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TECHNOLOGY USE IN SCHIZOTYPY UTILIZING THE DOMAINS OF TECHNOLOGY USE SURVEY (DOTUS)

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by

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Dedications

I would like to dedicate this thesis to the friends and family who have provided me with support over the years.

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Abstract

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The diathesis stress model for schizophrenia posits that genetics and prenatal factors confer vulnerability (diathesis) for mental illness which then may be activated through exposure to environmental stressors during life. One component of our contemporary environment involves technology use which has demonstrated risk and beneficial capabilities in regards to the schizophrenia spectrum. Using an online and in-person survey, this study aimed to elucidate the manner in which time spent on technology related to schizotypy, problematic technology use (PTU), and health behaviors in 227 undergraduate students (aged 18-30). We hypothesized that levels of schizotypy, as well as time spent on social media and video games would predict increased problematic technology use and decreased engagement in health behaviors. We also hypothesized that time spent on health technologies (e.g. Fitbit) would predict decreased problematic technology use and increased engagement in health behaviors. After hierarchical linear regressions, levels of schizotypy predicted both increased problematic technology use and decreased engagement in health behaviors. Time spent on social media and video games predicted decreased engagement in health behaviors, while time spent on health technologies did not predict our outcome variables. Additional findings, implications, and further discussion on these topics are presented throughout the manuscript.

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Chapter 1

Introduction

Schizophrenia is a disorder, typically involving impaired reality testing, cognitive dysfunction, and functional difficulties, which is present in approximately 1% of the population (DSM-5; APA 2013). This disorder usually develops in adolescence and young adulthood (early to mid 20s), perhaps related to important aspects of physical and emotional development during this period (APA, 2013). A biological predisposition (genotype) is associated with increased risk for schizophrenia, with approximately 10% of carriers showing some behavioral indicators (endophenotype), termed “schizotypy” (Meehl, 1989; Meehl, 1962). However, not everyone with these risk indicators will develop the disorder (i.e., the genetic expression of the genotype, termed “phenotype”). Consistent with Meehl’s theory, research examining risk for the development of the disorder in family systems provides evidence for a genetic component with monozygotic twins having about 50% concordance rates for developing schizophrenia (Gottesman, 1989). While 50% concordance is high, the fact that concordance is not 100% suggests that environmental factors must also play a role. Furthermore, even if an individual exhibits risk indicators for schizophrenia, the transition rate to schizophrenia is relatively low. For example, only 30-40% of individuals displaying *ultra-high risk* (i.e. already displaying certain clinically relevant symptoms) will ultimately transition to psychosis (Cannon, Cadenhead, Cornblatt, & Woods, 2014; Yung et al., 2003).

The *diathesis-stress model* of schizophrenia provides a framework for understanding these gene-environment interactions (Fowles, 1992). This model posits that genetics and prenatal factors confer vulnerability (diathesis), for mental illness which then may be activated through exposure to environmental stressors during life. One important area of research involving the diathesis-stress model examines the role of “daily stressors” in risk-for-psychosis. This area of research recognizes that low-level stressors can become detrimental for mental health when they are persistent and overlapping (Norman & Malla, 1994). Additionally, these low level stressors are more common in individuals on the schizophrenia spectrum and are associated with increases in positive prodromal symptomology (Tessner, Mittal, & Walker, 2011). Thus, it is critical that researchers clarify how different forms of stress, especially contemporary forms of stress facing at-risk young adults, contribute to the development and course of schizophrenia-spectrum phenomena. This study aims to examine one potential stressor, technology use, as it relates to schizotypy in adolescents and emerging adults.

