



AKADÉMIAI KIADÓ

Problematic social media use is associated with the evaluation of both risk and ambiguity during decision making

Journal of Behavioral Addictions

10 (2021) 3, 779–787

DOI:

10.1556/2006.2021.00047

© 2021 The Author(s)

DAR MESHI^{1*†} , DAVID FREESTONE^{2†} and CEYLAN ÖZDEM-MERTENS¹

¹ Department of Advertising and Public Relations, Michigan State University, East Lansing, MI, USA

² Department of Psychology, William Paterson University, Wayne, NJ, USA

Received: December 31, 2020 • Revised manuscript received: April 13, 2021; June 16, 2021 • Accepted: July 1, 2021

Published online: July 30, 2021

FULL-LENGTH REPORT



ABSTRACT

Background and aims: People can engage in excessive, maladaptive use of social media platforms. This problematic social media use mirrors substance use disorders with regard to symptoms and certain behavioral situations. For example, individuals with substance use disorders demonstrate aberrations in risk evaluations during decision making, and initial research on problematic social media use has revealed similar findings. However, these results concerning problematic social media use have been clouded by tasks that involve learning and that lack a clear demarcation between risky and ambiguous decision making. Therefore, we set out to specifically determine the relationship between problematic social media use and decision making under both risk and ambiguity, in the absence of learning. *Methods:* We assessed each participant's ($N = 90$) self-reported level of problematic social media use. We then had them perform the wheel of fortune task, which has participants make choices between a sure option or either a risky or ambiguous gamble. In this way, the task isolates decisions made under risk and ambiguity, and avoids trial-to-trial learning. *Results:* We found that the greater an individual's problematic social media use, the more often that individual chooses high-risk gambles or ambiguous gambles, regardless of the degree of ambiguity. *Discussion and conclusions:* Our findings indicate that greater problematic social media use is related to a greater affinity for high-risk situations and overall ambiguity. These findings have implications for the field, specifically clarifying and extending the extant literature, as well as providing future avenues for research.

KEYWORDS

social media addiction, social networking addiction, decision making, risk, ambiguity, wheel of fortune task

INTRODUCTION

Over 3.5 billion people worldwide currently use online social media platforms, such as Facebook, Instagram, Twitter, Snapchat, and TikTok (Statista, 2021). These platforms allow users to interact, observe, and compare themselves with others, and as a result, users obtain a multitude of social rewards (Meshi, Tamir, & Heekeren, 2015). These social rewards act as reinforcers, bringing people back to these sites repeatedly and for substantial durations of time (Pew Research Center, 2019; Statista, 2020). As a result, some people may engage in social media use that is excessive and problematic (Griffiths, Kuss, & Demetrovics, 2014). Problematic social media use has been linked to job loss, poor academic performance, and poor mental health (Karaiskos, Tzavellas, Balta, & Paparrigopoulos, 2010; Marino, Gini, Vieno, & Spada, 2018b; Meena, Mittal, & Solanki, 2012). The symptoms of problematic social media use mirror substance use disorders and other behavioral addictive disorders (Griffiths et al., 2014). For example, these individuals may attempt to quit using social media and subsequently display withdrawal symptoms, and they may also relapse, failing their quit attempt and using these sites again. To note however, problematic social media use is not currently included in

[†]These authors contributed equally to this manuscript.

*Corresponding author.
E-mail: darmeshi@gmail.com

the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (APA, 2013), and the appropriateness of an official clinical diagnosis has been discussed in the literature (Brand et al., 2020; Carbonell & Panova, 2017). Nevertheless, in line with the above similarity to substance use disorders, members of the United States congress recently introduced legislation attempting to curb the use of social media platforms nationwide (Hawley, 2019).

Problematic social media use and substance use disorders appear to have similar underlying neural mechanisms as well. To explain, the brain's reward system – which is composed of regions such as the striatum, amygdala, and ventromedial prefrontal cortex – responds to both drug consumption (relevant to substance use disorders) and social rewards (relevant to problematic social media use) (Meshi, Morawetz, & Heekeren, 2013; Suckling & Nestor, 2017). Furthermore, morphological differences in these brain structures overlap; for example, the striatum and amygdalae are smaller in both problematic social media users and substance abusers (He, Turel, Brevers, & Bechara, 2017; Suckling & Nestor, 2017).

Importantly, these brain regions compute value during decision making (Bartra, McGuire, & Kable, 2013), and as one would expect, individuals with substance use and behavioral addictive disorders have difficulty making value-based decisions (Bechara & Martin, 2004; Verdejo-Garcia, Chong, Stout, Yücel, & London, 2018). Surprisingly however, very little research has investigated decision making in relation to problematic social media use. In an initial study, Meshi, Elizarova, Bender, and Verdejo-Garcia (2019) used a decision-making paradigm that has been well established to reveal differences in individuals with substance use disorders – the Iowa Gambling Task (IGT; Buelow & Suhr, 2009). The IGT is thought to assess decision making under both risk (when decision outcome probabilities are known) and ambiguity (when decision outcome probabilities are unknown). Specifically, decisions in the first half of the IGT are thought to involve ambiguity, while decisions in the second half of the IGT are thought to involve risk, after participants learn outcome probabilities (Bechara, Damasio, Tranel, & Damasio, 1997; He et al., 2010). Importantly, Meshi and colleagues found that the greater one's problematic social

media use, the worse one does in the second half of the task. These researchers therefore concluded that problematic social media use was related to increased risk-taking when making decisions (Meshi et al., 2019).

