Does pornography affect delay discounting and executive functions?

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Master´s Thesis in Psychology

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ÅBO AKADEMI – FACULTY OF ARTS, PSYCHOLOGY AND THEOLOGY

Abstract for Master's Thesis

Subject: Psychology	
Author: Miika Soini	
Title: Does pornography affect delay discounting and executive functions?	
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Abstract:

Introduction: The internet is widely available and enables rapid consumption of short pornographic clips with potentially endless novelty (Ashton et al., 2019). The instant and constant gratification that internet pornography offers may lead to habituation and reward seeking (Negash et al., 2015). Executive functions play a role in decision making and allow for delayed gratification (Bickel et al., 2007; Negash et al., 2015). Studies have found that sexual stimuli negatively affect decision making and delay discounting (Cheng & Chiou, 2018; Laier et al., 2013; Negash et al., 2015; O'Malley et al., 2010). Delay discounting is the preference of sooner smaller rewards over later larger rewards, and is an aspect of impulsivity (Negash et al., 2015). Negash et al. (2015) found that pornography causally affected delay discounting. The current study aimed to replicate the findings by Negash et al. (2015), and to further explore the effects of pornography consumption on three domains within executive functions: inhibition, updating, and shifting (Friedman et al., 2008; Miyake et al., 2000). Two hypotheses were formulated: 1) participants in the experiment group will demonstrate less delay discounting than the participants in the control group; 2) the experiment group will outperform the control group in all tasks except for the number letter task, which measures shifting abilities.

Method: Participants were recruited online. The inclusion criteria were the age of 18–35 and the consumption of pornography through the internet more often than once a month. Participation was anonymous, and the incentive to participate was the chance to win prizes in raffle ticket drawings at the end of the study. Participants were randomized into the treatment groups. The experiment group had to abstain from all pornography for the duration of three weeks, while the control group had to abstain from their favorite food or treat. At pre- and post-intervention measurements the participants reported frequency of pornography consumption, favorite food consumption, and sexual activity, and completed three executive tests. Finally, at the post-intervention measurements, participants completed the delay discounting task, which the raffle ticket drawings were part of. For each measured variable and measurement time, between-group differences and within-group differences were measured.

Results: None of the statistical analyses were significant.

Discussion: No conclusions can be drawn from the results. The procedure check failed for both treatment groups. Both pre-formulated hypotheses were rejected. The delay discounting task has ecological validity, but the test paradigm might have low predictive validity (see Benjamin et al., 2020) and requires further research. There were some limitations in the study and the clearest limitation was the small sample size ($N = 7$). A replication of the current study, but with a bigger sample, could yield significant results. Future research should explore the mediating and moderating variables between pornography consumption and the studied dependent variables. Future research could be of clinical importance, for example, to aid defining and noticing risky pornography consumption (Negash et al., 2015).

Keywords: pornography, delay discounting, delayed gratification, executive functions, decision making, cues, sexual stimuli

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Abstrakt för avhandling pro gradu

Ämne: Psykologi	
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Abstrakt:

Inledning: Internet har bred tillgänglighet och möjliggör snabb konsumtion av korta och potentiellt oändligt många nya pornografiska klipp (Ashton m.fl., 2019). Den omedelbara och kontinuerliga tillfredställelsen som internetpornografi erbjuder kan leda till vanebildning och belöningssökande beteende (Negash m.fl., 2015). Exekutiva funktioner har en stor betydelse vid beslutsfattning och möjliggör förskjutning av tillfredställelse (Bickel m.fl., 2007; Negash m.fl., 2015). Studier påvisar att sexuella stimuli negativt påverkar beslutsfattningsförmåga och orsakar förringande av framtida belöningar (Cheng & Chiou, 2018; Laier m.fl., 2013; Negash m.fl., 2015; O'Malley m.fl., 2010). Förringande av framtida belöningar innebär preferensen för mindre belöningar i en när framtid framför större belöningar längre i framtiden och är en aspekt av impulsivitet (Negash m.fl., 2015). Negash m.fl. (2015) fann ett kausalt samband mellan pornografikonsumtion och förringande av framtida belöningar. Den föreliggande studiens mål var att replikera Negash m.fl.:s (2015) resultat och att vidare studera effekterna av pornografikonsumtion på tre exekutiva domäner: inhibition, uppdatering och växlande (Friedman m.fl., 2008; Miyake m.fl., 2000).

Metod: Studiedeltagare var rekryterade via internet. Kriterierna för att delta var 18–35 års ålder och pornografikonsumtion oftare än en gång i månaden. Deltagandet var anonymt och motiveringen att delta var möjligheten att vinna i lotteridragningar i slutet av studien. Deltagarna blev randomiserade till behandlingsgrupperna. Experimentgruppen skulle avstå från pornografi under 3 veckor medan kontrollgruppen skulle avstå från sin favoritmat eller favoritdelikatess. Vid pre- och post-testerna rapporterade deltagarna hur ofta de sett på pornografi, ätit sin favoritmat eller favoritdelikatess och varit sexuellt aktiva under de senaste tre veckorna, varefter deltagarna gjorde tre exekutiva test. Vid slutet av post-testerna gjorde deltagarna ett test som mätte förringande av framtida belöningar i formen av lotteridragningar. För varje beroende variabel och mätningstillfälle analyserades skillnader mellan grupperna och inom grupperna.

Resultat: Inga statistiska analyser var signifikanta.

Diskussion: Det går inte att dra slutsatser utgående från resultaten. Den experimentella manipulationen misslyckades för båda behandlingsgrupperna. Båda hypoteserna förkastades. Testet som mätte förringande av framtida belöningar hade god ekologisk validitet, men testparadigmet har potentiellt låg prediktiv validitet (se Benjamin m.fl., 2020) och kräver mera forskning. Det fanns vissa begränsningar i den föreliggande studien och den tydligaste var det lilla samplet (*N* = 7). Framtida studier bör studera medierande och modererande variabler mellan pornografikonsumtion och de beroende variablerna i den föreliggande studien. Det kunde vara av betydelse för kliniskt arbete att fortsätta studera området, till exempel kunde vidare forskning bidra med att definiera och uppmärksamma riskabel konsumtion av pornografi (Negash m.fl., 2015).

Nyckelord: pornografi, förringande av framtida belöningar, förskjutning av tillfredställelse, exekutiva funktioner, beslutsfattning, signaler, sexuella stimuli	
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Does pornography affect delay discounting and executive functions?

Internet pornography draws large amounts of internet traffic, with the internet pornography website Pornhub.com totaling up to 33.5 billion visits in 2018 (Pornhub, 2018). What are the psychological consequences of being able to access sexually stimulating material upon will at any time? There are some studies conducted in this area, many of which cover the effects of pornography or sexual cues and decision making. O'Malley et al. (2010) write that "cues" are stimuli that could excite subjects to take action according to a conditioned response. Hunger and sexual desire (along with thirst, pain, and fear) are visceral cues, meaning that they have an instinctual or emotive force behind them. Visceral cues trigger a need for immediate gratification, and the stronger the effect of these cues are, the more difficult it becomes to delay gratification. This raises a question: can sexual desire as a cue influence our need for immediate gratification in other domains besides sexual gratification as well? Findings by O'Malley et al. (2010) seem to suggest so. Furthermore, Negash et al. (2015) demonstrated in an experimental study that pornography consumption leads to higher levels of delay discounting in both men and women. Delay discounting (also called "discounting" by some authors) was described by Negash et al. (2015) as an aspect of impulsivity, including a preference of smaller and sooner rewards over larger and later rewards. O'Malley et al. (2010) described delay discounting as "preference of instant gratification" (p. 1). The purpose of the current study was to replicate the findings demonstrated by Negash et al. (2015). Further, since executive functions (EFs) play a vital role in delayed gratification (Bickel et al., 2007; Negash et al., 2015), the effects of pornography consumption on three domains within EFs were studied. The studied domains were inhibition, updating and shifting (Friedman et al., 2008; Miyake et al., 2000).

Internet Pornography

Ashton et al. (2019) proposed a working definition of pornography for social science researchers: "Material deemed sexual, given the context, that has the primary intention of sexually arousing the consumer, and is produced and distributed with the consent of all persons involved" (p.

20). Ashton et al. (2019) wrote that the internet is widely accessible, increasingly fast and affordable, which enables the wide distribution of pornographic content. The phenomenon of easily accessible pornographic content through the internet has been described as the "Triple A Engine" by Cooper (1998), since the internet offers accessibility, affordability and anonymity. Today, most pornography consumers access pornographic content through the internet (Ashton et al., 2019), which is why "pornography" and "internet pornography" are used as interchangeable concepts in the current study. An immensely popular website is Pornhub.com, with total visits being around 33.5 billion in 2018, an increase of 5 billion visits from 2017 (Pornhub, 2018). An increasing number of users accessed Pornhub.com through their mobile phone and, respectively, a decreasing number through their desktop computers, with 80% of the visits made to Pornhub.com through smartphones and tablets in 2018. Female visitors amounted up to 29% of the website's total visitors. The average age of users was 33.5 years, with user ages ranging from 18 to 65+ and most users being in the age range from 25 to 34. Potentially many users of free pornography streaming websites could be under the age of 18, since there is usually no other method to block underage users besides asking age upon entering these websites and when creating user profiles for these websites.

