Internet and Facebook Related Images Affect the Perception of Time.

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Abstract

Even though there is a wealth of research on *addiction* and implicit measures, the effects of *addiction* on time perception are still unclear. *Internal clock* models separate the effects of attention and arousal which could have important implications for *addiction* research. The present study investigated whether Internet related stimuli can lead to distorted time perception. We found evidence that Internet and Facebook related stimuli can distort time perception due to attention and arousal related mechanisms. This highlights that Facebook related stimuli lead to an underestimation of time compared to Internet related stimuli, and both Facebook and Internet related stimuli were associated with better discriminability of time compared to matched neutral stimuli. Implications of these findings on *addiction* are discussed.

Internet addiction (IA) emerged during the last 20 years with the introduction of the *web*, and has since seen a constantly increasing prevalence (e.g. Kuss, Griffiths, & Binder, 2013; Kuss & Griffiths, 2011). Traditionally, addiction was strictly associated with the abuse of a substance, such as alcohol, nicotine, or other drugs. This association required the presence of a substance that would be associated with an uncontrolled urge to use, withdrawal symptoms, or relapse. However, in the presence of non-substance related addictive behaviours the study of addiction shifted from the classical view to a more holistic biopsychological perspective (Griffiths, 2005). Griffiths (1996) proposed that all addictions consist of seven components (salience, mood modification, tolerance, withdrawal, conflict, and relapse). This allowed us to focus on addictive behaviours and not necessarily substances, behaviours such as pathological gambling or Internet addiction.

Contrary perhaps to most substance addictions, IA is an umbrella term that can include a number of different addictive behaviours. This was apparent even from the early years of IA research where Young (1999) identified five different types of IA. These were, *computer addiction*, *information overload addiction*, *net compulsion addiction*, *cyber-sexual addiction*, and *cyber-relationship addiction.* This categorisation is very important as different factors can affect different IA types. For example, a form of *information overload addiction* could be the urge to surf the Internet in constant search for new information, whereas, a form of *cyber-relationship addiction* could be an addiction to social networks such as Facebook. Furthermore, researchers have found that excessive Facebook users exhibit a number of addiction criteria such as thought withdrawal symptoms and mood swings when they cannot access Facebook (for a review see Kuss & Griffiths, 2011).

Despite the fact that IA shares similarities with substance addictions, the majority of the research focuses on the prevalence of use, personality traits, motivation and correlational research. To the knowledge of the authors the amount of research that focuses on implicit phenomena such as attentional bias or arousal in IA is rather limited. The same cannot be said for substance addictions where attentional bias has been well researched and is a robust finding, examples among others include research on alcohol (Sharma, Albery, and Cook, 2001), nicotine (Ehrman et al., 2002), cannabis (Cane, Sharma, and Albery, 2009), cocaine (Copersino et al., 2004), heroin (Waters, Marhe, and Franken, 2012), and opioids (Lubman et al., 2000); for a review see Cox, Fardadi and Pothos (2006). Furthermore, attentional bias has also been researched on Pathological Gambling (e.g. Molde et al., 2010; Brevers et al., 2011).

This limited research highlights the need for more investigation on IA and implicit measures, especially if we consider the first two components that Griffith proposed, salience and mood modification. IA salience could refer to raising the activity of "being online" as the predominant thought and preoccupation throughout the day. This could lead to craving to *go online* and consistent with addiction theories could initiate a vicious circle between craving and attentional bias (Franken, 2003; Kavanagh, Andrade, and May, 2005). Furthermore, mood modification could result in arousal changes that can lead to increased dopaminergic activity that can further enhance the activation of IA related cues and the urge to *go online*.

This highlights the possibility that IA, through dopaminergic activity triggered by the presence of *salient* stimuli, could affect time perception. The effects of dopamine in time perception have been demonstrated in a number of studies (e.g., Buhusi & Meck, 2005; Meck, 2005, 2006; Tipples, Meck, Cheng, & Narayanan, 2016). Dopamine has been thought to affect arousal which in the *internal clock* models can affect the rate of the pulses generated by the *pacemaker* (Buhusi & Meck, 2002, 2005). However, studies that compare Parkinson's disease (PD) patients to neurologically healthy groups are reporting mixed results, in the best case, or even non-significant differences (Wearden et al., 2008; Wearden et al., 2009). Therefore, investigating time perception in non-substance addiction could be informative for both time perception and addiction models as it could provide further evidence for the role of dopamine.

