university of groningen / faculty of science and engineering / artificial intelligence

Does TikTok-style content impair sustained attention?

Bachelor's Project Thesis

Serban-Andreas Dumitru, s5170516, s.dumitru.3@student.rug.nl,
Supervisor: Lisa Vortmann

Abstract: The rapid growth of short-form video platforms such as TikTok has raised concerns about their potential impact on cognitive functions, particularly sustained attention. This study investigated the effects of TikTok-style short-form content (SFC) and mindfulness meditation on sustained attention in young adults, using behavioural and EEG measures. Participants (aged 19–24) were categorised as either addicted or non-addicted to SFC and completed three sustained attention tasks, with two interventions—viewing SFC and mindfulness meditation—randomly assigned between tasks. EEG data were recorded throughout to examine neural correlates of attentional engagement. Results indicated that addicted participants showed significantly faster reaction times compared to non-addicted participants. Increases in reaction time following the SFC intervention are present for both groups. Additionally, a reduction in the P300 component was observed in addicted individuals after viewing SFC. These findings suggest that SFC may have immediate, measurable effects on attentional processes, highlighting the need for further research into its cognitive and neural implications.

1 Introduction

1.1 Background

The internet has fundamentally transformed communication, reshaping how people create, share, and interact with information. In many developed countries, it has become so integrated into daily life that individuals can effectively be considered to be living online (Ngai et al., 2015). Beyond information exchange, the internet now serves as a central hub for entertainment, social interaction, career development, validation, and community support (Grover et al., 2022). The advent of the smartphone has made the internet ubiquitously accessible, turning it into an ever-present aspect of everyday life, offering instant access with minimal effort (Firth et al., 2019).

However, this accessibility also introduces risks. The low-effort, high-reward dynamic can foster excessive use, potentially leading to problematic internet use (PIU). This is especially true for adolescents, who, compared to children or adults, find themselves in a pivotal period of cognitive, social, and emotional development (Choudhury et al., 2006). During this period, the brain and many cognitive processes go through a series of changes that could be affected "in both beneficial and adverse ways - as many cognitive processes are not entirely innate, but rather are strongly influenced by environmental factors" (Firth et al., 2019, p. 119). Moreover, adolescence is a life stage marked by social interactions and identity exploration facilitated by the internet (Grover et al., 2022). Consequently, the internet, particularly social media, has become a highly attractive and dominant social space for adolescents. For example, as many as 73% of the youth in Turkey aged between 16 and 24 reported using the internet (Öztürk & Özmen, 2016).

PIU has been defined as "the excessive use of the internet that causes disturbances or harm to the individual" (Chemnad et al., 2023, p. 2). It has been linked to a series of symptoms in adolescents, which may include lack of impulse control, high levels of inattention, altered sleep patterns, physical inactivity and/or a sedentary lifestyle, impaired decision making, self-destructive behaviour and school burnout (Mahdizadeh et al., 2017; Reed, 2023; Salmela-Aro et al., 2017).

PIU has also been associated with an increased risk of developing mental health disorders such as anxiety, depression, suicidal thoughts, conduct problems and symptoms of attention-deficit disorder (ADHD) (Brino et al., 2022; Durkee et al., 2016; Ioannidis et al., 2016). These cognitive and emotional developments underscore the complex and potentially harmful effects of sustained digital engagement.

A significant subset of PIU is social media addiction (SMA), characterised by compulsive engagement with social media platforms (SMPs). Some have defined addiction as not being a disease, "but rather, an association between an unfulfilled psychological need and a set of actions that assuaged that need in the short-term, but was ultimately harmful in the long-term"(Hunter & Morganstein, 2021, p. 206). These platforms meet the core psychological needs described in Self-Determination Theory, which include relatedness, autonomy, and competence, through instant feedback and peer validation (Legault, 2020).

One of the challenges posed by the digital world today is attentional regulation. The massive constant wave of information quickly floods our attention resources, causing attentional overload. Attention has many facets, including sustained attention, divided attention, and selective attention, all of which are crucial abilities that allow us to focus on tasks, process information, and make decisions (Alam, 2023). Attentional overload occurs "when the demands of the environment exceed the capacity of an individual's attentional resources. The digital world presents a wide range of stimuli, including alerts, personalised notifications, social media updates, emails, tweets, calendar reminders, texts and news feeds, all of which compete for an individual's attention" (Shanmugasundaram & Tamilarasu, 2023, p. 2). One of the symptoms of attentional overload is continuous partial attention, where an individual superficially splits their attention across multiple tasks, without fully immersing themselves into a single task for a prolonged period (Shanmugasundaram & Tamilarasu, 2023).

In recent years, TikTok has emerged as a new form of SMP that may pose an even greater threat to attentional regulation. TikTok's core innovation lies in the delivery of short-form content (SFC)-highly visual, stimulating videos lasting between 15 and 60 seconds-optimised for instant gratification and algorithmic personalisation (Yao & Omar, 2022). The success of TikTok, particularly among adolescents, reflects a shift in media consumption patterns. This shift raises critical questions about the long-term cognitive consequences of frequent SFC exposure, particularly in adolescent and young adult users (ages 18-25). For example, during the COVID-19 outbreak in China, daily time spent on TikTok increased from 68.8 to 122.3 minutes, alongside a 19.4% rise in active users (Yao & Omar, 2022). Its addictive potential is also tied to the infinite scroll feature, which enables seamless and endless consumption of new content, causing users to fall into an entertainment spiral (Yao & Omar, 2022). The success of SFC in user engagement has caused other SMPs (e.g. Instagram, YouTube and Facebook) to adopt it (Das & Mishra, 2024). Given these features, it is crucial to understand how platforms like TikTok and the consumption of SFC more broadly may influence cognitive functions.

Emerging literature has begun to raise concerns about the cognitive costs of such hyper-stimulating platforms. Particularly their contribution to decreased attention spans, impaired sustained attention, and a preference for rapid, low-effort information processing (Das & Mishra, 2024; Montag & Markett, 2023; Montag et al., 2021). However, most existing studies on SMA have focused on traditional platforms, leaving a significant gap in understanding the specific cognitive consequences of TikTok and SFC on adolescent users. Moreover, there is a considerable literature gap that does not address the effects of SFC through brain imaging techniques, such as electroencephalogram (EEG) data, and link it further with addiction levels.

To better understand how attention is neurologically modulated by SFC use, EEG offers valuable insights into underlying cognitive activity. Studies have linked specific frequency bands from EEG data to psychological states. Increases in the alpha frequency band (α 8-13 Hz) have been linked with less attentive states of mind and lower mental vigilance (Coelli et al., 2015). Increases in the beta frequency band β (13-30 Hz) have been linked with inhibition control, focus and active cognitive engagement (Choi et al., 2013; Coelli et al., 2015). In real classroom settings, it has been observed, through a visual attention task, that increases in beta power over the occipital lobe precede correct responses, and decreases in beta power over the same region precede erroneous responses (Ko et al., 2017). Moreover, a study that used an engagement index to detect engagement levels found that increases in the mean engagement index recorded over a minute were linked with a decrease in the mean reaction time (Coelli et al., 2015).

The P300 event-related potential (ERP) component has been utilised in various studies to measure attentional processes; the amplitude of this component is linked to the intensity of processing (Kok, 2001). The P300 component appears between 300 and 500 ms post-stimuli. In tasks requiring attention for target onset, the P300 component has been observed to peak over electrodes in the posterior region of the scalp (Groom & Cragg, 2015). Using an oddball experiment paradigm, one study observed a decreased amplitude of the P300 ERP component for target onset over the parietal region in participants who self-reported heavy SFC consumption (above 4 hours) (Walla & Zheng, 2024). For response inhibition tasks related to non-target onset, the P300 ERP component exhibits a shift in spatial distribution, with increased amplitude over the frontal (anterior) regions, particularly the prefrontal cortex. This frontal reallocation of neural resources has been interpreted as reflecting a greater need to inhibit a response than to execute one, more specifically referred to as no-go anteriorisation (NGA) (Fallgatter et al., 1997; Fallgatter & Strik, 1999; Groom & Cragg, 2015).

Addiction research has shown that there might be differences in beta power between addicted and non-addicted during resting state conditions. Various studies have shown that participants with internet addiction exhibit a significantly lower beta power during resting state conditions when compared to non-addicted (Choi et al., 2013; Lee et al., 2014). The contrary has been shown in alcoholics, where elevated beta power was found during the resting state (López-Caneda et al., 2017).

