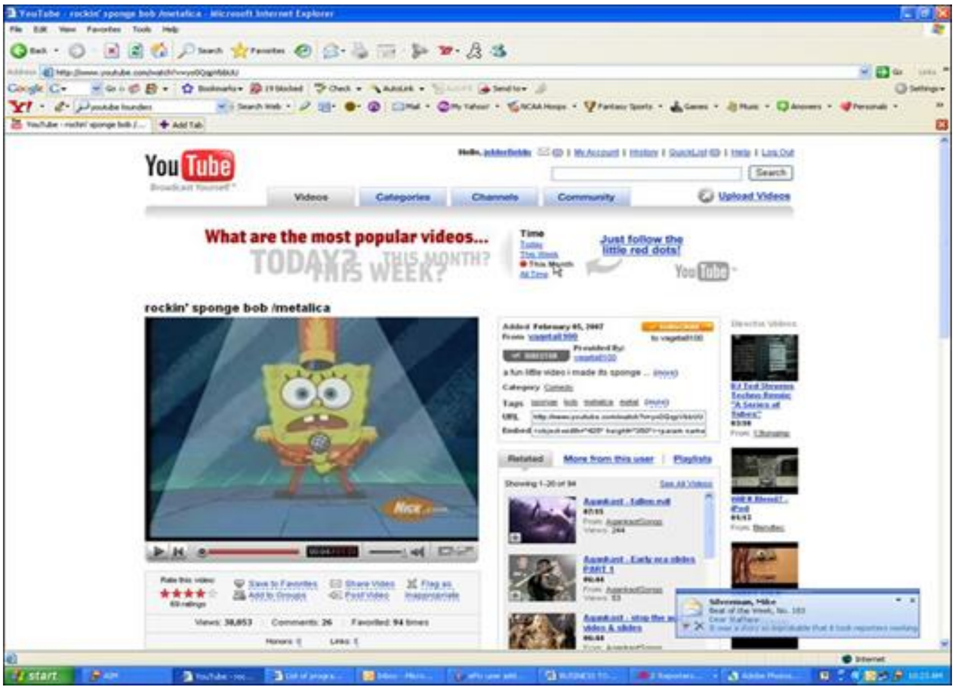
Google
Get started with Google ...
http://www.google.co.uk/
Web Images Videos Maps News Shopping Gmail more
iGoogle | Search settings | Sign in
Google
UK
Advanced Search
Language Tools
Google Search
I'm Feeling Lucky
Find out where to watch the World Cup with Google Maps
Advertising Programmes
Business Solutions
About Google
Go to Google.com
© 2010 - Privacy
Change background image

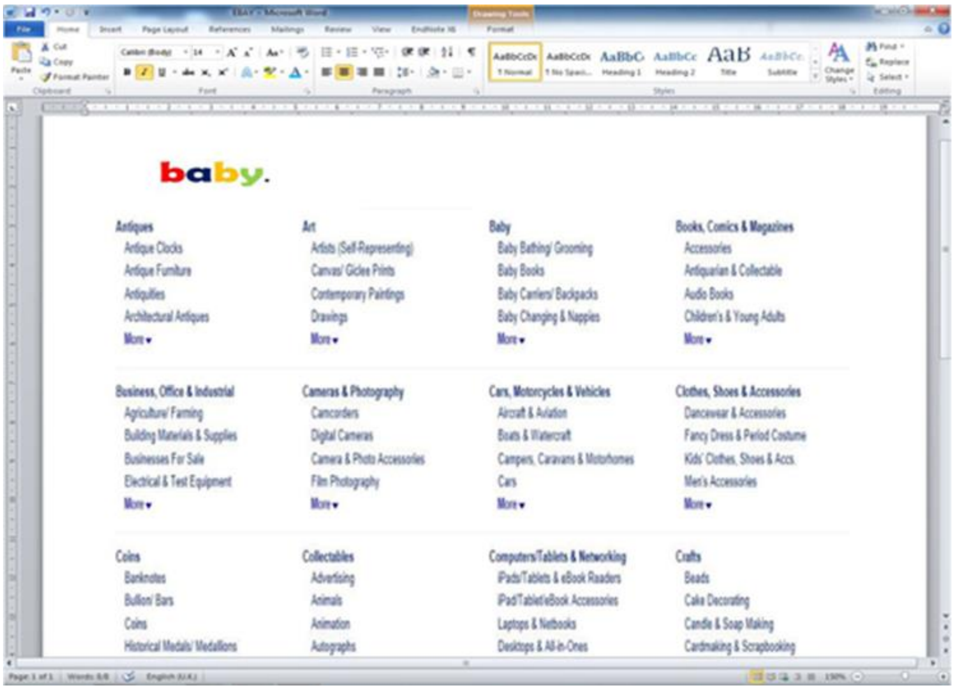

World, UK and Business news and comment from The Times and The Sunday Times - TimesOnline
http://www.timesonline.co.uk/tol/global/
Windows Live
Introducing Related Searches.
Our new look
Times Online has relaunched. Love it? Hate it? Let us know
TIMESONLINE
“Adopt change after 2,000 years? Never!” William Rees-Mogg
Send your views
NEWS COMMENT BUSINESS SPORT LIFE & STYLE ARTS & ENTERTAINMENT
OUR PAPERS AUDIO / VIDEO CLASSIFIEDS
UK WORLD POLITICS WEATHER TECH & WEB RELATED REPORTS
Where am I? Home NEWS
SEARCH
MY PROFILE OFFERS SITEMAP
GLOBAL EDITION SWITCH TO UK EDITION
LATEST FROM TIMES ONLINE: Blair's closest aide faces 'loans conspiracy' probe
Bush escapes Senate no-confidence vote on Iraq
OUT OF IRAQ
President Bush faces down a Senate vote on his Iraq war plan after he asked Congress for £319bn for the Pentagon
'Spending a fortune and gambling on good luck'
Roadside bomb claims life of 100th British soldier in Iraq
MOST READ MOST COMMENTED MOST CURIOUS
TODAY
Times Online relaunch: Ask the Designers
Welcome to the new Times Online
Myth of the yummy mummy
Poultry farmers face export ban as vets warn threat is here to stay
Six Nations podcast
Jonny Wilkinson, now live
Outrage at Eta prisoner's Times interview
Spanish Home Office launches an investigation into how The Times interviewed a hunger-striking Eta prisoner in hospital
Italy calls for an end to football hooliganism
Italy came to a halt for the funeral of Filippo Raciti, the police officer killed during a rampage by football hooligans
Apple warns iPod users off Microsoft's Vista
Microsoft's new operating system Windows Vista is incompatible with music download service iTunes, claims Apple
travelocity
Plus Travelocity Exclusive:
Biggest Giveaway EVER!
Destination:
Length of Cruise:
Month:
Day:
Book
Your World
Explore our new travel experiences website - then tell us your travel tales and tips and win a holiday
BUSINESS
Check-in charges help Ryanair profits
The Irish carrier said net profits had risen to €47.7 million as fuel surcharges levied by rivals allowed the group to nudge up fares
TPG and Cinven join forces for rival Sainsbury's bid
COMMENT
“Michael O'Leary is forcing airlines to look again at their
FOCUS ZONE
Entrepreneur
In business those who dare, win...


Google
Google Search
I'm Feeling Lucky
Move, sing, and dream on the web with a new Chrome experiment


amazon.com
Prime
What's New, Cupcake?
Books
The Girl of the Moment
2010 Edgar Award Nominees
More Items to Consider


ΦM Live - 4.3.2013
691 views
THE STATE OF DREAMING - ΟΛΟΚΑΙΝΟΥΡΓΙΑ
MARINA AND THE DIAMONDS
Top 10 DVD and Blu-ray releases!


YouTube
What are the most popular videos...
TODAY? THIS WEEK? THIS MONTH?
Just follow the little red dots!
rockin' sponge bob /metalica


baby.
Antiques
Antique Clocks
Antique Furniture
Antiquities
Architectural Antiques
More
Art
Artists (Self-Representing)
Canvas/ Giclee Prints
Contemporary Paintings
Drawings
More
Baby
Baby Bathing/ Grooming
Baby Books
Baby Carriers/ Backpacks
Baby Changing & Nappies
More
Books, Comics & Magazines
Accessories
Antiquarian & Collectable
Audio Books
Children's & Young Adults
More
Business, Office & Industrial
Agriculture/ Farming
Building Materials & Supplies
Businesses For Sale
Electrical & Test Equipment
More
Cameras & Photography
Camcorders
Digital Cameras
Camera & Photo Accessories
Film Photography
More
Cars, Motorcycles & Vehicles
Aircraft & Aviation
Boats & Watercraft
Campers, Caravans & Motorhomes
Cars
More
Clothes, Shoes & Accessories
Dancewear & Accessories
Fancy Dress & Period Costume
Kids' Clothes, Shoes & Accs.
Men's Accessories
More
Coins
Banknotes
Bullion/ Bars
Coins
Historical Medals/ Medallions
Collectables
Advertising
Animals
Animation
Autographs
Computers/Tablets & Networking
iPads/Tablets & eBook Readers
iPad/Tablet/eBook Accessories
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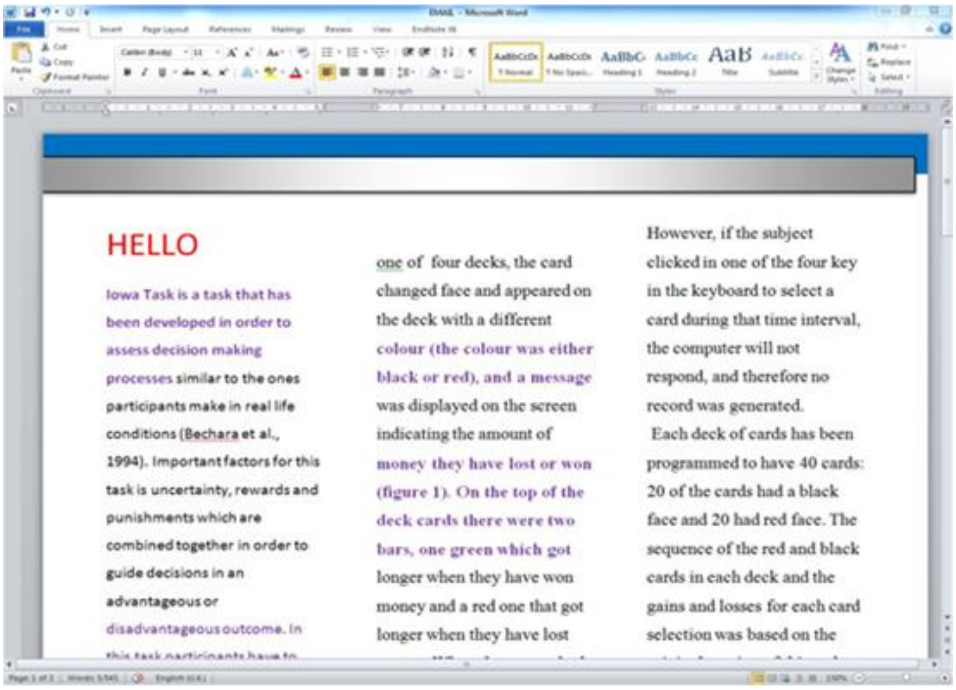
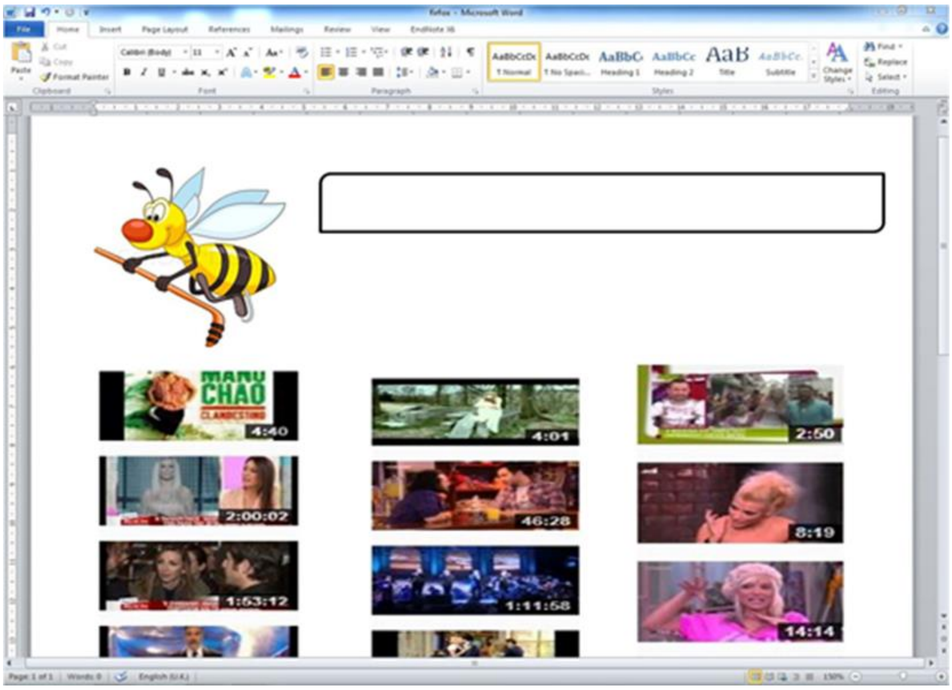
Desktops & All-in-Ones
Crafts
Beads
Cake Decorating
Candle & Soap Making
Cardmaking & Scrapbooking


HELLO
Iowa Task is a task that has been developed in order to assess decision making processes similar to the ones participants make in real life conditions (Bechara et al., 1994). Important factors for this task is uncertainty, rewards and punishments which are combined together in order to guide decisions in an advantageous or disadvantageous outcome. In
one of four decks, the card changed face and appeared on the deck with a different colour (the colour was either black or red), and a message was displayed on the screen indicating the amount of money they have lost or won (figure 1). On the top of the deck cards there were two bars, one green which got longer when they have won money and a red one that got longer when they have lost
However, if the subject clicked in one of the four key in the keyboard to select a card during that time interval, the computer will not respond, and therefore no record was generated.
Each deck of cards has been programmed to have 40 cards: 20 of the cards had a black face and 20 had red face. The sequence of the red and black cards in each deck and the gains and losses for each card selection was based on the


MANU CHAO
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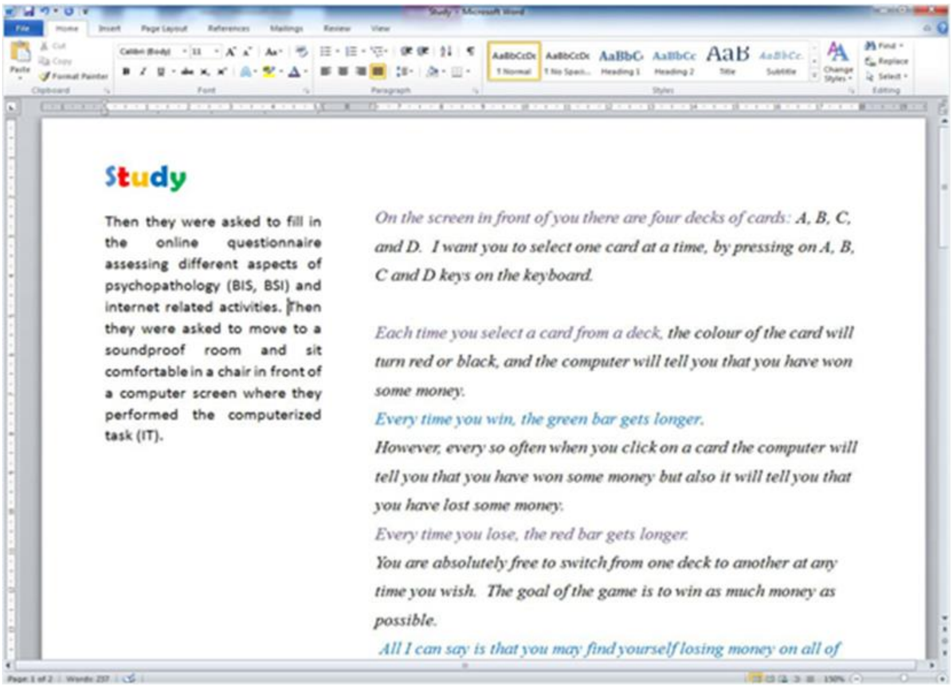
2:00:02
46:28
8:19
1:53:12
1:11:58
14:14



Study

Then they were asked to fill in the online questionnaire assessing different aspects of psychopathology (BIS, BSI) and internet related activities. Then they were asked to move to a soundproof room and sit comfortable in a chair in front of a computer screen where they performed the computerized task (IT).

On the screen in front of you there are four decks of cards: A, B, C, and D. I want you to select one card at a time, by pressing on A, B, C and D keys on the keyboard.

Each time you select a card from a deck, the colour of the card will turn red or black, and the computer will tell you that you have won some money.