Chapter 2

Literature Review

Technology Use in the Schizophrenia Spectrum

One potential set of stressors that may be relevant to schizophrenia onset in those at-risk for schizophrenia involves the unanticipated consequences of new technologies. The emergence of the internet and wide acceptance of social media platforms and video games have impacted popular culture and how we live our day-to-day lives. There is some suggestion that increased internet use patterns may be related to anxiety and depression (Amichai-Hamburger, Wainapel, & Fox, 2002; Correa, Hinsley, & de Zúñiga, 2010; Lin et al., 2016; Muise, Christofides, & Desmarais, 2009; Vannucci, Flannery, & Ohannessian, 2017). However, in the realm of schizophrenia-spectrum disorders, research has primarily focused on technology-based interventions for adults with a clinical diagnosis (Bao & Pincus, 2015; Ben-Zeev, Davis, Kaiser, Krzsos, & Drake, 2013; Torous, 2018; Torous et al., 2014). While some research does focus on how patterns of technology use may inform “daily hassles/stress” exposure (Akin & İskender, 2011; Deatherage, Servaty-Seib, & Aksoz, 2014), more research is needed in this area. Thus, it is important to identify whether certain technological platforms serve as a stressor, a protective factor, or both for those with heightened risk for schizophrenia. Furthermore, a better understanding of general patterns of technology use, as well as further exploration of adverse health effects in individuals on the schizophrenia spectrum (Leas & Mccabe, 2007) can inform clinical and educational interventions aimed at improving outcomes across the schizophrenia-spectrum.

Individuals on the schizophrenia spectrum commonly use smartphones and social networking sites (upwards of 88%; Ben-Zeev et al., 2013; Bao & Pincus, 2015). These individuals often report that they would be amenable to using technology to gain information about treatment as an adjunct to their current treatment (Bao & Pincus, 2015; Ben-Zeev et al., 2013; Miller, Stewart, Schrimsher, Peeples, & Buckley, 2015) and state they often use social media to learn about their diagnosis and to connect with others with similar experiences (Daker-White & Rogers, 2013; Miller et al. 2015). Further, individuals who carry a clinical diagnosis tend to report that the use of social media does not exacerbate symptoms (Miller et al., 2015).

In terms of other technology use, gaming is common in individuals with schizophrenia spectrum disorders (Choi et al., 2020). Moderate commercial video game use is associated with increased neuroplasticity and grey matter volume increases in schizophrenia-relevant brain areas such as hippocampus, insula, cingulate and frontotemporal networks (Suenderhauf, Walter, Lenz, Lang, & Borgwardt, 2016). In some cases, playing Massive Multiplayer Online Role-Playing Games (MMORPGs) has been associated with a decrease in schizotypal symptoms (Schimmenti, Infanti, Badoud, Laloyaux, & Billieux, 2017) and may be motivated by social contingencies (Yee, 2007). Thus, we theorize that individuals with bizarre behaviors, personal beliefs, or generally anxious or awkward behaviors (all common in those with schizotypy and schizophrenia) may actually prefer online social interactions which provide a buffer for these symptoms. Similarly, playing video games may help remediate cognitive impairments in executive functioning, attentional processing, and visuospatial skills in participants with schizophrenia (Stanmore, Stubbs, Vancampfort, de Bruin, & Firth, 2017). Similar effects have been found in cognitive remediation programs which simply use computer assisted technology (Holzer et al., 2014; Lewandowski et al., 2016; Stip & Rialle, 2005). Therefore, using technology may have a number of benefits for individuals on the schizophrenia spectrum.

Health Behaviors and Technology Use

In addition to social media and gaming, there is interest in how technology maybe used to improve exercise and health behaviors in individuals with schizophrenia spectrum disorders. Relationships between increased physical activity and benefits in those with schizophrenia include: improvements in social cognition, working memory, and attention (Firth et al., 2017); as well as: reduced auditory hallucinations, improve sleep quality, and improved self-esteem (Gorczynski & Faulkner, 2010). There are a number of video games which incorporate aerobic exercise and have the potential to be played socially (i.e. Dance Dance Revolution, Wii Sports, Pokémon Go) and more are being developed with specific target demographics of individuals with mental illness (Yim & Graham, 2007). Feasibility studies have provided support for the efficacy of these games in increasing exercise behavior in both clinical and non-clinical populations (Kimhy et al., 2016; LeBlanc & Chaput, 2017). In addition, researchers have utilized physical hardware such as Fitbits in studies on technology assisted interventions for exercise. Such studies have demonstrated feasibility in the use of wearable technologies for physical health interventions in schizophrenia (Kerz et al., 2016; Shin et al., 2016). To our knowledge, there is at least one study which examines technology use in this population outside of a lab setting (Choi et al., 2020), but which does not examine the relationship between health behaviors and technology use in those at-risk for schizophrenia.