Studies have reported that addicts, in general, may exhibit a shift toward left hemispheric dominance, or a more pronounced hemispheric asymmetry, compared to non-addicted individuals. This hemispheric asymmetry has been observed through EEG data and "hypothesised to relate to appetitive (approach-related) and aversive (withdrawal-related), with heightened approach tendencies reflected in left frontal activity and heightened withdrawal tendencies reflected in relative right frontal activity" (Balconi & Finocchiaro, 2016, p. 273). For example, one study has found that individuals with internet addiction exhibit a pronounced left-frontal activation, as indicated by decreased alpha activity, over the prefrontal cortex while viewing game-related cues (Balconi & Finocchiaro, 2016). The contrary has been shown in alcoholics, where alcoholics showed significantly higher beta over the right frontal cortex when presented with alcohol-related cues, when compared to social drinkers (Kim et al., 2023). The conflicting body of research provides a basis for investigating how SFC may modulate EEG data activities in addicted individuals.

Mindfulness meditation (MM) has emerged as a promising intervention for counteracting attentional impairments, with evidence supporting its role in enhancing cognitive control, emotional regulation, and well-being. Studies have reported numerous benefits for mental health, including reducing anxiety, depression, and stress, as well as improving memory, cognition, and overall well-being (Palmer et al., 2023). Central executive functions, such as attention — specifically, sustained attention — can be impaired due to a lack of inhibitory control. However, MM practices may help counteract these deficits (Youngs et al., 2021). Moreover, MM, even in brief 10-minute sessions, can be used to improve mindfulness (Palmer et al., 2023). These findings suggest that MM may be a valuable tool for enhancing attention. However, the extent to which MM benefits the sustained attention of individuals with SFCA (SFCA), compared to non-addicted individuals, remains underexplored and warrants further investigation.

1.2 Aim of the study

With the dual goals of understanding the impact of SFC on attention and assessing whether MM can mitigate these effects, the present study builds on existing literature by integrating behavioural and EEG data to explore the impact of SFC and SFCA on sustained attention among adolescents and young adults (ages 18-25). The difference between SMA and SFCA is that the former, as previously mentioned, is characterised by compulsive engagement with SMPs. While the latter is characterised by compulsive engagement towards SFC specifically, regardless of the platform it appears on. Thus, the primary focus of this paper is to answer the following questions: **(1)** Does SFC inhibit sustained attention in individuals, regardless of addiction levels? **(2)** Is there a difference in sustained attention between individuals with SFCA and those who do not have SFCA? **(3)** Are there differences in sustained attention post a brief session of MM between the two groups? **(4)** What are the observable EEG data differences in sustained attention between SFC addicted and non-addicted, post to watching SFC or performing MM?

1.3 Operationalization

To answer the research questions, the sustained attention of the participants will be assessed through a Conjunctive Continuous Performance Test-Visual (CCPT-V) task. Reaction time (RT) is considered a key indicator of attention in sustained attention tasks. Higher or lower RTs correlate with more or less attentive states, respectively (Sarter et al., 2001). To assess SFCA levels, the participants will complete an SFCA survey (Andreassen et al., 2012). The sustained attention test will consist of three phases.

- Baseline - performing the sustained attention test with no prior intervention.
- Post-MM - performing the sustained attention test with MM as a previous intervention.
- Post-SFC - performing the sustained attention test with SFC is performed as a previous intervention.

The study aims to compare behavioural data, comprising RT and target accuracy, between addicted and non-addicted individuals.

This study also identifies specific EEG targets of interest, particularly within the frontal and prefrontal cortices, which are associated with attention and cognitive control (Sarter et al., 2001). Considering this and previous studies on attention, this study will measure sustained attention by examining an engagement index, which records alpha and beta frequencies over the frontal and prefrontal cortices (Coelli et al., 2015). To detect changes in attention through the P300 component, the P300 component will be monitored over the prefrontal and parietal areas for non-target onset and target onset, respectively (Fallgatter et al., 1997; Fallgatter & Strik, 1999; Walla & Zheng, 2024).

The following hypotheses were formulated to guide the current study:

1.4 Behavioural Hypotheses

(1) During Post-MM, there will be a significantly lower mean RT when compared to baseline, regardless of addiction levels. **(2)** During Post-SFC, there will be a significantly higher mean RT when compared to baseline, regardless of addiction levels. **(3)** During Post-SFC, there will be a significantly higher mean RT for addicted participants compared to non-addicted. **(4)** During Post-MM, addicted participants will show significantly greater improvement in RT compared to baseline and non-addicted participants. **(5)** During Baseline, mean RT will be significantly higher for addicted participants compared to non-addicted participants.

1.5 EEG Hypotheses

(6) Significantly lower engagement index post-SFC when compared to baseline, regardless of addiction levels. **(7)** Significantly higher engagement index post-MM when compared to baseline, regardless of addiction levels.

1.6 P300 ERP Component (Cz Electrode)

(8) Significantly lower peak mean amplitude for the P300 component post-target onset (Cz electrode) post SFC, when compared to baseline and Post-MM, regardless of addiction levels. **(9)** Significantly lower peak mean amplitude for the P300 component post-target onset (Cz electrode) for addicted participants compared to non-addicted participants during baseline. **(10)** Significantly lower peak mean amplitude for the P300 component post-target onset (Cz electrode) for addicted participants compared to non-addicted participants during Post-SFC.

1.7 P300 ERP Component (Fz Electrode)

(11) Significantly lower peak mean amplitude for the P300 component post-non-target onset (Fz electrode), post-SFC, when compared to baseline and Post-MM, regardless of addiction levels. **(12)** Significantly lower peak mean amplitude for the P300 component post-non-target onset (Fz electrode) for addicted participants when compared to non-addicted participants during baseline. **(13)** Significantly lower peak mean amplitude for the P300 component post non-target onset (Fz electrode) for addicted participants when compared to non-addicted participants during Post-SFC.

1.8 Addiction EEG Hypotheses

(14) Significantly lower engagement index for addicted participants compared to non-addicted participants during MM intervention. **(15)** Significantly lower alpha power activity over the F3 electrode when compared to the F4 electrode for addicted participants during the SFC intervention. **(16)** No significant difference in alpha power activity over the F3 electrode when compared to the F4 electrode for non-addicted participants during the SFC intervention.

2 Methods

2.1 Participants

The participants consisted of 15 undergraduate university students, aged between 19 and 24 years old. To be eligible for the study, the participants had to be healthy individuals with no prior exposure to any substance addiction in the last year (i.e. alcohol, nicotine, cannabis, opioids). After taking part in the study, the participants were asked if they had any substance addictions in the last year. Data from two participants had to be dropped because they did not meet this criterion. After removing the data from those two participants, the mean age of the participants was 20.61, with 30.76% of them being female.

To determine SFCA, the participants completed a survey adapted from the Bergen Facebook Addiction Scale (BFAS). The BFAS is a reliable measure of Facebook addiction, with a reliability coefficient of 0.82. Studies assessing TikTok addiction have used the BFAS as a basis for their TikTok addiction scale, showing a reliability coefficient of 0.85 (Günlü et al., 2023). The scale for this study consisted of 18 items, three for each of the six features of addiction: salience, mood modification, tolerance, relapse, withdrawal and conflict. Each item is scored on a Likert scale from 1 (Very Rarely) to 5 (Very Often). The maximum score a participant can achieve is 90. If a participant scored at least 42 points, they would be labelled as having SFCA. The survey used for this study can be found under Appendix A.

The participants were gathered through social media platforms, including WhatsApp and Instagram. Announcements asking for participant recruitment were shared through social media groups. All participants provided written informed consent before participating in the study, and they received sufficient information about the study's details. After the study, the participants were not compensated with any payment.

2.2 EEG Acquisition

EEG data were recorded using a BioSemi Active Two system with 32 active Ag–AgCl electrodes, positioned according to the international 10–20 system. Recordings were sampled at 512 Hz. The Common Mode Sense (CMS) and Driven Right Leg (DRL) electrodes served as references to stabilise the signal. Additionally, four electrooculogram (EOG) electrodes were used to monitor eye movements: two horizontal EOGs placed at the outer canthi of each eye (aligned with the pupils), and two vertical EOGs placed above and below the left eye. Before data collection, electrode impedance was confirmed to be below 20 kΩ to ensure signal quality.