In a subsequent study, Meshi and colleagues again investigated the relationship between problematic social media use and decision making, but with the Balloon Analogue Risk Task (BART; Meshi, Ulusoy, et al., 2020). Some researchers consider the BART to assess only decision making under risk (Buelow, Okdie, & Cooper, 2015), while others believe it also assesses decision making under ambiguity (Campbell, Samartgis, & Crowe, 2013). Indeed, BART participants are naïve to decision outcome probabilities at the start of the task and learn these decision outcome probabilities over a series of trials. Therefore, in line with the above definition of ambiguity, some decisions in the BART are made while evaluating ambiguity and some while evaluating risk. Interestingly, and in contrast to the IGT study, Meshi and colleagues found a learning effect in the BART, in which the greater one's problematic social media use, the more risk averse one becomes after exposure to negative outcomes. Taken together, research with the IGT involves learning and indicates a positive association between problematic social media use and risk taking, while research with the BART involves learning and indicates a negative association between problematic social media use and risk taking. Clearly, there is a dire need for further investigation, specifically with a task that isolates these decision-making aspects – where learning from decision outcomes does not occur, and where risk and ambiguity evaluations are separate and independent of each other. Understanding the relationships between problematic social media use and decision making under both risk and ambiguity is needed for the development of effective intervention strategies. In the absence of this knowledge, interventions for problematic social media use will remain speculative.

With the above in mind, we investigated problematic social media use and decision making by employing an established behavioral paradigm, the wheel of fortune task (Fig. 1; Blankenstein, Crone, van den Bos, & van Duijvenvoorde, 2016; Ernst et al., 2004; Tymula et al., 2012). In this task, participants make isolated decisions under either risk

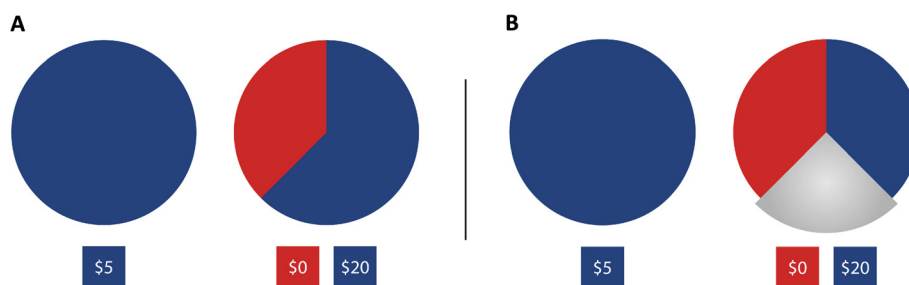


Fig. 1. Schematic examples of the wheel of fortune task. (A) A decision made under risk. This example presented the participant with a sure option of \$5, and a gamble option with a monetary payoff of \$20 at a null-outcome probability of 37.5%. (B) A decision made under ambiguity. This example presented the participant with a sure option of \$5, and a gamble option with a monetary payoff of \$20 at an ambiguity level of 25% (gray lid). Please see the Methods section for more detail about the wheel of fortune task

or ambiguity, and participants do not receive feedback after their decisions. In this way, the wheel of fortune task independently assesses decision making under both risk and ambiguity, in the absence of trial-to-trial learning. In a single experimental session, we first collected participant survey data to assess individual levels of problematic social media use, as well as demographic covariates. Participants then performed the wheel of fortune task. We then analyzed our data with a single logistic regression predicting participant choices in the task.

METHODS

Participants

Undergraduate students at a large U.S. university were recruited through an online student pool and participated for course credit. To take part in our study, individuals were required to be at least 18 years of age and use at least one social media platform. Our sample size was 90 participants (female = 76, male = 13, other/prefer not to answer = 1), after excluding 15 participants because: one participant always chose the same option, and 14 participants failed our attention check (see below). The average age of our final sample was 21.2 years ($SD = 2.8$; range = 18–32), and the majority of our sample, 73% ($n = 66$), was white, while 26% ($n = 23$) was non-white (American Indian, Asian, black, Native Hawaiian), and 1% ($n = 1$) did not respond. Participants self-reported using social media for an average of 327.6 min per day ($SD = 311.9$; obtained by asking participants to estimate daily time spent on up to seven different platforms that they used, and then we summed across platforms).

Procedure

Participants came to a quiet behavioral testing room and we placed them in front of a computer. They provided informed consent, then filled out a survey consisting of demographic questions (age and sex) and questions about their social media use. The survey also included an attention check of three questions distributed across the questionnaire. All participants should have known the answers to these questions, which assessed, for example, participants' knowledge of the city where their university is located. Participants then performed the wheel of fortune task to assess their decision making under both risk and ambiguity.

Measures

Problematic social media use. Problematic social media use was measured with the 6-item Bergen Social Media Addiction Scale (Andreassen, Torsheim, Brunborg, & Pallesen, 2012; Bányai et al., 2017). The reliability and validity of this scale has been established (Bányai et al., 2017), and it is one of the most widely used scales to assess problematic social media use (Marino, Gini, Vieno, & Spada, 2018a). Participants were prompted with “Please answer the

following questions with regard to your social media use over the past year” and each item assessed a commonly accepted core aspect of addiction: preoccupation, mood modification, tolerance, conflict, withdrawal, and relapse (Griffiths et al., 2014). For example, the item concerning withdrawal asked, “Do you become restless or troubled if you are prohibited from using social media?” Participants responded on a 5-point Likert scale (1 = very rarely; 5 = very often), and we summed their responses ($M = 15.2$, $SD = 4.5$, range = 6 to 27, skewness = 0.04, kurtosis = 3.47, Cronbach's $\alpha = 0.79$). We z-scored problematic social media use scores for all analyses, producing a new range from about -2 to 2 .