The number of smart phone users worldwide was 2.9 billion in 2018 (Gu, 2019). The wide usage of hand-held devices to browse the internet has enabled new platforms to emerge from where pornographic content can be accessed in various media formats, including social media platforms, blogs, interest-focused websites, virtual reality websites, games, producer-specific pornography sites, "tube" sites that contain content from many pornography producers, and smartphone applications (Ashton et al., 2019). The various platforms enable and encourage the consumption of many short pornographic video clips in rapid succession, which, in turn, provides a possibly endless stream of novel pornographic content. The constant novelty and instant gratification that internet pornography offers to its user can lead to habituation over time, which can lead to reward-seeking behavior (Negash et al., 2015).

Executive Functions

Executive functions (EFs) seem to reside in the frontal lobes, specifically in the pre-frontal cortex (Bickel et al., 2007; Friedman & Miyake, 2017; Miyake et al, 2000). There are several theories of what the EFs are and what they consist of, but the general notion seems to be that EFs are cognitive processes on a "higher" level, that monitor goal-directed behavior through the information gathered from perceptual experiences on a "lower" cognitive level (Friedman & Miyake, 2017; Miyake, 2000). EFs play a role in decision making and allow for delayed gratification (Bickel et al., 2007; Negash et al., 2015). Friedman and Miyake (2017) presented two models, explored with confirmatory factor analyses, to encapsulate EFs: the correlated factor model and the bi-factor model. The correlated factor model presents EFs as consisting of the latent variables "inhibition, updating and shifting" factors. The bi-factor model presents EFs as consisting of the latent variables updating, shifting and a common executive function variable that explains common variance in updating and shifting. Inhibition is not included in this model, because the common executive function factor could explain all the correlations in tasks that measure inhibition. Friedman and Miyake (2017) write that this could be evidence that updating and shifting tasks require inhibitory functions. Further, Friedman and Miyake (2017, p. 194) proposed that "the Common EF factor reflects individual differences in the ability to maintain and manage goals, and use those goals to bias ongoing processing". Friedman and Miyake (2017) elaborated that this ability is required in all EF tasks and especially inhibition tasks, which partly also explains why inhibition does not have a place in their bi-factor model. Obtaining goals and monitoring the environment for goal-related ques could also be parts of the common EF factor.

Regarding the correlated factors model, which includes the inhibition factor, Miyake et al. (2000) described inhibition as the "ability to deliberately inhibit dominant, automatic, or prepotent responses when necessary". Therefore, it is possible that inhibition could be an important aspect of hindering impulsive decision making. Miyake et al. (2000) wrote that updating tasks require a constant replacing of some old information in the working memory, while other information is maintained, and, thus, updating tasks measure variance in the precision of the updating process.

Further, Miyake et al. (2000) wrote that shifting tasks require rapid switching between two (or more) subtasks according to random cues, which again requires using the suitable task set and rapidly replacing these task sets or goals, and, thus, shifting tasks measure the speed of this goal replacement. Friedman and Miyake (2017) proposed that there could be a so called "stability/flexibility" tradeoff between aspects of the common EF factor and shifting abilities, meaning that individuals with lower common EF scores may show higher performance in shifting tasks than expected from their common EF scores (p. 194).

The factors included in the correlated factor model and bi-factor model were based on previous studies suggesting that these factors are prominent in executive functioning, and EFs could consist of different factors and modalities according to which theoretical standpoint is taken (Friedman & Miyake, 2017). In the current study, shifting, updating and inhibition functions will be explored, acknowledging that updating and shifting tasks require inhibition to some extent.

Pornography and decision making

O'Malley et al. (2010) found that for single, heterosexual, young adult men, sexual cues produced discounting rates that were dependent on time horizons when a possible reward was presented. Subjects who were presented with sexual cues preferred more immediate but smaller rewards when the rewards were presented in a short time horizon (tomorrow or in 3 months). In contrast, subjects did not show this preference for sooner but smaller rewards when the rewards were presented in a longer time horizon (in 3 or 6 months). Subjects who were not presented with cues did not show a significant difference in discounting rates depending on the presented time horizons. In a study by Cheng and Chiou (2018), heterosexual male test participants showed higher delay discounting rates when exposed to sexually appealing stimuli. Delay discounting positively mediated the association between exposure to sexual stimuli and cyber delinquency (e.g., illegal downloading from the internet and cyber fraud). In a study by Laier et al. (2013), heterosexual male test participants made worse economic decisions when aroused. Laier et al. (2013) demonstrated that in the Iowa Gabling Task (Bechara et al., 1994), when sexual images were displayed on

advantageous card decks and neutral pictures were displayed on disadvantageous card decks, and vice versa, participants who were sexually aroused more often chose the disadvantageous card deck when sexual images were associated with that card deck.

In a study by Antons et al. (2019), heterosexual male participants with pathological/unregulated internet pornography usage had significantly higher attentional impulsivity scores than recreational-occasional and recreational-frequent pornography users. Also, they used more dysfunctional coping styles to deal with their issues. Messina et al. (2017) found that at baseline tests (time 0), sexually compulsive men (experiment group) were not more impulsive in their decision making than men in the control group. Later, when being presented with sexual stimuli at time 1, the experiment group reported greater amounts of sexual desire and arousal than the control group. After being presented with sexual stimuli, the control group performed better than the experiment group in a test measuring cognitive flexibility. In a test measuring decision making, the control group improved their performance from time 0 to time 1, while the experiment group did not. The time between time 0 and time 1 was at least 6 months to control for practice effects. The authors discussed that sexually compulsive men might be worse at learning from experience and modifying their behavior accordingly. The study included heterosexual, bisexual, and homosexual men.

Negash et al. (2015) found in their experimental intervention study, that study participants who were asked to abstain from pornography over a period of three weeks demonstrated less delay discounting at the end of the three-week period, than participants who were asked to abstain from their favorite food. The study included 24 men and 13 women. The results indicated that pornography use could have a causal effect on impulsivity beyond momentary arousal. The findings have clinical implications, for example, when treating relational difficulties and noticing risky behavior that could lead pornography addiction and sexual compulsivity (Negash et al., 2015). Though there were promising initial findings, there were also limitations that are to be noted when replicating the study. The relatively small sample size and narrow participant age range may limit the

generalizability of the findings. Further, it is unclear whether it requires equal levels of self-control to abstain from pornography as it does for abstaining from one's favorite food, be it a meal or a certain food item. Finally, the use of self-report measures and concerns regarding social desirability might have biased how participants reported their pornography consumption. Given recent findings suggesting that a large number of psychology studies — especially studies performed on limited sample sizes — do not produce independently reproducible results (e.g., Open Science Collaboration, 2015); replication of the promising initial findings by Negash et al. (2015) is warranted.

The Predictive Validity of the Delay Discounting Paradigm

Since delay discounting means discounting future rewards, theoretically, more delay discounting should lead to less capital formation over time, including human, social and financial capital, as capital formation requires an investment into the future (Benjamin et al., 2020). Findings by Benjamin et al. (2020) do not support this notion. Benjamin et al. (2020) found that preference of later bigger monetary rewards over smaller sooner rewards (i.e., less delay discounting) had a positive, but non-significant association with the other mid-life capital formation variables (e.g., net worth, permanent income, and social status). There seems to be some evidence that the ability to delay gratification, measured as an average through the ages 17, 27, and 37, predicts some mid-life capital formation variables, but the evidence is inconclusive, and more research is still needed. Thus, the delay discounting paradigm might have limitations in its predictive validity.

The Purpose of the Study and Hypotheses

The aim of the current study was to perform an experimental study to replicate results that were obtained from the second study by Negash et al. (2015). As in the previously mentioned study, the current study differentiated the effects of practice of self-control and that of pornography use with an experiment group that abstained from pornography, and a control group that abstained from their favorite food or treat without being given an explicit instruction to abstain from pornography. Delay discounting was measured with a test that resembles the one used by Negash et

al. (2015). Further, the current study sought to explore how pornography consumption affects executive functions in the domains of inhibition, updating and shifting. Two specific hypotheses were formulated based on previous studies:

1. Participants in the experiment group will demonstrate less delay discounting than the participants in the control group.

2. The experiment group will outperform the control group in all tasks except for the number letter task, which measures shifting abilities.

For exploratory purposes, the participants were asked at the pre-intervention measurements whether they usually masturbate while watching pornography. At both the pre- and post-measurements, the participants also had to report how frequently they had been sexually active during the past three weeks.

Method

Study Design

I planned the current study to be part of my Master's thesis. I was in charge of designing the study, recruiting participants, conducting the experimental intervention and analyzing the collected data. My supervisors guided me in the process. From here on in this thesis, I will refer to myself as the author of the current study.