2.3 EEG Pre-Processing

Any channels missing or visibly noisy were marked as bad and would later be interpolated. The means of the two electrodes placed on the left and right mastoids were used as a reference for the data. Any empty channels and the two mastoids were then dropped. The data was further filtered between 1 and 40 Hz. The data was manually inspected for artifacts. Any visibly noisy sections were marked as bad and would be ignored while epoching. Ocular artifacts were removed using the independent component analysis (ICA) algorithm by correlating EOG components with the eye channels. Any bad channels were then interpolated. All the preprocessing steps were done using the MNE-Python library (Gramfort et al., 2013).

2.4 Materials

All participants performed the study while comfortably seated in an upright position in a well-lit and quiet room. Every participant performed the study on the same computer. The external screen had a diagonal of 24 inches, a brightness of 280 cd/m^2 and a 60 Hz refresh rate.

Open Sesame version 4.0.24 was used to create the environment for the study (Mathot & March, 2021; Mathôt et al., 2012). The behavioural data, comprising RTs, commissions (choosing a non-target stimuli as target stimuli) and omission errors (missing the target stimuli), were gathered automatically by OpenSesame and analysed using Microsoft Excel.

The participants used the same iPhone 13 Pro device for the SFC intervention. The screen was an OLED display with a 6.1-inch diagonal and a 120 Hz refresh rate. The screen brightness ranged from 1000 to 1200 nits, depending on whether the content was HDR. The volume output was half its total power, with a decibel range between 30 and 60 dB. All participants logged into the same device using their account and accessed their preferred SFC platform (i.e., TikTok or Instagram). The device was set to block any notifications so that the participants would not be distracted by them. This approach implies more randomisation in what SFC each participant is exposed to. However, this was done to accurately explore the addictive effects of the algorithmically tailored SFC content (Yao & Omar, 2022).

A five-minute MM recording guided the participants through the MM intervention. In this guide, participants were instructed first to close their eyes and focus on their sensation of breathing. They were asked to perform a body scan, acknowledging any bodily sensations from the top of their head to the bottom of their toes. While distractions may arise in their mind, they are guided to recognise those thoughts and continue to focus further on their breath. Those are standard techniques employed in any MM mental practice (Zeidan et al., 2010). The decibel volume range of this recording was between 50 and 60 dB.

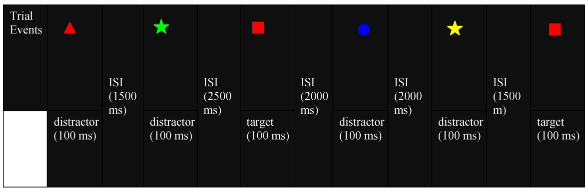

Figure 2.1: Representation of what a sequence of trials of the CCPT-V task within this study looks like.

2.5 Stimuli

The CCPT-V task design of this study was based on another study that tested the CCPT-V as an accurate measure for sustained attention (Shalev et al., 2011). The CCPT-V task design of the present study consisted of a training phase comprising 15 trials and three subsequent phases, each consisting of 260 trials. The stimuli within each trial were a coloured geometrical shape shown in the middle of the screen. The size of the stimuli varied between 1.4 and 1.8 cm in height and between 1.8 and 1.9 cm in width. The stimuli could have four shapes: circle, triangle, square, or star, and appeared in four different colours: red, yellow, blue, or green. All the stimuli appeared on a dark purple background.

The target stimuli —a red square—appeared on 30% of the trials. Non-target stimuli included: a non-red square (17.5%), a red non-square shape (17.5%), and shapes that were neither red nor squares (35%). Each stimuli was displayed for 100 ms, followed by an interstimuli interval (ISI) of either 1000, 1500, 2000, or 2500 ms, with each ISI duration occurring equally often (25% of trials). Both stimuli and ISI durations were randomly selected across trials. Participants were instructed to press the space bar with the index finger of their dominant hand as quickly as possible only when the target (red square) appeared, and to withhold responses for all other stimuli. A representation of the sequence of trials can be seen in Figure 2.1.

The software for the CCPT-V task was adapted from an OpenSesame version 2.8.2 to version 4.0.24 (Gorgolewski, 2022).

2.6 Procedure

All the participants were tested with the CCPT-V task throughout three phases: baseline, post-

MM, and post-SFC, each consisting of 260 trials of the CCPT-V task. MM and SFC were five-minute interventions taken between the first and second phases and the second and third phases. The order of the interventions was randomly assigned to each participant, who was required to complete both interventions and all three phases before the study concluded.

The participants first signed a consent form and received information about the study. Next, they completed the SFCA survey, which also collected information about their age and gender. The participants were informed that information about their individual SFC accounts would not be stored. They would log in to their preferred SFC platform and confirm that the algorithm is working. After the EEG cap was placed and set up on them, they were presented with a fixed set of instructions. The instruction set stated that they would have to respond to only the target stimuli, a red square, using the index finger of their dominant hand as quickly as possible. They were presented with an example of what the red square looks like. Then, the participants underwent a training phase during which they received feedback on their input. A correct input triggered the text "correct" in green, while an incorrect input triggered the text "incorrect" in red. After completing the training phase, the participants were instructed that there would be no further feedback for the remaining trials. The participants would then proceed to the baseline phase of the experiment, where no prior MM or SFC intervention was present. After completing the baseline phase, the participant was randomly assigned either the MM or SFC intervention. After completing the first intervention, participants would proceed to the next phase of the CCPT-V task, which would be noted based on the prior intervention (i.e., post-MM or post-SFC). The participants would have to go through the second intervention and the third CCPT-V phase before completing the experiment. It is essential to note that during the SFC intervention, participants were instructed to focus solely on SFC and refrain from engaging with other aspects of the SFC platform, such as the comments section. Once the five minutes were completed, they were instructed to continue to the next phase of the CCPT-V task.

Once the participants had gone through all three phases and both interventions, the EEG cap was removed from their heads, and they were invited to ask any questions related to the study.

2.7 Design

The present study employed a mixed experimental design to examine how intervention type MM or SFC and addiction level influence behavioural and EEG responses during a sustained attention test. The primary task utilised the CCPT-V task, administered across three phases: baseline, post-MM, and post-SFC. Each trial of the CCPT-V task within each phase featured either a target or a non-target stimuli. The independent variables were the **Intervention phase** (within-subjects): baseline, post-MM, post-SFC; **Addiction Group** (between-subjects): addicted vs non-addicted; **Stimulus Type** (within-subjects): target vs non-target stimuli onset.

The behavioural measures consisted of RT, measured for each participant on every target trial. This served as the dependent variable for the Behavioural Hypotheses (see section 1.4). Accuracy was computed using Equation 2.1.

$$accuracy = \frac{correct\ answers}{all\ answers} \tag{2.1}$$

An engagement index was used to answer the EEG Hypotheses (see section 1.5), which has been shown to reflect cognitive engagement (Coelli et al., 2015). It is computed as the ratio of β (13-30 Hz) to α (8-13 Hz) power across several predefined electrode groups. The groups are M1: F4, F3, F7, F8 (frontal), M2: Pz, P3, Fz, C3 (central-parietal), M3: Pz, P3, P4, Cz (parietal), M4: Fp1 (prefrontal). For each channel within a group, the power spectral density (PSD) was computed using Welch's method. Average beta and alpha power values were extracted by integrating the PSD over the corresponding frequency bands. The engagement index was then computed as the mean beta power divided by the mean alpha power across all channels in a group using Equation 2.2. This was computed separately for each group and for each participant for each experimental phase (baseline, post-MM, post-SFC).

$$engagement\_index = \frac{Mean\ Beta\ Power}{Mean\ Alpha\ Power} \tag{2.2}$$

The amplitude of the P300 component served as an ERP marker of attentional allocation and cognitive processing and was used to answer hypotheses 1.6 and 1.7. The peak of the P300 was measured at electrode Cz for target stimuli (300-500 ms post-target onset) and at electrode Fz for non-target stimuli (300-500 ms post-non-target onset), capturing the peak amplitude of the P300 component. The mean value of the P300 component across trials, from each phase, was used for analysis.