Wheel of fortune task. All participants performed 80 trials of a wheel of fortune task, modeled after previous studies (Blankenstein et al., 2016; Ernst et al., 2004; Tymula et al., 2012). In each trial, participants were asked to choose between one of two options presented by a wheel graphic (Fig. 1): a sure option of \$5 or a gamble option. The gamble varied in monetary payoff (\$5, \$8, \$20, \$50, and \$125), null-outcome probability (12.5%, 37.5%, 50%, 62.5%, 87.5%), and ambiguity (0%, 25%, 50%, 75%). Ambiguity was created by covering the wheel with a gray lid to obscure outcome probabilities. The ambiguity amount reflects the proportion of the wheel hidden underneath the lid. Accordingly, participants were told that there were still outcome probabilities, but that they were hidden underneath the lid.

Before the task, participants were instructed that all monetary amounts were hypothetical and provided with 5 practice trials. The task was self-paced, and participants indicated their choice by clicking the computer cursor on one of the wheels to select either the \$5 sure option or the wheel presenting the gamble. All monetary payoff and outcome probability combinations (25 combinations) were presented while ambiguity was at 0%, without a lid. We consider the decision between one of these gamble combinations and the sure \$5 option to be a decision made under risk (Fig. 1A). This is because participants either prefer the safe \$5 option, or they prefer to take the known risk for a chance at winning the other monetary payoff amount. Conversely, all possible monetary payoff and ambiguity combinations were also presented (15 combinations). We consider the decision between one of these gamble combinations and the sure \$5 option to be a decision made under ambiguity (Fig. 1B). This is because participants did not explicitly know the probability that they'll receive the payoff if they chose the gamble option. All of the 40 possible gamble combinations were shown to the participants twice, for a total of 80 trials. In the first half of the task, the 40 possible combinations were shown in random order with the sure option always presented on the left side of the screen; and in the second half of the task the 40 possible combinations were shown in random order with the sure option always presented on the right side of the screen. Importantly, participants were never given feedback about the outcome of their choices, so participants couldn't learn from the results of their decisions across trials.

Statistical analysis

All analyses were conducted in R (R Development Core Team, 2020) using the tidyverse functions for data manipulation and brms for statistical tests (Bürkner, 2017; Carpenter et al., 2017; Wickham et al., 2019). Our statistical approach consisted of a single logistic regression (Gelman & Hill, 2006; Gelman, Hill, & Vehtari, 2020; McElreath, 2018) using Bayesian estimation techniques (Gelman et al., 2013; Kruschke, 2014), which we largely did on philosophical grounds to avoid recent criticisms of *P*-values (Amrhein & Greenland, 2018; Benjamin et al., 2018; Lakens et al., 2018) and to avoid confounds associated with multiple individual tests. We estimated the proportion of gamble choices using a logistic regression that had the following covariates: the trial terms (monetary payoff, null-outcome probability, ambiguity, and side of screen where gamble appeared) and participant specific terms (age, sex, and problematic social media use). Every choice from every participant was included in our analysis (a total of 7,200 choices). This allowed us to estimate the effects of trial terms, participant specific terms, and the effects of the interaction between these task and participant variables. We treated the trial terms and sex as categorical variables. In addition, both age and problematic social media use were z-scored so that their coefficients reflect differences from their respective averages. We included three interaction terms for problematic social media use: monetary payoff \times problematic social media use; null-outcome probability \times problematic social media use; and ambiguity \times problematic social media use. These interactions allowed us to test our hypotheses about problematic social media use and the assessment of risk and ambiguity during decision making. Specifically, we were able to investigate whether problematic social media use moderates the effects of risk and ambiguity on choice.

To note, our reported logistic regression model did not include any other interaction terms, because the above-described model provided the better fit. For example, we could have included the following two interactions: monetary payoff \times null-outcome probability and monetary payoff \times ambiguity. We compared our simpler model to a model with these two interaction terms using a standard model selection technique called Leave-One-Out Cross Validation (LOO; Vehtari, Gelman, & Gabry, 2017). To explain, the LOO Information Criterion (LOOIC) measures how well each of the two models captures our data and can make predictions about new data. The model with the smaller LOOIC is preferred. In our case, the simpler model without these two interaction terms provided a better explanation of our data (model with two interaction terms: $4,689.0 \pm 88.1$; model without two interaction terms: $4,665.4 \pm 86.7$). The strength of evidence in favor of the simpler model is calculated as the difference in the expected log pointwise predictive density of each model. In our case, the simpler model was favored $11.3 (\pm 4.3)$ over the model that included the two interaction terms.