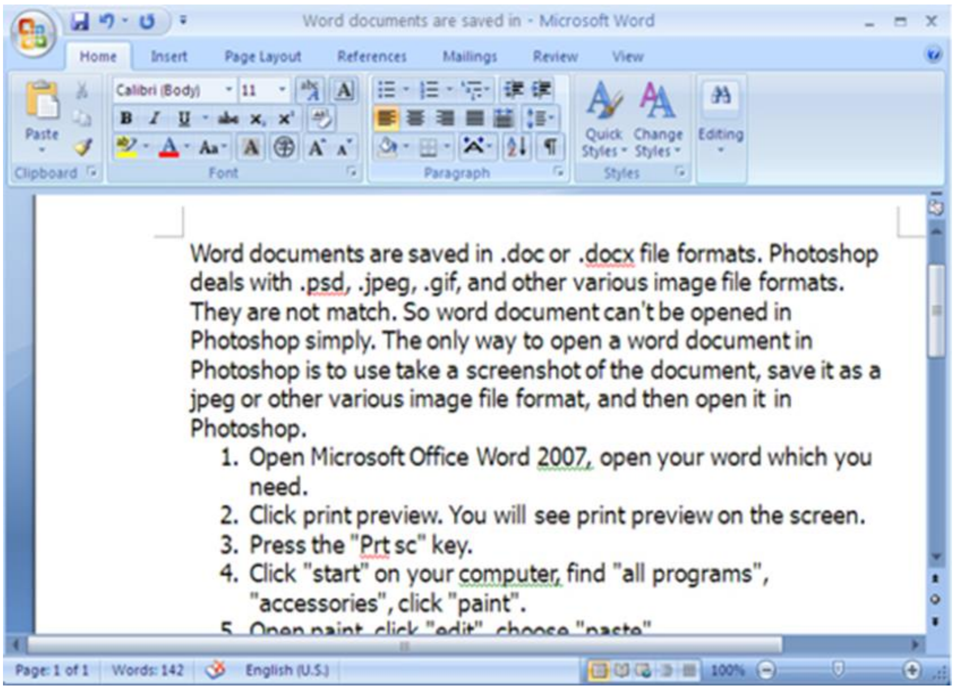
Every time you win, the green bar gets longer.

However, every so often when you click on a card the computer will tell you that you have won some money but also it will tell you that you have lost some money.

Every time you lose, the red bar gets longer.

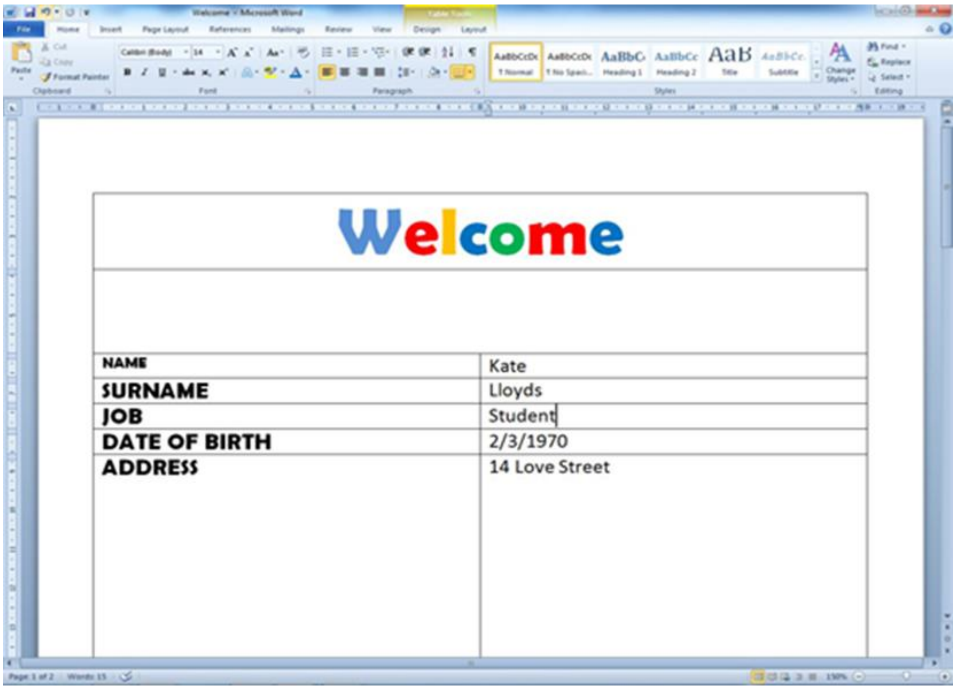
You are absolutely free to switch from one deck to another at any time you wish. The goal of the game is to win as much money as possible.

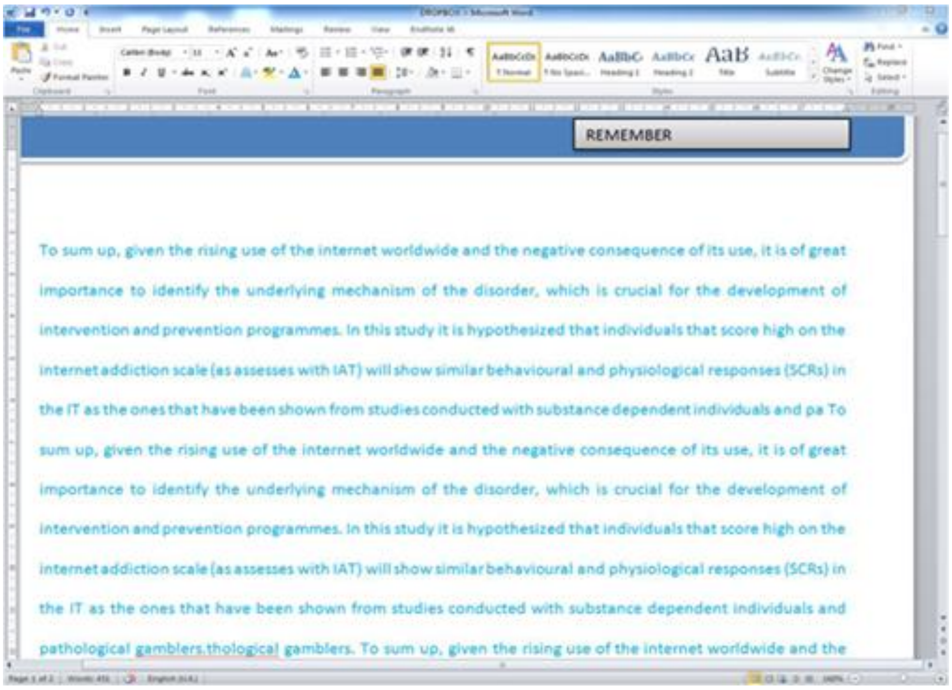
All I can say is that you may find yourself losing money on all of



Word documents are saved in .doc or .docx file formats. Photoshop deals with .psd, .jpeg, .gif, and other various image file formats. They are not match. So word document can't be opened in Photoshop simply. The only way to open a word document in Photoshop is to use take a screenshot of the document, save it as a jpeg or other various image file format, and then open it in Photoshop.

1. Open Microsoft Office Word 2007, open your word which you need.
2. Click print preview. You will see print preview on the screen.
3. Press the "Prt sc" key.
4. Click "start" on your computer, find "all programs", "accessories", click "paint".
5. Open paint, click "edit", choose "paste"


Welcome
NAME
Kate
SURNAME
Lloyds
JOB
Student
DATE OF BIRTH
2/3/1970
ADDRESS
14 Love Street


REMEMBER
To sum up, given the rising use of the internet worldwide and the negative consequence of its use, it is of great importance to identify the underlying mechanism of the disorder, which is crucial for the development of intervention and prevention programmes. In this study it is hypothesized that individuals that score high on the internet addiction scale (as assesses with IAT) will show similar behavioural and physiological responses (SCRs) in the IT as the ones that have been shown from studies conducted with substance dependent individuals and pa To sum up, given the rising use of the internet worldwide and the negative consequence of its use, it is of great importance to identify the underlying mechanism of the disorder, which is crucial for the development of intervention and prevention programmes. In this study it is hypothesized that individuals that score high on the internet addiction scale (as assesses with IAT) will show similar behavioural and physiological responses (SCRs) in the IT as the ones that have been shown from studies conducted with substance dependent individuals and pathological gamblers.thological gamblers. To sum up, given the rising use of the internet worldwide and the

THE ECONOMIC TIMES

PROTECTIONISM BLEEDS EXPORTERS

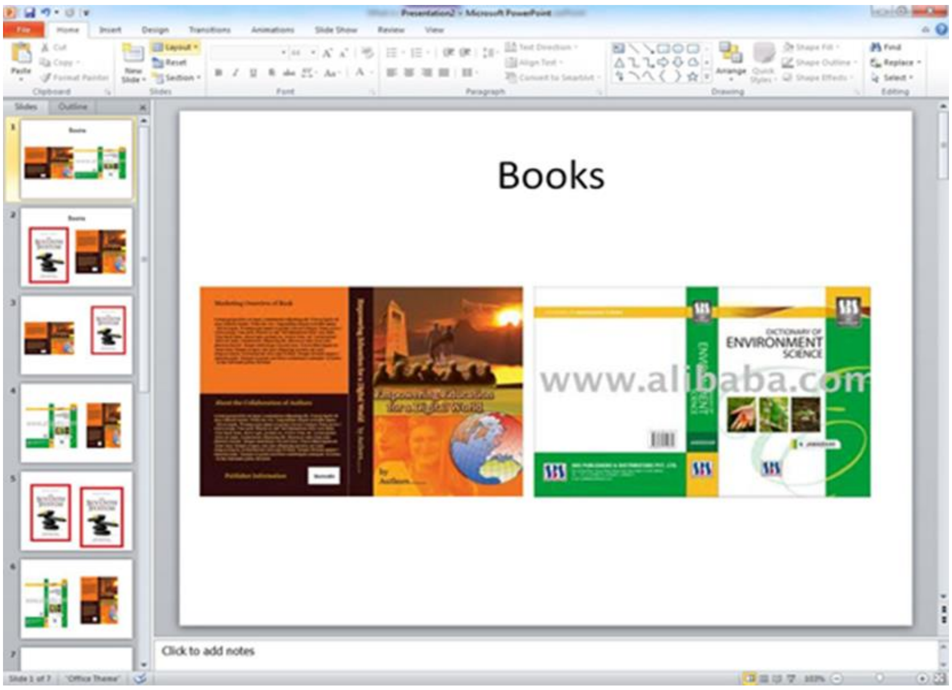
200 BPS

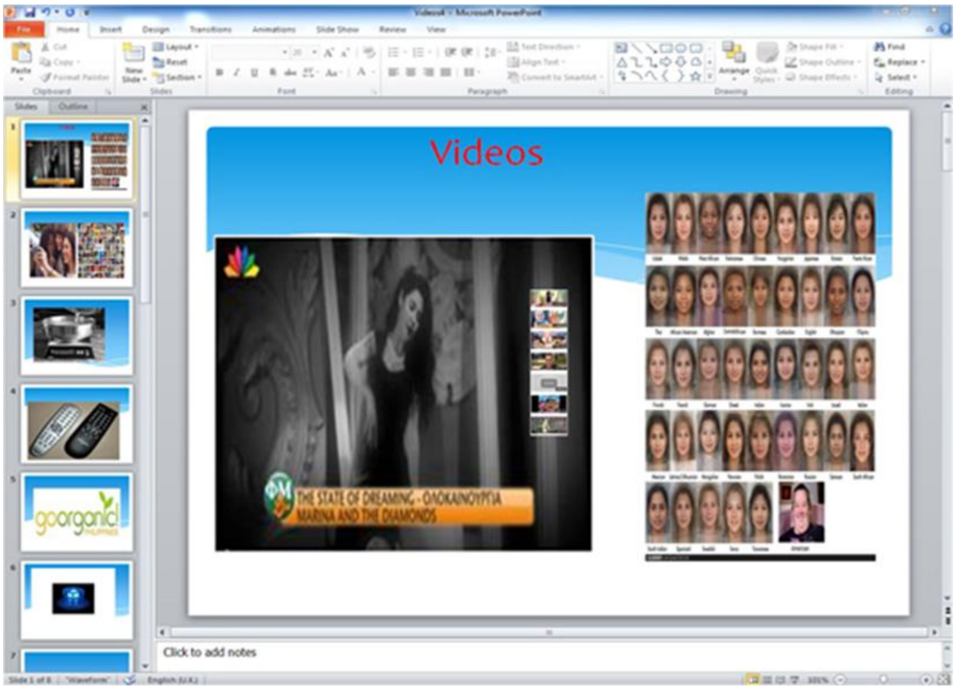
BANKERS HINT AT FURTHER LENDING RATE CUTS

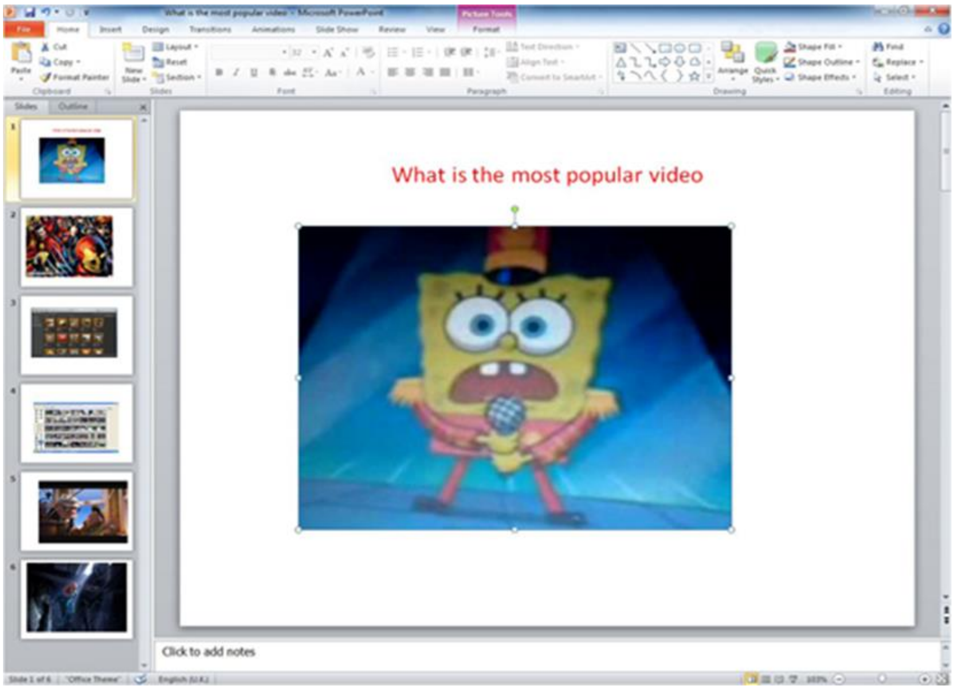
Sebi to ease open offer price rules

EXPORTS DIP, BUT IMPORTS POINT TO STRONG FED SHOW

Trade numbers bring cheer




Videos
THE STATE OF DREAMING - ΟΛΟΚΑΙΝΟΥΡΓΙΑ
MARINA AND THE DIAMONDS
Click to add notes


What is the most popular video
Click to add notes

Control- Non Computer

FRIDAY, SEPTEMBER 16, 1960

WANDA DANKWORTH SERVICES MONDAY

Funeral services for Mrs. Arnold Dankworth were conducted Monday, Sept. 12, at 10:30 a.m. in the Layton Ward Chapel, Church of Jesus Christ of Latter-day Saints. Bishop Spencer Brinkerhoff of the Layton Second Ward officiated.

Music for the services was furnished by the ward Singing Mothers under the direction of Mrs. Fern Burrell, and accompanied at the organ by Mrs. Lucille Morris. Their opening song was, "I Know that My Redeemer Lives." The invocation was offered by Willard R. Richardson. George Andrew Burrell gave the obituary. As a special musical number, Mrs. Oleta Hunt sang, "I've Done My Work." Phil McBride delivered the sermon.

Closing song by the choral group was, "Peace I Leave With You." The benediction was pronounced by C. Vernon Burrell.

Interment was in the Safford Cemetery where Charles Watson offered the dedicatory prayer. Pallbearers were Volley Dryden, Al Fritz, Clarence Handley, Leonard McBride, Melvin Watson, and Jim Webb.

The funeral arrangements were under direction of Roger David of the Safford Funeral Home.

Martha Wanda Packer Dankworth, daughter of Amos Packer and Lillian Curtis was born in Pima, Ariz. on December 22, 1911. She was the fourth of eight children. Her education was gained in the local schools in Pima, where she became skilled in acrobatics. During her childhood she spent much of her time in her father's blacksmith shop.

On March 12, 1929 she was united in marriage to Arnold Andrew Dankworth, son of George A. and Betty Ann Spence Dankworth. Their marriage was solemnized in Prescott, Ariz.

The couple established a home in Miami, Ariz., and later settled in the Gila Valley where their two children were born.

Mrs. Dankworth was interested in genealogy, and spent much of her time gathering information and doing research on family lines. On a trip to Texas she and her father-in-law gathered valuable and interesting information on the Dankworth line. Her trips in search of genealogical data took her to Salt Lake City, Utah and San Francisco, Calif.

As a hobby, Mrs. Dankworth collected antiques, her friends knowing of her hobby often brought her precious items which she prized highly. Oil painting held a fascination for her also.

For a number of years when the Lebanon Ward was active, Mrs. Dankworth taught a Sunday School class, and was active in Relief Society work.

One of Mrs. Dankworth's outstanding characteristics was her readiness to stand up for anybody she thought was being done an injustice. She could always be depended upon for help when she was needed. She was especially kind to older people and respected their advice and counsel.

With her husband Arnold, the Dankworth Fishing Lake was developed, here the couple enjoyed the association of many friends and acquaintances who came from various localities of the state as well as from other states.