The engagement index during the MM intervention was still computed as the ratio of beta to alpha power. However, only the M1 group was used for comparison. The M1 group was selected since central executive functions, including attention, and more specifically sustained attention, can be tied to the frontal areas of the brain (Sarter et al., 2001). To compare brain lateralisation differences between addicted and non-addicted participants, alpha power (8-13 Hz) was extracted from all EEG channels. For each participant, alpha band power was computed using Welch's method applied to the EEG signal from each electrode. Then, to compare brain lateralisation differences, only the left prefrontal (F3) and right prefrontal (F4) electrodes were selected for analysis.

2.8 Statistical Analysis

From the Behavioural Hypotheses 1.4, hypotheses **(1)** and **(2)** were assessed using one-tailed paired t-tests to compare RT across different phases. Hypotheses **(3)**-**(5)** were tested using one-tailed independent t-tests comparing addicted to non-addicted participants. The engagement index differences from hypotheses **(6)** and **(7)** of the EEG Hypotheses 1.5 were analysed using one-tailed paired t-tests. P300 peak amplitude comparisons were done across phases (within-subjects) using one-tailed repeated measures ANOVA for hypotheses **(8)** and **(11)**; between groups, addicted compared to non-addicted, one-tailed independent t-tests were used to test hypotheses **(9)**, **(10)**, **(12)** and **(13)**. Addiction Hypotheses 1.8 were compared within groups using one-tailed paired t-tests.

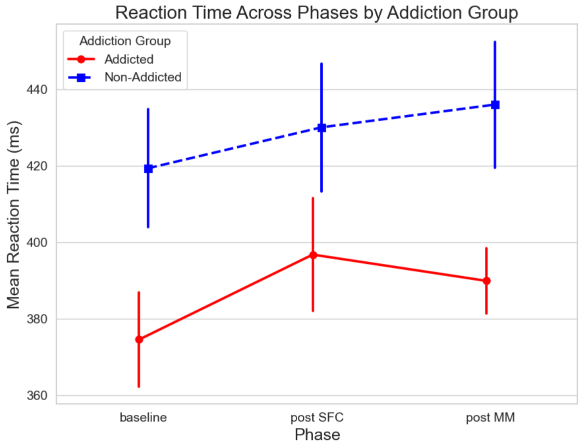

Figure 3.1: Displaying differences in mean reaction time between addicted and non-addicted individuals, across the three phases. The error lines indicate the standard errors(SE).

3 Results

Thirteen participants completed the SFCA survey, with a mean score of 43.23. Of the 13 participants, six scored above the 42 threshold and were considered addicts (N=6); the rest were considered non-addicts (N=7). The mean score for the SFCA survey of addicted participants was 49.8, while for non-addicted participants it was 36.16.

3.1 Behavioral data

For hypotheses (1) and (2) of the Behavioural Hypotheses 1.4, behavioural data were compared across different phases (baseline, post-SFC, post-MM) across all participants ($N = 13$). RT was not significantly lower during post-MM ($M = 417.7$ ms, $SD = 41.2$) compared to baseline ($M = 398.7$ ms, $SD = 41.8$), $t(12) = -2.5$, $p = .986$. RT was significantly higher during post-SFC ($M = 414.7$ ms, $SD = 42.6$) compared to baseline, $t(12) = 2.1$, $p = .029$.

Behavioural data was also compared between addicted (N=6) and non-addicted (N=7) participants. The RT was not significantly higher during post-SFC for addicted ($M = 396.8$ ms, $SD = 36.1$) compared to non-addicted participants ($M = 430.0$ ms, $SD = 44.1$), $t(11) = -1.4$, $p = .915$. RT was not significantly lower between post-MM and baseline for addicted participants ($M = -15.3$ ms, SD

= 12.8) compared to non-addicted participants between post-MM and baseline (M = -16.6 ms, SD = 30.4), $t(11) = 0.1$, $p = .462$. RT was not significantly higher during baseline for addicted (M = 374.6 ms, SD = 30.2) compared to non-addicted participants (M = 419.3 ms, SD = 40.8), $t(11) = -2.2$, $p = .975$.

Figure 3.1 shows the differences in RT between addicted and non-addicted participants across all three phases. The RT of non-addicted participants decreased during the post-SFC phase compared to the post-MM phase. Table 3.1 shows the mean accuracy of addicted and non-addicted participants across the three phases.

3.2 Engagement Index Results

Due to signal issues, the data from four participants had to be dropped. The remaining participants (N=9) were still split between addicts (N=4) and non-addicts (N=5).

A one-tailed paired-samples t-test was conducted to compare the beta/alpha engagement index between baseline and post-SFC phases across the four electrode groups across all participants. M1 (F4, F3, F7, F8): M1 was not significantly lower during post-SFC (M = 0.3, SD = 0.2) compared to baseline (M = 0.4, SD = 0.3), $t(8) = -1.2$, $p = .146$. M2 (Pz, P3, Fz, C3): The engagement index was significantly lower post-SFC (M = 0.2, SD = 0.1) compared to baseline (M = 0.2, SD = 0.1), $t(8) = -2.4$, $p = .020$. M3 (Pz, P3, P4, Cz): The engagement index was significantly lower post-SFC (M = 0.2, SD = 0.1) compared to baseline (M = 0.2, SD = 0.1), $t(8) = -2.5$, $p = .017$. M4 (Fp1): M4 was not significantly lower during post-SFC (M = 0.3, SD = 0.2) compared to baseline (M = 0.4, SD = 0.3), $t(8) = -0.9$, $p = .180$.

Table 3.1: Stats of each group from all three phases, with mean accuracy computed over its respective phase (baseline, post-SFC and post-MM)

Group	Phase	Accuracy
Addicted	Baseline	0.9897
Addicted	Post-MM	0.9948
Addicted	Post-SFC	0.9884
Non-Addicted	Baseline	0.9950
Non-Addicted	Post-MM	0.9961
Non-Addicted	Post-SFC	0.9912

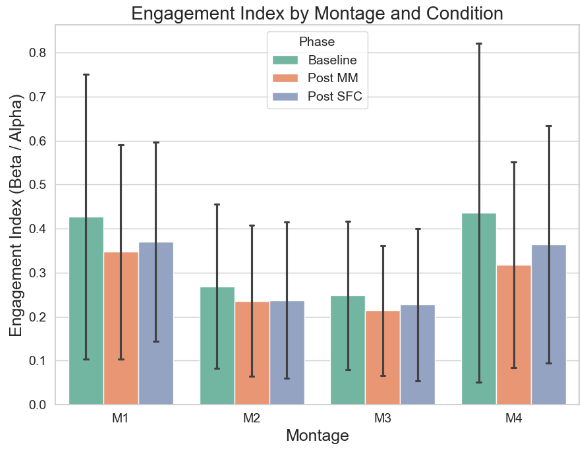

Figure 3.2: Displaying differences in mean engagement index values across the three phases for all participants, regardless of addiction levels. The lines are used to display the standard deviation (SD).

A one-tailed paired samples t-test was conducted to compare the beta/alpha engagement index between the baseline and post-MM phases across the four groups for all participants. M1 was not significantly lower during baseline (M = 0.4, SD = 0.3) compared to post-MM (M = 0.3, SD = 0.2), $t(8) = -2.0$, $p = .962$. M2 was not significantly lower during baseline (M = 0.2, SD = 0.1) compared to post-MM (M = 0.2, SD = 0.1), $t(8) = -2.8$, $p = .988$. M3 was not significantly lower during baseline (M = 0.2, SD = 0.1) compared to post-MM (M = 0.2, SD = 0.1), $t(8) = -2.4$, $p = .979$. M4 was not significantly lower during baseline (M = 0.4, SD = 0.3) compared to post-MM (M = 0.3, SD = 0.2), $t(8) = -1.6$, $p = .926$. The values of the four groups (M1, M2, M3, M4) can be seen in Figure 3.2 across the three phases of the experiment.

3.3 P300 component results over Cz electrode

A two-tailed repeated-measures ANOVA was conducted for all participants, regardless of their addiction levels, to examine the effect of the two interventions (MM and SFC) on P300 peak amplitude (300-500 ms post-target onset) at the Cz electrode.