Moreover, using time perception paradigms could provide implicit measurements of the effects of IA in our internal clock, especially since arousal and attention are factors that affect its accuracy. One of the most popular internal clock models is the one proposed by the *scalar timing theory* (Gibbon, 1977; Gibbon et al., 1984). This model consists of three distinct stages, the *clock stage*, the *memory stage*, and the *decision stage*. In the *clock stage*, a *pacemaker* is generating pulses throughout the duration of an event; a *mode switch* is either allowing the pulses to be carried to the *accumulator* or not. In simple terms, when our attention is focused on the event then the *mode switch* stays on and the generated pulses gather in the accumulator. When we are distracted, *mode switch* could be turned off disallowing the pulses from reaching the accumulator. The *accumulator* then passes the number of the collected pulses to the *memory* and *decision stages* where the *comparator* concludes if the event we experienced was *short* (a small number of accumulated pulses) or *long* (a larger number of accumulated pulses), for more details see Droit-Volet and Gil (2009).

A number of studies have provided evidence that using drugs that affect arousal impacts our time perception. This is thought to be mainly by influencing the *pacemaker*, thus affecting the rate at which pulses are generated (Drew et al., 2003; Cheng et al., 2007). Furthermore, negative stimuli can accelerate the *pacemaker* and lead to temporal overestimation compared to positive or neutral stimuli (e.g. Droit-Volet and Meck, 2007; Tipples, 2008; Tipples, 2011). In addition, attention can also have an impact on our time perception (Thomas & Weaver, 1975; Zakay & Block, 1996). Losing our attention would result in the *mode switch* switching off thus not allowing the generated pulses to reach the *accumulator*. This would lead to fewer pulses being accounted thus perceiving the event as shorter (temporal underestimation). Attentional bias effects could result in underestimation when we shift our attention to external cues or events (Tipples, 2008).

However, attention effects on the *internal clock* are not limited to merely attentional bias. Another factor that could affect our *mode switch* is the attentional resources available to time (Sylvie Droit-Volet, Bigand, Ramos, & Bueno, 2010; Thomas & Weaver, 1975).

Additionally, Hansen and Trope (2013) have suggested that the amount of the attentional resources available to time could depend on our mind-set. Their findings suggest that when we are primed with a concrete mind-set less attentional resources are allocated to time leading to a shorter experience of time. Contrary, when we are primed with an abstract mind-set more attentional resources are allocated to time leading to a longer experience of time. This could help us distinguish even more between the effects of different stimuli in IA. One could argue that by using general Internet related stimuli we are primed with a more abstract mind-set since the Internet is a collection of a number of different activities. On the other hand, using Facebook related stimuli we are primed with a more concrete mind-set since Facebook has more specific and detailed uses compared to the Internet as a whole.

Our study is the first to investigate the effects of internet *salient* stimuli on time perception. We used the temporal bisection task to investigate predictions from the *internal clock* model for Internet *salient* stimuli. If *salient* stimuli elicit intrusive cognitions then this could be due to attention and/or arousal. The *internal clock* model predicts that if the effects are due to attention we should have an underestimation of time durations leading to a change in the subjective point of equality (also known as the bisection point). If the effects are due to arousal we should expect differences in our time perception discriminability, which can be reflected in changes in Weber's ratio (Sylvie Droit-Volet & Meck, 2007). Therefore, we hypothesise that *salient* stimuli, compared to *neutral* stimuli will lead to distorted time perception due to effects on attention and/or arousal.

Method

Participants

Forty-four University of Kent psychology students (33 women, 11 men, M_{age} = 20, SD_{age} = 5.12) were recruited for course credit. Participants had to be over 18 years old and have a Facebook® account in order to participate.