SAFFORD, ARIZONA

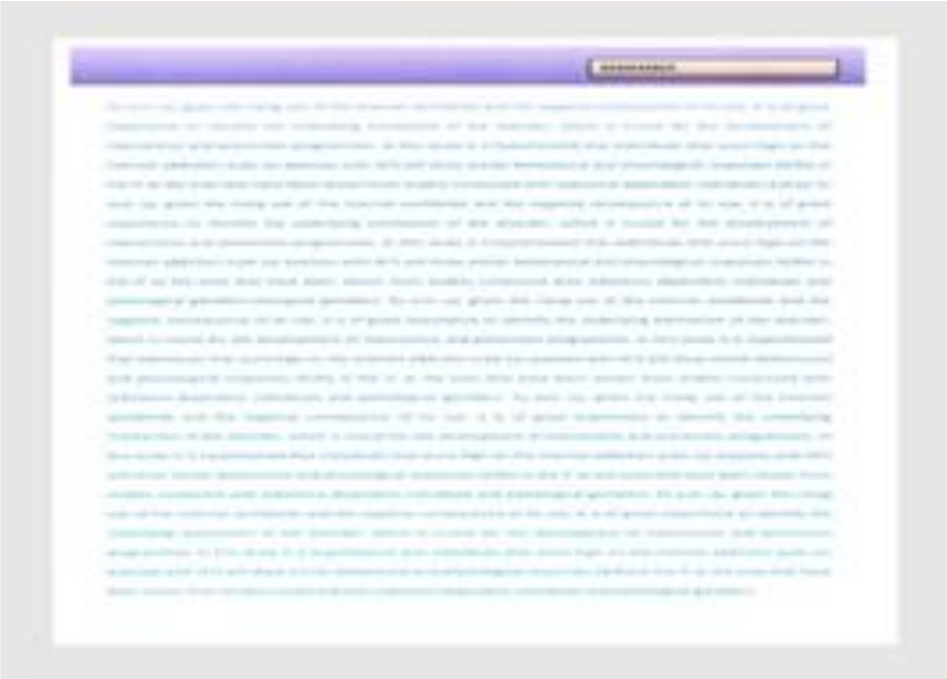
Mrs. Dankworth's death came as a great shock to her family and friends, occurring Thursday, September 8 while undergoing surgery.

Survivors include her husband Arnold A. Dankworth; two daughters, Fay Ola Handley of Willcox, and Veris Kay Webb of San Manuel; two brothers, Curtis Packer of Phoenix, and Helgar Packer of Tehama, Calif.; three sisters, Bessie Watson of Thatcher; Ila Fritz of Globe, and Lillian Sargent of Bakersfield, Calif.; five grandchildren also survive her.

Out-of-town relatives attending the funeral services of Mrs. Wanda (Packer) Dankworth were Mr. and Mrs. Curtis Packer of Phoenix; Mr. and Mrs. Al Fritz of Globe; Mrs. Lilian Sargent and two daughters, Mrs. Jewell Acres and Alta Mae Holyoke, of Bakersfield, Calif.; Claude, Theola and Andrew Sargent, of El Centro, Calif.; Helgar Packer, of Tehana, Calif.; Mildred Watson and Hazel Tanner and daughters Cheryl and Janell, of Mesa; Mrs. Elda Hawkins and daughter, of Phoenix; Mr. and Mrs. Alex Thomas, of Phoenix; Mr. and Mrs. Glen Saline and Mrs. Zella Saline of Aztec, N. M.; Arthur Dankworth of Ashland, Ore.; Mrs. Josephine McCashlin and children, Ira, R. J. and Burl, of Texas and Era McCornish, also of Texas; Mr. and Mrs. Clarence Handley of Willcox, and Mr. and Mrs. James Webb of San Manuel. (Mrs. Handley and Mrs. Webb are daughters of the deceased woman).

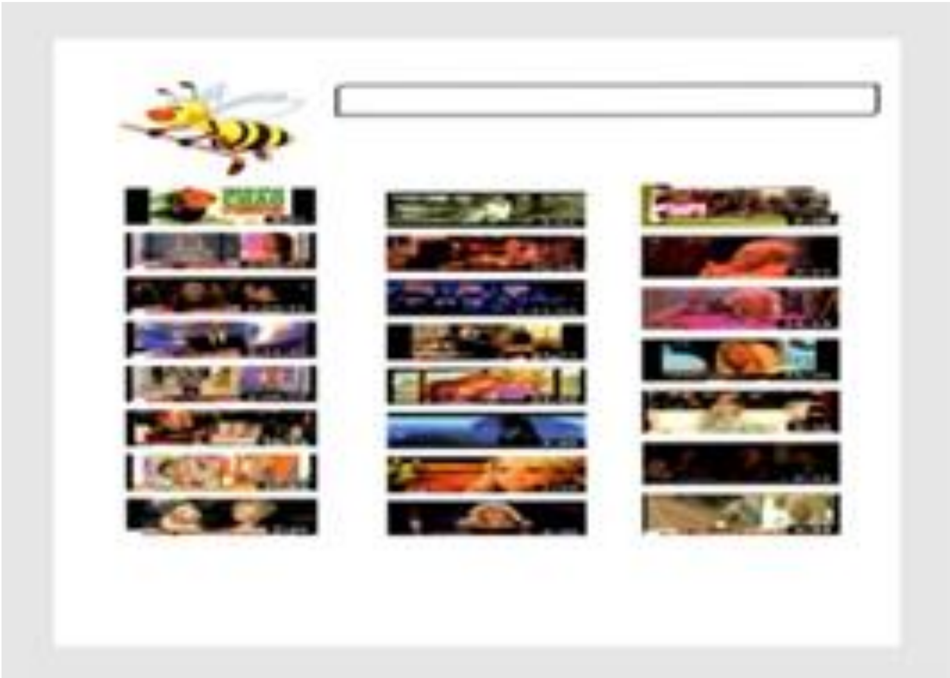
BABY.

Naruto




HELLO


goorganic!




RESULTS
Descriptive Statistics:


Study
On the screen in front of you there are four decks of cards
Each time you select a card from a deck,
Every time you win, the green bar gets longer.
Every time you lose, the red bar gets longer.
All I can say is that you may find yourself losing money on all of the decks, but some decks will make you lose more than others.
On the screen in front of you there are four decks of cards
Each time you select a card from a deck,
Every time you win, the green bar gets longer.


Welcome
SURNAME
JOB
DATE OF BIRTH

Appendix II

Instructions Experimental Studies Two and Three

In this experiment, you will see a series of displays. Each display will consist of a pair of pictures. Immediately after the pictures are shown, a dot will be presented on the left side of the screen or the right side of the screen. Your task is to decide where the dot is presented on each display. If you see the dot on the right side of the screen (.) press red button. If you see the dot on the left side of the screen (.) press blue button. Please respond as quickly and as accurately as possible. Each display will start with a fixation cross in the middle of the screen. You have to look at the cross before each display presented. During the experiment try not to move your head and look at the fixation cross before each trial. Press any key on the keyboard to continue.

Instructions Experimental Study Four

In this experiment you will be presented with a series of images that belong to two different categories (one category consists of internet/SNS related images and the other category consists of house related images). The main requirement of the task is to respond as quickly and as accurately as possible (by pressing the spacebar) to “target” category images and at the same time withhold your response (don’t respond, don’t press the spacebar) to “non-target” category images. The task is divided into different blocks. At the beginning of each block you will be given specific instructions of which category is the “target” category and which one is the “non-target” category. For example in block one the instructions might say that when you see internet/SNS related images press the spacebar but when you see house images don’t press the spacebar. Instructions might change or might stay the same between blocks so you have to be attentive at the beginning of each block. The images will be presented for a brief period of time and thus it is very important to respond as quickly and accurately as possible. Try to make your responses as quickly as when you first see the image otherwise your response will not count. If you press the spacebar for images that belong to “non-target” category then you will hear a sound through the headphones. The first two blocks are practice blocks in order to familiarize you with the task. There will be two resting breaks. Once you read these instructions please call the experimenter before you carry on. Press spacebar to continue.

Appendix III

Addiction-Engagement Questionnaires in Charlton and Danforth

(2007) study used for Asheron's Call

Addiction- Core items

I sometimes neglect important things because of an interest in Asheron's Call

My social life has sometimes suffered because of me playing Asheron's Call (C)

Playing Asheron's Call has sometimes interfered with my work (C)

When I am not playing Asheron's Call I often feel agitated (C)

I have made unsuccessful attempts to reduce the time I spend playing Asheron's Call (C)

I am sometimes late for engagements because I am playing Asheron's Call.

Arguments have sometimes arisen at home because of the time I spend on Asheron's Call (C)

I think that I am addicted to Asheron's Call

I often fail to get enough sleep because of playing Asheron's Call (C)

I never miss meals because of playing Asheron's Call (C)

I have never used Asheron's Call as an escape from socialising

I often feel that I spend more money than I can afford on Asheron's Call

Engagement- Peripheral items

It would not matter to me if I never played Asheron's Call again

I feel happy at the thought of playing Asheron's Call

The less I have to do with Asheron's Call the better

Asheron's Call is unimportant in my life

I would hate to go without playing Asheron’s Call for more than a few days

I rarely think about playing Asheron’s Call when I am not using a computer (P)

I pay little attention when people talk about Asheron’s Call

It is important to me to be good at Asheron’s Call

I often experience a buzz of excitement while playing Asheron’s Call (P)

I like the challenge that learning to play Asheron’s Call presents

Asheron’s Call jargon sounds stupid to me

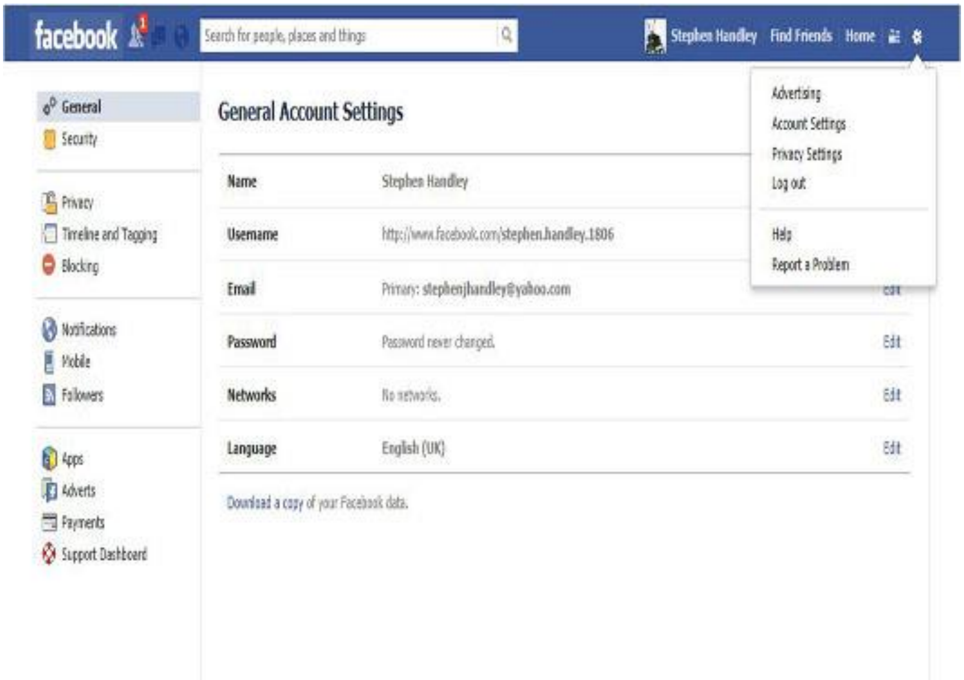
I can’t understand why people like Asheron’s Call

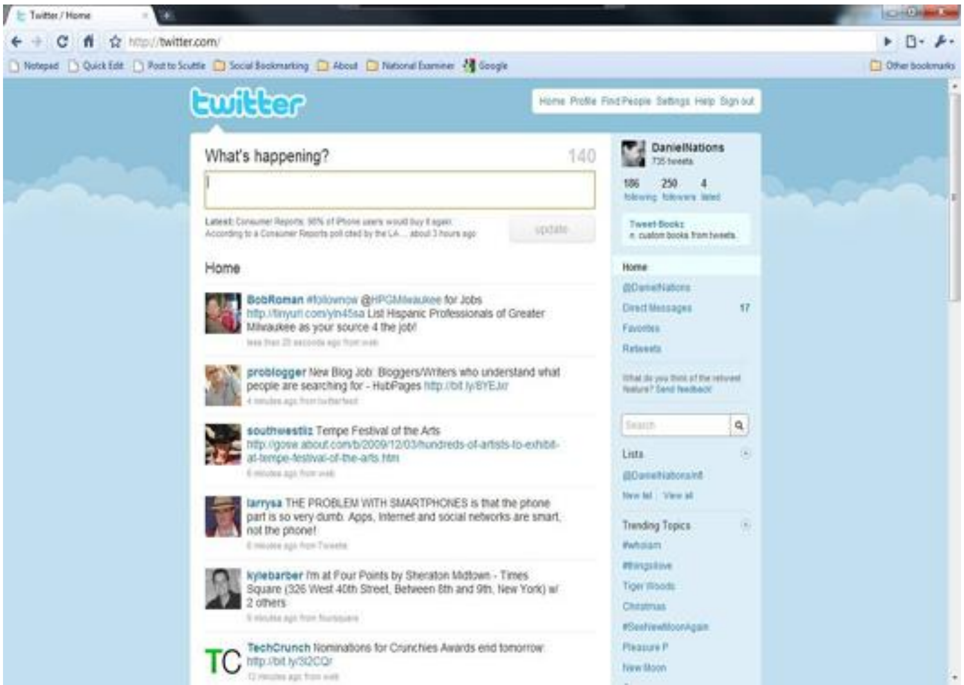
For the purpose of this thesis Asheron’s Call was either replaced by “internet”, “SNS” or “online-gaming”.

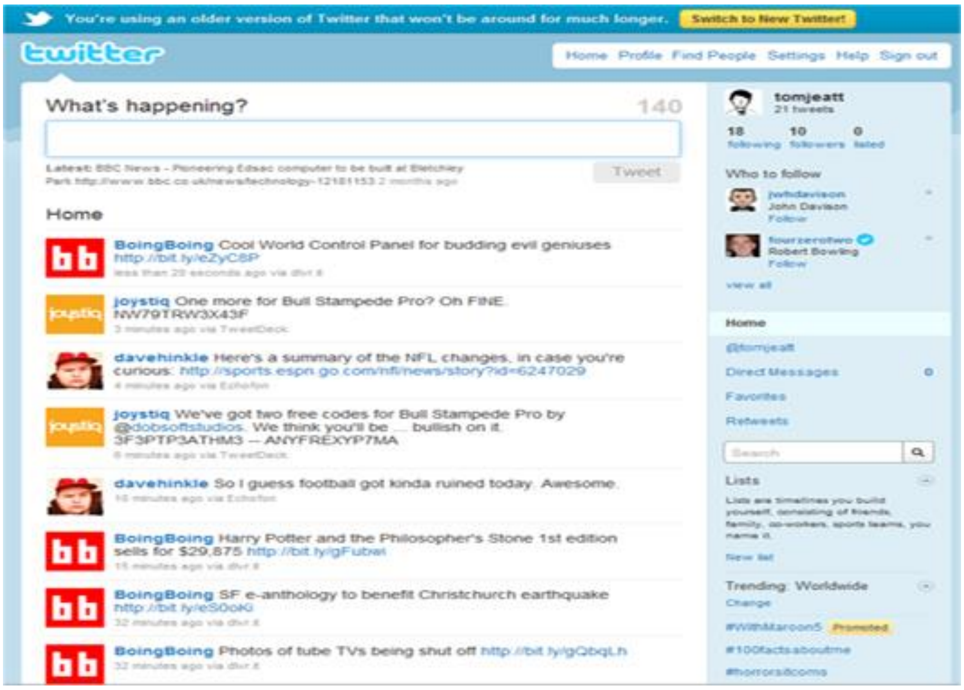
Appendix IV

Images used in study 3

SNS images


facebook
Search for people, places and things
Stephen Handley
Find Friends
Home
General
Security
Privacy
Timeline and Tagging
Blocking
Notifications
Mobile
Followers
Apps
Adverts
Payments
Support Dashboard
General Account Settings
Name
Stephen Handley
Username
http://www.facebook.com/stephen.handley.1806
Email
Primary: stephenjhandley@yahoo.com
Password
Password never changed.
Edit
Networks
No networks.
Edit
Language
English (UK)
Edit
Download a copy of your Facebook data.
Advertising
Account Settings
Privacy Settings
Log out
Help
Report a Problem


Twitter / Home
http://twitter.com/
twitter
Home Profile Find People Settings Help Sign out
What's happening?
140
update
Home
DanielNations
Lists
Trending Topics