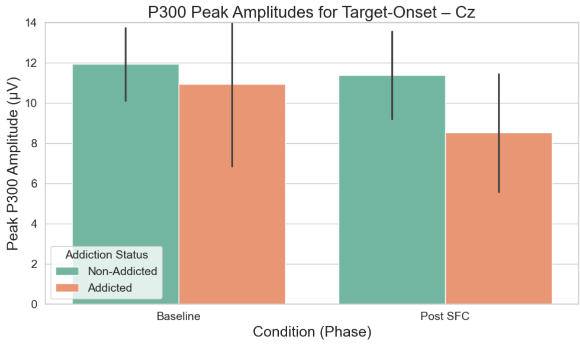

Figure 3.3: Displaying differences in mean P300 peak amplitude values recorded over the Cz electrode, 300-500 ms post target onset, across the three phases between addicted and non-addicted participants. The lines are used to display the SD.

The effect of the interventions was not statistically significant, $F(2,\ 8)$ = 2.92, p = .082, η^2 = .049. Pairwise, two-tailed, Bonferroni-corrected comparisons showed no significant differences in P300 peak amplitude between baseline (M = 11.5 μV, SD = 2.8) and post-MM (M = 11.3 μV, SD = 2.8), $t(8)$ = 0.3, p = 1.00, g = .066; Baseline and post-SFC (M = 10.1 μV, SD = 2.8), $t(8)$ = 2.2, p = .160, g = .463; post-MM and post-SFC, $t(8)$ = 2.0, p = 0.221, g = .3397. The Bayes factor (BF10 = 0.33-1.73) provided only anecdotal to weak evidence against the effect, consistent with the null hypothesis.

One-tailed paired t-tests were conducted to compare the peak P300 component amplitude post-target onset (at the Cz electrode) for addicted participants compared to non-addicted participants during baseline and post-SFC phases. There was no significantly lower peak amplitude between addicted (M = 10.9 μV, SD = 4.1) and non-addicted participants (M = 11.9 μV, SD = 1.8) during baseline, $t(7)$ = -0.4, p = .338. There was no significantly lower peak amplitude between addicted participants (M = 8.5 μV, SD = 2.9) compared to non-addicted participants (M = 11.4 μV, SD = 2.1) during the post-SFC phase, $t(7)$ = -1.6, p = .079. The difference in peak amplitude for the Cz electrode between addicted and non-addicted participants across the three phases can be seen in Figure 3.3.

3.4 P300 component results over Fz electrode

A two-tailed repeated measures ANOVA was conducted for all participants, regardless of their addiction levels, to examine the effect of the two interventions on P300 peak amplitude (300-500 ms post-non-target onset) at the Fz electrode. The effect of the interventions was statistically significant, $F(2,\ 8)$ = 5.39, p = .016, η^2 = .056‘. Pairwise, two-tailed, Bonferroni-corrected comparisons showed no significant differences in P300 peak amplitude between baseline (M = 4.6 μV, SD = 2.6) and post-MM (M = 4.2 μV, SD = 3.0), $t(8)$ = 1.5, p = .516, g = .142; post-MM and post-SFC, $t(8)$ = 1.8, p = .330, g = .372. There was a significant difference between baseline and post-SFC (M = 3.2 μV, SD = 1.9), $t(8)$ = 3.1, p = .041, g = .583. The Bayes factor suggests a moderate difference while comparing only the baseline to the post-SFC phases (BF10 = 4.94), while for the other comparisons, it provides only anecdotal to weak evidence against the effect (BF10 = 0.75-1.02).

One-tailed paired t-tests were conducted to compare the peak P300 component amplitude post-non-target onset (at the Fz electrode) for addicted participants compared to non-addicted participants during baseline and post-SFC phases. The peak amplitude was not significantly lower for addicted (M = 4.1 μV, SD = 3.2) compared to non-addicted participants (M = 5.1 μV, SD = 2.4) during baseline, $t(7)$ = -0.4, p = .329. The peak amplitude was not significantly lower for addicted (M = 2.4 μV, SD = 2.4) compared to non-addicted participants (M = 3.9 μV, SD = 1.1) during the post-SFC phase, $t(7)$ = -1.2, p = .162. The difference in peak amplitude for the Fz electrode between addicted and non-addicted participants across the three phases can be seen in Figure 3.4.

3.5 Addiction EEG Hypotheses results

A one-tailed independent t-test was conducted to examine whether addicted participants showed reduced frontal engagement index, through the M1 group, during the MM intervention compared to non-addicted participants. There was no significantly lower difference in the engagement index of the M1 group between addicted (M = 0.3, SD =

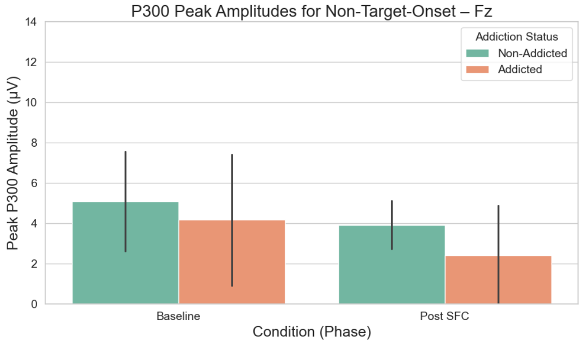

Figure 3.4: Displaying differences in mean P300 peak amplitude values recorded over the Fz electrode, 300-500 ms post non-target onset, across the three phases between addicted and non-addicted participants. The lines are used to display the SD.

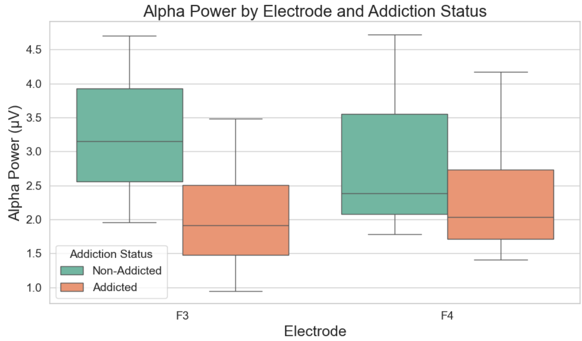

Figure 3.5: Displaying differences in alpha power between addicted and non-addicted individuals, over the F3 and F4 electrodes. The boxes show the quartiles, and the whiskers show the most extreme values. The mean values for the F3 and F4 are displayed in their respective boxes by the markers.

0.2) and non-addicted participants (M = 0.2, SD = 0.1), $t(7) = 0.7$, $p = .757$.

A one-tailed independent t-test was used to compare alpha power asymmetry between the left (F3) and right (F4) prefrontal regions in addicted and non-addicted participants during the SFC intervention. Two of the participants' alpha values for the F3 and F4 electrodes were abnormally high; Therefore, they were excluded from this analysis. The comparison was still between addicted (N=4) and non-addicted participants (N=3). The alpha power over the F3 electrode (M = 2.0 μV, SD = 1.0) was significantly lower compared to the F4 electrode (M = 2.4 μV, SD = 1.2) for addicted participants, $t(3)$ = 2.5, $p = .043$. The alpha power over the F3 electrode (M = 3.2 μV, SD = 1.3) was not significantly lower compared to the F4 electrode (M = 2.9 μV, SD = 1.5) for non-addicted participants, $t(2)$ = -1.3, $p = .321$. The differences in alpha power between the F3 and F4 electrodes can be seen in Figure 3.5.

4 Discussion

The present study investigates sustained attention in addicted and non-addicted participants using the Conjunctive Continuous Performance Test-Visual (CCPT-V) and EEG data. Two interventions, where participants watched short-form content (SFC) and practised mindfulness meditation (MM) for five minutes each, were introduced to assess their respective effects on attentional performance. The study was guided by five sets of hypotheses: Behavioural 1.4, EEG 1.5, P300 component (Cz) 1.6, P300 component (Fz) 1.7 and Addiction EEG-related 1.8.

To evaluate the Behavioural Hypotheses 1.4, reaction time (RT) was used as the primary metric (measured in ms) for detecting variations in sustained attention across the three experimental phases (baseline, post-SFC, and post-MM), with comparisons made both between groups (addicted vs. non-addicted) and within groups across phases.

Statistical significance is present only while comparing the post-SFC phase to baseline. Regardless of addiction levels, RT increased after the SFC intervention for both groups. This finding is in line with Hypothesis **(2)** of the Behavioural Hypotheses 1.4. Interestingly, RT during post-MM increased for groups, suggesting that the MM intervention might not benefit the RT of the participants. Nonetheless, the decrease in RT for addicted participants during post-MM was not enough to reach statistical significance to support Hypothesis **(4)** and therefore does not offer conclusive support.