Design

The experiment employed a 2x2x5x7 within participants design: *Image Type* (Facebook, Internet) x *Saliency* (Salient, Matched) x *Block* (1, 2, 3, 4, 5) x *Duration* (400, 600, 800, 1000, 1200, 1400, 1600ms) being the IVs. The dependent measures were the mean proportion of "long" responses p(long), the Bisection Point (BP), and the Weber's Ratio (WR). The p(long) value is calculated as the ratio of "long" responses divided by the total number of responses and it is a first indication on whether we have an overestimation or underestimation of the time intervals per duration. The BP indicates at which duration each participant was crossing the threshold to pressing "long" over "short" response. We calculated BPs by running probit analysis and acquiring the values for probabilities equal to .5 or p(50). The WR is a measurement of discriminability and is the ratio of half the difference between p(75) and p(25) divided by p(50), for more details read Droit-Volet and Rattat (2007). In this case WR indicates the minimum time interval in durations that a participant would be able to detect. Therefore, the smaller the WR the better a participant would be at detecting smaller changes in durations.

Material

Visual Stimuli. In total, 20 images were used in this experiment: 5 Facebook salient (FS), 5 Facebook matched (FM), 5 Internet salient (IS) and 5 Internet matched (IM). Initially, we selected five images related to Facebook and proceeded with creating five matching images. These matching images had similar geometrical features as the five Facebook ones. Similarly, we selected five images related to the use of Internet (e.g. email icon) and proceeded with creating five matching images as described above. Furthermore, in order to avoid colour saliency issues between stimuli all matching images had similar colour and luminosity means. This was checked using Photoshop® and independent online tools (e.g. http://mkweb.bcgsc.ca/color-summarizer). Furthermore, a neutral image was selected to be used in the two training tasks. The dimensions of all images were 300 x 300 pixels.

Hardware and Software. For the temporal bisection task, the images were presented on a 19-inch monitor (1,024 x 768, 60Hz) connected to an Intel i5 powered PC. The software used to present the stimuli and collect the responses was Psychopy v1.82 (Peirce, 2009). Standard keyboard and mouse were used to input responses and all images were presented in grey background.

Young's Internet Addiction Test (IAT). Young's IAT (1998) was used in order to measure the severity of problems caused by the use of Internet. This is a 20-item questionnaire with five-point Likert scale items. The items measure the impact of the Internet on sleeping pattern, feelings, social life, productivity, and daily routine. Scores can range from 20 to 100 with the author suggesting three different severity groups. For scores of 20-39 the use of Internet is average and non-problematic, for scores of 40-69 frequent problems could arise from the use of Internet, and finally for scores of 70-100 the use of Internet is causing significant problems. The questionnaire has been found to have moderate to good internal consistency with Cronbach's alphas ranging from .54 to .82 (Chang & Man Law, 2008; Khazaal & Billieux, 2008). The IAT was completed online at the Qualtrics website (Qualtrics ©, http://www.qualtrics.com, 2015).