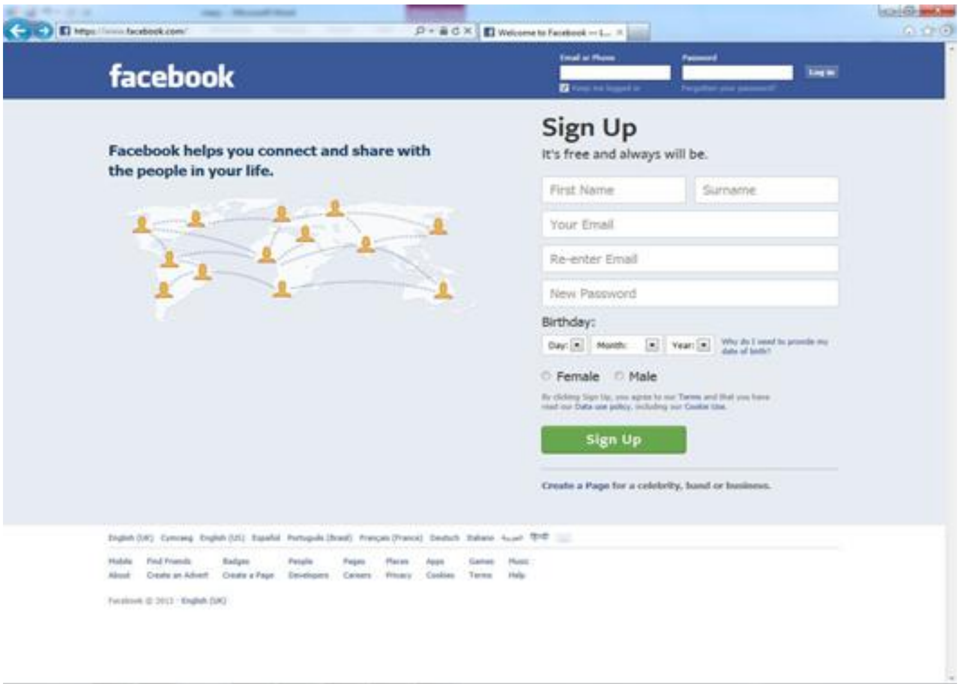

You're using an older version of Twitter that won't be around for much longer.
Switch to New Twitter!
twitter
Home Profile Find People Settings Help Sign out
What's happening?
140
Tweet
Home
BoingBoing Cool World Control Panel for budding evil geniuses http://bit.ly/eZyC8P
joystiq One more for Bull Stampede Pro? Oh FINE. NW79TRW3X43F
davehinkle Here's a summary of the NFL changes, in case you're curious: http://sports.espn.go.com/nfl/news/story?id=6247029
joystiq We've got two free codes for Bull Stampede Pro by @dobsoftstudios. We think you'll be ... bullish on it. 3F3PTP3ATHM3 -- ANYFREXYP7MA
davehinkle So I guess football got kinda ruined today. Awesome.
BoingBoing Harry Potter and the Philosopher's Stone 1st edition sells for $29,875 http://bit.ly/gFubwi
BoingBoing SF e-anthology to benefit Christchurch earthquake http://bit.ly/eS0oKi
BoingBoing Photos of tube TVs being shut off http://bit.ly/gQbqLh
tomjeatt
21 tweets
18 following
10 followers
0 listed
Who to follow
John Davison
Robert Bowling
Home
@tomjeatt
Direct Messages
Favorites
Retweets
Lists
Trending: Worldwide
#WithMaroon5
#100factsaboutme

LinkedIn

facebook®

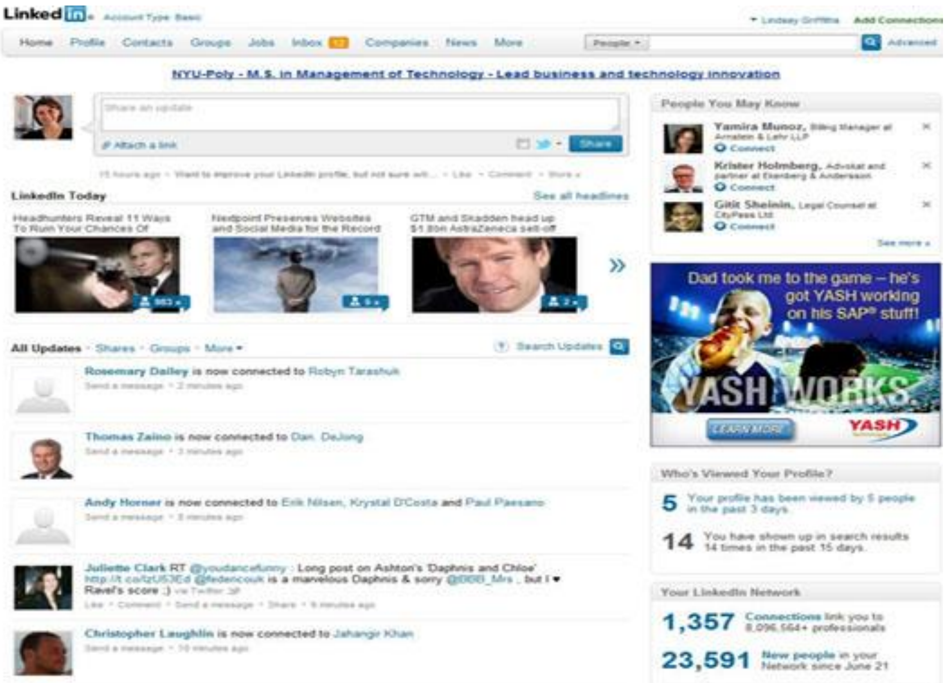

twitter
Search
Have an account? Sign in
Discover what's happening right now, anywhere in the world
New to Twitter?
Twitter is a rich source of instant information. Stay updated. Keep others updated. It's a whole thing.
Let me in ›
Customize Twitter by choosing who to follow. Then see tweets from those folks as soon as they're posted.
Using Twitter for a business? Check out Twitter 101
See who's here
Friends and industry peers you know. Celebrities you watch. Businesses you frequent. Find them all on Twitter.
Top tweets
rhodri Spot the subtle Tory bias in this Sky News infographic: http://twitpic.com/1h88ui
DamnItsTrue I pretend not to hear the alarm clock until I absolutely have to get up. #DamnItsTrue
jimmymachan So this Saturday, ur not allowed to tweet anything but twitpics. & the caption has to be #twitpicsaturday =D all day! Take photos of ur day!
© 2010 Twitter
About Us Contact Blog Status Goodies API Business Help Jobs Terms Privacy
Language: English


Google+
Find people
People in your circles (17)
People who've added you (17)
Find and Invite (0)
Selected (3)
Sort by: Relevance
Add a new person
Paul Dupree
Nathan Garcia
Lauren Thompson
Erika Nansen
Courtney Wilson
Brett Glider
Bill Crosby
Arlene Garcia
Kenine
Eileen Alvarez
Devin Sandroz
Becca Garcia
Anne Merriwether
Drag people to your circles to follow and share
3 people
Drop here to create a new circle
Friends 6
Family 3
Bike Geeks 3

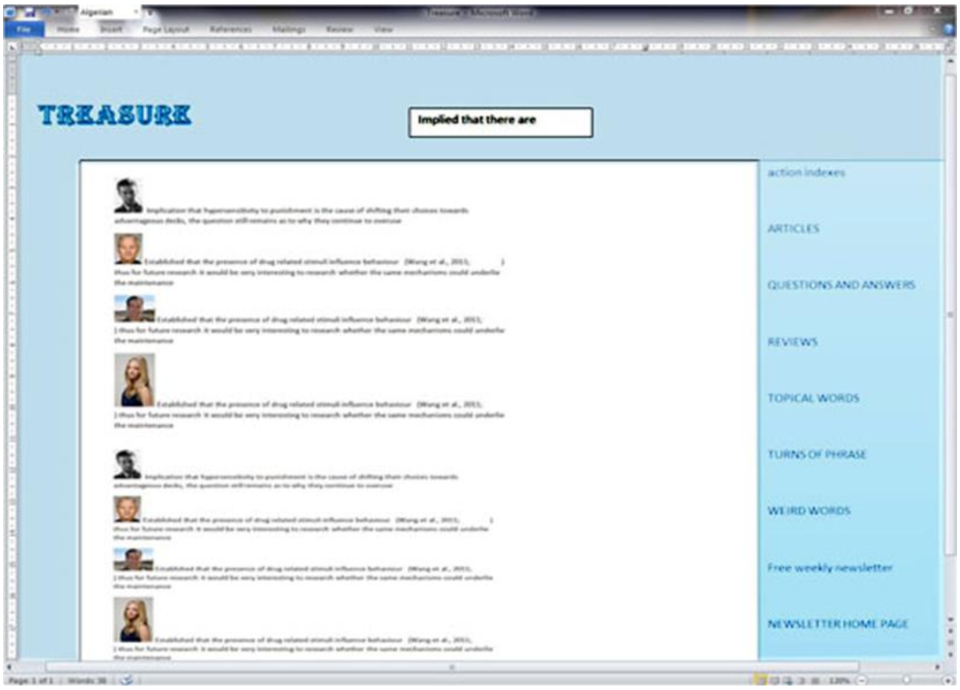

facebook
Sign Up
It's free and always will be.
Facebook helps you connect and share with the people in your life.
First Name
Surname
Your Email
Re-enter Email
New Password
Birthday:
Female
Male
Sign Up

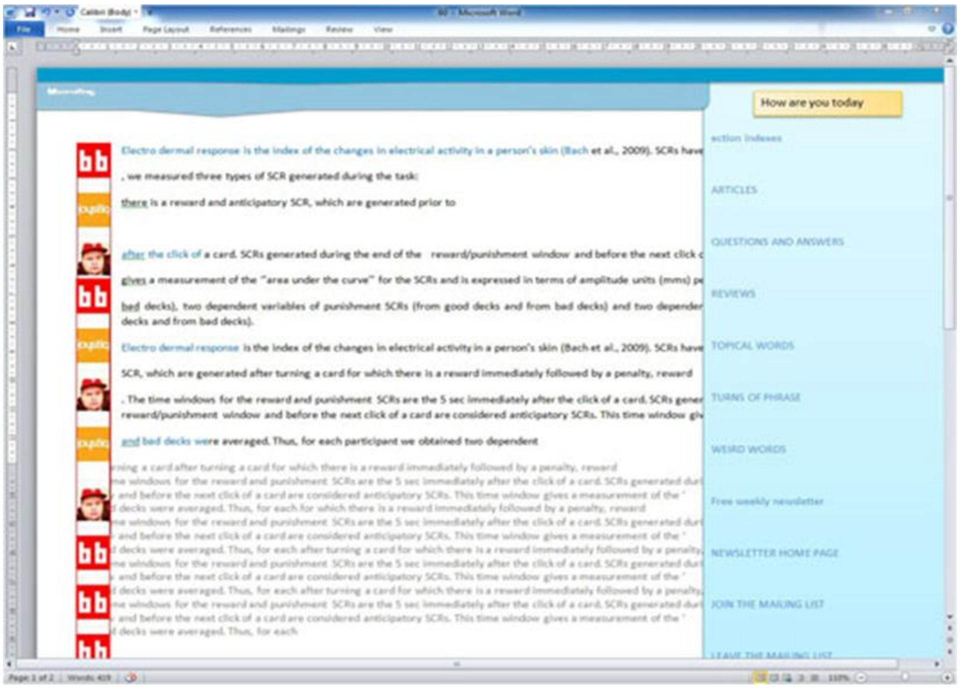

facebook
Email or Phone
Password
Log in
Keep me logged in
Forgotten your password?
Heading out? Stay connected
Visit facebook.com on your mobile phone.
Get Facebook Mobile
Sign Up
It's free and always will be.
First Name:
Surname:
Your Email:
Re-enter Email:
New Password:
I am:
Select Gender:
Birthday:
Day:
Month:
Year:
Why do I need to provide my date of birth?
By clicking Sign Up, you agree to our Terms and that you have read our Data use policy, including our Cookie Use.
Sign Up
Create a Page for a celebrity, band or business.


facebook
Debra Verber
Share

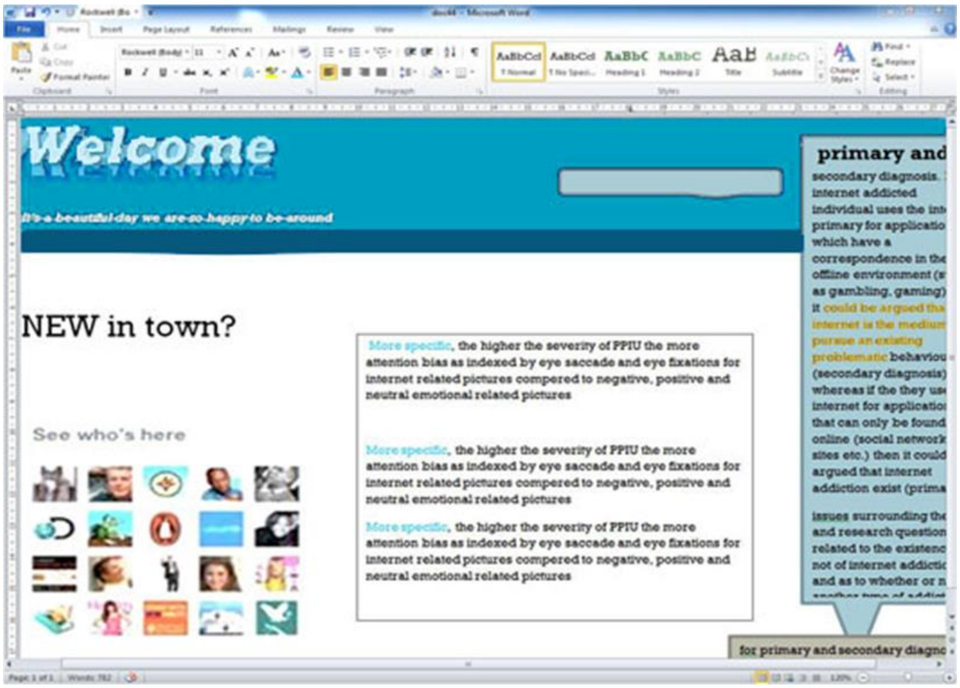

Linked in
Home
Profile
Contacts
Groups
Jobs
Inbox
Companies
News
More
NYU-Poly - M.S. in Management of Technology - Lead business and technology innovation
Share an update
Attach a link
Share
LinkedIn Today
See all headlines
Headhunters Reveal 11 Ways To Ruin Your Chances Of
Nextpoint Preserves Websites and Social Media for the Record
GTM and Skadden head up $1 Bbn AstraZeneca sell-off
All Updates
Shares
Groups
More
Search Updates
Rosemary Dailey is now connected to Robyn Tarashuk
Thomas Zaino is now connected to Dan. DeJong
Andy Horner is now connected to Erik Nilsen, Krystal D'Costa and Paul Paesano
Christopher Laughlin is now connected to Jahangir Khan
People You May Know
Yamira Munoz
Krister Holmberg
Gitit Shelnin
Connect
Dad took me to the game – he's got YASH working on his SAP® stuff!
YASH WORKS
LEARN MORE
YASH
Who's Viewed Your Profile?
5
Your profile has been viewed by 5 people in the past 3 days
14
You have shown up in search results 14 times in the past 15 days
Your LinkedIn Network
1,357
Connections link you to 8,096,564+ professionals
23,591
New people in your Network since June 21