Contrary to Hypothesis **(5)**, the RT of addicted participants was lower when compared to that of the non-addicted participants during baseline. The RT of the addicted participants was lower when compared to that of non-addicted participants across all three phases of the experiment. Results which are contradictory also with Hypothesis **(3)**. To understand this pattern, it may be helpful to compare the CCPT-V task with the experience of watching SFC. At its core, the CCPT-V task requires participants to respond selectively to target stimuli, engaging attention and inhibitory control. A similar mechanism may be at play during the consumption of SFC, while users passively scroll through a stream of content, certain videos may act as "target stimuli", the ones algorithmically generated with maximum utility, that capture attention or elicit a reaction amidst an otherwise passive viewing experience. Therefore, SFC addicts may be primed for such a task, showing decreased RTs when compared to non-addicts. Nonetheless, these findings are in contradiction with the arguments that the CCPT-V task is "a pure measure of sustained attention", or that SFC may decrease sustained attention (Alam, 2023; Shalev et al., 2011).

Although no specific hypotheses were made regarding accuracy, descriptive trends across the three experimental phases offer preliminary insights into performance consistency. Across both groups, accuracy remained high throughout all phases, with all mean scores above 98%, suggesting that participants maintained a generally high level of task performance regardless of condition. Nonetheless, the mean reaction time is lower for addicted participants.

Results from the engagement index across the four groups (M1, M2, M3 and M4) show only a statistical significance in the M2 (Pz, P3, Fz, C3) and M3 (Pz, P3, P4, Cz) groups while comparing them over the baseline and post-SFC phases, with a significantly lower engagement index during the post-SFC phase. These findings suggest that the SFC intervention may affect beta and alpha activity in the posterior parietal, midline frontal, left central (M2) and the midline and bilateral parietal and midline central (M3) areas of the brain. Therefore, a lower engagement index for the M2 and M3 groups can be interpreted as reduced executive monitoring and reduced resource allocation (in the frontal and central areas), as well as impaired stimulus discrimination and sustained attention (in the parietal regions). No statistically significant increase in the engagement index was found when comparing the post-MM phase to the baseline phase for any group. While there are minimal differences between the means of those groups across phases, Hypotheses **(6)** and **(7)** of the EEG Hypotheses 1.5 were tested for within-subject variability. Therefore, significantly lower M2 and M3 results suggest that consistent changes in the engagement index have been observed in the participants when comparing post-SFC to baseline.

Analysis of the P300 component at the Cz electrode revealed no statistically significant changes in peak amplitude post-target onset as a result of either intervention (MM or SFC), nor between the phases. Specifically, P300 amplitudes did not differ significantly between baseline, post-MM, and post-SFC conditions. The P300 amplitude was observed not to be considerably lower for addicted compared to non-addicted participants during both the baseline and post-SFC phases, suggesting comparable levels of attentional resource allocation at the start of the study. This finding suggests that the SFC intervention may not have differentially impacted attentional processing in addicted individuals, which was hypothesised to reduce their capacity to allocate cognitive resources toward target stimuli. This pattern of results is inconsistent with previous literature, where a reduced P300 component was found for addicted participants when compared to non-addicted participants post-target onset(Walla & Zheng, 2024). The Bayes factor analysis provided only anecdotal to weak evidence against the null hypothesis, suggesting these effects should be interpreted with caution. Notably, the differences in mean peak amplitudes can be seen in Figure 3.3, where a trend of lower values for addicted participants is present, when compared to non-addicted participants.

There were no significant differences in peak amplitude of the P300 component between the baseline and post-MM conditions. Similarly, no significantly lower difference was observed between the post-MM and post-SFC phases. Nonetheless, a significantly lower difference was observed between post-SFC and baseline, suggesting that SFC may have an effect on inhibition control across participants. These results are inconsistent with the claim that SFC may not reduce response inhibition (Wade et al., 2024). This is further supported by the Bayesian analysis, which indicated only moderate evidence for a difference between baseline and post-SFC. At the same time, all other comparisons yielded anecdotal to weak evidence, consistent with the null hypothesis.

Furthermore, there were no significantly lower differences in P300 amplitude (over Fz) between addicted and non-addicted participants during either the baseline or post-SFC phases, suggesting comparable inhibitory control across groups under these conditions. The results from the present study indicate that there are no significant differences in response inhibition during the post-MM period, suggesting that MM may not improve response inhibition. This comparison is being done between baseline to post-MM and post-MM to post-SFC, for all participants regardless of addiction. Nonetheless, it is worth taking note that the mean peak amplitude of the P300 component, recorded over the Fz electrode, is lower for addicted participants when compared to non-addicted participants. This difference does not reach statistical significance to support Hypothesis **(12)** and **(13)**, as previously mentioned.

No significantly lower engagement index was found across the frontal region over the M1 group during the MM intervention, while comparing addicted with non-addicted participants. This suggests that, under resting conditions, engagement-related neural activity may not differ meaningfully between the two groups. Conversely, in an experiment where beta power was compared between internet addicts with non-addicts a lower beta power has been found for addicts during resting state (Choi et al., 2013).

The current findings revealed a significantly lower alpha power between F3 (left-hemisphere) and F4 (right-hemisphere) electrodes for participants with addiction during the SFC intervention. At the same time, no such difference was observed in the non-addicted group. This frontal asymmetry in the addicted group may reflect differential hemispheric engagement, potentially indicating a heightened imbalance in neural processing related to sustained attention or emotional regulation. In contrast, a lack of asymmetry in non-addicted participants suggests more balanced or stable frontal activity during the same intervention. These results align with previous research linking a shift toward left-hemispheric dominance while presented with addiction-related material (Balconi & Finocchiaro, 2016).

4.1 Potential Problems

One major limitation of this study was the small sample size, which may have limited the statistical power and generalisability of the findings. Additionally, a potentially confounding element in the procedure involved asking participants to confirm whether the SFC algorithm had worked as intended. This step may have influenced participants' performance on the CCPT-V task and affected the EEG data. To minimise such confounds, future research should consider removing this procedural element when examining the effects of SFC and SFC algorithms on sustained attention. Another potential limitation of the study is that most of the participants had never practised MM before taking part in the study. Therefore, most of them might not have even benefited from the MM intervention. Moreover, the environment in which they took the intervention did not promote optimal focus. Considering that the participants were in a laboratory and connected to a computer, they could not fully focus while taking the MM intervention. Lastly, the study protocol may have been mentally fatiguing for participants, as completing the three experimental phases along with the two interventions required approximately 35 minutes. As a result, participants may have experienced cognitive fatigue or habituation to the CCPT-V task by the final phase, which could have potentially influenced their performance and the corresponding EEG measures.

4.2 Future Research

For future research, it would be beneficial to extend the current findings by examining the effects of long-term MM-controlled sessions and comparing them to those of long-term SFC sessions on the sustained attention of individuals. It would be interesting to compare the performance in sustained attention and EEG data between participants who undergo controlled MM sessions in an environment that promotes concentration and mindfulness, and participants who consistently consume SFC over the same period. Moreover, other brain imaging techniques, such as functional magnetic resonance imaging (fMRI) could be employed to study the long term effects of SFC consumption on the brains of individuals.

4.3 Conclusion

This study aimed to investigate the effects of TikTok-style short-form content (SFC) and mindfulness meditation (MM) on sustained attention, using both behavioural and EEG data. By comparing participants categorised as addicted or non-addicted to SFC, this study explored how these two interventions influenced attention-related outcomes across three experimental phases.

The results revealed that SFC exposure led to a significant increase in reaction time across participants, indicating a temporary impairment in sustained attention. In contrast, the MM intervention did not yield statistically significant improvements in reaction time or EEG markers of engagement, possibly due to environmental and procedural limitations. Interestingly, addicted participants consistently exhibited lower reaction times compared to their non-addicted counterparts, challenging the assumption that SFC addiction inherently reduces sustained attention.

EEG analyses revealed decreased engagement indices in posterior brain regions following SFC exposure, supporting the notion of reduced attentional resource allocation. Moreover, while trends in P300 ERP components pointed toward diminished attentional and inhibitory control in addicted participants, especially after SFC, these effects did not reach statistical significance, likely due to the study's limited sample size. Nevertheless, the observed asymmetry in alpha power over the frontal cortex in addicted individuals aligns with prior research on neural signatures of addictive behaviour.