To ensure that the present study would not stray too far from the original study, much of the study design was copied from the second study by Negash et al. (2015) and modified to a small extent to better fit current study conditions. Negash et al. (2015) asked the experiment group to abstain from pornography and the control group to abstain from their favorite food for three weeks, after which delay discounting was assessed. Negash et al. (2015) assumed that sex and food are both natural rewards and similarly affect the brain's reward circuitry and decided that food would be the most comparable reinforcer to abstain from. In the current study, data was collected at the pre-intervention measurements and the post-intervention measurements. At the pre-intervention measurements, the participants first completed a questionnaire: all participants reported their

gender, how frequently they had watched pornography through the internet, how frequently they had eaten their favorite food, and how frequently they had been sexually active for the past three weeks. Then, the participants completed three executive tasks. After the intervention period of three weeks, the participants took part in the post-intervention measurements, where the participants again completed a questionnaire: all participants reported how frequently they had watched pornography through the internet, how frequently they had eaten their favorite food, and how frequently they had been sexually active for the past three weeks. Then, the participants completed the same three executive tasks for a second time. At the end of the post-intervention measurements, the participants also completed the delay discounting task. The recruitment of participants, study procedure and used tasks will be described in more detail below.

Participants and Recruitment

The participant recruitment and the data collection were originally planned to start in the spring of 2020. Due to the COVID-19 pandemic's possible influence on the recruitment of participants and the collected data, the author of the current study decided to postpone the data collection until after the pandemic. The pandemic did not pass, and due to time limitations the participant recruitment and the data collection were started in the autumn of 2020.

Prior to participant recruitment, the Board for Research Ethics at Åbo Akademi University approved the data collection plan for the current study. Participants were recruited online, mainly through social media and mailing lists of subject associations at Åbo Akademi University, University of Turku, Novia University of Applied Sciences, Turku University of Applied Sciences and HUMAK university of Applied Sciences. At the recruitment and screening stage, the participants were told that they were invited to anonymously participate in a study regarding pornography consumption, self-control, decision making and executive functions, and that the study was recruiting participants in the age range 18-35, who consume internet pornography more than once a month. Negash et al. (2015) also included the participation criteria of internet pornography consumption of at least once a month, but in their study, the participants were unaware that they were picked for the study

based on their pornography consumption. In the current study, the age range was based on the age range used by Negash et al. (2015). The participants were also told that the study is part of a Master's thesis and that the topics for the thesis are pornography consumption, self-control, and executive functions. The participants were told that the current study is an experimental intervention study and that they were either going to abstain from pornography or their favorite food/treat for three weeks for the purpose of the study. The participants were informed that the whole study would be conducted in English through the internet. The initiative to participate were raffle drawings for six 30-euro vouchers after the intervention period had ended. The participants were informed about the timeframe of the study and what was expected of their effort in participating.

At the recruitment and screening phase, participants were asked to provide informed consent to participate in the study. It was explained that no data would be personally connected to them in any results or future publications of the study. The confidentiality of the study was explained. The voluntary nature of the study was explained, and the participants were informed that they were free to terminate their participation at any time without giving a reason, upon which the participant's data would be deleted. The participants were informed that they have the right to access their personal collected data. The participants were instructed that they could contact the principal investigator (the author of the current study) or the supervisors via email at any time if questions arose. To ensure anonymity, the participants were required to create new email addresses specifically for the purpose of the study. The participants were instructed to set up automatic forwarding from their new email addresses to their actual email addresses. Then, the participants were asked to enter their new email addresses to receive a link for the experimental platform and instructions how to proceed with the intervention. Emails reminding the participants to adhere to the study were sent every week. Participant age was asked, as well as how often the participant usually watches pornographic content through the internet (with choices: never, once a month or less, more than once a month).

The study caught some interest, with over 450 page views on the screening and informed consent questionnaire. Altogether 16 persons showed interest in participating in the current study and 12 were eligible to participate. Four participants were excluded from the study: two persons did not enter their email addresses, and another two did not watch pornography once a month or more. Twelve participants were randomized into the two intervention groups. Only seven participants completed the tests at the pre-intervention measurements at the beginning of the intervention, and all of these completed the post-intervention measurements. Considering that the current study was specifically designed to be part of a Master's thesis, all within reasonable limits was done to recruit as big a sample as possible. Still, the final sample amounted to seven participants. The average age of these seven participants was 23.57 years (*SD* = 1.72). The participants' ages ranged from 21 to 26. Of the seven participants who completed the intervention, four were assigned to the experiment group (abstaining from pornography) and three to the control group (abstaining from their favorite food or treat). All participants identified as males.

Most of the participants completed the pre-intervention measurements later than when the intervention started: two participants completed the questionnaire and the tests on time, and three participants completed the questionnaire and the tests one day late. Seeing that only five participants had completed the pre-intervention measurements two days after the intervention had started, all 12 eligible participants were reminded to complete the pre-intervention measurements. After this, two more participants completed the questionnaire and the tests, although being three days late. These seven participants also completed the post-intervention measurements. Again, most participants completed the post-intervention measurements late; one completed the questionnaire and the tests on time. Seeing that only one participant had completed the post-intervention measurements, the participants were reminded to complete the post-intervention measurements. Three participants completed the questionnaire and the tests one day late, two participants two days late, and one participant three days late.

One participant forgot to provide their study email address when taking part in the pre-intervention measurements, but the email was obtained through inspecting the emails entered at the post-intervention measurements. Two participants forgot to provide their study email address at the post-intervention measurements. One of the email addresses was obtained when the participant contacted the author of the current study, and the other was obtained through inspecting the emails entered the pre-intervention measurements.

Procedure

The participants were randomized into two intervention groups. Data were collected at two points in time, at the pre-intervention and post-intervention measurements. The participants in the experimental condition were given the following instructions when the intervention started: “You have been assigned to abstain from viewing pornography, including all websites, magazines, videos, etc. that show nudity or sexually explicit materials of any kind for the next three weeks. We hope that you will be diligent at abstaining from pornography use for this short period of time. However, we kindly ask you to be honest and let us know if you did view pornography anyway. Please write a personal plan how you are going to abstain from pornography (e.g., distract yourself) during the given time period. Also, please keep a personal diary on a daily basis where you indicate if you have watched pornographic material, masturbated or had partnered sexual contact during the three weeks.” The instruction to write a plan was a measure to ensure that the participants had a better chance to abstain from pornography. The diary was not only a memory tool for the participants, as at the end of the study these parameters were measured. In the study conducted by Negash et al. (2015), the participants were further asked to write a paragraph at the beginning of each week about their success (or lack thereof) in abstaining from pornographic material, as a tool to remind the participants to abstain from pornography. This procedure was not included in the current study.

The participants in the favorite food/treat abstinence group were given the following instructions: “You have been assigned to abstain from eating your favorite food or treat for the next three weeks. We hope that you will be diligent at refraining from your favorite food or treat for this

short period of time, but also, please be honest and let us know if you did eat your favorite food or treat anyway. Please write a personal plan how you are going to abstain from your favorite food or treat (e.g. distract yourself) during the given time period. Also, please keep a personal diary on a daily basis where you indicate whether you have eaten your favorite food or treat, masturbated or had partnered sexual contact during the three weeks." The instructions given to both groups are largely the same as used by Negash et al. (2015).

The pre-intervention measurements were conducted on the same day the intervention started. At the pre-intervention measurements, the participants chose what gender they identified with (with answer options: man, woman, other, I do not want to answer this question), and whether they usually masturbated while watching pornography. The second question was asked since masturbation, like sexual activity in general, could be a mediating or moderating variable between pornography consumption and executive functioning and delay discounting. Then, the participants were asked how often they had watched pornographic content through the internet, how often they had eaten their favorite food or treat, and how often they had been sexually active during the past three weeks (with answer options: never, once a month, twice a month, once a week, several times a week, every day, several times a day). It is possible that lower pornography consumption affects frequency of sexual activity, which could be a mediating variable between pornography consumption and delay discounting, and, thus, the study participants were asked how frequently they had been sexually active. Negash et al. (2015) did not measure the frequency of sexual activity in their study. After the questionnaire, the participants completed three executive tasks. After abstaining from pornography or their favorite food or treat for three weeks, the post-intervention measurements were conducted. Yet again, participants reported frequency of pornography consumption, favorite food consumption, and sexual activity, and completed the same three executive tasks. At the post-intervention measurements, the participants also completed the delay discounting task.

After completing the delay discounting task, the participants were debriefed on the purpose of the study and the raffle ticket drawings. The data were gathered during the academic year of 2020-2021 and the participants were informed that the study results will be found on the "Doria.fi" website, when searching for Miika Soini.

Measures

At both pre- and post-intervention measurements, the participants performed the antisaccade task, three numerical n-back tasks with digits, and a number-letter task, which respectively provided measures executive functioning in the domains of mental inhibition, updating and shifting (Friedman et al., 2008; Miyake et al., 2000). The chosen task paradigms are well established and widely used. The tasks have both congruent and discriminant validity, though they are affected by the "task impurity problem" (Friedman et al., 2008; Miyake et al., 2000). This problem signifies that tasks that are designed to measure specific domains within executive functioning also measure variance that is not produced by the target domain, for example, unintentionally measuring motor speed when observing shifting abilities. The individual tasks likely have a low content validity on their own. Several convergent tasks for each domain would have been required to measure each domain more accurately. Performances in the used tasks are, thus, only largely indicative of the variance in the target domain, and the scores should be interpreted cautiously.