Procedure

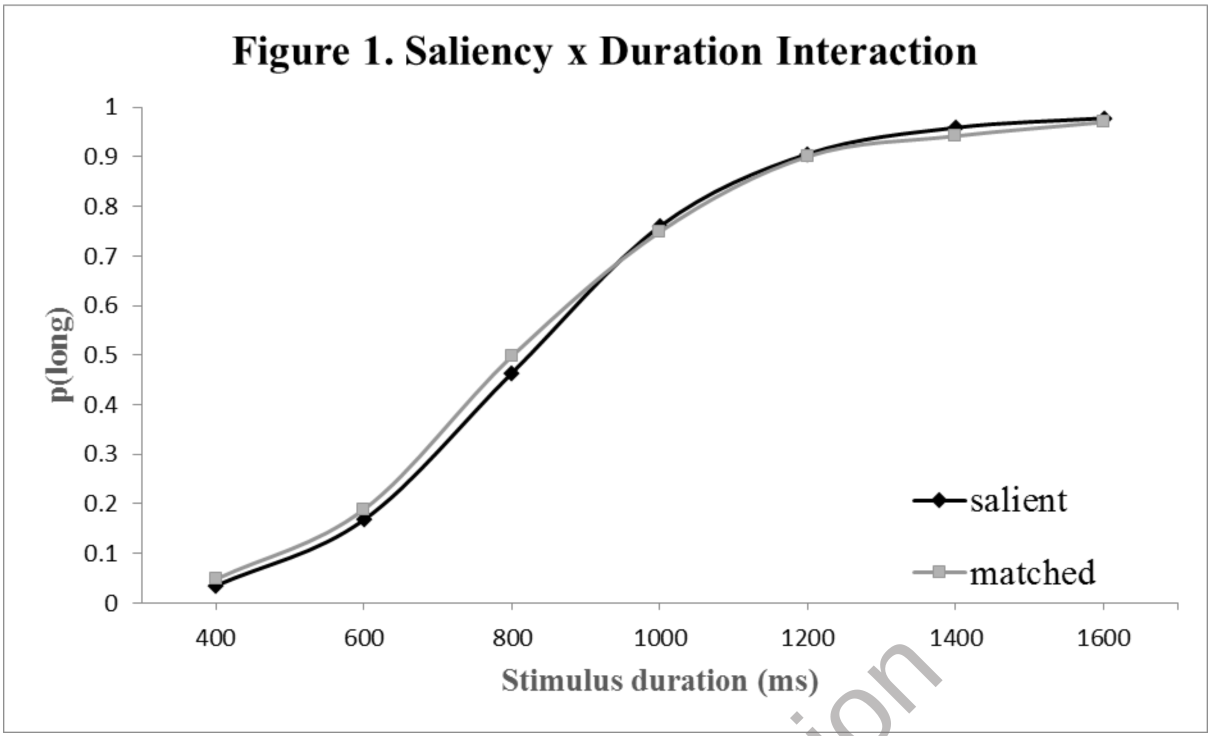
After being briefed and providing consent, each participant completed the experiment in individual cubicles. The experiment was comprised of two training tasks, one main task of five blocks with 140 trials each, followed by completion of the online version of the IAT questionnaire. Participants were instructed that the first two tasks were training tasks and that the experimenter would stay in the cubicle in order to provide further instructions if needed. Participants were told that the purpose of the training tasks was to introduce them to the "short" (400ms) and "long" (1600ms) standards and also to provide them with sufficient training to discriminate between them. During the first training it was explicitly mentioned that the single image would be shown over the course of the "short" and "long" standards. The image would be presented in a fixed alternating short-long order and that the participant would have to respond "short" (by pressing "s") or "long" (by pressing "l"). After each response, ("correct" / "incorrect") feedback was displayed on the centre of the screen for 1 second. Consequently, a randomly varying intertrial interval (0.5s to 1.5s) would follow. During the second training task, the same image was presented on the screen either for 400ms or 1600ms, but in a random order. The second training task lasted until the participant produced eight consecutive correct responses. Again, feedback was provided after each response. Once the second task was completed the instructions about the main task were presented on the screen. The instructions informed that more stimuli would be presented in varying durations and they would have to respond whether these durations were closer to "short" or "long". The experimenter would ask the participant if he/she was happy with the instructions and then leave the cubicle before the main task started. During this task 20 images would be presented for seven durations (400, 600, 800, 1000, 1200, 1400, 1600ms) in random order, this resulted in 140 trials. The participant responded "short" or "long" with no feedback following responses. Upon the completion of the first block of 28 trials there was a break of one minute before the next block of 28 trials would begin. Finally, once the temporal bisection task was completed, the online IAT questionnaire was completed. Participants were fully debriefed and thanked for their participation.