Control-Computer

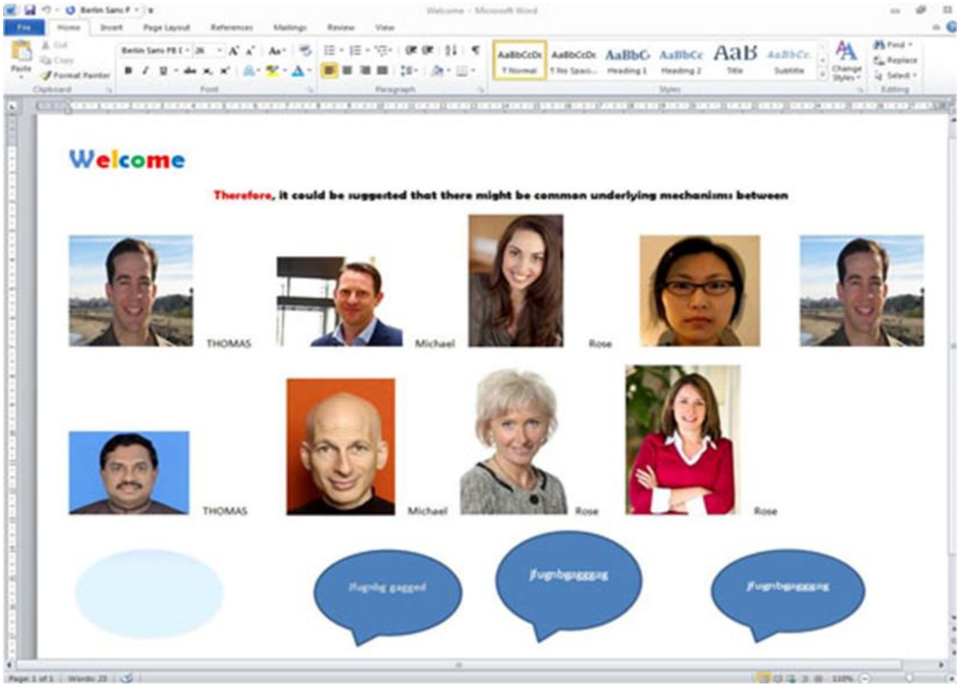


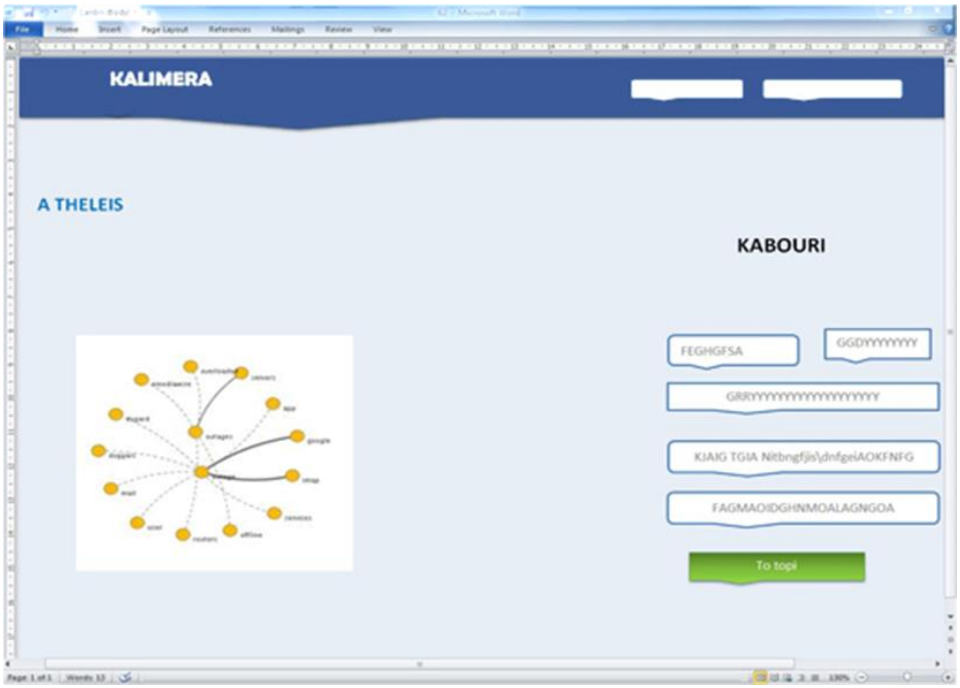


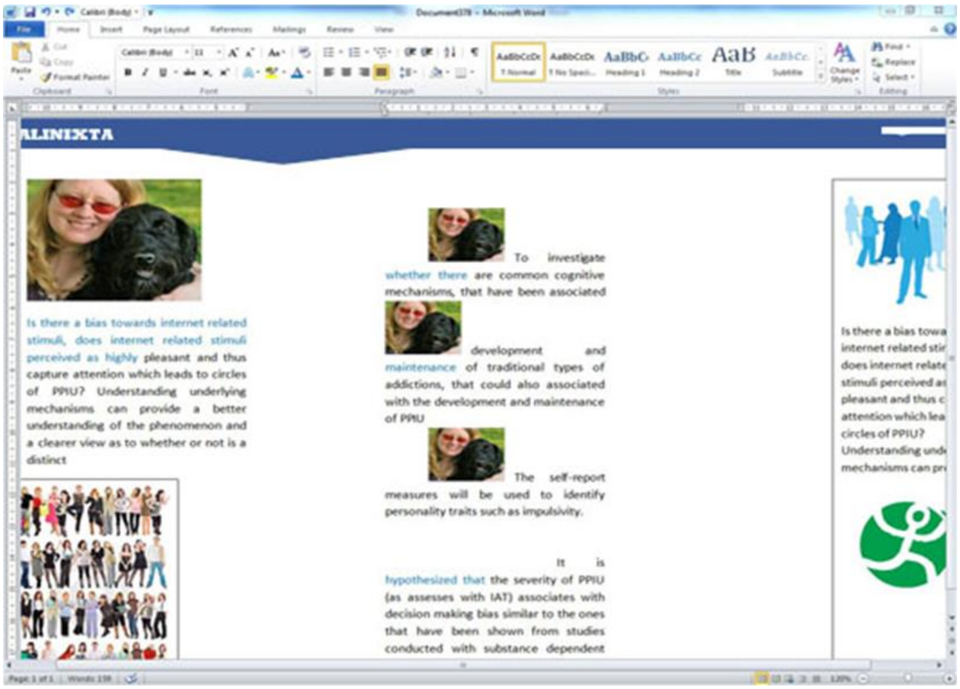
How are you today
ARTICLES
QUESTIONS AND ANSWERS
REVIEWS
TOPICAL WORDS
TURNS OF PHRASE
WEIRD WORDS
Free weekly newsletter
NEWSLETTER HOME PAGE
JOIN THE MAILING LIST

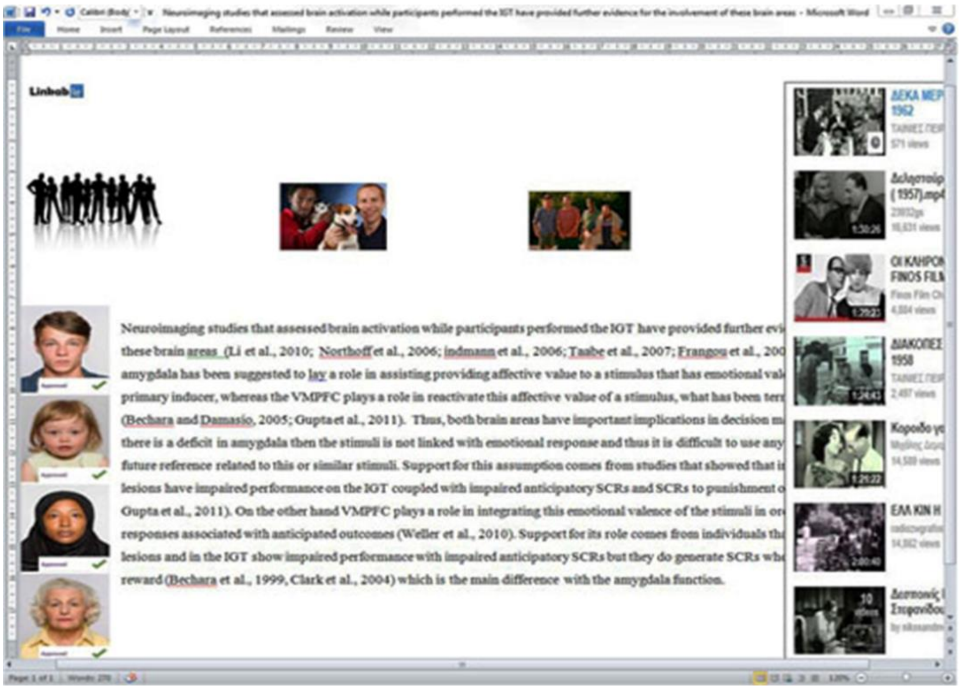


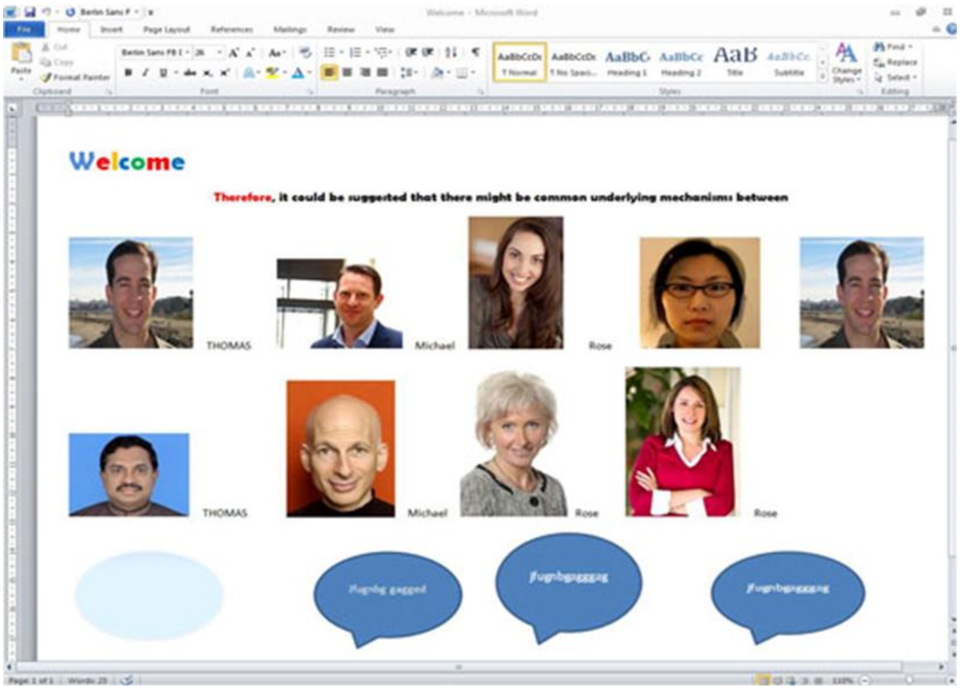
Welcome
NEW in town?
See who's here
More specific, the higher the severity of PPIU the more attention bias as indexed by eye saccade and eye fixations for internet related pictures compered to negative, positive and neutral emotional related pictures
primary and


Welcome
Therefore, it could be suggested that there might be common underlying mechanisms between
THOMAS
Michael
Rose
THOMAS
Michael
Rose
Rose


KALIMERA
A THELEIS
KABOURI
FEGHGFSA
GGDYYYYYYYY
GRRYYYYYYYYYYYYYYYYY
KIAIG TGIA Nitbngfjis\dnfgeiAOKFNFG
FAGMAOIDGHNMOALAGNGOA
To topi


Document378 - Microsoft Word
Is there a bias towards internet related stimuli, does internet related stimuli perceived as highly pleasant and thus capture attention which leads to circles of PPIU? Understanding underlying mechanisms can provide a better understanding of the phenomenon and a clearer view as to whether or not is a distinct
To investigate whether there are common cognitive mechanisms, that have been associated
development and maintenance of traditional types of addictions, that could also associated with the development and maintenance of PPIU
The self-report measures will be used to identify personality traits such as impulsivity.
It is hypothesized that the severity of PPIU (as assesses with IAT) associates with decision making bias similar to the ones that have been shown from studies conducted with substance dependent


Neuroimaging studies that assessed brain activation while participants performed the IGT have provided further evidence for the involvement of these brain areas - Microsoft Word
Neuroimaging studies that assessed brain activation while participants performed the IGT have provided further evi
these brain areas (Li et al., 2010; Northoff et al., 2006; indmann et al., 2006; Taabe et al., 2007; Frangou et al., 200
amygdala has been suggested to lay a role in assisting providing affective value to a stimulus that has emotional val
primary inducer, whereas the VMPFC plays a role in reactivate this affective value of a stimulus, what has been ter
(Bechara and Damasio, 2005; Gupta et al., 2011). Thus, both brain areas have important implications in decision m
there is a deficit in amygdala then the stimuli is not linked with emotional response and thus it is difficult to use any
future reference related to this or similar stimuli. Support for this assumption comes from studies that showed that i
lesions have impaired performance on the IGT coupled with impaired anticipatory SCRs and SCRs to punishment o
Gupta et al., 2011). On the other hand VMPFC plays a role in integrating this emotional valence of the stimuli in or
responses associated with anticipated outcomes (Weller et al., 2010). Support for its role comes from individuals th
lesions and in the IGT show impaired performance with impaired anticipatory SCRs but they do generate SCRs wh
reward (Bechara et al., 1999, Clark et al., 2004) which is the main difference with the amygdala function.


File
Home
Insert
Page Layout
References
Mailings
Review
View
Welcome
Therefore, it could be suggested that there might be common underlying mechanisms between
THOMAS
Michael
Rose
THOMAS
Michael
Rose
Rose

Control- Non Computer

Naruto+


[Newsletter Title]

[Pick the date] [Edition 1, Volume 1]

Story Title

Story Subtitle or summary

You can easily change the formatting of selected text in the document text by choosing a look for the selected text from the Quick Styles gallery on the Home tab. You can also format text directly by using the other controls on the Home tab. On document. You can use these galleries to insert tables, headers, footers, lists, cover pages, and other document building blocks.

You can easily change the formatting of selected text in the document text by choosing a look for the

[Type a quote from the document or the summary of an interesting point. You can position the text box anywhere in the document. Use the Drawing Tools tab to change the formatting of the pull quote text box.]

the Insert tab, the galleries include that are designed to coordinate with the overall look of your document. You can use these galleries to insert tables, headers, footers, lists, cover pages, and other document.

selected text from the Quick Styles gallery on the Home tab. On the Insert tab, the galleries include that are designed to coordinate with the overall look of your document. You can use these galleries to insert

Story Title

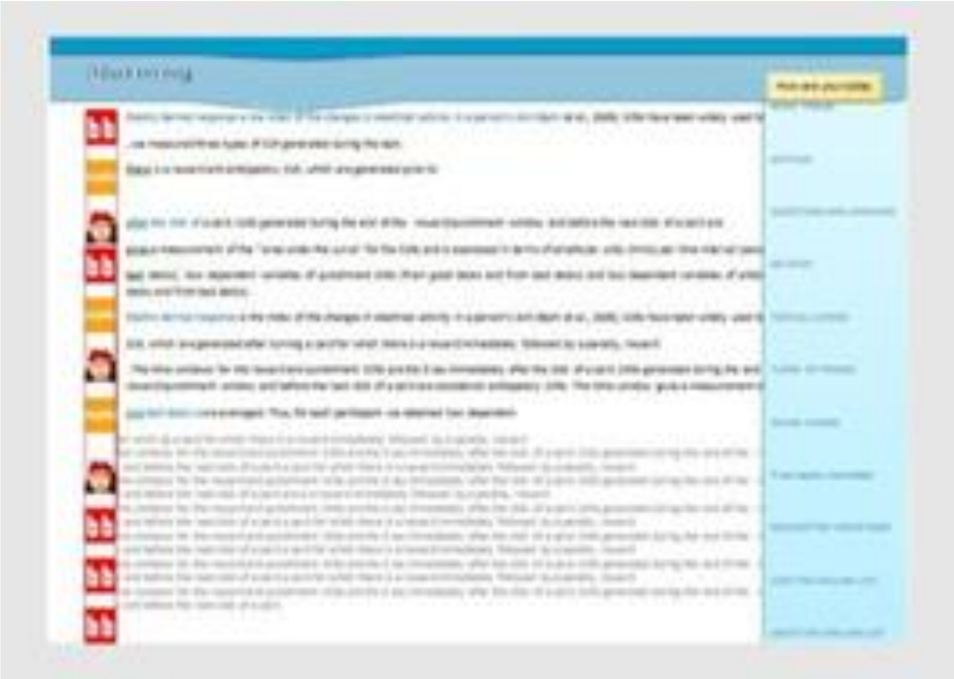
You can easily change the formatting of selected text in the document text by choosing a look for the selected text from the Quick Styles gallery on the Home tab. You can also format text directly by using the other controls on the Home tab. On the Insert tab, the galleries include that are designed to coordinate with the overall look of your document. You can use these galleries to insert tables, headers, footers, lists, cover pages, and other document.