Delay discounting was measured in the form of raffle ticket drawings at the post-intervention measurements, similarly to the second study by Negast et al. (2015). Negash et al. (2015) only used the delay discounting task in their study and no other tests. The executive tests in the current study were thought to provide additional information about how pornography consumption affects cognition.

The Antisaccade Task

The antisaccade task that was used in the current study was previously described and used by Draheim et al. (n.d.)., who found that the task had high initial and retest internal consistency

(both .92, “calculated using an even-odd split procedure and corrected using the Spearman-Brown prophecy formula” (Draheim et al., n.d., table 2)). The test also had high test-retest reliability (a correlation of .73) when controlling for outliers. The antisaccade task measures inhibitory functions within EFs (Friedman et al., 2008; Miyake et al., 2000). In the task, the participants were presented with a central fixation cross on the test window which they were to look at. An asterisk appeared on either the left or right side of the test window, immediately followed by a target “Q” or “O” letter on the opposite side of the test window. After this, the location of the asterisk and the target were masked by “##”. The participants’ goal was to ignore the asterisk in order to see the target, and then press the corresponding letter on their keyboard. Reaction time was unlimited. The participants completed 72 trials and the measured dependent variable was the number of correctly identified targets. The task that is used in the current study varies from the previous study by Draheim et al. (n.d.) in that there is no alerting tone before the asterisk is shown and no performance feedback for each trial nor for test performance in whole.

The N-back Tasks

The n-back tasks that were used in the current study were similar to the task variants used by Waris et al. (2017), Waris et al. (2018), Lukasik et al. (2019), Fellman et al. (2020) and Salmi et al. (2020). Waris et al. (2017) used the 1- and 2-back tasks and found their version of the 2-back task to have an internal consistency of $\alpha = .98$ (calculated using Cronbach’s Alpha). The n-back tasks that were used in the current study were numerical, meaning that the participants were presented with series of numbers, each number being a trial. In each n-back task respectively, the goal was to determine whether the current item (number) had appeared 1 (n-1), 2 (n-2) or 3 (n-3) trial(s) before (1-back, 2-back, and 3-back task respectively). Each n-back task contained 48 trials. The three tasks were presented in a random order for each participant. Before the actual tests, the participants practiced each n-back task, 12 trials for each n-back task. Each practice task was administered up to three times. In the actual tasks, all participants received the same pseudorandomized set of items including 16 target items, 16 non-target items and 16 lure items (described below), totaling to 48

items for each n-back task. The potentially distracting lures were incorporated to make the tasks more difficult and to avoid test performances that would be based merely on item familiarity (Fellman et al., 2020; Lukasik et al., 2019). Same as in the study by Waris et al. (2017), the dependent variable was the proportion of correctly identified targets minus the proportion of false alarms ("same" responses on no-target items). Performance scores could be negative for each n-back task. For each n-back task, the maximum performance score was 16, while the minimum was −32.

In the current study, the 1-back task contained n+1 (n = 16) lures (e.g., in the list 5-7-1-7, the last 7 is a n+1 lure. In the 2-back task, the lure items were either n+1 (n = 4), n−1 (n = 4) or n+ and −1 (n = 8, e.g., in the 2-back block, a list of 2-5-2-2 would contain a "2" that is both an n+1 and n−1 item at the same time, being a separate item from a n+1 or n−1 item). Additionally, in the 2-back task, 3 target items also matched the item presented 1 step back, 3 target items matched the item 3 steps and 10 target items matched only the target item when considering the most recently presented items. The 3-back task contained n+1 (n = 8) and n−1 (n = 8) lures.

The domains within EFs that were studied in the current study were based on the study by Friedman et al. (2008), where the authors used a spatial 2-back task to measure variance within the updating domain. Findings by Waris et al (2017) suggest that numerical-verbal and visuospatial 2-back tasks measure the same higher cognitive ability (i.e., updating within EFs), which, in turn, suggests that the n-back tasks used in the current study also measure variance withing the updating domain. It is conceivable that the 1-back and 3-back tasks measure the same ability as the 2-back task, and, therefore, these tasks were also included in the current study.

The Number-letter Task

The number-letter task that was used in the current study was previously described and used by Jylkkä et al. (2017). Friedman et al. (2008) found their version of the task to have an internal consistency of .89, "calculated by adjusting split-half or Part 1–Part 2 correlations with the Spearman–Brown prophecy formula" (p. 208). In another study, the number-letter task had a test-retest reliability of r = .68 in the switching cost measure, and a test-retest reliability of r = .65 in the

mixing cost measure (Soveri et al., 2018). The aforementioned studies had similar descriptions of the number-letter task.

In the number-letter task, the participants were presented with number-letter pairs (e.g., 4-B) inside of two boxes, one of which was higher up on the test window, and one that was directly under the upper box. When the number-letter pair was presented in the upper box, the participants had to answer whether there was an even or odd number, and when the pair was presented in the lower box, the participants had to answer whether there was a vowel or a consonant. The task consisted of three blocks of trials: one block with number monitoring only, one block with letter monitoring only and one block with mixed number and letter monitoring. In the mixed block, there were either repeated trials of letter or number monitoring or switching trials between letter and number monitoring, in other words, the number-letter pairs appeared randomly in the boxes on the screen. The single-task blocks consisted of 32 trials each, while the mixed-task block consisted of 32 switching trials and 48 repetition trials (24 number trials and 24 letter trials). A practice sequence preceded each block.

The number-letter task produced two executive measures, switching cost and mixing cost (Jylkkä et al., 2017; Soveri et al., 2018). Switching cost was calculated by subtracting average reaction time on repetition trials in the mixed task-block from average reaction time on switching trials on the mixed-task block and is thought to measure shifting ability. Mixing cost was calculated by subtracting average reaction time in single-task blocks from average reaction time in repetition trials in the mixed block and is thought to reflect monitoring and sustained attention. Smaller values in these measures indicate better performance. The online experimental platform used in the current study produced individual participant's overall average reaction time in the task, as well as in correct single-task, repetition and switching trials, totaling up to four different means measured in milliseconds. The online experiment platform also produced "cleaned" average reaction times, meaning that trials exceeding three standard deviations over and under the individual participants

average reaction time were excluded from the calculation of cleaned average reaction times. The current study used cleaned average reaction times when calculating the executive measures.

Delay Discounting

The delay discounting task used in the current study was largely the same as in the study by Negash et al. (2015), with a difference in the raffle ticket drawing prizes. To measure delay discontinuing, four raffle ticket drawings were held with six 30€ gift cards to an online store as prizes. The drawings were held two weeks apart, starting from the day after the intervention had ended, and the participants had to choose which drawings to participate in. The later the drawing, the more electronic raffle tickets the participants received. Three questions were asked: “Would you prefer to enter all your electronic raffle tickets today for our upcoming drawing or would you prefer to have all those tickets plus 10 entered in two weeks for our drawing in two weeks?” Next, the participants were asked: “Or would prefer to have all your initial tickets plus 20 entered in 4 weeks for our drawing in 4 weeks”. Finally, the participants were asked: “Or would prefer to have all your initial tickets plus 30 entered in 6 weeks for our drawing in 6 weeks?” The participants were given the option to stay with an earlier choice in the two latter questions. Because the participants answered only three questions, and they made this decision without knowing exactly how many tickets they would have in total, the percentage that later drawings were chosen over a sooner drawings was calculated as the dependent variable. The lower this percentage was, the worse was their chance at winning, and the higher the delay discounting was; the longer the participants waited, the better their chance was at winning, and the lower their delay discounting was.

Statistical Analyses

The choice of statistical analyses was guided by Field (2014). All statistical analyses were defined after collecting the data. Between-group differences (experimental group vs. control group) were analyzed with a Mann-Whitney U test, and within-group differences (pre-intervention measurements vs. post-intervention measurements) were analyzed with a Wilcoxon matched-pair signed-rank test, using the computer software IBM SPSS Statistics version 27 for Windows (IBM,

2020). Effect sizes were interpreted according to Cohen (1992): r = .10, small effect; r = .30, medium effect; r = .50, large effect. Altogether 37 analyses were made. A Bonferroni correction was applied to the α-level to control Type 1 error rate (Field, 2014), resulting in the criterion of statistical significance being p = .001.

Results

Descriptive statistics for each group at both measurement points are presented in Tables 1 and 2. Statistics for frequency of pornography consumption, favorite food/treat consumption, and sexual activity are presented in table 1. Results from the antisaccade task, the n-back tasks, the number-letter task, and the delay discounting task are presented in table 2. At the pre-intervention measurements, all seven participants reported that they usually masturbate while watching pornography.