Results

P(long) Analysis

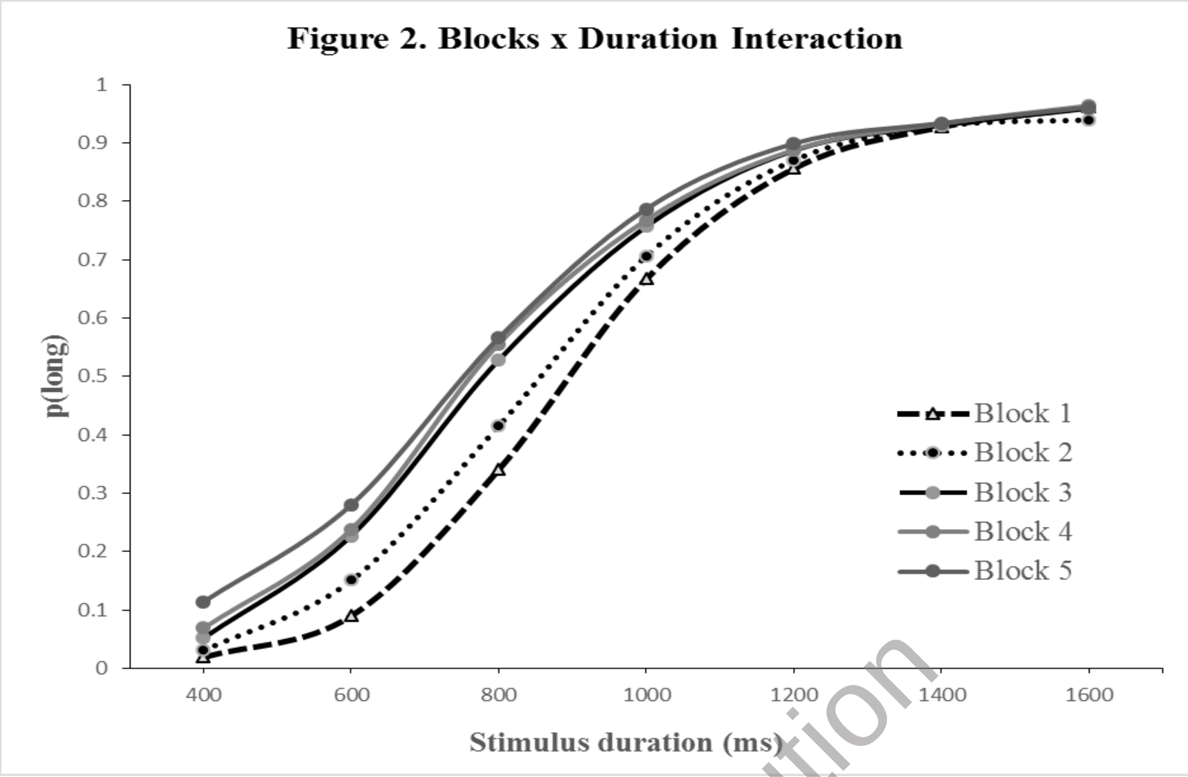
The p(long) values were entered into a three-way within-participants analysis of variance including Image (*F, I*), Saliency(*S, M*), Block (1-5), and Duration (400, 600, 800, 1000, 1200, 1400, 1600ms). There was a main effect of Image, $F(1, 34) = 6.334$, $p = .017$, indicating an underestimation of time for the Facebook images compared to the Internet images (respective p(long) means: .606 and .617). There was a main effect of Block, F (4, 134) = 13.173, $p < .001$, indicating that participants overestimated time more as we moved from Block 1 to 5 (respective p(long) means: .556, .588, .624, .636, .656). Furthermore, Block 1 was not significantly different from Block 2, however they were both significantly different from Block 3, 4, and 5. Finally, there was no significant difference after Block 3 suggesting that perhaps a peak in p(long) responses had been reached. There was also a main effect of Duration, F (6, 204) = 543.591, $p < .001$, indicating as expected that the p(long) values would increase as the time duration increased (respective means for 400 to 1600ms: .041, .178, .481, .755, .903, .950, and .974). Furthermore, there was a Saliency x Duration interaction, $F(1,34) = 3.60$, $p = .002$. Simple main effects of Saliency showed significant effects at durations 800ms, 1400ms and 1600ms, indicating an underestimation of time at 800ms for Salient stimuli compared to Matched stimuli, and an overestimation of time at 1400ms and 1600ms for Salient stimuli compared to Matched stimuli, see Figure 1.

Figure 1: Showing the interaction between Saliency and Duration on probability of long responses, p(long).