Risk Factors Related to Technology Use

The risks of video game and social media usage in those at-risk for psychosis are relatively unknown, apart from a handful of studies. For example, Schimmenti et al., (2017) state that despite overall finding suggesting positive benefits of MMORPG gaming in their sample, there were some individuals (typically those high in schizotypy) who saw negative effects which reinforced schizotypal symptomology such as: lack of close friends, social anxiety (during in-person interactions), constricted affectivity, or magical thinking (Schimmenti et al., 2017). Similarly, impulsive non-conformity (lack of regard for social rules) and introverted anhedonia (blunted emotion and asocial tendencies) have been associated with problematic technology use, use of technology which interferes with social, academic, and professional functioning (Truzoli, Osborne, Romano, & Reed, 2016). This being said, there are a wide variety of technological platforms and relationships between technology and pathology which have not been examined by the schizophrenia-spectrum researchers. Social media use has demonstrated both risk and protective power in a non-clinical population in regards to health behaviors (Buda, Lukoševičiūtė, Šalčiūnaitė, & Šmigelskas, 2021; Vaterlaus, Patten, Roche, & Young, 2015). Video game use has shown similar mixed effects (Busch, Manders, & De Leeuw, 2013) and video games are being utilized to foster health behaviors in non-clinical populations (Thompson, 2012) as well as in individuals on the schizophrenia spectrum (Yim & Graham, 2007). Thus, the specific elements that make certain technological platforms a risk factor rather than a protective factor are not fully understood.

A few studies have examined problematic use of technology and schizotypal personality traits (Truzoli et al., 2016), but most studies examining technology use in the schizophrenia spectrum aim to assess the efficacy of new interventions. The current body of research is narrow in focus and mainly examines technology in professional research or a clinical context. Even the few studies which examine technology use as it organically occurs outside of clinical or research settings (Ben-Zeev et al., 2013; Choi et al., 2020) focus on specific topics, such as the prevalence of cell phone ownership. It may be more beneficial to shift focus to *how* technology is used, for example: differences in outcomes contingent on whether technology is used actively (individuals engaging with others online) or passively (individuals observing or “lurking” online without posting or interacting) (Escobar-Viera et al., 2018). Patterns of avoidance have been shown to manifest in online behavior (Deatherage et al., 2014; Massaro & Dinzeo, under review) along with alternatives methods for social connection (Yee, 2007; Massaro & Dinzeo, under review). The difference between these behaviors may lie in how these technological platforms are being used and a better understanding of how patterns of use relate to pathology and outcomes in the schizophrenia spectrum can provide clinical and ecological utility in future research.

The DOTUS: A New Measurement for A New Generation

To complicate matters further, research paradigms which assess technology use have difficulty keeping pace with current use due to the incongruence between the haste of technological trends and the lethargy of academic research. Trends in technology progress far faster than the methods which have been used to assess them, presenting barriers to accurate assessment of technology use (Massaro & Dinzeo, under review). To address these methodological shortcomings, we designed a questionnaire, the Domains Of Technology Use Survey (DOTUS), to assess how often a technological platform is used and for what purposes. The DOTUS has a modular framework which assesses the same set of behaviors and motivators for a wide variety of technological platforms. However, it also utilizes platform specific language (i.e., using “like” vs. “upvote”), so that each module will adequately assess use of a particular platform and each module can be replaced in the future following the same framework without sacrificing reliability and validity of the overall questionnaire. It is our hope that the DOTUS can then be used to establish a baseline for the frequency of and the motivations of technology use that can be used in a flexible manner by a wide range of researchers.