Taken together, these findings suggest that short-term exposure to algorithmically tailored SFC can have measurable, albeit subtle, adverse effects on attentional processes. While mindfulness meditation holds theoretical promise, its benefits may not be fully realised in brief, non-ideal settings. Future research should employ larger samples, controlled long-term interventions, and more immersive experimental environments to understand better the cognitive and neural consequences of SFC consumption and the mitigating potential of mindfulness practices.

References

Alam, A. (2023). How Reels affect our Attention Span. *Health Psychology*.

Andreassen, C. S., Torsheim, T., Brunborg, G. S., & Pallesen, S. (2012). Development of a Facebook Addiction Scale [Publisher: SAGE Publications Inc]. *Psychological Reports*, *110*(2), 501–517. https://doi.org/10.2466/02.09.18.PR0.110.2.501-517

Balconi, M., & Finocchiaro, R. (2016). Deficit in rewarding mechanisms and prefrontal left/right cortical effect in vulnerability for internet addiction. *Acta Neuropsychiatrica*, *28*(5), 272–285. https://doi.org/10.1017/neu.2016.9

Brino, K. A. S., Derouin, A. L., & Silva, S. G. (2022). Problematic internet use in adolescents and implementation of a social media hygiene protocol [Publisher: Elsevier]. *Journal of Pediatric Nursing: Nursing Care of Children and Families*, *63*, 84–89. https://doi.org/10.1016/j.pedn.2021.10.011

Chemnad, K., Aziz, M., Belhaouari, S. B., & Ali, R. (2023). The interplay between social media use and problematic internet usage: Four behavioral patterns [Publisher: Elsevier]. *Heliyon*, *9*(5). https://doi.org/10.1016/j.heliyon.2023.e15745

Choi, J.-S., Park, S. M., Lee, J., Hwang, J. Y., Jung, H. Y., Choi, S.-W., Kim, D. J., Oh, S., & Lee, J.-Y. (2013). Resting-state beta and gamma activity in Internet addiction. *International Journal of Psychophysiology*, *89*(3), 328–333. https://doi.org/10.1016/j.ijpsycho.2013.06.007

Choudhury, S., Blakemore, S.-J., & Charman, T. (2006). Social cognitive development during adolescence. *Social cognitive and affective neuroscience*, *1*(3), 165–174. https://doi.org/10.1093/scan/nsl024

Coelli, S., Sclocco, R., Barbieri, R., Reni, G., Zucca, C., & Bianchi, A. M. (2015). EEG-based index for engagement level monitoring during sustained attention [ISSN: 1558-4615]. *2015 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, 1512–1515.

https://doi.org/10.1109/EMBC.2015.7318658
Das, A., & Mishra, M. H. (2024). The Effect of Reels on Attention among Young and Middle-Aged Adults [Number: 3]. *International Journal of Indian Psychlogy*, *12*(3). https://doi.org/10.25215/1203.031
Durkee, T., Carli, V., Floderus, B., Wasserman, C., Sarchiapone, M., Apter, A., Balazs, J. A., Bobes, J., Brunner, R., Corcoran, P., Cosman, D., Haring, C., Hoven, C. W., Kaess, M., Kahn, J.-P., Nemes, B., Postuvan, V., Saiz, P. A., Värnik, P., & Wasserman, D. (2016). Pathological Internet Use and Risk-Behaviors among European Adolescents [Number: 3 Publisher: Multidisciplinary Digital Publishing Institute]. *International Journal of Environmental Research and Public Health*, *13*(3), 294. https://doi.org/10.3390/ijerph13030294
Fallgatter, A. J., Brandeis, D., & Strik, W. K. (1997). A robust assessment of the NoGo-anteriorisation of P300 microstates in a cued Continuous Performance Test [Company: Springer Distributor: Springer Institution: Springer Label: Springer Number: 4 Publisher: Kluwer Academic Publishers-Human Sciences Press]. *Brain Topography*, *9*(4), 295–302. https://doi.org/10.1007/BF01464484
Fallgatter, A. J., & Strik, W. K. (1999). The NoGo-anteriorization as a neurophysiological standard-index for cognitive response control. *International Journal of Psychophysiology*, *32*(3), 233–238. https://doi.org/10.1016/S0167-8760(99)00018-5
Firth, J., Torous, J., Stubbs, B., Firth, J. A., Steiner, G. Z., Smith, L., Alvarez-Jimenez, M., Gleeson, J., Vancampfort, D., Armitage, C. J., & Sarris, J. (2019). The "online brain": How the Internet may be changing our cognition. *World Psychiatry*, *18*(2), 119–129. https://doi.org/10.1002/wps.20617
Gorgolewski, C. (2022, November). NeuroanatomyAndConnectivity/ConjunctiveContinuousPerformanceTask [original-date: 2014-02-06T10:44:44Z]. Retrieved June 21, 2025, from https://github.com/NeuroanatomyAndConnectivity/ConjunctiveContinuousPerformanceTask
Gramfort, A., Luessi, M., Larson, E., Engemann, D. A., Strohmeier, D., Brodbeck, C., Goj, R., Jas, M., Brooks, T., Parkkonen, L., & Hämäläinen, M. (2013). MEG and EEG data analysis with MNE-Python [Publisher: Frontiers]. *Frontiers in Neuroscience*, *7*. https://doi.org/10.3389/fnins.2013.00267
Groom, M. J., & Cragg, L. (2015). Differential modulation of the N2 and P3 event-related potentials by response conflict and inhibition. *Brain and Cognition*, *97*, 1–9. https://doi.org/10.1016/j.bandc.2015.04.004
Grover, P., Kar, A. K., & Dwivedi, Y. (2022). The evolution of social media influence - A literature review and research agenda. *International Journal of Information Management Data Insights*, *2*(2), 100116. https://doi.org/10.1016/j.jjimei.2022.100116
Günlü, A., Oral, T., Yoo, S., & Chung, S. (2023). Reliability and validity of the problematic TikTok Use Scale among the general population. *Frontiers in Psychiatry*, *14*, 1068431. https://doi.org/10.3389/fpsyt.2023.1068431
Hunter, M. T., & Morganstein, J. C. (2021). Irresistible: The Rise of Addictive Technology and the Business of Keeping Us Hooked: ALTER, ADAM. New York: Penguin Books, 2017. 368 pp. ISBN: 9780735222847 [Publisher: Taylor & Francis Ltd]. *Psychiatry: Interpersonal & Biological Processes*, *84*(2), 204–206. https://doi.org/10.1080/00332747.2021.1925508
Ioannidis, K., Chamberlain, S. R., Treder, M. S., Kiraly, F., Leppink, E. W., Redden, S. A., Stein, D. J., Lochner, C., & Grant, J. E. (2016). Problematic internet use (PIU): Associations with the impulsive-compulsive spectrum. An application of machine learning in psychiatry. *Journal of Psychiatric Research*, *83*, 94–102. https://doi.org/10.1016/j.jpsychires.2016.08.010
Kim, J., Nam, S., Kim, D. H., Lee, S.-K., Jung, H. W., Kim, C.-H., Chang, J. G., & Roh, D. (2023). Frontal EEG response to alcohol craving elicited by individually tailored

video cues. *Alcohol*, *112*, 1–7. https://doi.org/10.1016/j.alcohol.2023.05.005

Ko, L.-W., Komarov, O., Hairston, W. D., Jung, T.-P., & Lin, C.-T. (2017). Sustained Attention in Real Classroom Settings: An EEG Study. *Frontiers in Human Neuroscience*, *11*, 388. https://doi.org/10.3389/fnhum.2017.00388

Kok, A. (2001). On the utility of P3 amplitude as a measure of processing capacity. *Psychophysiology*, *38*(3), 557–577. https://doi.org/10.1017/S0048577201990559

Lee, J., Hwang, J. Y., Park, S. M., Jung, H. Y., Choi, S.-W., Kim, D. J., Lee, J.-Y., & Choi, J.-S. (2014). Differential resting-state EEG patterns associated with comorbid depression in Internet addiction. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, *50*, 21–26. https://doi.org/10.1016/j.pnpbp.2013.11.016