As mentioned, we estimated the proportion of gamble choices using Bayesian techniques. To do this, we needed to specify priors for the regression coefficients. We placed a generalized t distribution centered around zero with $\nu = 10$ and $\sigma = 2$ for all parameters. This is the mathematical equivalent of expecting null effects but allows for the possibility of large effects. These priors are more conservative than traditional null hypothesis tests since they place most of our prior around the null hypothesis, that problematic social media use does not moderate the effects of risk or ambiguity on choice. In addition, our Bayesian procedure used a Hamiltonian Monte Carlo algorithm to iterate over possible coefficients to find the best fits. We used the brms package in

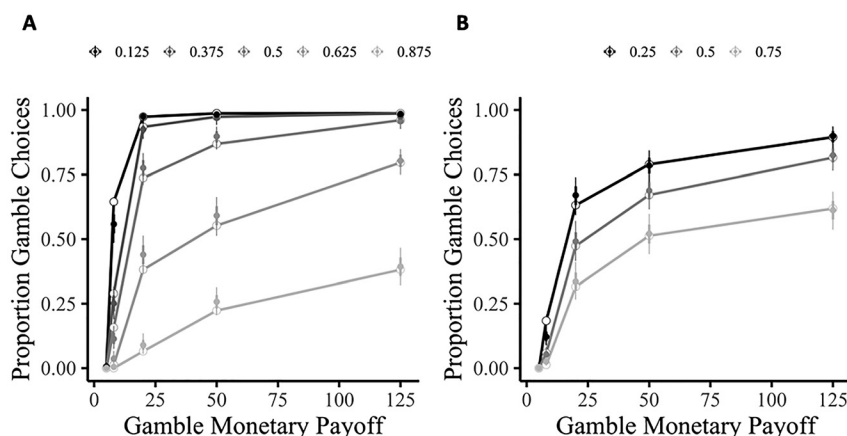


Fig. 2. Performance in the wheel of fortune task presented as average choice curves. (A) Gamble choice curves split by gamble outcome probability, with lighter colors indicating greater null-outcome probability gambles. (B) Gamble choice curves split by gamble ambiguity, with lighter colors indicating greater ambiguity gambles. The x-axis in both panels represents the monetary payoff of the gamble option. The y-axis in both panels represents the proportion of times a gamble was chosen over the \$5 sure option. The open circles connected by lines show the data, averaged over participants, and the filled circles show the estimated proportions from the model fit (and error bars for 68% and 95% credible intervals). These graphical results show that participants were highly sensitive to the monetary payoff, the null-outcome probability, and the ambiguity of the presented gamble options, and the model accurately captured performance. Please see Table 1 for statistical results

R with 1,000 warm up iterations and 2,000 iterations total. Samples were collected on four chains using eight CPU cores. All coefficients converged with an $\hat{R} < 1.01$. Posterior predictive checks suggest that the logistic regression model fit the data well (see Fig. 2 for two examples). Nearly identical fits were obtained using lme4's glm command. To note, all data and analysis scripts are available online at the Open Science Framework (<https://osf.io/skqpq3/>).

Ethics

Study procedures were carried out in accordance with the Declaration of Helsinki and approved by the ethics review committee of a large U.S. university. All participants were informed about the study and all provided informed consent for participation.

RESULTS

Descriptive statistics for age, sex, and problematic social media use are reported in the Methods section. We also conducted zero-order correlations between these variables, revealing no significant relationships: age did not correlate with sex ($r = 0.15$, $P = 0.44$, 95%CI = $-0.23/0.48$); age did not correlate with problematic social media use ($r = 0.00$, $P = 0.99$, 95%CI = $-0.36/0.36$); and sex did not correlate with problematic social media use ($r = -0.18$, $P = 0.35$, 95%CI = $-0.50/0.20$).

Overall participant performance in the wheel of fortune task is presented in Table 1 and Fig. 2. Participants were highly sensitive to all three trial parameters of the presented gamble options: the monetary payoff, the null-outcome probability, and the ambiguity. Participants chose the gamble option significantly more often as the monetary payoff value increased, and participants chose the gamble option significantly less often as the null-outcome probability increased and as the ambiguity increased. These results show that participants were indeed performing the task, and the model accurately captured performance. Regarding our covariates, older participants were more likely to choose the gamble option; men were more likely than women to choose the gamble option; and participants were more likely to choose the gamble option when it was presented on the left side of the screen.

To address our hypothesis, we analyzed performance in the wheel of fortune task with respect to problematic social media use (Table 1, Fig. 3). To begin with, problematic social media use did not predict overall proportion of gamble choices in the wheel of fortune task. We next report the interactions of problematic social media use with each of our three gamble parameters. We found that problematic social media use was not significantly associated with the proportion of gamble choices across monetary payoffs. We did find, however, that problematic social media use was significantly associated with the proportion of gamble choices at certain outcome probabilities. Specifically, the greater an individual's problematic social media use, the

Table 1. Performance in the wheel of fortune task revealed by a single logistic regression predicting the proportion of gamble choices