Table 1

Frequencies of Pornography Consumption, Favorite Food/Treat Consumption, and Sexual Activity Pre- and Post-Intervention

Parameter	*M*	*Mdn*	*SD*	Variance	Range, min–max	Percentiles	
						25	75
			Experiment group				
Pornography pre	5.50	5.50	0.58	0.33	1, 5–6	5.00	6.00
Pornography post	3.25	3.00	1.26	1.58	3, 2–5	2.25	4.50
Favorite food pre	3.50	3.50	0.58	0.33	1, 3–4	3.00	4.00
Favorite food post	4.00	4.50	1.41	2.00	3, 2–5	2.50	5.00
Sexual activity pre	3.25	3.50	2.06	4.25	4, 1–5	1.25	5.00
Sexual activity post	3.25	3.50	1.71	2.92	4, 1–5	1.50	4.75
			Control group				
Pornography pre	5.33	5.00	1.53	2.33	3, 4–7	4.00	.
Pornography post	4.00	4.00	1.00	1.00	2, 3–5	3.00	.
Favorite food pre	3.00	4.00	1.73	3.00	3, 1–4	1.00	.
Favorite food post	1.00	1.00	0.00	0.00	0, 1–1	1.00	1.00
Sexual activity pre	2.33	1.00	2.31	5.33	4, 1–5	1.00	.

Parameter	*M*	*Mdn*	*SD*	Variance	Range, min–max	Percentiles	
						25	75
Sexual activity post	2.33	2.00	1.53	2.33	3, 1–4	1.00	.

Note. Total N = 7 (experiment group n = 4, control group n = 3). The parameters were measured on a 7-point Likert scale (based on the study by Negash et al., 2015). The answers were coded into numbers 1–7, where 1 indicated the lowest frequency and 7 indicated the highest frequency. Possible answers were: not at all, once, twice, once a week, several times a week, once every day, several times every day.

Table 2

Results From the Antisaccade task, the N-Back tasks, and the Number-Letter Task Pre- and Post-Intervention, and the Delay Discounting Task Post-Intervention.

Parameter	*M*	*Mdn*	*SD*	Variance	Range, min–max	Percentiles	
						25	75
			Experiment group				
Antisaccade[a] pre	61.75	62.00	6.08	36.92	11, 56–67	56.25	67.00
Antisaccade[a] post	66.25	67.00	2.99	8.92	7, 62–69	63.25	68.50
N-back 1[b] pre	12.50	13.50	4.04	16.33	9, 7–16	8.25	15.75
N-back 1[b] post	14.25	15.00	2.22	4.92	5, 11–16	12.00	15.75
N-back 2[b] pre	2.00	2.00	5.16	26.67	12, −4–8	22123.00	7.00
N-back 2[b] post	5.75	6.00	1.26	1.58	3.00, 4–7	4.50	6.75

Parameter	*M*	*Mdn*	*SD*	Variance	Range, min–max	Percentiles	
						25	75
N-back 3[b] pre	−2.00	−3.00	6.68	44.67	14, −8–6	−7.75	4.75
N-back 3[b] post	−0.75	−1.00	2.22	4.92	5, −3–2	−2.75	1.50
Number-letter switch[c] pre	297.78	256.19	106.20	11278.35	227.26, 225.74–453.00	227.51	409.65
Number-letter switch[c] post	376.69	391.63	127.01	16132.18	252.95, 235.27–488.22	252.34	486.09
Number-letter mix[c] pre	242.31	130.54	262.84	69086.83	560.08, 74.03–634.11	84.40	511.97
Number-letter mix[c] post	67.19	24.97	121.34	14722.30	262.87, −22.02–240.85	−19.09	195.69
Delay discounting[d]	0.42	0.33	0.42	0.18	1.00, 0.00–1.00	0.08	0.83
			Control group				
Antisaccade[a] pre	54.00	53.00	3.61	13.00	7, 51–58	51	.
Antisaccade[a] post	62.67	65.00	8.74	76.33	17, 53–70	53	.
N-back 1[b] pre	12.33	15.00	5.51	30.33	10, 6–16	6	.
N-back 1[b] post	12.33	15.00	5.51	30.33	10, 6–16	6	.
N-back 2[b] pre	5.00	3.00	5.29	28.00	10, 1–11	1	.
N-back 2[b] post	5.00	5.00	5.00	25.00	10, 0–10	0	.
N-back 3[b] pre	−3.33	−4.00	2.08	4.33	4, −5–−1	−5	.
N-back 3[b] post	2.33	0.00	6.81	46.33	13, −3–10	−3	.
Number-letter switch[c] pre	281.15	305.43	75.02	5628.54	144.03, 196.99–341.02	196.99	.
Number-letter switch[c] post	178.74	202.96	63.81	4071.99	120.54, 106.37–226.91	106.37	.
Number-letter mix[c] pre	84.26	62.81	76.67	5877.84	148.76, 20.61–169.37	20.61	.

Parameter	*M*	*Mdn*	*SD*	Variance	Range, min–max	Percentiles	
						25	75
Number-letter mix[c] post	176.52	242.55	118.21	13974.22	206.92, 40.04–246.96	40.04	.
Delay discounting[d]	0.56	0.67	0.51	0.26	1.00, 0.00–1.00	0.00	.

Note. Total N = 7 (experiment group n = 4, control group n = 3).

[a] The dependent variable was the number of correct responses (Draheim et al., n.d.). The maximum obtainable score was 72.00, while the minimum was 0.00.

[b] The dependent variable was the proportion of correctly identified targets minus the proportion of false alarms (Waris et al. 2017), and for each task, the maximum obtainable score was 16.00, while the minimum was −32.00.

[c] The dependent variables were switching cost and mixing cost (Jylkkä et al., 2017; Soveri et al., 2018). Switching cost was calculated by subtracting average reaction time on repetition trials in the mixed task-block from average reaction time on switching trials on the mixed-task block. Mixing cost was calculated by subtracting average reaction time in single-task blocks from average reaction time in repetition trials in the mixed block. Smaller values in these two measures indicate better performance The maximum obtainable score was 0.00, while there was no defined minimum score.

[d] The dependent variable was the index of how often the delayed option was chosen (Negash et al., 2015). The maximum obtainable score was 1.00, while the minimum could be 0.00 (i.e., 100% and 0% respectively). The lower the score, the higher the delay discounting was.

Procedure Check

Frequency of Pornography Consumption

There was no significant difference in frequency of pornography consumption at the pre-intervention measurement between the experiment group (*Mdn* = 5.50) and the control group (*Mdn* = 5.00), *U* = 5.00, *z* = −0.37, *p* = .857, *r* = .14. There was no significant difference at the post-intervention measurement between the experiment group (*Mdn* = 3.00) and the control group (*Mdn* = 4.00), *U* = 8.50, *z* = 0.93, *p* = .400, *r* = .35.

The participants in the experiment group did not significantly change their pornography consumption from the pre-intervention measurement (*Mdn* = 5.50) to the post-intervention measurement (*Mdn* = 3.00), *T* = 0.00 *z* = −1.84, *p* = .066, *r* = .65. The participants in the control group did not significantly change their pornography consumption either when comparing the pre-intervention measurement (*Mdn* = 5) and post-intervention measurement (*Mdn* = 4), *T* = 0.00, *z* = −1.41, *p* = .157, *r* = .58.

Frequency of Favorite Food or Treat consumption

There was no significant difference in frequency of favorite food or treat consumption at the pre-intervention measurement between the experiment group (*Mdn* = 3.50) and the control group (*Mdn* = 4.00), *U* = 6.00, *z* = 0.00, *p* = 1.000, *r* = .00. There was no significant difference at the post-intervention measurement between the experiment group (*Mdn* = 4.50) and the control group (*Mdn* = 1.00), *U* = 0.00, *z* = −2.22, *p* = .057, *r* = .84.

The participants in the experiment group did not significantly change their favorite food/treat consumption from pre-intervention (*Mdn* = 3.50) to post-intervention (*Mdn* = 4.50), *T* = 4.50, *z* = 0.82, *p* = .414, *r* = .29. The participants in the control group did not significantly lower their favorite food/treat consumption from pre-intervention (*Mdn* = 4) to post-intervention (Mdn = 1), *T* = 0.00, *z* = −1.41, *p* = .157, *r* = −.58.

Frequency of sexual activity

There was no significant difference in frequency of sexual activity at the pre-intervention measurement between the experiment group (*Mdn* = 3.50) and the control group (*Mdn* = 1.00), *U* = 4.00, *z* = −0.76, *p* = .629, *r* = −.29. There was no significant difference at the post-intervention measurement between the experiment group (*Mdn* = 3.50) and the control group (*Mdn* = 2.00), *U* = 4.00, *z* = −0.72, *p* = .629, *r* = −.27.

The participants in the experiment group did not significantly change their frequency of sexual activity from pre- to post-intervention measurement (*Mdn* = 3.50 at both times), *T* = 3.00, z = 0.00, *p* = 1.000, *r* = 0.00. The participants in the control group did not significantly change their sexual activity from pre-intervention measurement (*Mdn* = 1) to the post-intervention measurement (Mdn = 2), *T* = 1.50, *z* = 0.00, *p* = 1.000, *r* = .00.

The Antisaccade Task

There was no significant difference in the amount of correctly identified targets in the antisaccade task at the pre-intervention measurement between the experiment group (*Mdn* = 62.00) and the control group (*Mdn* = 53.00), *U* = 2.00, *z* = −1.43, *p* = .229, *r* = .54. There was neither a significant difference at the post-intervention measurement between the experiment group (*Mdn* = 67.00) and the control group (*Mdn* = 65.00), *U* = 5.00, *z* = −0.38, *p* = .857, *r* = .13.