Aims and Hypotheses

One of the overarching goals of this study is to elucidate the frequency, quantity, and manner in which technology is used by individuals on the schizophrenia spectrum. This was originally intended to be accomplished by examining technology use in two samples; one sample of individuals with clinical diagnoses of schizophrenia, and one sample of individuals without a diagnosis of schizophrenia. However, due to the COVID-19 pandemic, in person research was halted at the hospital in which we planned to collect our clinical sample. As a result, we were unable to recruit a sufficient number of participants prior to the conclusion of this study (n=1). However, our findings in our non-clinical sample can help establish basic patterns, and relationships, of technology use which can serve as a foundation for more nuanced research in the future.

We aim to examine how the use of technology in those with schizophrenia-spectrum conditions relates to real-world outcomes involving health behaviors and internet addition using confirmatory analyses. More specifically, we hypothesize that we will see relationships which parallel previous research (i.e. Truzoli et al., 2016, Massaro & Dinzeo, in prep) in which the three domains of schizotypy would be predictive of increased scores on a measure of problematic technology use (contained within the DOTUS). We would expect the disorganized domain to be the best predictor, followed by the negative domain, and the positive domain, respectively. Additionally, we expect these domains to predict decreased engagement in health behaviors in our sample with the same hierarchy of predictive power.

In terms of specific facets of technology use, we hold three hypotheses (denoted a-c). We hypothesize that (a) greater use of health technologies will predict increased engagement in health behaviors and decreased levels of problematic technology use; (b) greater use of social media will predict decreased engagement in health behaviors and increased levels of problematic technology use; and (c) greater use of video games will predict decreased engagement in health behaviors and increased problematic technology use. Although we have stated hypotheses, we also acknowledge that studying technology use comes with a myriad of unforeseen variables which may influence the relationships between technology use and our outcome variables. Therefore, the influence of social media and video game use on physical activity and problematic technology use in our sample will likely vary contingent on the type of platform and manner in which the platform is used, in ways we are likely unable to predict at this time.

Finally, we aim to elucidate the nature of how technology is used in our sample. More precisely, we wish to examine the interplay between specific technological platforms, active technology use, and schizophrenia spectrum symptomology. We do not hold specific hypotheses on use seeing as the research on this topic is lacking; however, we hope to elucidate relationships which can be explored by other researchers in the future.

Chapter 3

Methods

Procedure

This study utilized a cross sectional design. Participants completed a 30-minute online questionnaire through Qualtrics survey software as part of an hour and half long research paradigm examining cognitive functioning, sexual behavior, lifestyle habits, and technology use. The survey contained four “infrequency questions”; questions which have clear correct answers (i.e. “I believe lightbulbs run on electricity”) which assisted our team in identifying participants who were not engaging truthfully or accurately with the survey.

Participants

We recruited 227 undergraduate students (121 male, 105 female, 1 nonbinary) from Rowan University in Glassboro NJ. The mean age of participants was 19 years of age and 61% of our sample identified as white. Detailed statistics on means and standard deviations of all of our variables can be found in Table 1 and a detailed report of racial and ethnic representation in our sample can be found in Appendix B (Table 7). Undergraduate participants were recruited over the course of at least one year as part of a larger study via the Rowan University Psychology Subject Pool system (SONA). Participants were eligible to receive credit through SONA in order to participate and were compensated with research credit for their introductory psychology courses.

Measures

Demographics and Health Questionnaire

The demographic and health questionnaire was used to attain demographic information, previous individual or familial mental health diagnoses, nicotine use, height, weight, and general health-related sense of wellbeing. Items in the questionnaire consist of yes/no and open response and are used to glean a wide range of demographic information about the sample.

Domains of Technology Use Survey (DOTUS; Massaro, Pujji, Sullivan, & Dinzeo, in prep)

This questionnaire asks participants about their use of different technological platforms as well as how often platforms are used. The DOTUS includes items assessing general patterns of technology use as well as modular sections which assess details regarding use of specific technological platforms. If participants endorse the use of a specific technological platform, they are directed to follow-up items regarding particular aspects of their use. If they do not endorse the use of a specific technological platform, participants are prompted with additional follow up items relating to their non-use. All participants have the opportunity to provide additional information or comments at the end of each specific technology. Problematic technology use was also assessed through questions adapted from the Michigan Alcohol Screening Test (Selzer, 1971) referred to from this point forward as the PTU section (or PTUS).