Independent Variables and Covariates	β	95% CI	
		LL	UL
(Intercept)	-4.89	-6.33	-3.81
Age	0.08	0.004	0.16
Sex (ref: Female)			
Male	1.07	0.84	1.30
Other/Prefer Not To Answer	0.65	-0.05	1.36
Side of Display Gamble Presented (ref: Left)			
Right	-0.18	-0.33	-0.02
Monetary Payoff (ref: \$5)			
\$8	5.04	3.93	6.50
\$20	8.32	7.21	9.80
\$50	9.13	8.00	10.63
\$125	9.80	8.68	11.29
Null-Outcome Probability (ref: 12.5%)			
37.5%	-1.21	-1.58	-0.83
50%	-2.15	-2.53	-1.78
62.5%	-3.72	-4.11	-3.35
87.5%	-5.39	-5.80	-5.00
Ambiguity (ref: 0%)			
25%	-0.72	-1.02	-0.43
50%	-1.30	-1.59	-1.01
75%	-2.10	-2.40	-1.81
Problematic Social Media Use	-0.02	-0.98	0.87
Problematic Social Media Use \times Monetary Payoff (ref: \$5)			
\$8	0.03	-0.88	0.98
\$20	-0.38	-1.31	0.58
\$50	-0.42	-1.35	0.54
\$125	-0.32	-1.26	0.64
Problematic Social Media Use \times Null-Outcome Probability (ref: 12.5%)			
37.5%	0.01	-0.35	0.37
50%	-0.08	-0.43	0.27
62.5%	0.43	0.07	0.78
87.5%	0.46	0.09	0.83
Problematic Social Media Use \times Ambiguity (ref: 0%)			
25%	0.49	0.18	0.78
50%	0.48	0.18	0.77
75%	0.56	0.28	0.86

Note: Coefficients resulting from interactions with the problematic social media use term show the log odds change at each level of the task parameter for a one-unit change in problematic social media use scores, and are best thought of as additive terms. CI = Credible intervals.

more likely that individual was to choose the risky gamble in trials with 62.5% and 87.5% null-outcome probability. In other words, people with greater problematic social media use are more likely to choose the risky gamble, but only in very risky situations. In regard to ambiguity, problematic social media use was significantly associated with the proportion of gamble choices across ambiguity level. Specifically, the greater an individual's problematic social media

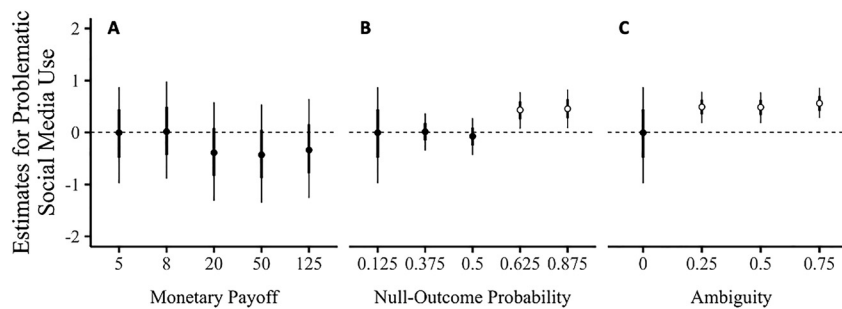


Fig. 3. Performance in the wheel of fortune task as a function of problematic social media use, revealed by a single logistic regression predicting the proportion of gamble choices. (A) Beta coefficients for the interaction of problematic social media use \times monetary payoff (ref: \$5). (B) Beta coefficients for the interaction of problematic social media use \times null-outcome probability (ref: 12.5%). (C) Beta coefficients for the interaction of problematic social media use \times ambiguity (ref: 0%). Open circles are significant as their 95% CI (credible intervals) does not contain zero. Because of our reference category, the same datapoints are shown for monetary payoff of \$5 in A, null-outcome probability of 12.5% in B, and ambiguity of 0% in C. Exact values for datapoints are provided in Table 1. Error bars = 95% CI

use, the more likely that individual chooses the ambiguous gamble, at all levels of ambiguity.

DISCUSSION

To the best of our knowledge, the current study is the first to independently assess risk and ambiguity evaluations during decision making with respect to problematic social media use. To do this, we capitalized on the wheel of fortune task, replicating previous research that demonstrated changes in decision making with respect to monetary amount, risk and ambiguity (Blankenstein et al., 2016; Ernst et al., 2004; Tymula et al., 2012). Overall, participants chose to gamble more often when offered greater potential monetary gains, and less often when presented gambles with more null-outcome probability and ambiguity. With regard to our research question, our study revealed two primary relationships: 1. People with greater problematic social media use are more likely to choose high risk gambles, and 2. People with greater problematic social media use are more likely to choose ambiguous gambles, regardless of the degree of ambiguity. In regard to the first finding, there were no differences in risk taking with respect to problematic social media use at low null-outcome probabilities. It was only when the null-outcome probability of the gambles increased that individuals low in problematic social media use reduced their number of gamble choices, while individuals high in problematic social media use continued to choose the gamble option.

The current study was conducted to clarify previous research on decision making with respect to problematic social media use. Meshi et al. (2019) used the IGT to demonstrate that the greater one's problematic social media use, the worse one does in the task. Meshi and colleagues found impairment in the second half of the task, concluding that problematic social media use was related to increased risk-taking. Subsequently, Meshi, Turel, and Henley (2020) used the BART to reveal a learning effect, in which the greater one's problematic social media use, the more risk

averse one becomes after exposure to negative outcomes. As both the IGT and BART involve transitioning from ambiguous decisions to risky decisions through learning, we conducted the current study which isolated ambiguous and risky decisions, in the absence of learning. In this way, we clarified the relationship between problematic social media use and decision making to reveal effects in high-risk situations and ambiguous situations, regardless of the degree of ambiguity. We speculate that decisions involving maladaptive social media use require certain high-risk and ambiguous evaluations. These decisions would primarily concern issues of self-control, such as whether to use a social media platform, or whether to share content or comment on others' posts, for example. In line with this, future research should probe the perceptual risk and ambiguity involved in these types of decisions. Furthermore, although our study did not address causality, we speculate that the neural circuitry involved in the evaluation of certain types of risk and ambiguity could be altered in problematic social media users, leading to the maladaptive use of these platforms. Indeed, there is already evidence for aberrations in reward system morphology of problematic social media users (He et al., 2017). Future neuroimaging research will likely be able to elucidate the exact mechanisms between problematic social media use and high-risk evaluations, as well as overall ambiguity evaluations.