There was no significant difference in the scores of the experiment group when comparing the pre-intervention measurement (*Mdn* = 62.00) and the post-intervention measurement (*Mdn* = 67.00), *T* = 6, *z* = 1.60, *p* = .109, *r* = .57 There was neither a significant difference in the scores of the control group when comparing the pre-intervention measurement (Mdn = 53.00) and the post-intervention measurement (*Mdn* = 65.00), *T* = 6.00, *z* = 1.63, *p* = .102, *r* = .67.

Number-Letter Switch Cost

There was no significant difference in the Number-Letter Task switch costs at the pre-intervention measurement between the experiment group (*Mdn* = 256.19) and the control group (*Mdn* = 305.43), *U* = 6.00, *z* = 0.00 *p* = 1.000, *r* = .00. There was no significant difference at the post-

intervention measurement between the experiment group (*Mdn* = 391.63) and the control group (*Mdn* = 202.96), *U* = 0.00, *z* = −2.12, *p* = .057, *r* = .80.

There was no significant difference in the scores of the experiment group when comparing the pre-intervention measurement (*Mdn* = 256.19) and the post-intervention measurement (*Mdn* = 391.63), *T* = 8.00, *z* = 1.10, *p* = .273, *r* = .39. There was neither a significant difference in the scores of the control group when comparing the pre-intervention measurement (*Mdn* = 305.43) and the post-intervention measurement (*Mdn* = 202.96), *T* = 0.00, *z* = −1.60, *p* = .109, *r* = .65.

Number-Letter Mix Cost

There was no significant difference in the Number-Letter Task mix costs at the pre-intervention measurement between the experiment group (*Mdn* = 130.54) and the control group (*Mdn* = 62.81), *U* = 3.00, *z* = −1.10 *p* = .400, *r* = .40. There was a no significant difference at the post-intervention measurement between the experiment group (*Mdn* = 24.98) and the control group (*Mdn* = 242.55), *U* = 10.00, *z* = 1.41, *p* = .229, *r* = .53.

There was no significant difference in the scores of the experiment group when comparing the pre-intervention measurement (*Mdn* = 130.54) and the post-intervention measurement (*Mdn* = 24.98), *T* = .000, z = −1.83, p = .068, r = −.65. There was no significant difference in the scores of the control group when comparing the pre-intervention measurement (*Mdn* = 62.81) and the post-intervention measurement (*Mdn* = 242.55), *T* = 6.00, z = 1.60, *p* = .109, *r* = .65.

The N-Back Tasks

The n-back tasks used in the current study consisted of the 1-back-, 2-back-, and 3-back task. In the 1-back task, two participants got full scores (16 correct) at the pre-intervention and two other participants got full scores at the post-intervention measurement, which signifies a possible ceiling effect in the scores.

The 1-Back Task

There was no significant difference in the performance in the 1-back task at the pre-intervention measurement between the experiment group (*Mdn* = 13.50) and the control group

(*Mdn* = 15.00), *U* = 6.00, *z* = 0.00 *p* = 1.000, *r* = 0.00. There was a no significant difference at the post-intervention measurement between the experiment group (*Mdn* = 15.00) and the control group (*Mdn* = 15.00), *U* = 5.50, *z* = −0.19, *p* = .857, *r* = .07.

There was no significant difference in the scores of the experiment group when comparing the pre-intervention measurement (*Mdn* = 13.50) and the post-intervention measurement (*Mdn* = 15.00), *T* = 8.50, *z* = 1.29, *p* = .197, *r* = .46. There was neither a significant difference in the scores of the control group when comparing the pre-intervention measurement (*Mdn* = 15.00) and the post-intervention measurement (*Mdn* = 15.00), *T* = 1.50, *z* = 0.00 *p* = 1.000, *r* = .00.

The 2-Back Task

There was no significant difference in the performance in the 2-back task at the pre-intervention measurement between the experiment group (*Mdn* = 2.00) and the control group (*Mdn* = 3.00), *U* = 8.00, *z* = 0.71 *p* = .629, *r* = .27. There was a no significant difference at the post-intervention measurement between the experiment group (*Mdn* = 6) and the control group (*Mdn* = 5.00), *U* = 5.00, *z* = −0.36, *p* = .857, *r* = .13.

There was no significant difference in the scores of the experiment group when comparing the pre-intervention measurement (*Mdn* = 2.00) and the post-intervention measurement (*Mdn* = 6.00), *T* = 5.00, *z* = 1.07, *p* = .285, *r* = .38. There was neither a significant difference in the scores of the control group when comparing the pre-intervention measurement (*Mdn* = 3.00) and the post-intervention measurement (*Mdn* = 5.00), *T* = 3.00, *z* = 0.00 *p* = 1.000, *r* = .00.

The 3-Back Task

There was no significant difference in the performance in the 3-back task at the pre-intervention measurement between the experiment group (*Mdn* = −3.00) and the control group (*Mdn* = −4.00), *U* = 6.00, *z* = 0.00, *p* = 1.000, *r* = .00. There was a no significant difference at the post-intervention measurement between the experiment group (*Mdn* = −1.00) and the control group (*Mdn* = 0.00), *U* = 7.00, *z* = 0.36, *p* = 1.000, *r* = .14.

There was no significant difference in the scores of the experiment group when comparing the pre-intervention measurement (*Mdn* = −3.00) and the post-intervention measurement (*Mdn* = −1), *T* = 7.00, *z* = 0.736, *p* = .461, *r* = .26. There was neither a significant difference in the scores of the control group when comparing the pre-intervention measurement (*Mdn* = −4.00) and the post-intervention measurement (*Mdn* = 0.00), *T* = 6.00, *z* = 1.60 *p* = .109, *r* = .57.

The Delay Discounting Task

There was no significant difference in the delay discounting index between the experiment group (*Mdn* = .33) and the control group (*Mdn* = .67), *U* = 7.00, *z* = 0.36, *p* = 1.000, *r* = .14.

Discussion

The aim of the current study was to replicate the findings by Negash et al. (2015) and to further explore the effects of pornography consumption on EFs. The findings by Negash et al. (2015) indicated that pornography consumption could causally affect delay discounting. EFs were explored in the current study, since they play an important role in decision making and delayed gratification (Bickel et al., 2007; Negash et al., 2015). Three domains within EFs were explored: inhibition, updating, and shifting (Friedman et al., 2008; Miyake et al., 2000).

The experiment group was intended to abstain from pornography over the course of three weeks, while the control group was intended to abstain from their favorite food or treat for three weeks. However, the statistical analyses revealed that the procedure did not have the intended effect. The experiment group did not significantly change their pornography consumption, and the control group did not significantly change their favorite food/treat consumption. None of the other statistical analyses yielded a significant result either, neither with nor without a Bonferroni correction. With 37 analyses in total, there was a high risk for type 1 errors without a Bonferroni correction. A replication of the current study with a larger sample could result in more reliable findings, but in the current study, the small sample size imposes difficulties to draw any conclusions at all. While without a Bonferroni correction some results were nearing the level of significance, this was not the case when applying the correction. These findings, if they had been significant, would

imply the following: the experiment group consumed less pornography over time; the control group consumed less of their favorite food or treat at the post-intervention measurement compared to the experiment group; the control group had better performance in the switch-cost measure at the post-measurement than the experiment group; the experiment group improved their performance in the mix-cost measure over time. Again, these findings were non-significant and are presented for speculation on which tests could be significant with a larger sample.

Two hypotheses were formulated for the current study: the participants in the experiment group will demonstrate less delay discounting than the participants in the control group; the experiment group will outperform the control group in all tasks expect for the number letter task, which measures shifting abilities. The hypotheses were not proven by the results in the current study and are thus rejected. No hypothesis was formed regarding the mediating or moderating effects of frequency of sexual activity on the link between pornography consumption and delay discounting. The exploratory analyses show that the groups did not significantly differ from each other in regards of frequency of sexual activity, neither at the pre- nor post-intervention measurements. Furthermore, the groups did not significantly change how frequently they were sexually active from the pre- to post-intervention measurements. Thus, no conclusions can be drawn regarding the mediating or moderating effects of the frequency of sexual activity.

In the delay discount task, the participants made decisions that would have real-life consequences for them, which provides ecological validity for the task. The study design in Negash et al. (2015) had some possible flaws. Since the current study was aimed to be a replication of the previously mentioned study, the current study largely has the same flaws. First, it is questionable whether willfully abstaining from pornography consumption imposes the same requirements on self-control as willfully abstaining from one's favorite food or treat. Sexual desire and hunger are instinctual/emotive forces or drives that affect behavior, as described by O'Malley et al. (2010), and it is conceivable that most humans would seek to gratify these drives. Pornography consumption might be a tool to gratify sexual desire, possibly the only way for some to gratify this drive, while

there may be several other foods or treats than specifically one's favorite food or treat to gratify hunger. Further, it could be difficult to find a source for sexual gratification that provides as much novelty and quick gratification as internet pornography (Ashton et al., 2019). Furthermore, sexual imagery is present in our daily lives, very often in advertisements or visual entertainment (e.g., movies and tv-shows), and as discussed by O'Malley et al. (2010), these stimuli could work as cues for behavior (e.g., watching pornography). Then again, seeing imagery depicting food, or coming across one's favorite food or treat in the grocery store, could trigger the desire to consume one's favorite food or treat. In conclusion, it remains unclear if the findings by Negash et al. (2015) are due to the absence of pornography consumption, or due to the different requirements of self-control in the two study conditions.