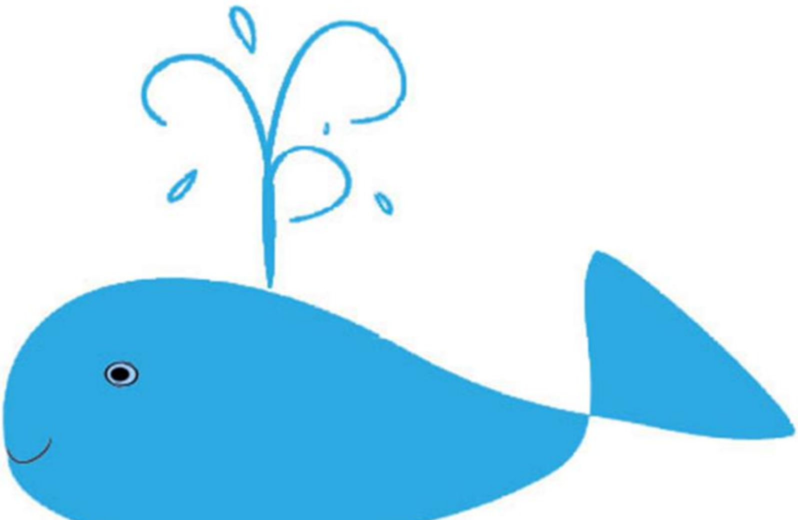

TREASURE


Welcome
primary and
NEW in town?
See who's here


Welcome


FARM
B KABOURI
KALIMERA
Redesign





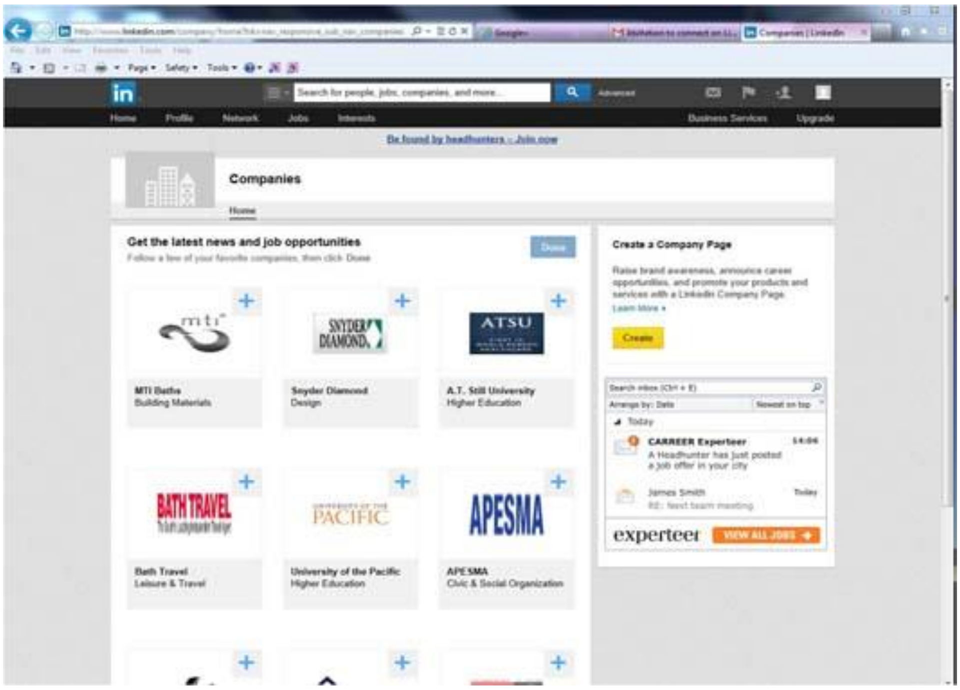
Linkable

NIVEA

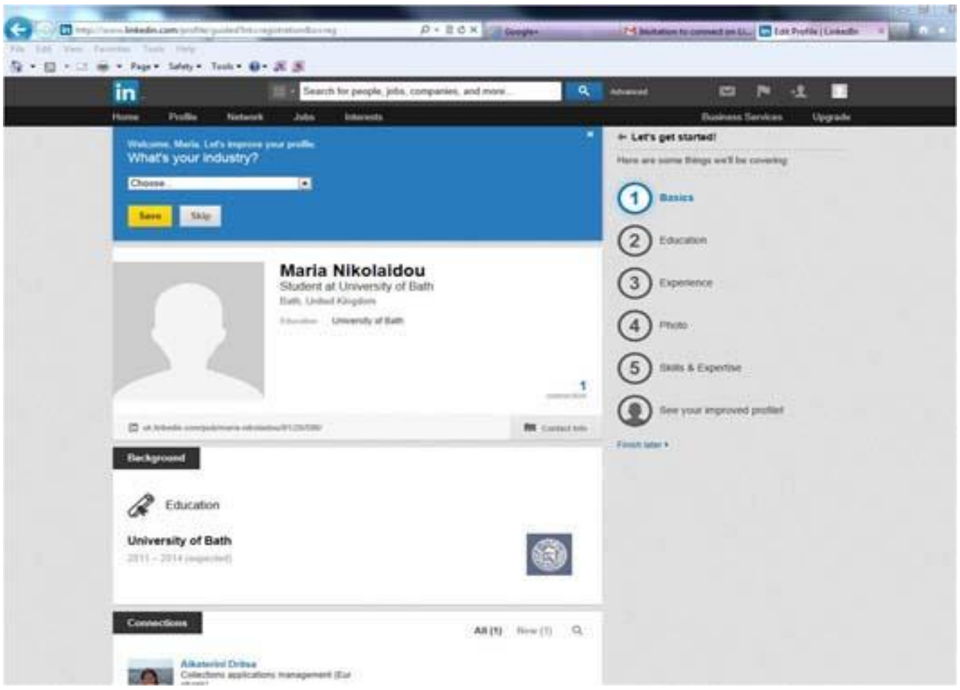

The New
Company
MAIN MENU
Home
Redesign

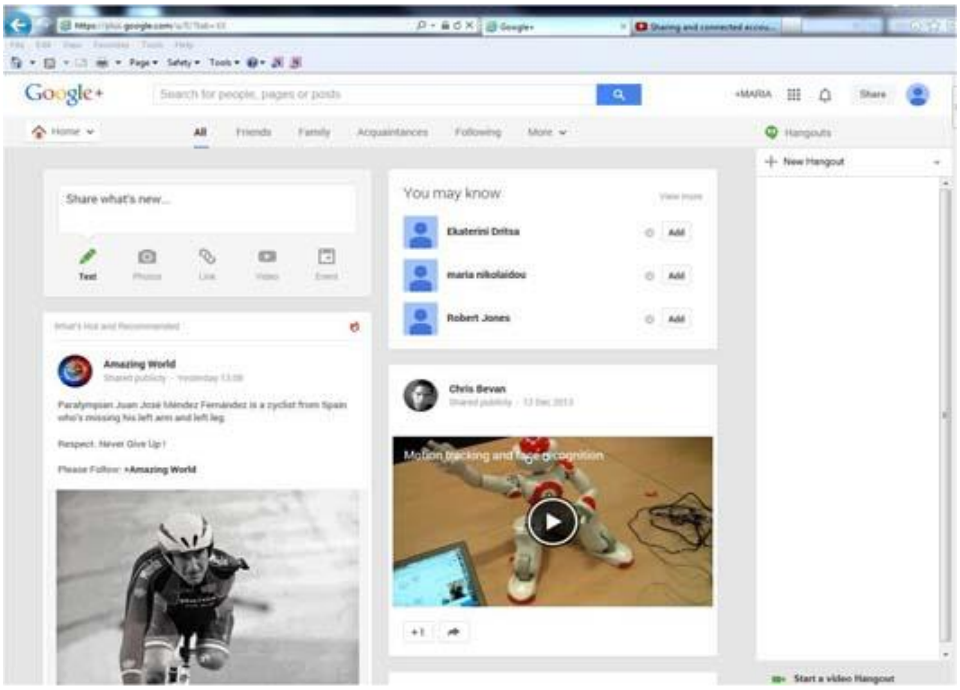
Appendix V

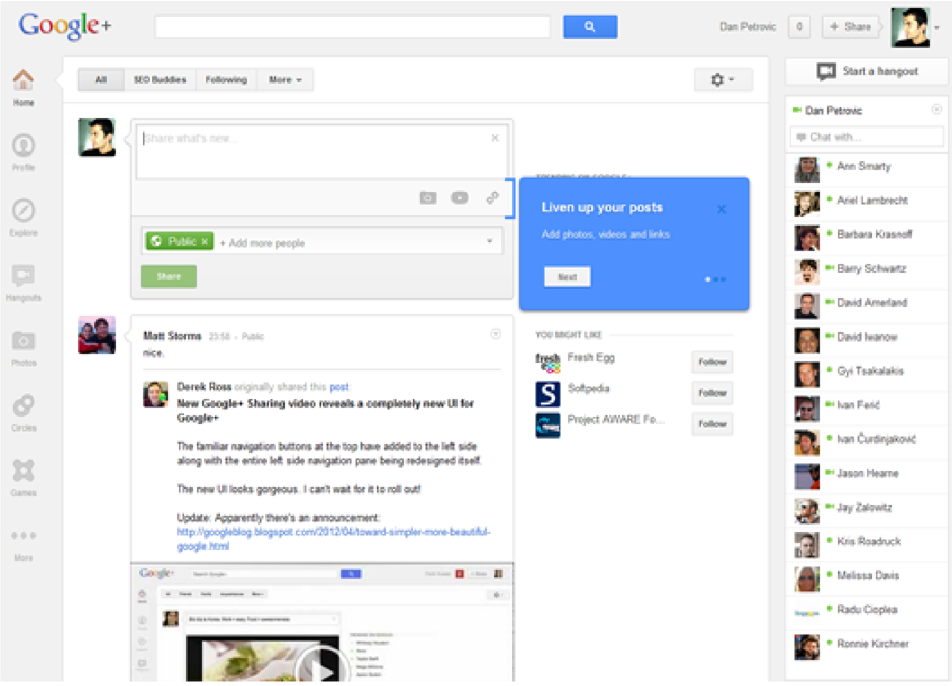
30 extra Images used in study 4


Companies
Home
Get the latest news and job opportunities
Done
Create a Company Page
Create
MTI Baths
Building Materials
Snyder Diamond
Design
A.T. Still University
Higher Education
Bath Travel
Leisure & Travel
University of the Pacific
Higher Education
APESMA
Civic & Social Organization
experteer
VIEW ALL JOBS

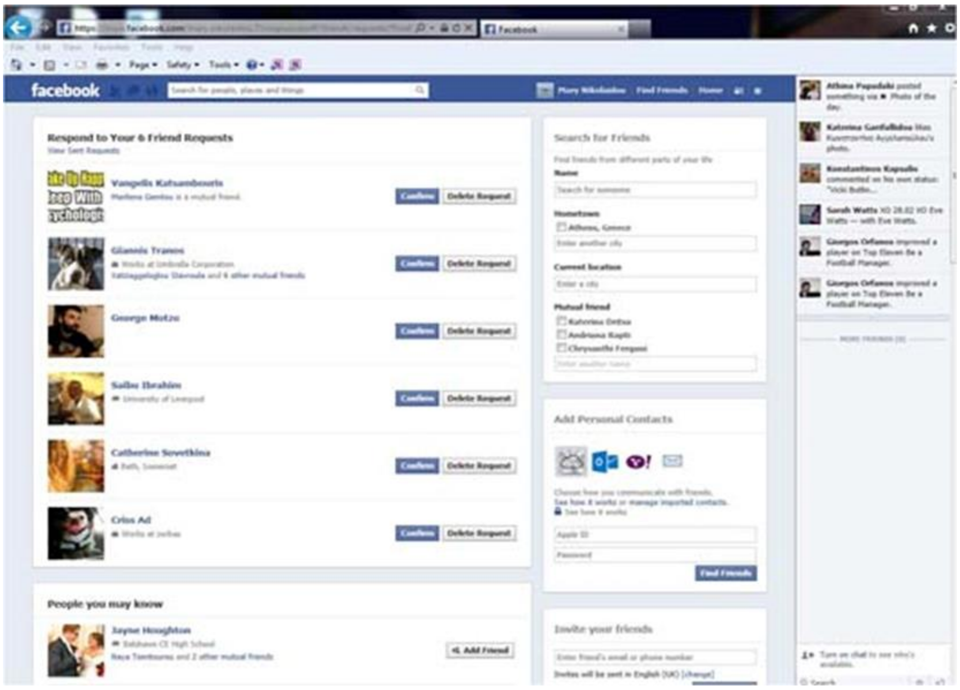

facebook
Živa Bobek
Mary Nikolaidou
Reply

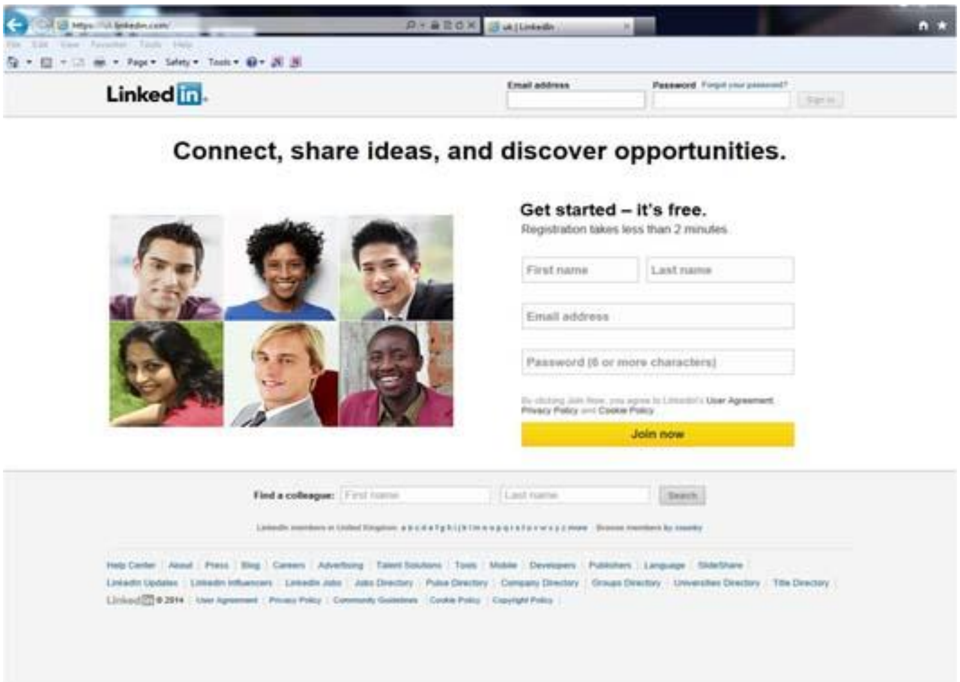

What's your industry?
Choose
Save
Skip
Maria Nikolaidou
Student at University of Bath
Let's get started!
Basics
Education
Experience
Photo
Skills & Expertise
See your improved profile!
Background
Education
University of Bath
Connections

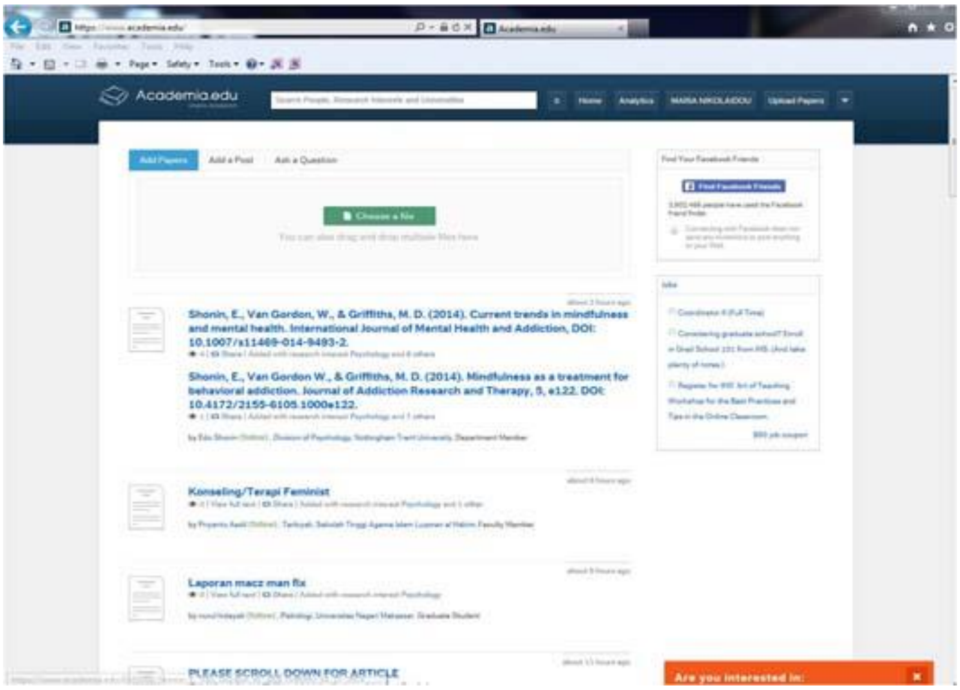

Google+
Search for people, pages or posts
Share what's new...
You may know
Ekaterini Dritsa
maria nikolaidou
Robert Jones
Amazing World
Chris Bevan
Motion tracking and face recognition
Hangouts
New Hangout
Start a video Hangout


Google+
Dan Petrovic
Share
Start a hangout
All
SEO Buddies
Following
More
Home
Profile
Explore
Hangouts
Photos
Circles
Games
More
Share what's new...
Public
+ Add more people
Share
Liven up your posts
Add photos, videos and links
Next
Matt Storms
nice.
Derek Ross originally shared this post
New Google+ Sharing video reveals a completely new UI for Google+
The familiar navigation buttons at the top have added to the left side along with the entire left side navigation pane being redesigned itself.
The new UI looks gorgeous. I can't wait for it to roll out!
Update: Apparently there's an announcement:
http://googleblog.blogspot.com/2012/04/toward-simpler-more-beautiful-google.html
YOU MIGHT LIKE
Fresh Egg
Softpedia
Project AWARE Fo...
Follow
Dan Petrovic
Chat with...
Ann Smarty
Ariel Lambrecht
Barbara Krasnoff
Barry Schwartz
David Amerland
David Iwanow
Gyi Tsakalakis
Ivan Farić
Ivan Ćurdinjaković
Jason Hearne
Jay Zalowitz
Kris Roadruck
Melissa Davis
Radu Cioplea
Ronnie Kirchner


facebook
Mary Nikolaidou
Find Friends
Home
Update Info
Activity log
Timeline
About
Photos
Friends
More
Mary, where do you work?
University of Liverpool
N.A.S.A
I don't have a job right now.
Public
Next
Skip
About
Studied at University of Liverpool
From Athens, Greece
Photos
Status
Photo
Place
Life event
What's on your mind?
Mary Nikolaidou changed her profile picture.
Like · Comment · Stop Notifications · Promote · Share
Sponsored
Secret Escapes
Buy to Let in Bath
Cops'n' Robbers Slots


facebook
Respond to Your 6 Friend Requests
Search for Friends
Add Personal Contacts
People you may know
Invite your friends


Linked in
Email address
Password
Connect, share ideas, and discover opportunities.
Get started – it's free.
Registration takes less than 2 minutes
First name
Last name
Email address
Password (6 or more characters)
Join now
Find a colleague:
Search