The current study has limitations worth mentioning. First, our participant sample consisted of more females than males. Although we controlled for sex in our analysis, our sample is not consistent with the distribution of sex in the population, and therefore our results should be generalized with caution. Next, our sample consisted of undergraduate college students, so this should also be taken into consideration when generalizing our results. However, given the high prevalence of social media use in this age group (Pew Research Center, 2018), understanding social media use in this particular demographic is important. In addition, the observed associations between problematic social media use and wheel of fortune task performance could be explained by a third, unmeasured variable affecting both problematic social media

use and task performance. For example, this could include clinical confounds such as major depressive disorder, attention-deficit/hyperactivity disorder, impulse control disorders, and substance use disorders. Furthermore, individuals can play games on certain social media platforms, and we did not assess internet gaming disorder. Therefore, future research that includes additional measures of these disorders, as well as other relevant dimensions (e.g., personality traits, see Meshi, Turel, & Henley, 2020), will be better able to address this issue. Finally, we did not use a clinical sample to compare with healthy controls, rather we looked for a correlation across individuals who displayed a wide range of problematic social media use. Future research will be able to address this limitation by assessing wheel of fortune task performance in individuals specifically reporting severe adverse effects and negative consequences of social media use.

In sum, we conducted the current study to clarify and extend previous research, specifically determining the relationships between problematic social media use and decision making in both risky and ambiguous situations. We found that the greater an individual's problematic social media use, the more that individual displays an affinity to high-risk situations and ambiguous situations, regardless of the degree of ambiguity. Our findings have implications for the research field. For example, risk and ambiguity are evaluated at an early stage of the decision-making process while individuals are considering their decision options (Verdejo-Garcia et al., 2018). Therefore, researchers developing interventions may be able to specifically target this initial phase of decision making to help problematic social media users avoid engaging with social media platforms. In addition, interventions can take into account the nature of our findings with regard to specific high-risk situations and overall ambiguous situations. Furthermore, our research paradigm has implications for researchers investigating substance use and other behavioral addictive disorders. Researchers widely use tasks such as the IGT and BART (Buelow & Suhr, 2009; Lauriola, Panno, Levin, & Lejuez, 2014) that depend on learning, and therefore confound risk and ambiguity. Researchers have also previously attempted to disentangle risk and ambiguity evaluations when investigating substance use and behavioral addictive disorders, such as problematic gambling (Brevers et al., 2012). Therefore, researchers may prefer to apply the wheel of fortune task in future studies on substance use and behavioral addictive disorders to help clarify the risk and ambiguity evaluations of individuals with these disorders. Overall, our findings will likely have a positive impact, not just on research into problematic social media use, but on the greater field of behavioral addictive disorders.

Funding sources: None.

Authors' contribution: DM: study concept, study design, study supervision, interpretation of data, manuscript writing; DF: study design, statistical analysis, interpretation of data, manuscript writing; COM: data collection.

Conflict of interest: The authors report no financial or other relationship relevant to the subject of this article.

REFERENCES

- American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders: DSM-V. In *DSM-V* (5th ed.). American Psychiatric Association.
- Amrhein, V., & Greenland, S. (2018). Remove, rather than redefine, statistical significance. *Nature Human Behaviour*, 2(1), 4. <https://doi.org/10.1038/s41562-017-0224-0>.
- Andreassen, C. S., Torsheim, T., Brunborg, G. S., & Pallesen, S. (2012). Development of a Facebook addiction scale. *Psychological Reports*, 110(2), 501–517. <http://www.ncbi.nlm.nih.gov/pubmed/22662404>.
- Bányai, F., Zsila, Á., Király, O., Maraz, A., Elekes, Z., Griffiths, M. D., ... Demetrovics, Z. (2017). Problematic social media use: Results from a large-scale nationally representative adolescent sample. *Plos One*, 12(1), e0169839. <https://doi.org/10.1371/journal.pone.0169839>.
- Bartra, O., McGuire, J. T., & Kable, J. W. (2013). The valuation system: A coordinate-based meta-analysis of BOLD fMRI experiments examining neural correlates of subjective value. *NeuroImage*, 76, 412–427. <https://doi.org/10.1016/j.neuroimage.2013.02.063>.
- Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (1997). Deciding advantageously before knowing the advantageous strategy. *Science*, 275, 1293–1294. <https://doi.org/10.1126/science.275.5304.1293>.
- Bechara, A., & Martin, E. M. (2004). Impaired decision making related to working memory deficits in individuals with substance addictions. *Neuropsychology*, 18(1), 152–162. <https://doi.org/10.1037/0894-4105.18.1.152>.
- Benjamin, D. J., Berger, J. O., Johannesson, M., Nosek, B. A., Wagenmakers, E. J., Berk, R., ... Johnson, V. E. (2018). Redefine statistical significance. *Nature Human Behaviour*, 2(1), 6–10. <https://doi.org/10.1038/s41562-017-0189-z>.
- Blankenstein, N. E., Crone, E. A., van den Bos, W., & van Duijvenvoorde, A. C. K. (2016). Dealing with uncertainty: Testing risk- and ambiguity-attitude across adolescence. *Developmental Neuropsychology*, 41(1–2), 77–92. <https://doi.org/10.1080/87565641.2016.1158265>.
- Brand, M., Rumpf, H.-Jü., Demetrovics, Z., Müller, A., Stark, R., King, D. L., ... Potenza, M. N. (2020). Which conditions should be considered as disorders in the International Classification of Diseases (ICD-11) designation of “other specified disorders due to addictive behaviors”? *Journal of Behavioral Addictions*. <https://doi.org/10.1556/2006.2020.00035>.
- Brevers, D., Cleeremans, A., Goudriaan, A. E., Bechara, A., Kornreich, C., Verbanck, P., & Noël, X. (2012). Decision making under ambiguity but not under risk is related to problem gambling severity. *Psychiatry Research*, 200, 568–574. <https://doi.org/10.1016/j.psychres.2012.03.053>.
- Buelow, M. T., Okdie, B. M., & Cooper, A. B. (2015). The influence of video games on executive functions in college students.