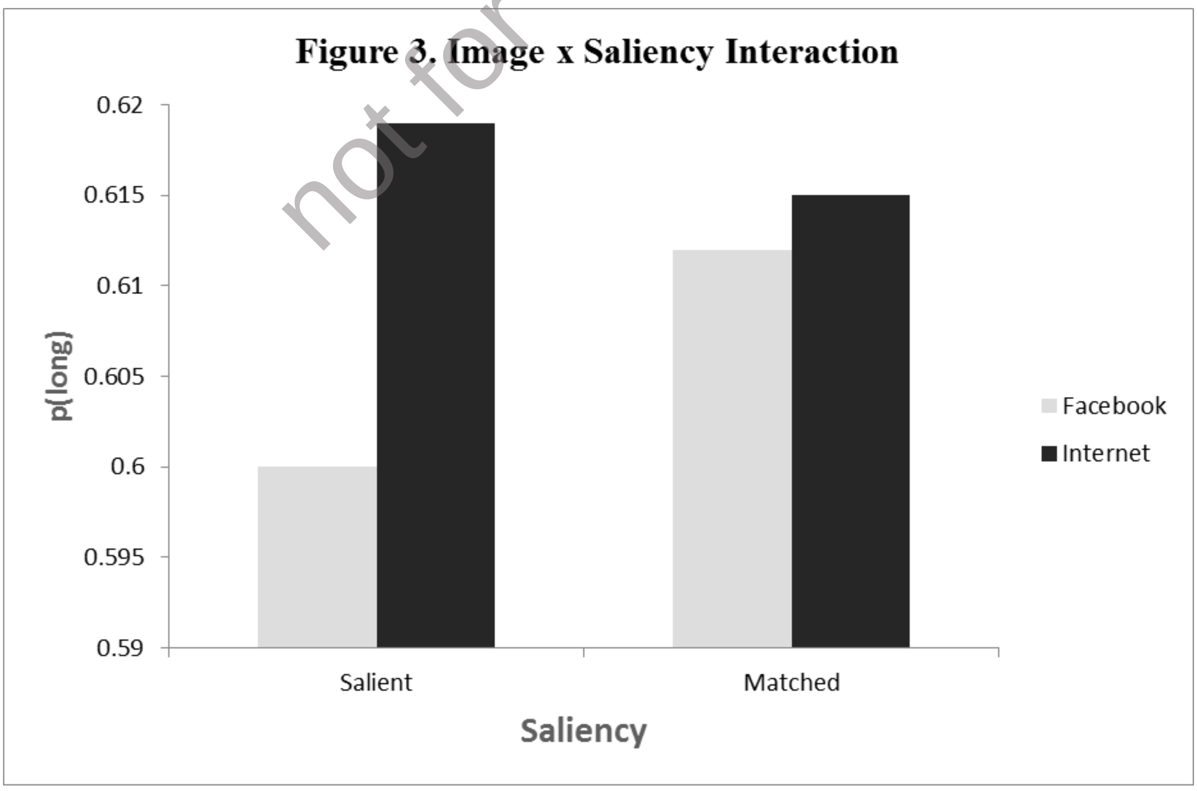
There was also a significant Block x Duration interaction, $F(1,34) = 6.96$, $p < .001$. There were significant simple main effects of Block at durations 400ms, 600ms, 800ms, and 1000ms (all F's > 2.83, $p < .05$) but not 1200ms and 1400ms (all F's < 1, $p > .5$). Although there was a simple main effect of Block at duration 1600ms, further post-hoc t-tests did not reveal any significant differences. At duration 400ms Block 5 was significantly different from all other Blocks. At duration 600ms, 800ms and 1000ms, Blocks 1 and 2 were significantly different from 3, 4 and 5, see Figure 2.

Figure 2. Showing the interaction between Block and Duration on probability of long responses, p(long).



Finally, there was a significant Image x Saliency interaction, $F(1, 34) = 4.87$, $p = .034$. There was a significant simple main effect of Saliency for Facebook images ($p = .042$) but not Internet images ($p = .324$), see Figure 3.