The second possible flaw in the study by Negash et al. (2015) is that the authors seem to assume that pornography provides sexual gratification. It could be the sexual desire, which pornography arouses, that could be the actual driving force behind delay discounting behavior (see Laier et al. 2013). Looking at the matter this way, continued pornography consumption could perpetuate a higher level of sexual desire, which, in turn, could explain the findings by Negash et al. (2015). If this is the case, Negash et al. (2015) falsely assume that it is the continuous sexual gratification, which pornography provides, that affects delay discounting. In a proposed working definition of pornography for social sciences, Ashton et al. (2019) wrote that pornography is primarily meant to sexually arouse the consumer. This supports the notion that pornography is a tool to raise sexual desire, not to provide sexual gratification. Further, one finding in the current study points in the same direction: all seven study participants reported that they usually masturbate while watching pornography on the internet. Thus, it is possible that pornography provides heightened sexual desire, and masturbation provides sexual gratification.

Limitations and future directions

As mentioned in the introduction, the delay discounting task used in the current study has potential limitations in its predictive validity, given the findings by Benjamin et al. (2020). In the

study by Benjamin et al. (2020), delay discounting was not significantly associated with other mid-life capital formation variables. In theory, delay discounting behavior should lead to worse economic outcomes, but this was not the case in the study by Benjamin et al. (2020). Future research in the area could study the causal connection between delay discounting and later wealth. It is worth noting, that delay discounting could not only affect economic decisions, but also decisions in other domains, as sexual behavior, which could lead to sexually impulsive behavior (Negash et al., 2015). It is possible that pornography does not affect delay discounting within economic decisions as much as in other domains. Therefore, future studies should explore other areas of delay discounting as well.

The tasks that are used in the current study aimed to measure inhibition, updating, and shifting. The tasks are based on well-established paradigms and are widely used, but provide only a snapshot of the full functioning within respective target domain within EFs. To further complicate the matter, the tasks are affected by the "task impurity problem" (Friedman et al., 2008; Miyake et al., 2000), meaning that they measure variance that is not part of their respective target domain. In other words, these tasks on their own might have low content validity. To combat this problem in future studies, multiple different congruent tasks are needed to measure each domain. Another limitation that complex executive tasks have is that internal and test-retest reliabilities tend to be low, possibly because subjects change strategies to do these tasks both within and between sessions (Miyake et al., 2000). To assess these strategy changes could be a way to combat this problem.

In the current study, most participants completed either the pre-intervention measurements or post-intervention measurements late. This could be a sign of low motivation to actively participate in the study. A low motivation among participants could mean that the test performances seen in the study are not representative of the participants' best performance levels. Further, as discussed earlier, self-report measures are prone to biased answers. Also, participants were instructed to write a plan to help them complete the intervention, and to keep a daily diary over their success or failure in adhering to the intervention. Participants were not required to show

evidence of them taking these measures, and, therefore, it is unknown whether the participants followed the instructions.

The current study had a small sample (*N* = 7) consisting of men exclusively. A replication of the current study, but with a larger sample consisting of both men and women, could make it possible to detect any statistically significant findings. As discussed earlier, the current study largely had the same limitations as the study by Negash et al. (2015), including the usage of self-report measures and narrow participant age range. Since age could influence delay discounting behavior (Negash et al., 2015), future studies should recruit participants with a wider age range to increase the generalizability of the results. Further, future studies could explore the moderating effects of age on the link between sexual stimuli and delay discounting and EFs, as Negash et al. (2015) point out. Future studies in the area could also seek to explore whether sexual orientation moderates the link between sexual stimuli and delay discounting and EFs. An interesting aspect to explore would be whether primary rewards, such as food or sexual gratification, influence delay discounting differently than more abstract secondary rewards, as money (Negash et al., 2015). For example, would an obtained monetary reward affect delay discounting differently than a sexually stimulating picture?

As discussed earlier, it is unclear whether it is the pornography or the masturbation while watching pornography that provides sexual gratification. It is possible that pornography arouses sexual desire, which, in turn, affects delay discounting. Future studies should explore what role pornography really has in delay discounting and which mediating and moderating variables could be in play. In the current study, the participants were asked whether they usually masturbate while watching pornography. Also, the participants reported both at the pre- and post-intervention measurements how frequently they had been sexually active. These two variables were measured in exploratory purposes to see if they mediated or moderated the effects of pornography and delay discounting. No ex-ante hypotheses were formulated regarding these two variables, nor was any there any pre-planned statistical analyses to explore their mediating or moderating properties.

Future studies should explore these variables further, with predefined hypotheses and statistical analyses to ensure more reliable results.

Further research in the effects of pornography on delay discounting and executive functioning could be of clinical importance. Noticing risky behavior that could lead to pornography addiction, which, in turn, could lead to sexual compulsivity, could be of importance for therapists when treating individual distress and relational problems (Negash et al., 2015). Messina et al. (2017) found some aversive executive effects of sexual compulsivity, which further highlights the importance of developing preventative and clinical interventions for pornography addiction.

Summary in Swedish – Svensk sammanfattning

”Kan pornografi påverka exekutiva funktioner och attityden till framtida belöningar?”

Inledning

Att konsumera pornografi via internet är mycket populärt i dagens läge. Exempelvis nätsidan Pornhub.com hade 35,5 miljarder besök under år 2018 (Pornhub, 2018). Ashton m.fl. (2019) skrev i sin artikel att internet har en bred tillgänglighet, som möjliggör en bred distribution av pornografi, och att de flesta konsumerar pornografi via internet. Ashton m.fl. (2019) skriver vidare att de olika nätplattformerna som erbjuder pornografi möjliggör och uppmuntrar konsumtionen av flera korta pornografiska filmsnuttar, vilket i sin tur möjliggör ett potentiellt oändligt flöde av nytt pornografiskt material. Det konstanta flödet av nytt material och den omedelbara tillfredställelse som internetpornografi erbjuder kan leda till vanebildning, som i sin tur kan leda till belöningssökande beteende (Negash m.fl., 2015).

Vad är de andra psykologiska konsekvenserna som följer av ständigt lättillgängligt sexuellt stimulerande material? Det finns många studier på detta område som omfattar hur sexuella signaler (eng. *cues*) påverkar beslutsfattning. O’Malley m.fl. (2010) skriver att signaler är stimuli som kan få någon att göra något enligt en betingad respons. Hunger och sexuell begäran (tillsammans med törst, smärta och rädsla) är invärtes (eng. *visceral*) signaler som bottnar i instinktiva eller emotionella drivkrafter. Invärtes signaler triggar ett behov av omedelbar tillfredställelse. O’Malley m.fl. (2010)

fann i sin studie att sexuell begäran påverkade heterosexuella män så att de föredrog mindre pengamässiga belöningar i en när framtid framför större pengamässiga belöningar längre in i framtiden. Detta beteende kan kallas för att förringa framtida belöningar (eng. *delay discounting*) och är en aspekt av impulsivitet (Negash m.fl., 2015). Det O'Malley m.fl. (2010) iakttog tyder på att sexuell begäran kan påverka människors behov av omedelbar tillfredställelse även på andra områden förutom sexuell tillfredställelse. Även andra studier pekar åt samma håll (Cheng & Chiou, 2018; Laier m.fl., 2013). Resultaten av Benjamin m.fl. (2020) tyder dock på att förringande av framtida belöningar inte har en effekt på ackumulering av kapital, vilket utgör ett problem i begreppsvaliditeten.

Negash m.fl. (2015) fann ett kausalt samband mellan konsumtion av pornografi och förringande av framtida belöningar genom ett experimentellt interventionsstudieupplägg. I studien avstod en experimentgrupp från pornografi under en tidsperiod på tre veckor medan en aktiv kontrollgrupp avstod från sin favoritmat eller favoritdelikatess, varefter deltagarna fick välja att delta i ett av fyra lotterier för verkliga pengamässiga vinster. De fyra lotterierna var åtskilda från varandra med två veckors mellanrum och ju längre deltagarna valde att vänta, desto större chans hade de att vinna. Syftet med den föreliggande studien var att replikera resultaten från Negash m.fl.:s (2015) studie. Utöver det inkluderades även mått för exekutiva funktioner som beroende variabler, eftersom exekutiva funktioner har en stor betydelse vid beslutsfattning och möjliggör förskjutning av tillfredsställelse (Bickel m.fl., 2007; Negash m.fl., 2015). Tre domäner inom exekutiva funktioner utvärderades: inhibition, uppdatering och växlande (eng. *inhibition, updating and shifting*) (Friedman m.fl., 2008; Miyake m.fl., 2000). Exekutiva funktioner är kognitiva processer som styr målinriktat beteende (Friedman & Miyake 2017; Miyake m.fl., 2000). Det finns olika teorier om vad exekutiva funktioner omfattar och hur de indelas, men för denna studie användes ovannämnda domäner som indelning. Miyake m.fl. (2000) skriver att inhibering innebär förmågan att inhibera reaktioner; uppdatering innebär förmågan att konstant ersätta en del gammal information i arbetsminnet och

upprätthålla annan information; växlande innebär förmågan att snabbt växla mellan två (eller flera) målsättningar i tankarna eller beteendet.