- Computers in Human Behavior*, 45, 228–234. <https://doi.org/10.1016/j.chb.2014.12.029>.
- Buelow, M. T., & Suhr, J. A. (2009). Construct validity of the Iowa gambling task. *Neuropsychology Review*, 19, 102–114. <https://doi.org/10.1007/s11065-009-9083-4>.
- Bürkner, P. C. (2017). brms: An R package for Bayesian multilevel models using Stan. *Journal of Statistical Software*, 80(1), 1–28. <https://doi.org/10.18637/jss.v080.i01>.
- Campbell, J. A., Samartgis, J. R., & Crowe, S. F. (2013). Impaired decision making on the Balloon Analogue Risk Task as a result of long-term alcohol use. *Journal of Clinical and Experimental Neuropsychology*, 35(10), 1071–1081. <https://doi.org/10.1080/13803395.2013.856382>.
- Carbonell, X., & Panova, T. (2017). A critical consideration of social networking sites' addiction potential. *Addiction Research and Theory*, 25(1), 48–57. <https://doi.org/10.1080/16066359.2016.1197915>.
- Carpenter, B., Gelman, A., Hoffman, M. D., Lee, D., Goodrich, B., Betancourt, M., ... Riddell, A. (2017). Stan: A probabilistic programming language. *Journal of Statistical Software*, 76(1). <https://doi.org/10.18637/jss.v076.i01>.
- Ernst, M., Nelson, E. E., McClure, E. B., Monk, C. S., Munson, S., Eshel, N., ... Pine, D. S. (2004). Choice selection and reward anticipation: An fMRI study. *Neuropsychologia*, 42(12), 1585–1597. <https://doi.org/10.1016/j.neuropsychologia.2004.05.011>.
- Gelman, A., Carlin, J. B., Stern, H. S., Dunson, D. B., Vehtari, A., & Rubin, D. B. (2013). Bayesian data analysis. In *Bayesian data analysis* (3rd ed.). CRC Press.
- Gelman, A., & Hill, J. (2006). Data analysis using regression and multilevel/hierarchical models. In *Data analysis using regression and multilevel/hierarchical models*. Cambridge University Press. <https://doi.org/10.1017/cbo9780511790942>.
- Gelman, A., Hill, J., & Vehtari, A. (2020). Regression and other stories. In *Analytical methods for social research*. Cambridge University Press.
- Griffiths, M. D., Kuss, D. J., & Demetrovics, Z. (2014). Social networking addiction: An overview of preliminary findings. In K. P. Rosenberg & L. C. Feder (Eds.), *Behavioral addictions: criteria, evidence, and treatment* (pp. 119–141). Elsevier Inc. <https://doi.org/10.1016/B978-0-12-407724-9.00006-9>.
- Hawley, J. (2019). Sen. Hawley introduces legislation to curb social media addiction. <https://www.hawley.senate.gov/sen-hawley-introduces-legislation-curb-social-media-addiction>.
- He, Q., Turel, O., Brevers, D., & Bechara, A. (2017). Excess social media use in normal populations is associated with amygdala-striatal but not with prefrontal morphology. *Psychiatry Research: Neuroimaging*, 269, 31–35. <https://doi.org/10.1016/j.psychres.2017.09.003>.
- He, Q., Xue, G., Chen, C., Lu, Z., Dong, Q., Lei, X., ... Bechara, A. (2010). Serotonin transporter gene-linked polymorphic region (5-HTTLPR) influences decision making under ambiguity and risk in a large Chinese sample. *Neuropharmacology*, 59(6), 518–526. <https://doi.org/10.1016/j.neuropharm.2010.07.008>.
- Karaiskos, D., Tzavellas, E., Balta, G., & Paparrigopoulos, T. (2010). Social network addiction: A new clinical disorder? (P02-232). *European Psychiatry*, 25, 855. [https://doi.org/10.1016/S0924-9338\(10\)70846-4](https://doi.org/10.1016/S0924-9338(10)70846-4).
- Kruschke, J. K. (2014). Doing Bayesian data analysis: A tutorial with R, JAGS, and stan. In *Doing Bayesian data analysis: a tutorial with R, JAGS, and stan* (2nd ed.). Academic Press. <https://doi.org/10.1016/B978-0-12-405888-0.09999-2>.
- Lakens, D., Adolfs, F. G., Albers, C. J., Anvari, F., Apps, M. A. J., Argamon, S. E., ... Zwaan, R. A. (2018). Justify your alpha. *Nature Human Behaviour*, 2(3), 168–171. <https://doi.org/10.1038/s41562-018-0311-x>.
- Lauriola, M., Panno, A., Levin, I. P., & Lejuez, C. W. (2014). Individual differences in risky decision making: A meta-analysis of sensation seeking and impulsivity with the Balloon Analogue risk task. *Journal of Behavioral Decision Making*, 27(1), 20–36. <https://doi.org/10.1002/bdm.1784>.
- Marino, C., Gini, G., Vieno, A., & Spada, M. M. (2018a). A comprehensive meta-analysis on problematic Facebook use. *Computers in Human Behavior*, 83, 262–277. <https://doi.org/10.1016/j.chb.2018.02.009>.
- Marino, C., Gini, G., Vieno, A., & Spada, M. M. (2018b). The associations between problematic Facebook use, psychological distress and well-being among adolescents and young adults: A systematic review and meta-analysis. *Journal of Affective Disorders*, 226, 274–281. <https://doi.org/10.1016/j.jad.2017.10.007>.
- McElreath, R. (2018). Statistical rethinking: A Bayesian course with examples in R and stan. In *Statistical rethinking: a Bayesian course with examples in R and stan*. CRC Press. <https://doi.org/10.1201/9781315372495>.
- Meena, P., Mittal, P., & Solanki, R. (2012). Problematic use of social networking sites among urban school going teenagers. *Industrial Psychiatry Journal*, 21(2), 94–97. <https://doi.org/10.4103/0972-6748.119589>.
- Meshi, D., Elizarova, A., Bender, A., & Verdejo-Garcia, A. (2019). Excessive social media users demonstrate impaired decision making in the Iowa Gambling Task. *Journal of Behavioral Addictions*, 1–5. <https://doi.org/10.1556/2006.7.2018.138>.
- Meshi, D., Morawetz, C., & Heekeren, H. R. (2013). Nucleus accumbens response to gains in reputation for the self relative to gains for others predicts social media use. *Frontiers in Human Neuroscience*, 7, 439. <https://doi.org/10.3389/fnhum.2013.00439>.
- Meshi, D., Tamir, D. I., & Heekeren, H. R. (2015). The emerging neuroscience of social media. *Trends in Cognitive Sciences*, 19(12), 771–782. <https://doi.org/10.1016/j.tics.2015.09.004>.
- Meshi, D., Turel, O., & Henley, D. (2020). Snapchat vs. Facebook: Differences in problematic use, behavior change attempts, and trait social reward preferences. *Addictive Behaviors Reports*, 12, 100294. <https://doi.org/10.1016/j.abrep.2020.100294>.
- Meshi, D., Ulusoy, E., Özdem-Mertens, C., Grady, S. M., Freestone, D. M., Eden, A., & Ellithorpe, M. E. (2020). Problematic social media use is associated with increased risk-aversion after negative outcomes in the Balloon Analogue Risk Task. *Psychology of Addictive Behaviors*, 34(4), 549–555. <https://doi.org/10.1037/adb0000558>.
- Pew Research Center. (2018). Social media use in 2018. <http://www.pewinternet.org/2018/03/01/social-media-use-in-2018/>.
- Pew Research Center. (2019). Social networking fact sheet. <http://www.pewinternet.org/fact-sheets/social-networking-fact-sheet/>.
- R Development Core Team, R. (2020). R: A language and environment for statistical computing. *R Foundation for Statistical Computing*. <https://doi.org/10.1007/978-3-540-74686-7>.