Schizotypal Personality Questionnaire - Brief Revised (SPQ-BR; Cohen et al., 2010)

This measure is composed of 32 statements that are rated on a Likert-type scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). This measure has three subscales believed to reflect important symptom domains including (1) *Interpersonal* (negative) schizotypy; higher scores reflect discomfort in social situations, difficulty expressing emotions or feeling close to others, (2) *Disorganized* schizotypy*;* higher scores reflect odd speech or eccentric behavior, and (3) *Cognitive-perceptual* (positive) schizotypy; higher scores on this subscale illustrate odd perceptual experiences, magical thinking, and suspicious beliefs. These subscales have good internal consistency (α=.80-.90) with scores from the cognitive-perceptual scale (in particular) differentiating between the relatives of those with schizophrenia vs. those with no family history of schizophrenia (i.e., evidence for construct validity; Callaway et al., 2014). Participants ranged in positive schizotypy from 14.00 to 61.00 (possible range 14-70) with a mean of 33.55. Participants ranged in negative (interpersonal) schizotypy from 11.00 to 46.00 (possible range 10-50) with a mean of 27.68. Participants ranged in disorganized schizotypy from 8.00 to 38.00 (possible range 8-40) with a mean of 22.65. Participants ranged in overall schizotypy from 38.00 to 128.00 (possible range 32-160) with a mean of 83.89. This measure demonstrated good internal reliability in this study (α=0.921).

Positive and Negative Affect Schedule (PANAS; Watson & Clark, 1988)

This measure comprises two mood scales which utilize a 5-point Likert scale, one that measures positive affect and the other which measures negative affect. For the Positive Affect (PA) Scale, the Cronbach's α = 0.86 to 0.90; for the Negative Affect (NA) Scale, α= 0.84 to 0.87 (Watson & Clark, 1988). Participants ranged in positive affect from 10.00 to 46.00 (possible range 10-50) with a mean of 24.71. Participants ranged in negative affect from 10.00 to 38.00 (possible range 10-50) with a mean of 17.87. This measure demonstrated good internal reliability in this study (α=0.875).

Lifestyle Habits Questionnaire (LHQ-B; Dinzeo, Thayasivam, & Sledjeski, 2014)

We utilized the health and exercise subscale in the lifestyle habits questionnaire to measure health behaviors. This measure uses a 5-point Likert scale to assess self-reported frequency of exercise behavior in addition to attitudes regarding health and health behavior. This measurement has been shown to be internally reliable with Cronbach's α values between 0.75 and 0.82 for the health and exercise items (Dinzeo et al., 2014). Participants ranged from 7.00 to 30.00 in their health behaviors (possible range 5-30) with a mean of 19.67. This measure demonstrated good internal reliability in this study (α=0.907).

Analyses

We began our analyses by obtaining descriptive (means and standard deviations) statistics for demographic variables and well as by examining skew and kurtosis through statistical and graphical means. We inspected the database for missing data, outliers, and points of high leverage or influence. We examined assumptions of normality, independence, and homogeneity graphically by plotting univariate distributions of our variables in addition to our statistical analyses of these factors. Responses which were incomplete or missing (as determined by incorrectly responding to ≥50% of infrequency questions throughout our survey) were not included in our analyses. Individuals who did not endorse use of specific technological platforms had their time spent on those platforms entered as zero minutes.

We conducted two hierarchical linear regressions: one predicting problematic technology use and one predicting health behaviors. Demographic variables (i.e., gender, age, and race) and scores for affect (our proxy for mood symptoms) were entered in the first step to account for demographic confounds. Schizotypy, divided by the three subtypes (positive, interpersonal, and disorganized) was entered in the second step. Time spent on social media, video games, and health technologies were entered for our third and final step in order to examine the influence of these platforms on our outcome variables above and beyond the influence of demographics, and levels of schizotypy.