Två hypoteser formulerades för den föreliggande studien: 1) deltagarna i experimentgruppen skulle uppvisa mindre förringande av framtida belöningar; 2) deltagarna i experimentgruppen skulle prestera bättre i alla mått, förutom i *number-letter task*, som mäter exekutiv växlingsförmåga.

Metod

Studieupplägget var i många avseenden identiskt med upplägget i studien av Negash m.fl. (2015), med en del tillägg och mindre modifikationer. Experimentgruppen skulle avstå från pornografi i tre veckor medan kontrollgruppen skulle avstå från sin favoritmat eller favoritdelikatess. Etiska nämnden vid Åbo Akademi gav sitt samtycke till forskningsplanen. Studiedeltagare rekryterades via internet, främst genom sociala medier och olika föreningars e-postlistor inom Åbo Akademi, Åbo Universitet, Yrkeshögskolan Novia, Åbo Yrkeshögskola och Humanistinen Ammattikorkeakoulu. Studien var anonym och deltagarna gav informerat samtycke att delta i studien. Kriterierna för att delta var 18–35 års ålder och konsumtion av pornografi via internet oftare än en gång i månaden. Totalt 16 människor visade intresse att delta, varav 12 uppfyllde inklusionskriterierna och gav sina kontaktuppgifter, men endast sju deltagare slutförde interventionen och deltog i post-testerna. Medeltalet för deltagarnas ålder var 23,57 (*SD* = 1,72). Deltagarna randomiserades till de två behandlingsgrupperna så att fyra kom i experimentgruppen och tre i kontrollgruppen. Alla deltagare identifierade sig som män.

Vid interventionens början gjordes pre-test och vid slutet av interventionen post-test. Vid första mätningen fick deltagarna ange sin könsidentifikation (om någon) och ifall de oftast masturberar medan de ser på pornografi. Vid båda mätningarna rapporterade deltagarna hur ofta de under de tre senaste veckorna hade sett på pornografi via internet, ätit sin favoritmat eller favoritdelikatess och varit sexuellt aktiva. Masturbation och annan sexuell aktivitet hypotiserades som möjliga medierande eller modererande variabler mellan pornografi och de beroende

variablerna, men det gjordes inga hypoteser gällande vilken riktning dessa variabler skulle påverka de beroende variablerna. Deltagarna fick som uppgift att föra dagbok över de tre nämnda måtten och skriva en plan för att kunna avstå från det de skulle. En debriefing gavs efter den sista uppgiften vid post-interventionen.

Vid båda mätningarna gjorde deltagarna testerna *antisaccade task, n-back task* i tre olika nivåer och *number-letter task*, vilka i sin ordning mätte inhibition, uppdatering och växlande (Friedman m.fl, 2008; Miyake m.fl, 2000). Dessa test är välkända och brett använda, men i sig mäter de inte fullständigt den variation inom domänen som de är avsedda att mäta (Friedman m.fl, 2008; Miyake m.fl, 2000) och därmed har de enskilt utan konvergenta test låg innehållsvaliditet. Vid post-testerna gjorde deltagarna en liknande uppgift som Negash m.fl. (2015) använde, och deltog därmed i ett av fyra lotterier för sex stycken presentkort värda 30 euro styck till en nätaffär.

Resultat

Allt som allt 37 statistiska analyser utfördes och därmed blev kriteriet för statistisk signifikans med Bonferroni-korrigering p = 0,001. Deskriptiva mått för båda gruppernas resultat finns i tabell 1 och 2. Inget av de statistiska testerna var signifikant, varken med eller utan Bonferroni-korrigeringen.

Diskussion

Syftet med den föreliggande studien var att replikera fynden av Negash m.fl. (2015) och studera vidare hur pornografi påverkar exekutiva funktioner. Sampelstorleken utgör ett stort problem i de statistiska analyserna, där inga signifikanta resultat kunde hittas. Således kan man inte säkerställa att interventionen lyckades och att deltagarna faktiskt avstod från pornografi eller sin favoritmat eller favoritdelikatess. Man kan inte dra några andra slutsatser heller från resultaten. En replikering av den föreliggande studien men med ett större sampel kunde ge mera pålitliga resultat. Båda hypoteserna som formulerades förkastades. Inga slutsatser kan heller dras gällande hur sexuell aktivitet medierade eller modererade effekten av pornografi på de beroende variablerna.

Den föreliggande studien hade liknande styrkor och begränsningar som studien av Negash m.fl. (2015). Som styrka kan nämnas den ekologiska validitet som lotteriet som test medförde. Som

begränsningar kan några punkter nämnas. För det första är det osäkert om att avstå från pornografi är jämförbart med att avstå från ens favoritmat eller favoritdelikatess med tanke på självkontroll. För det andra är det osäkert om pornografi ger sexuell tillfredställelse eller väcker mera sexuell begäran. Denna begäran kan vara den egentliga drivande kraften bakom förringade av framtida belöningar och framtida studier i området bör skilja mellan sexuell tillfredställelse och begäran. För det tredje, som tidigare nämnt, pekar resultaten av Benjamin m.fl. (2020) i den riktningen att förringande av framtida belöningar inte har en effekt på ackumulering av kapital, vilket utgör ett problem i begreppets validitet eftersom det i teorin borde finnas en effekt. För det fjärde hade testerna som mätte de tre domänerna inom exekutiva funktioner låg innehållsvaliditet då de användes enskilt utan konvergenta test (Friedman m.fl., 2008; Miyake m.fl., 2000). För det femte var samplet litet, könsfördelningen fullständigt förskjuten och variationen i deltagarnas ålder snäv, vilket medför generaliseringsproblem. För det sjätte var det svårt att kontrollera att studiedeltagarna faktiskt utförde interventionen så som de var instruerade och att de svarade sanningsenligt på frågeformulären. Studiedeltagarna i den föreliggande studien var också för det mesta dels sena med att delta i pre- och post-testerna, vilket kan tyda på motivationsbrist att delta i studien.

Framtida studier bör uppmärksamma den föreliggande studiens begränsningar. Framtida studier kunde studera hur ålder och sexuell läggning modererar pornografikonsumtion och de oberoende variablerna. Det vore intressant att studera hur primära och sekundära belöningar (Negash m.fl., 2015) skiljer sig åt i hur de påverkar förringande av framtida belöningar. Framtida studier bör studera pornografins roll i förhållande till andra variabler i förringade av framtida belöningar och klargöra vilka medierande och modererande variabler ligger i mellan. Det kan vara av betydelse för kliniskt arbete att fortsätta studera området, till exempel kunde vidare forskning bidra med att definiera och uppmärksamma riskabel konsumtion av pornografi.

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Pressmeddelande

Pornografi Påverkade Inte Beslutsfattning eller Exekutiva Förmågor i Ny Studie

Pro gradu avhandling i psykologi

Fakulteten för humaniora, psykologi och teologi, Åbo Akademi

Resultaten från en experimentell interventionsstudie tyder inte på att pornografi hade någon påverkan på beslutsfattning och exekutiva förmågor. Studien var del av en magistersavhandling inom psykologi vid Åbo Akademi. Studien var ett försök att replikera Negash m.fl.:s (2015) resultat och även studera hur pornografi påverkar exekutiva förmågor.

Studiens sampel bestod av sju män i åldern 21–26. Deltagarna var främst rekryterade via sociala medier och e-postlistor för studerandeföreningar i högskolor i Åbo. Motiveringen att delta var utlottning av presentkort. Trots studien lockade relativt mycket intresse, förblev sampelstorleken liten. Deltagarna randomiserades i två grupper. Experimentgruppen skulle avstå från pornografi under tre veckors tid medan kontrollgruppen skulle avstå från sin favoritmat eller favoritdelikatess. Vid pre- och post-testerna rapporterade deltagarna hur frekvent de hade sett på pornografi, ätit sin favoritmat/favoritdelikatess och varit sexuellt aktiva, samt gjorde deltagarna tre exekutiva test som mätte exekutiva förmågorna inhibition, uppdatering och växlande. Som sista test mättes deltagarnas förringande av framtida belöningar i formen av val gällande utlottningen av presentkort.

Eftersom den föreliggande studien hade så litet sampel kunde det vara ändamålsenligt att replikera studien med ett större sampel. Fortsatta studier kunde vara av nytta i kliniskt arbete, exempelvis kunde vidare studier bidra med att definiera och observera riskabel konsumtion av pornografi.

Avhandlingen och studien utfördes av Miika Soini under handledningen av professor Patrik Jern och doktor Jussi Jylkkä.

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