- Statista. (2020). Daily time spent on social networking by internet users worldwide from 2012 to 2019. <https://www.statista.com/statistics/433871/daily-social-media-usage-worldwide/>.
- Statista. (2021). Number of global social network users 2017–2025. <https://www.statista.com/statistics/278414/number-of-worldwide-social-network-users/>.
- Suckling, J., & Nestor, L. J. (2017). The neurobiology of addiction: The perspective from magnetic resonance imaging present and future. *Addiction*, 112(2), 360–369. <https://doi.org/10.1111/add.13474>.
- Tymula, A., Rosenberg Belmaker, L. A., Roy, A. K., Ruderman, L., Manson, K., Glimcher, P. W., & Levy, I. (2012). Adolescents' risk-taking behavior is driven by tolerance to ambiguity. *Proceedings of the National Academy of Sciences of the United States of America*, 109(42), 17135–17140. <https://doi.org/10.1073/pnas.1207144109>.
- Vehtari, A., Gelman, A., & Gabry, J. (2017). Practical Bayesian model evaluation using leave-one-out cross-validation and WAIC. *Statistics and Computing*, 27(5), 1413–1432. <https://doi.org/10.1007/s11222-016-9696-4>.
- Verdejo-Garcia, A., Chong, T. T. J., Stout, J. C., Yücel, M., & London, E. D. (2018). Stages of dysfunctional decision-making in addiction. *Pharmacology Biochemistry and Behavior*, 164, 99–105. <https://doi.org/10.1016/j.pbb.2017.02.003>.
- Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L., François, R., . . . Yutani, H. (2019). Welcome to the tidyverse. *Journal of Open Source Software*, 4(43), 1686. <https://doi.org/10.21105/joss.01686>.