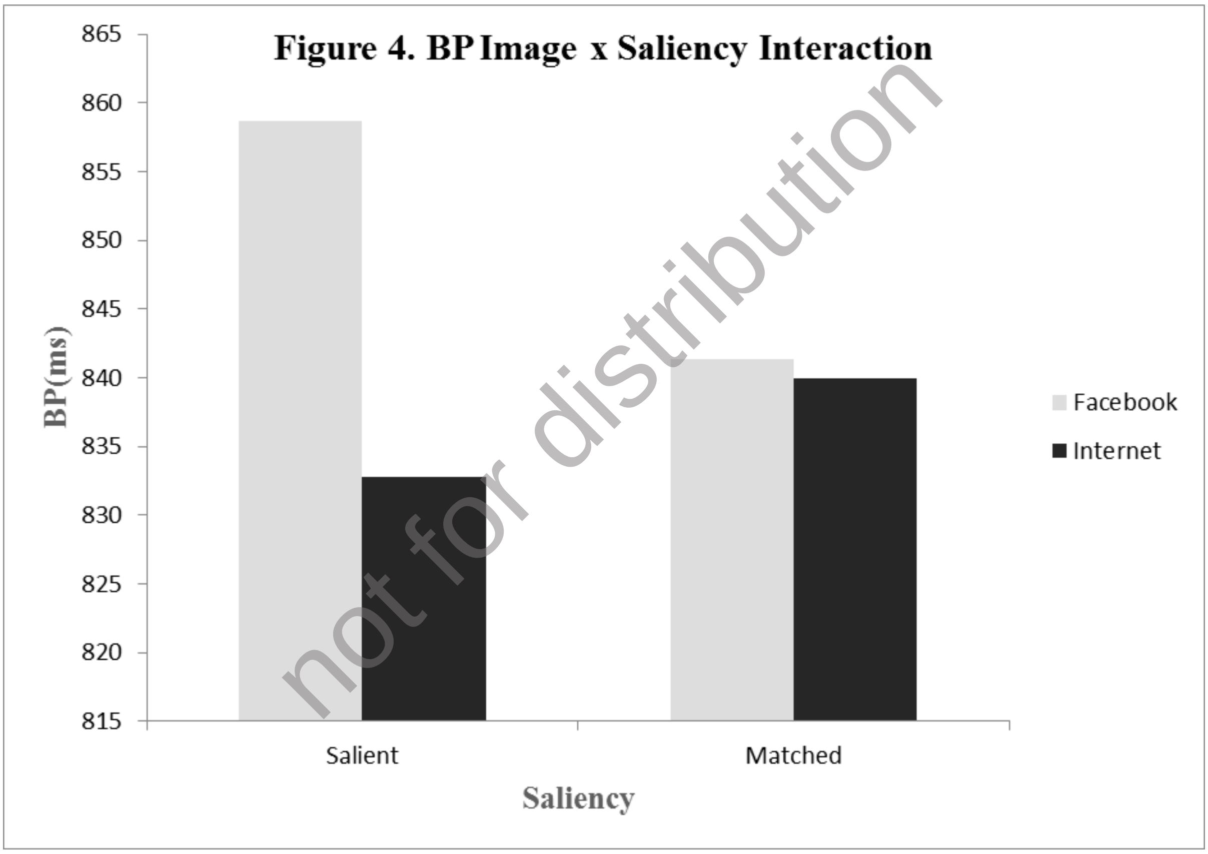
Figure 3. Showing the interaction between Image and Saliency on probability of long responses, p(long).



BP Analysis

A three-way within-participants ANOVA including Image(2), Saliency(2), and Block(5) was carried out. During the probit analysis for the calculation of BP, a number of participants had BP outside the 400 – 1600ms range. These participants were excluded from all analyses resulting in a final number of 35 participants in the analysis. There was a main effect of Image, $F(1,34) = 4.46$, $p = .04$ indicating that Facebook related stimuli had a higher BP, see Figure 4. There was a main effect of Block, $F(4,136) = 12.57$, $p < .001$ indicating that BPs were significantly reducing from Blocks 1 to 5 (respectively 924.26ms, 877.40ms, 827.10ms, 810.18ms and 776.94ms) with no significant difference between Blocks 1 and 2 but these were both significantly different from Blocks 3, 4 and 5. There was no main effect of Saliency $F(1,34) = 1.05$, $p = .31$.

Figure 4. Showing the interaction between Image and Saliency on bisection point, BP.



There was a significant interaction between Image and Saliency, $F(1, 34) = 5.20$, $p = .03$, see Figure 4. Simple main effect analysis of Saliency within Facebook images (FS=858ms, FM=841ms) was significant but not for Internet images (IS=832ms, IM=839ms). No other interactions were significant (all F’s<2.3, $p>.07$).

WR Analysis

A three-way within-participants analysis of variance including Image(2), Saliency(2), and Block(5) was carried out. There was a main effect of Saliency, $F(1, 35) = 16.39$, $p < .001$ indicating that salient stimuli had significant lower WR (0.167) than matched images (0.189), indicating participants were better able to discriminate changes in time durations for salient images compared to their matched image. No other main effect or interaction were found.

IAT Score and Correlations

The IAT scores varied from 23 to 63 (M_{IAT} = 45.01, SD_{IAT} =10.74). Fourteen participants had scores between 20 and 39 and were classified as average online users, 19 had scores between 40 and 69 and were classified as online users with frequent problems due to Internet use. There were no participants with scores higher than 70 that would indicate significant problems due to use of Internet (Young, 1998). Furthermore, we ran correlational analysis between the IAT scores and the attentional bias scores (*salient –matched)* in BP and WR for each image type in each block. All correlations were non-significant (r's $< .243$, p's $> .114$).