For our exploratory analysis, we conducted correlational analyses, supplementary regressions, and t-tests to elucidate relationships between schizotypy, active technology use, problematic technology use, and health behaviors.

Lastly, we examined the psychometrics of the DOTUS by running a Latent Factor Analysis to assess the extent to which items in the PTU section of the DOTUS measured the latent factor of problematic technology use. In addition, we examined correlations between this section and questions examining self-reported problematic behavior contained within each module of the DOTUS to examine the criterion validity of these sections. We also compared reported time spent on individual platforms to self-reports of the percentage of time participants spend on these same platforms to examine their validity.

Chapter 4

Results

Means and standard deviations for all of our predictor and outcome variables are reported in Table 1. When compared to other studies on college age students, our sample engaged in greater social media use (Vaterlaus et al., 2015) and slightly greater video game use (Przybylski & Weinstein, 2017) than previous samples. We found significant gender differences in all three types of technology use and divided the means in Table 1 accordingly. Univariate distributions of the variables of interest were normally distributed and distributions of technology use were slightly positively skewed with the mode close to zero. In addition, the distribution for daily health technology use was found to be non-gaussian (skew = 6.91, kurtosis = 56.399). This variable did not significantly impact our regressions and we utilized spearman correlations in the correlational analyses which included this variable to account for its non-parametric distribution.

All three of the steps in the first regression significantly predicted problematic technology use. In the first step, demographic variables predicted 5.5% of variation in problematic technology use ($R^2 = 0.055$, $p=0.035$). In the second step schizotypy explained an additional 9.8% of variation in problematic technology use above and beyond demographic variables ($R^2 = 0.153$, R^2 change = 0.098, $p<0.001$). In the third step, daily technology use of social media, health technology, and video games (measured in minutes spent on a platform) explained an additional 2.6% of variation above and beyond demographic variables and schizotypy ($R^2 = 0.178$, R^2 change =0.026, $p<0.001$).

All three of the steps in the second regression significantly predicted health behaviors. The first step, demographics, explained 8.5% of variation in health behaviors (R^2= 0.085, p=0.002). The second step, schizotypy explained an additional 9.5% of variation above and beyond demographic variables (R^2 = 0.181 R^2 change = 0.095, p<0.001). The third step, technology use, explained an additional 3.7% of variation above and beyond demographic variables and schizotypy (R^2= 0.218, R^2 change = 0.037, p<0.001).

While the first step, on its own, predicted reduced health behaviors and increased problematic technology use, only gender predicted our outcome variables in the full model. Female participants were found to engage in fewer health behaviors compared to male and nonbinary participants with gender as a whole predicting decreased health behaviors (β= -2.77, p=0.004), and not predicting problematic technology use.

Consistent with our hypotheses, levels of interpersonal (negative) and disorganized schizotypy were significant predictors of increased problematic technology use and reduced health behaviors above and beyond the influence of demographic variables. Disorganized schizotypy was the strongest predictor of problematic technology use, while interpersonal schizotypy was the strongest predictor of health behaviors (Tables 2 and 3). While we anticipated positive schizotypy would also be a significant predictor, levels of positive schizotypy did not significantly predict either of the outcome variables. Coefficients and significance for these variables in relation to problematic technology use and health behaviors are summarized in tables 2 and 3 respectively.

Among technological platforms, social media and video game use were significant predictors of reduced health behaviors, above and beyond the influence of demographic variables and schizotypy, whereas health technology use did not significantly predict any of our outcome variables. Video game use predicted decreased health behaviors (β= -0.11, p = 0.036), but did not predict problematic technology use. Additionally, social media use predicted reduced health behaviors (β= -0.004, p= 0.029), but did not predict problematic technology use.