Academia.edu
Add Papers
Add a Post
Ask a Question
Choose a file
Shonin, E., Van Gordon, W., & Griffiths, M. D. (2014). Current trends in mindfulness and mental health. International Journal of Mental Health and Addiction, DOI: 10.1007/s11469-014-9493-2.
Shonin, E., Van Gordon W., & Griffiths, M. D. (2014). Mindfulness as a treatment for behavioral addiction. Journal of Addiction Research and Therapy, 5, e122. DOI: 10.4172/2155-6105.1000e122.
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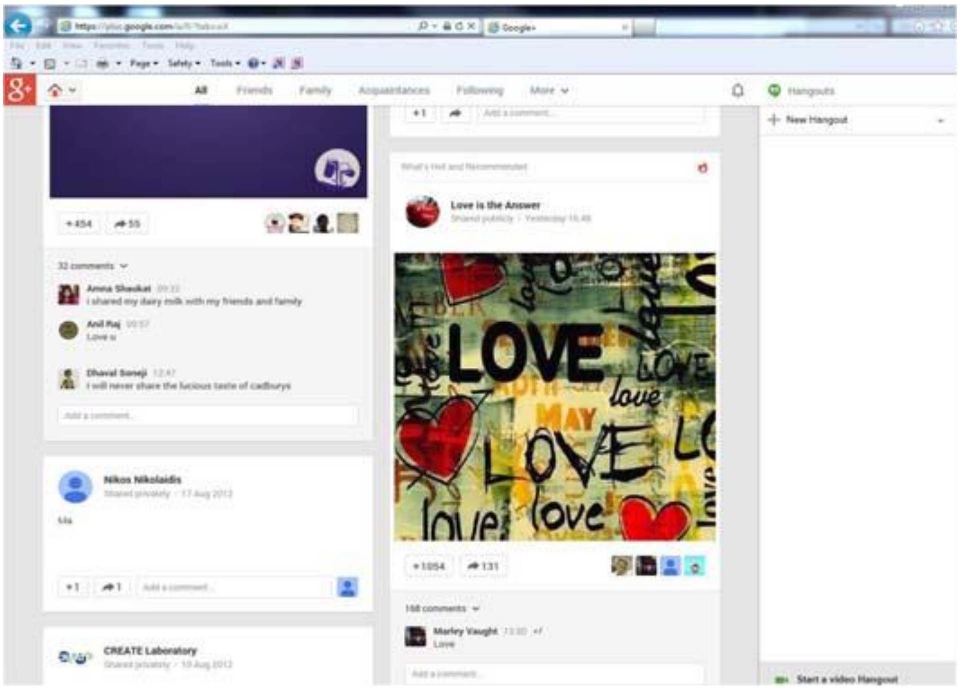
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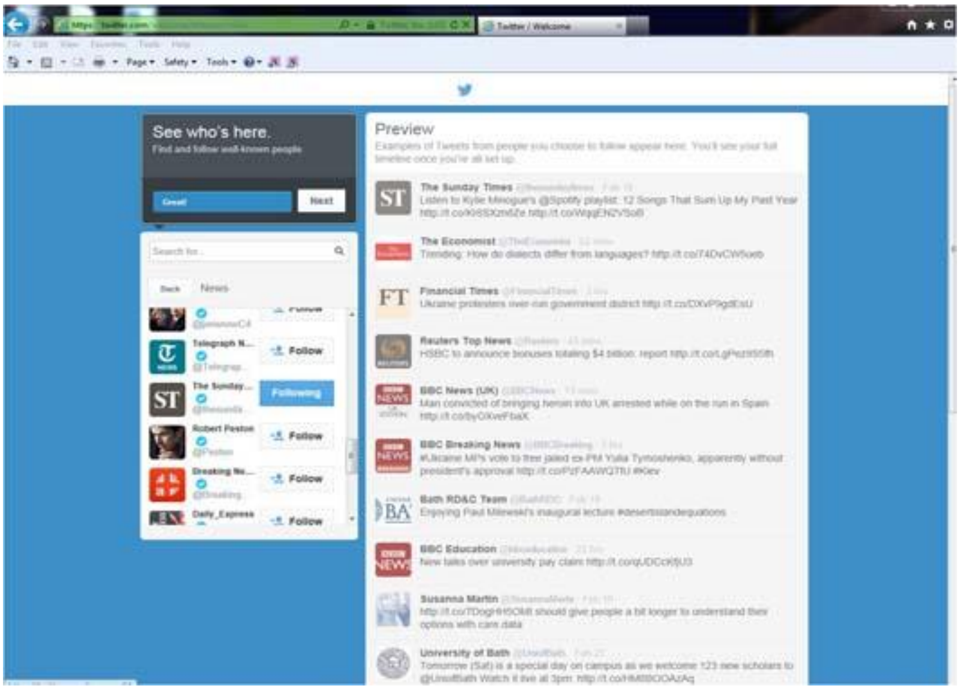
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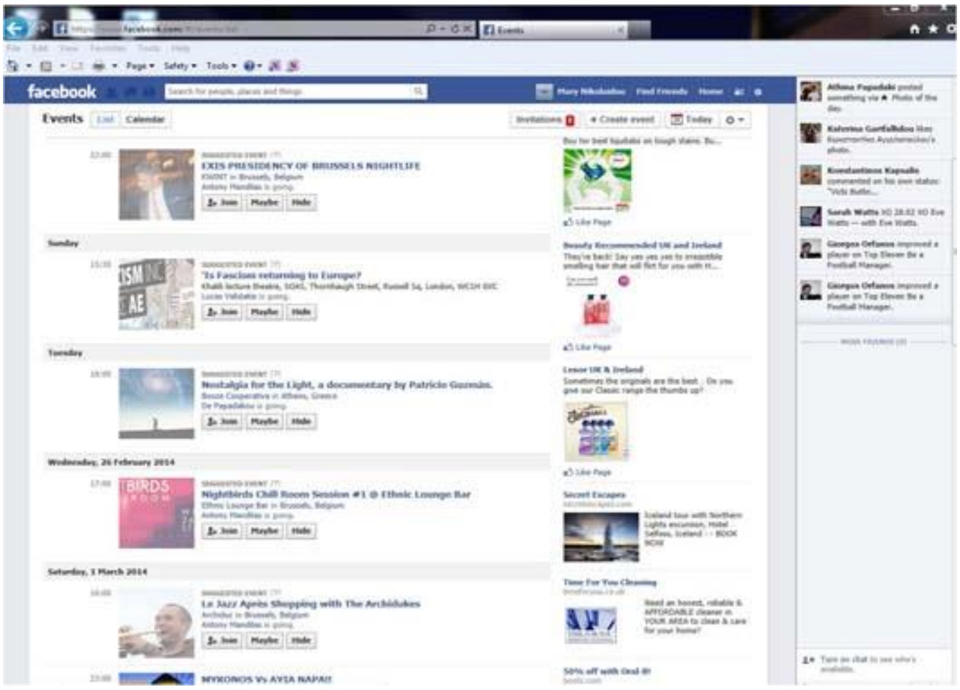
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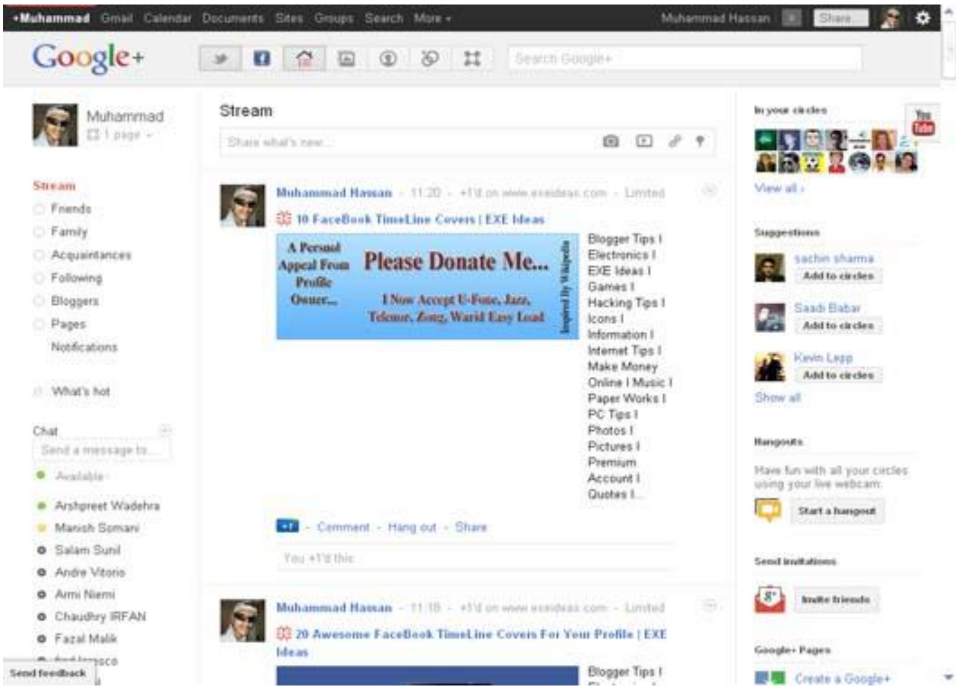
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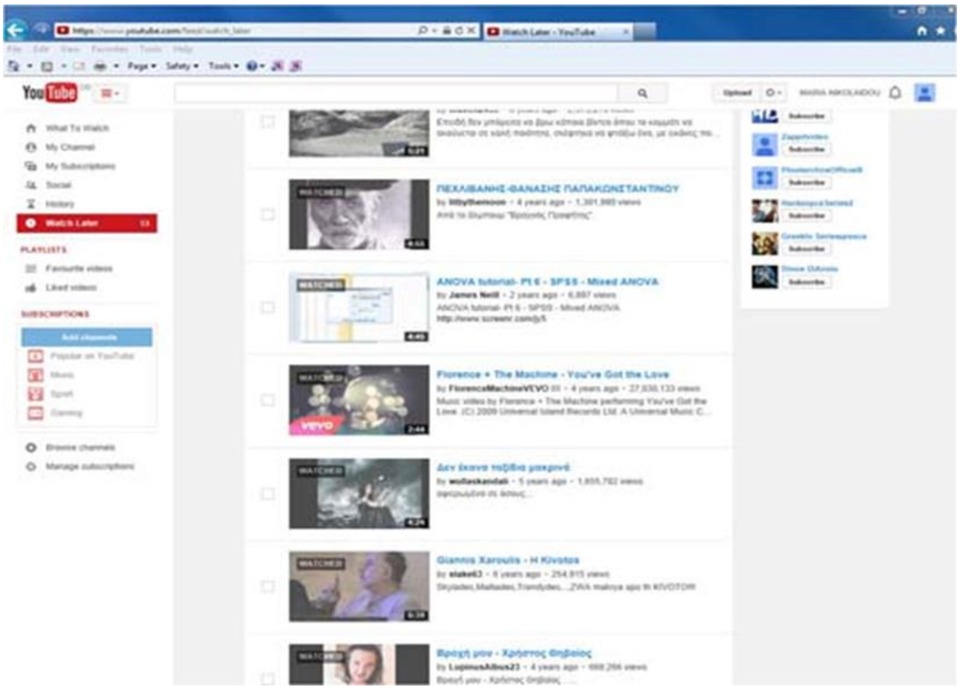
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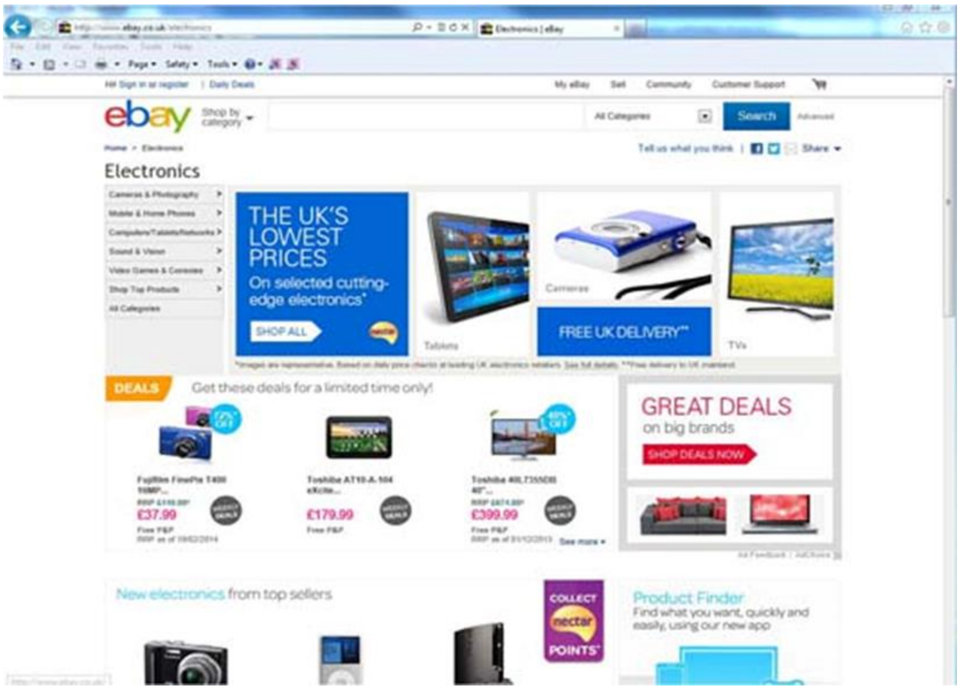
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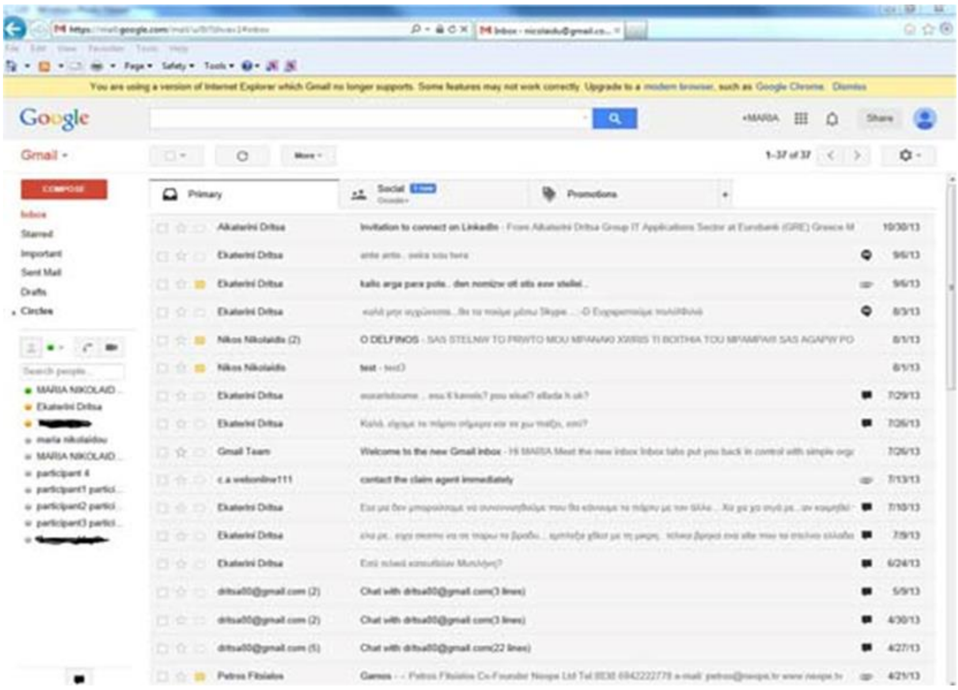
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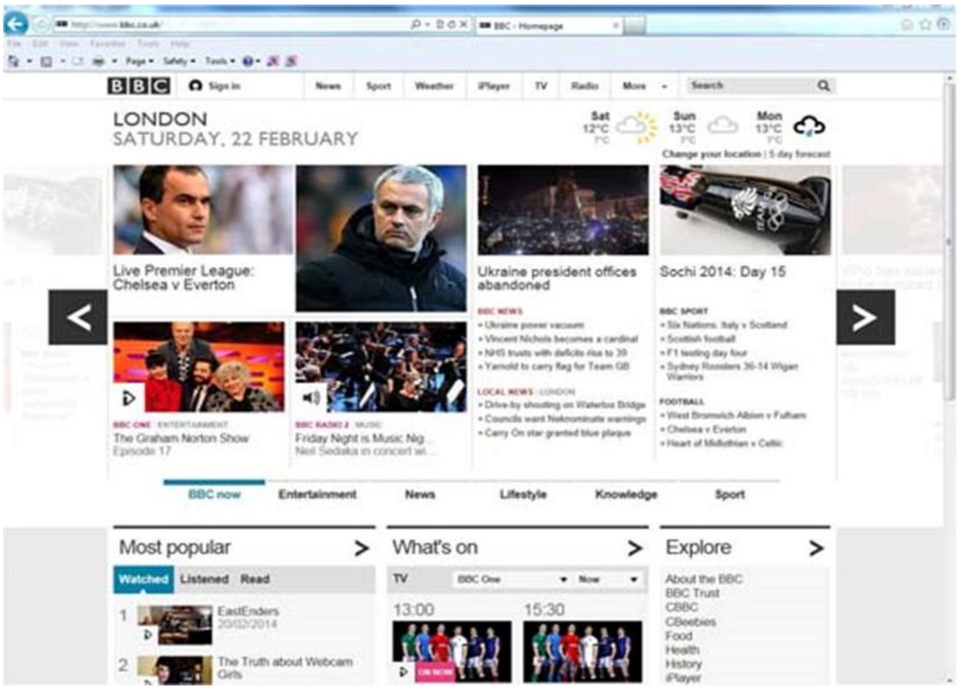