Legault, L. (2020). Self-Determination Theory. In *Encyclopedia of Personality and Individual Differences* (pp. 4694–4702). Springer, Cham. https://doi.org/10.1007/978-3-319-24612-3_1162

López-Caneda, E., Cadaveira, F., Correas, A., Crego, A., Maestú, F., & Rodríguez Holguín, S. (2017). The Brain of Binge Drinkers at Rest: Alterations in Theta and Beta Oscillations in First-Year College Students with a Binge Drinking Pattern [Publisher: Frontiers]. *Frontiers in Behavioral Neuroscience*, *11*. https://doi.org/10.3389/fnbeh.2017.00168

Mahdizadeh, M., Solhi, M., Ebadifard Azar, F., Taghipour, A., & Asgharnejad Farid, A. (2017). Psychosocial experiences of the internet in a group of adolescents: A qualitative content analysis. *Medical Journal of the Islamic Republic of Iran*, *31*(1), 263–270. https://doi.org/10.14196/mjiri.31.46

Mathot, S., & March, J. (2021, February). Conducting linguistic experiments online with OpenSesame and OSWeb. https://doi.org/10.31234/osf.io/wnryc

Mathôt, S., Schreij, D., & Theeuwes, J. (2012). OpenSesame: An open-source, graphical experiment builder for the social sciences. *Behavior Research Methods*, *44*(2), 314–324. https://doi.org/10.3758/s13428-011-0168-7

Montag, C., & Markett, S. (2023). Social media use and everyday cognitive failure: Investigating the fear of missing out and social networks use disorder relationship [Number: 1 Publisher: BioMed Central]. *BMC Psychiatry*, *23*(1), 1–9. https://doi.org/10.1186/s12888-023-05371-x

Montag, C., Yang, H., & Elhai, J. D. (2021). On the Psychology of TikTok Use: A First Glimpse From Empirical Findings [Publisher: Frontiers]. *Frontiers in Public Health*, *9*. https://doi.org/10.3389/fpubh.2021.641673

Ngai, E. W. T., Tao, S. S. C., & Moon, K. K. L. (2015). Social media research: Theories, constructs, and conceptual frameworks. *International Journal of Information Management*, *35*(1), 33–44. https://doi.org/10.1016/j.ijinfomgt.2014.09.004

Öztürk, E., & Özmen, S. K. (2016). The relationship of self-perception, personality and high school type with the level of problematic internet use in adolescents. *Computers in Human Behavior*, *65*, 501–507. https://doi.org/10.1016/j.chb.2016.09.016

Palmer, R., Roos, C., Vafaie, N., & Kober, H. (2023). The effect of ten versus twenty minutes of mindfulness meditation on state mindfulness and affect [Num Pages: 12 Place: Berlin Publisher: Nature Portfolio Web of Science ID: WOS:001165146800001]. *SCIENTIFIC REPORTS*, *13*(1), 20646. https://doi.org/10.1038/s41598-023-46578-y

Reed, P. (2023). Impact of social media use on executive function. *Computers in Human Behavior*, *141*, 107598. https://doi.org/10.1016/j.chb.2022.107598

Salmela-Aro, K., Upadyaya, K., Hakkarainen, K., Lonka, K., & Alho, K. (2017). The Dark Side of Internet Use: Two Longitudinal Studies of Excessive Internet Use, Depressive Symptoms, School Burnout and Engagement Among Finnish Early and Late Adolescents [Company: Springer Distributor: Springer Institution: Springer Label: Springer Number: 2 Publisher: Springer US]. *Journal of Youth and Adolescence*, *46*(2), 343–357. https://doi.org/10.1007/s10964-016-0494-2

Sarter, M., Givens, B., & Bruno, J. P. (2001). The cognitive neuroscience of sustained attention: Where top-down meets bottom-up. *Brain Research Reviews*, *35*(2), 146–160. https://doi.org/10.1016/S0165-0173(01)00044-3

Shalev, L., Ben-Simon, A., Mevorach, C., Cohen, Y., & Tsal, Y. (2011). Conjunctive Continuous Performance Task (CCPT)—A pure measure of sustained attention. *Neuropsychologia*, *49*(9), 2584–2591. https://doi.org/10.1016/j.neuropsychologia.2011.05.006

Shanmugasundaram, M., & Tamilarasu, A. (2023). The impact of digital technology, social media, and artificial intelligence on cognitive functions: A review [Publisher: Frontiers]. *Frontiers in Cognition*, *2*. https://doi.org/10.3389/fcogn.2023.1203077

Wade, C., Kumar, S., & Chen, H.-Y. (2024). Investigating brain responses in individuals with TikTok addiction, using Electroencephalogram (EEG). [Publisher: OSF]. https://doi.org/10.17605/OSF.IO/AP9TM

Walla, P., & Zheng, Y. (2024). Intense Short-Video-Based Social Media Use reduces the P300 Event-Related Potential Component in a Visual Oddball Experiment: A Sign for Reduced Attention [Number: 3 Publisher: Multidisciplinary Digital Publishing Institute]. *Life*, *14*(3), 290. https://doi.org/10.3390/life14030290

Yao, Q., & Omar, B. (2022). TikTok Addiction Behaviour Among Users: A Conceptual Model and Research Propositions [Publisher: European Publisher]. *European Proceedings of Social and Behavioural Sciences*, *Rethinking Communication and Media Studies in the Disruptive Era*. https://doi.org/10.15405/epsbs.2022.01.02.19

Youngs, M. A., Lee, S. E., Mireku, M. O., Sharma, D., & Kramer, R. S. S. (2021). Mindfulness Meditation Improves Visual Short-Term Memory [Num Pages: 14 Place: Thousand Oaks Publisher: SAGE Publications Inc Web of Science ID: WOS:000535636700001]. *PSYCHOLOGICAL REPORTS*, *124*(4), 1673–1686. https://doi.org/10.1177/0033294120926670

Zeidan, F., Johnson, S. K., Diamond, B. J., David, Z., & Goolkasian, P. (2010). Mindfulness meditation improves cognition: Evidence of brief mental training. *Consciousness and Cognition*, *19*(2), 597–605. https://doi.org/10.1016/j.concog.2010.03.014

A Short-form content Survey

You are invited to participate in a research study examining social media usage and its potential effects. Your participation is voluntary, and you may withdraw at any time without consequence.

This study aims to assess social-form content addiction levels using a standardised Social-Form Content Addiction Scale. Short-form content refers to the social media trend of very short and engaging videos (between 15 and 60 seconds) which are part of platforms such as TikTok, Instagram, Facebook or YouTube. Thus, when we refer to short-form content platforms, we mean using those apps to consume short-form content specifically.

Participants will complete a questionnaire to provide insight into their short-form content consumption habits. This questionnaire has been based on the Bergen Facebook Addiction Scale, which has been based on six core components of behavioural addiction: salience, mood modification, tolerance, withdrawal, conflict, and relapse.

Finally, please answer the questions below, keeping in mind that all of them refer to events that occurred within the past year.

How often during the last year have you...

Salience

(I) Spent a lot of time thinking about short-form content platforms or planned to use them?
(II) Thought about how you could free more time to spend on short-form content platforms?
(III) Thought a lot about what has happened on short-form content platforms recently

Tolerance

(I) Spent more time on short-form content platforms than initially intended?
(II) Felt an urge to use short-form content platforms more and more?
(III) Felt that you had to use short-form content platforms more and more in order to get the same pleasure from it?

Mood modification

(I) Used short-form content platforms in order to forget about personal problems?
(II) Used short-form content platforms to reduce feelings of guilt, anxiety, helplessness and depression?
(III) Used short-form content platforms in order to reduce restlessness?

Relapse

(I) Experienced that others have told you to reduce your use of short-form content platforms but not listened to them?
(II) Tried to cut down on the use of short-form content platforms without success?
(III) Decided to use short-form content platforms less frequently, but not managed to do so?

Withdrawal

(I) Become restless or troubled if you have been prohibited from using short-form content platforms?
(II) Become irritable if you have been prohibited from using short-form content platforms?
(III) Felt bad if you, for different reasons, could not log on to short-form content platforms for some time?

Conflict

(I) Used short-form content platforms so much that it has had a negative impact on your job/studies?
(II) Given less priority to hobbies, leisure activities, and exercise because of short-form content platforms?
(III) Ignored your partner, family members, or friends because of short-form content platforms?