Table 1

Means and Standard Deviations for Variables of Interest Divided by Gender (N=227)

	Male		Female		Overall		t-test	
Variable	M	SD	M	SD	M	SD	t	p
Age	19.37	1.35	18.72	1.00	19.01	1.24	4.04	0.009**
Race (% White)	-	-	-	-	61%	-	-0.92	0.239
Positive Affect	26.99	7.99	22.10	8.33	24.72	8.47	4.49	0.320
Negative Affect	17.94	6.42	17.72	6.28	17.87	6.34	0.26	0.629
Schizotypy Interpersonal	26.77	7.45	28.61	7.83	27.68	7.70	-1.80	0.546
Schizotypy Positive	32.05	9.48	35.17	9.98	33.56	9.84	-2.41	0.752
Schizotypy Disorganized	22.72	6.67	22.54	6.87	22.66	6.74	0.20	0.770
Daily Social Media Use	267.00	181.00	394.07	238.23	328.43	220.12	-4.46	0.003**
Daily Video Game Use	92.89	99.29	7.99	35.28	53.41	87.36	-1.92	0.001**
Daily Health Technology Use	3.57	23.60	12.01	41.27	7.46	33.13	8.28	<0.001***
Problematic Technology use	3.02	2.78	3.51	2.84	3.17	2.84	-1.31	0.828
Physical Activity	20.94	5.79	18.28	5.73	19.67	5.91	3.46	0.885

*Indicates statistical significance p<0.05; **Indicates statistical significance p<0.01; ***Indicates statistical significance p<0.001

Table 2

Coefficients for a Full Model of a Hierarchical Linear Regression Examining Problematic Technology Use†

Variable	Unstandardized β	SE	Standardized β	CI Lower Bound	CI Upper Bound	Significance
Constant	-2.948	2.869	-	-8.604	2.709	0.305
Age	-0.002	0.133	-0.001	-0.265	0.261	0.990
Gender Identity	0.602	0.416	0.121	-0.219	1.423	0.150
Race	0.142	0.091	0.101	-0.037	0.321	0.118
Positive Affect	-0.008	0.024	-0.028	-0.055	0.038	0.724
Negative Affect	0.045	0.031	0.114	-0.015	0.106	0.139
Interpersonal Schizotypy	0.487	0.262	0.150	-0.030	1.003	0.065
Disorganized schizotypy	0.668	0.239	0.223	0.197	1.139	0.006**
Positive Schizotypy	0.019	0.296	0.005	-0.564	0.603	0.948
Daily Social Media Use	0.001	0.001	0.098	0.000	0.003	0.158
Daily Health Technology Use	-0.010	0.005	-0.130	-0.020	0.000	0.053
Daily Video Game Use	0.003	0.002	0.116	-0.001	0.008	0.128

*Indicates statistical significance $p<0.05$; **Indicates statistical significance $p<0.01$; ***Indicates statistical significance $p<0.001$

† Problematic Technology Use was measured by the PTU subsection of the DOTUS, which was modeled on the MAST (Selzer, 1971)

Table 3

Coefficients for a Hierarchical Linear Regression Examining Health Behaviors†

Variable	Unstandardized β	SE	Standardized β	CI Lower Bound	CI Upper Bound	Significance
Constant	30.263	6.614	-	17.222	43.303	0.000
Age	0.030	0.308	0.006	-0.576	0.637	0.922
Gender Identity	-2.770	0.960	-0.236	-4.663	-0.877	0.004**
Race	-.059	0.209	-0.018	-0.472	0.353	0.776
Positive Affect	0.071	0.054	0.100	-0.037	0.178	0.196
Negative Affect	0.014	0.071	0.015	-0.125	0.153	0.840
Interpersonal Schizotypy	-1.884	0.604	-0.246	-3.075	-0.694	0.002**
Disorganized schizotypy	-1.172	0.551	-0.166	-2.258	-0.085	0.035*
Positive Schizotypy	0.582	0.682	0.068	-0.762	1.927	0.394
Daily Social Media Use	-0.004	0.002	-0.147	-0.008	0.000	0.029*
Daily Health Technology Use	0.018	0.012	0.100	-0.005	0.041	0.126
Daily Video Game Use	-0.011	0.005	-0.156	-0.020	-0.001	0.036*