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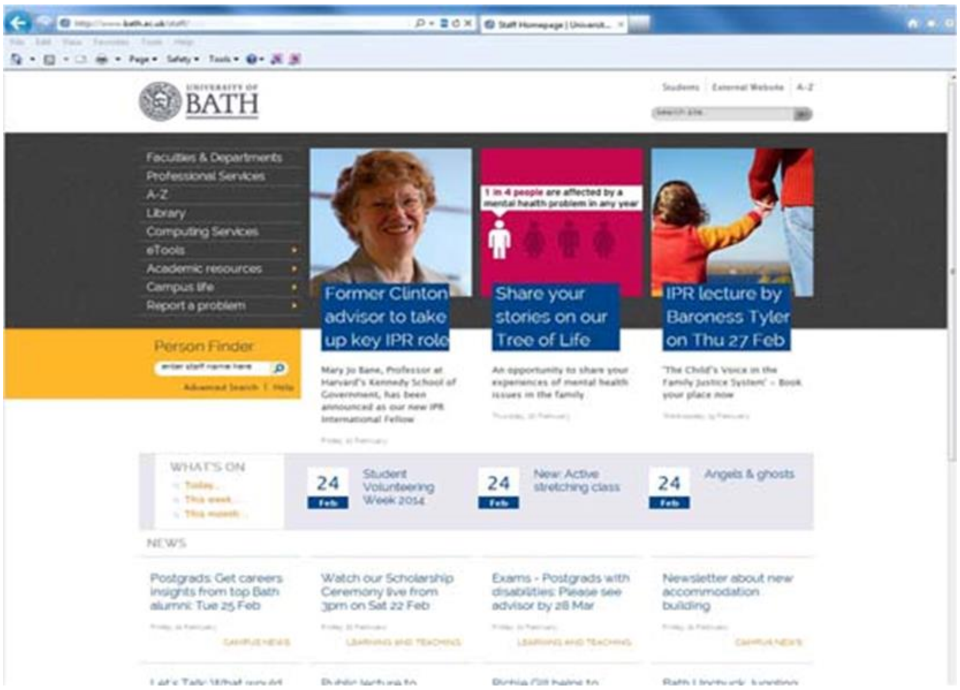
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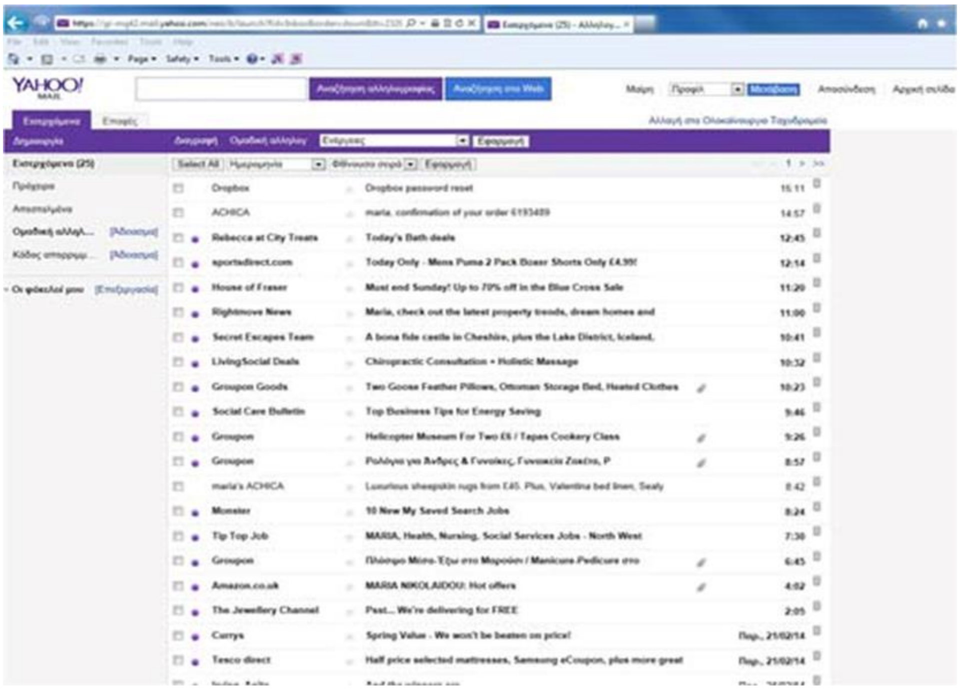
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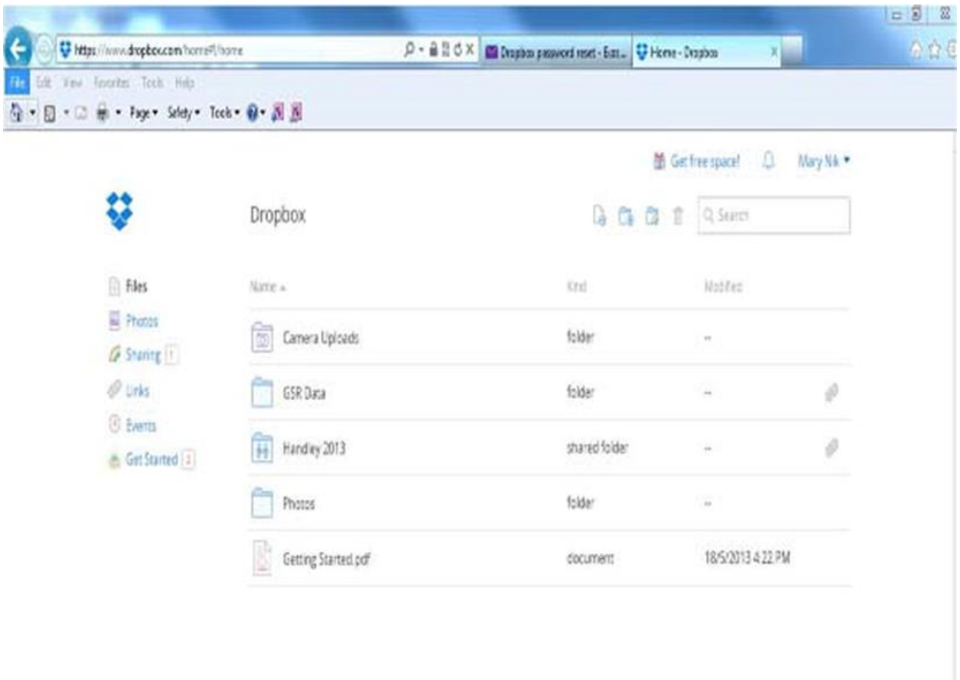
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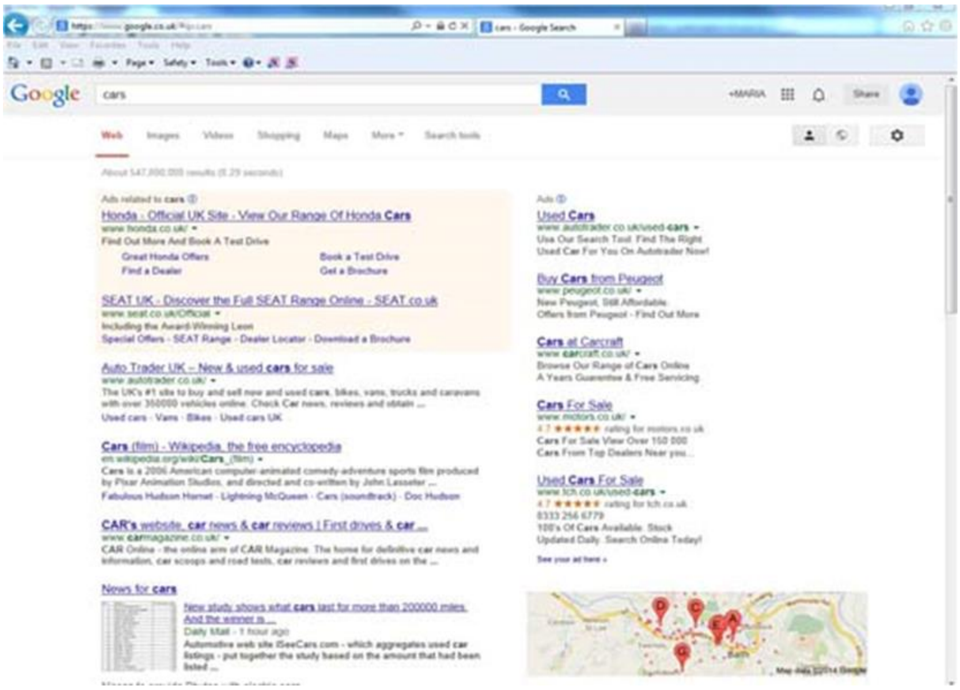
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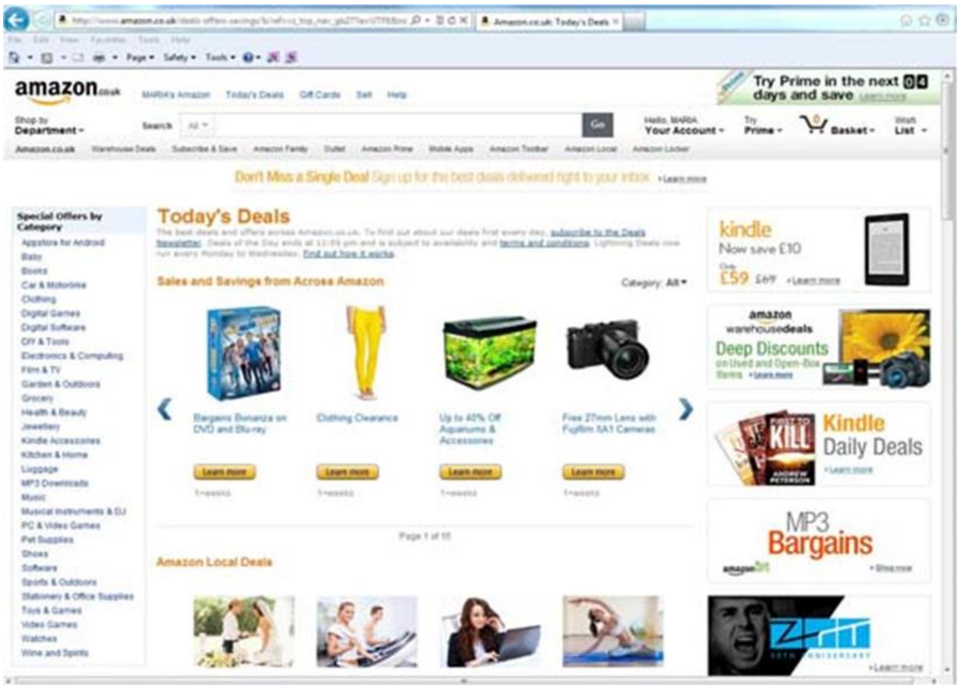
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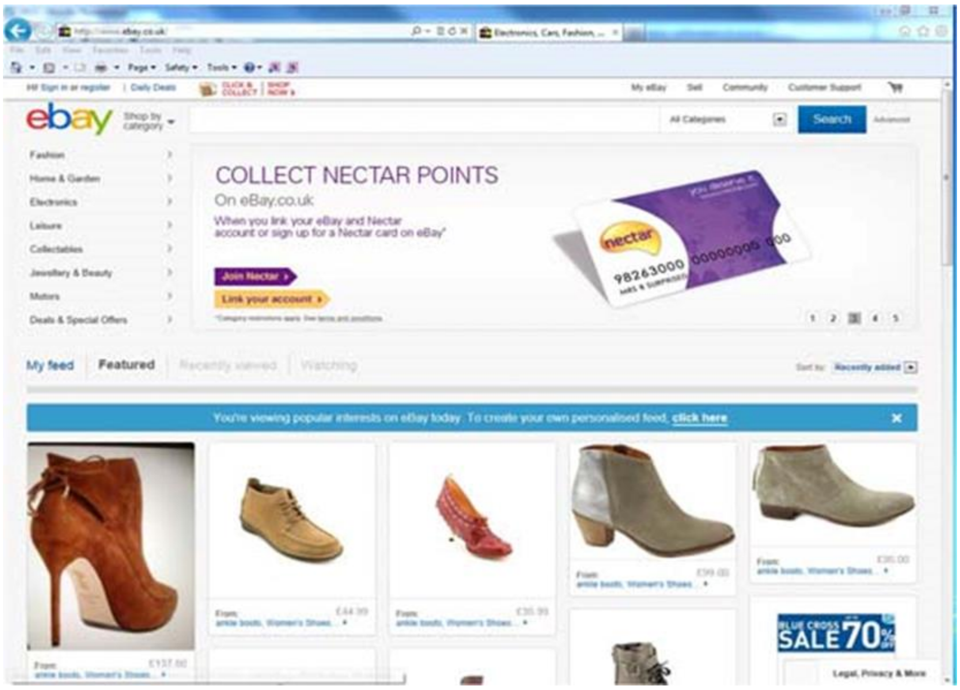
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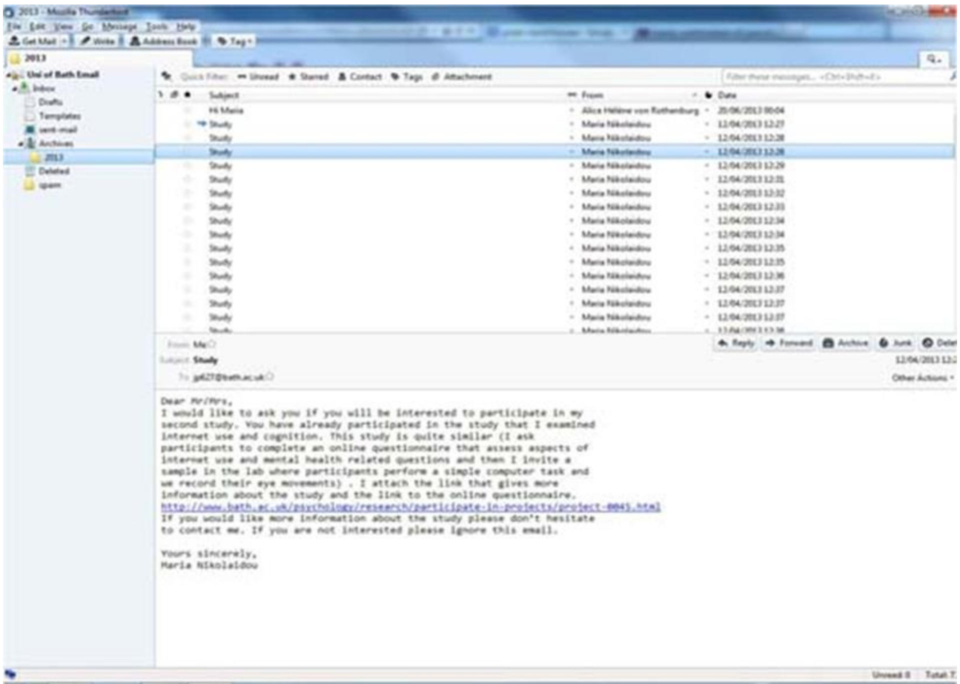
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If you would like more information about the study please don't hesitate to contact me. If you are not interested please ignore this email.
Yours sincerely,
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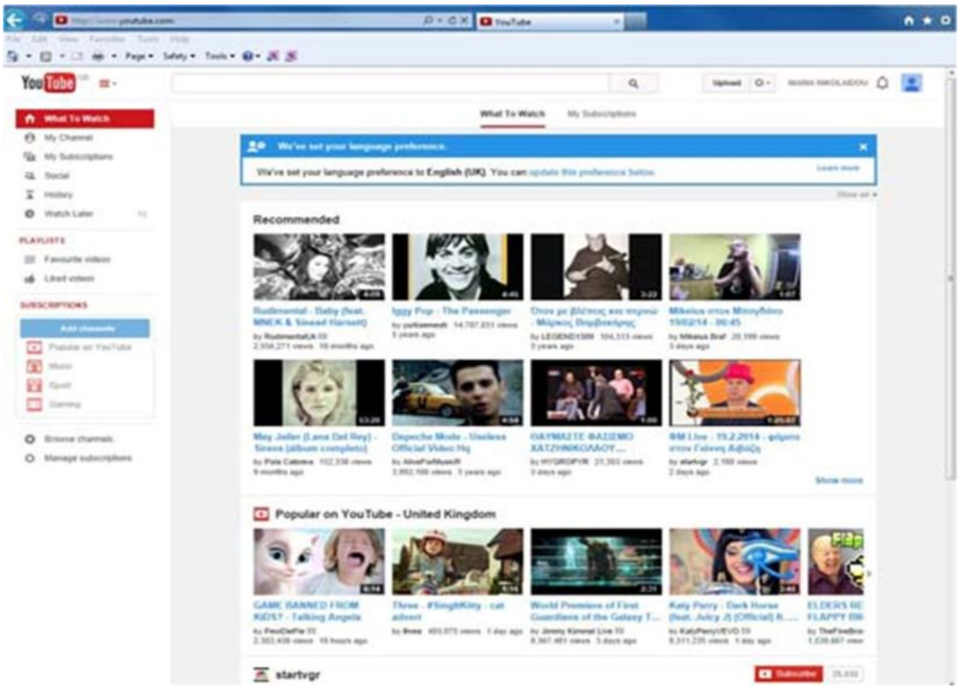
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Appendix VI

Formula used for the signal detection analysis (Snodgrass & Corwin 1988).

Hit and false alarm probability

P('hit') = (Σ answer)/(Σ target)

P('false alarm') = (Σ answer)/(Σ non-target)

Corrected probability

Pcorrected('hit') = (Σ answer + 0.5)/(Σ target + 1)

Pcorrected('false alarm') = (Σ answer + 0.5)/ (Σ non-target + 1)

Discrimination and decision bias

Delta (d') = Z[Pcorrected('hit')]– Z[Pcorrected('false alarm')]

C = −0.5 *{Z[Pcorrected('hit')]+ Z [(Pcorrected('false alarm')]}

'Σ answer' is the total number of responses, 'Σ target' the total number of targets, and 'Σ non-target' the total number of distracters. P('hit') is the probability to respond to a target. P('false alarm') is the probability of respond to a distracter. Z(p) is the quantile function of the normal distribution. Z are calculated on Pcorrected to avoid infinite value when P = 1.

Z(p) is the quantile function of the normal distribution of all participants' performance for a particular block. Z are calculated on Pcorrected to avoid infinite value when P = 1. The distribution of corrected hit and false alarm scores were used to transform each participant's block scores into standardized Z scores. Thus a participant's d' nd C indices for a particular block reflect their relative performance compared to all other participants on that same block. Scores above zero indicate better ability to discriminate targets from distracters (for d') and better ability to inhibit response appropriately (for C), i.e., less ''decision bias'' to respond in general. Scores below zero on d' and C indicate, respectively more difficulty discriminating targets from distracters and greater readiness to respond to both targets and distracters.