Discussion

The aim of this study was to investigate the effects of Internet *salient* stimuli on time perception. We employed the temporal bisection task to look into possible effects of *salient* stimuli on the predictions of the *internal clock* either due to attention, arousal, or both. The model predicts that attention can affect our time perception by causing underestimation of time duration due to distraction. However, arousal can have bidirectional effects either by accelerating or decelerating the *pulse maker*, leading to distorted time perception (e.g. Droit-Volet, Fanget, & Dambrun, 2015; Tipples, 2008).

Our data provide support for attentional effects as predicted by a *mode switch* in the *internal clock* model. This is supported by two results: main effects of Block and Image. As Block increased BP decreased suggesting an overestimation of time. This lengthened time experience could be a result of reduced attention on stimuli caused by repetitive exposure, hence leaving more attentional resources devoted to time. With regards to Image, there were higher BP scores for Facebook than Internet stimuli. This indicates an underestimation of time for Facebook stimuli than Internet stimuli suggesting greater attentional resources being allocated to Facebook than Internet stimuli.

Furthermore, there was an interaction between Image and Saliency in which BP was higher for Facebook *salient* stimuli than Internet *salient* stimuli but not for the *matched* stimuli. This highlights greater attentional bias to Facebook *salient* stimuli over Internet *salient* stimuli and no difference between the *matched* ones. This is a very interesting finding underlining perhaps differences between behaviours within the IA itself. This could provide further support to arguments that there are different behaviours and motivation behind different types of IA as were first identified by Young (1999). For example, an IA that is driven by *net compulsion* or *cyber-sexual addiction* could be driven by the need to surf the web in search of news and thus be more associated to excitation and arousal (Cooper, Putnam, Planchon, & Boies, 1999). On the other hand an IA that has *cyber-relationship addiction* in its core (the use of Facebook has been identified as such, Kuss and Griffiths, 2011) could have more emotional motives and thus perceive Facebook *salient* stimuli as not threatening and not trigger arousal effects that are associated with overestimations (e.g. Tipples, 2008, 2011).

A different explanation on why Facebook stimuli cause different effects than the Internet ones could lie in the effects they have on our mind-set. Hansen and Trope (2013) have hypothesised that placing ourselves in an abstract or concrete mind-set can affect our time perception. This is due to the fact that concrete mental representations (one that focuses more on specific details) take up more attention resources from the perception of time. It could be argued that Facebook addiction is a more specific form of IA. Thus Facebook stimuli might prime a more concrete mind-set than Internet stimuli.

Our findings also support arousal effects on the *pacemaker* within the *internal clock* model. The differences in WR scores between *salient* and *matched* stimuli suggest that our discriminability for *salient* stimuli remains better across all blocks compared to the *matched* ones. This could mean that *salient* stimuli are associated with higher arousal levels compared to *matched* ones, resulting in more pulses being generated by the *pacemaker*; hence experiencing time as longer when we see *salient* stimuli compared to *matched*. This finding is in line with predictions from addiction models that addiction related cues can lead to craving and excitation and thus increased arousal (Franken, 2003; Kavanagh, Andrade, & May, 2005).

In conclusion we believe that time perception in general, and the temporal bisection task specifically, can be a valuable tool in the study of addiction, substance-related or not at both theoretical and methodological levels. Our findings show clearly that the temporal bisection task can be used to demonstrate intrusive cognitions from *addiction* related stimuli. Furthermore, applying the *internal clock* model allows us to distinguish between attentional effects (*mode switch*) and arousal effects (*pacemaker*). This provides an advantage over other implicit tasks used in addiction research (e.g., dot-probe, Stroop) where intrusive cognitions can be detected but not distinguished between attention and arousal effects. Furthermore, in the case of IA, investigating time perception is even more important as one of the side-effects could be the time lost in the *net*. Of course it is possible that time is lost in other addictions but this issue has not been investigated. The current study also identifies the need for further investigation on the differences in different types of IA. It would also be valuable to employ different paradigms from the time perception research (e.g. time production) and attempt to further distinguish the individual roles of attention and arousal. Finally, the role of memory was not examined at all in this study and it would be interesting to investigate how memory can interact with both attention and arousal under the predictions of the *internal clock* model and what the effects would be on time perception.

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