*Indicates statistical significance p<0.05; **Indicates statistical significance p<0.01; ***Indicates statistical significance p<0.001
†*Health Behaviors are measured by the health subsection of the Lifestyle Habits Questionnaire (LHQ)

Time spent on specific technological platforms was not correlated with schizotypy or problematic technology use. Time spent on Twitter was correlated with higher active social media use overall (r= 0.251, p= 0.015). Engagement in health behaviors was correlated with lower problematic technology use (r= -0.283, p< 0.001), less time spent on Snapchat (r= -0.144, p= 0.048) and Instagram (r= -0.165, p= 0.017), as well as decreased schizotypy for all subtypes. Interpersonal and overall schizotypy were corelated with self-reported preferences for non-face-to-face interactions (r= -0.275, p< 0.001; r= -0.161, p= 0.016). Lastly, positive schizotypy was correlated with greater time spent on health technologies (r= 0.131, p=0.049) and overall schizotypy was correlated with greater time spent on forum based social media platforms (r= 0.270, p= 0.046).

Use rates for social media platforms in this sample are summarized in Table 4. Active social media use: posting, commenting, and generally interacting with other individuals on a site (Escobar-Viera et al., 2018) was not correlated with any variables of interest outside of overall social media use (r= 0.169, p= 0.012) and the aforementioned correlation with time spent on Twitter. When placed into a regression examining active social media use as a predictor of problematic technology use and health behaviors, active use did not significantly predict either outcome variable and the model including active use explained an additional 0.6% of variation in problematic use and an additional 1.1% or variation in health behaviors above and beyond demographic variables and schizotypy. Overall, the R^2 was lower than that of the model which included time spent on technological platforms.

Table 4

Endorsement Rates for Technological Platforms in College Students

Platform	Female	Male	Total
Facebook**	50%	35.8%	45.4%
Instagram	90.7%	85.4%	92.1%
Twitter*	48.0%	37.1%	41.0%
Snapchat**	88.7%	77.5%	84.1%
Blogs (i.e Tumblr, Blogspot)	7.3%	4.0%	6.2%
Forums (i.e Reddit, 4Chan)	22.7%	17.9%	24.2%
Health Technology*	18.0%	9.9%	13.7%
Video Games**	12.0%	63.6%	38.3%

*Indicates statistical significance p<0.05; **Indicates statistical significance p<0.01; ***Indicates statistical significance p<0.001

Among individuals who endorsed video game use, 9.3% reported a preference for playing single player videogames, 38.4% reported a preference for playing primarily multiplayer videogames, and 52.3% reported playing either type depending on the game they wished to play. This choice was correlated with active social engagement during video game use ($r = 0.307$, $p = 0.008$) as well as disorganized ($r = -0.266$, $p = 0.013$) and overall schizotypy ($r = -0.234$, $p = 0.030$), with singe player preferences correlated with higher mean schizotypy overall ($p = 0.089$). The group which stated a preference for both types of games had the highest average disorganized schizotypy compared to other gaming preferences ($p = 0.008$). Active use of video games, playing games with others and communicating with others on video games, was correlated with lower interpersonal schizotypy ($r = -0.251$, $p = 0.031$).

Active use of health technologies: using health-based apps with other people, was correlated with greater time spent on Instagram ($r = 0.529$, $p = 0.003$) and Snapchat ($r = 0.559$, $p = 0.002$), as well as with greater overall time spent on health technologies ($r = 0.454$, $p = 0.010$) and all social media platforms ($r = 0.543$, $p = 0.002$). Active use of health technologies did not significantly predict problematic technology use or overall health behaviors.

Lastly, analyses to examine the psychometrics of the DOTUS provided differing levels of support for the reliability and validity of the measure. Within the factor analysis, all items were treated as ordinal, with a score of 1 indicating endorsement and 0 indicating denial of the problematic behavior. Initially after running the model, the data fit poorly, indicating a beyond-chance departure of the data from the hypothesized model. The approximate fit indices also indicate less than desirable fit (CFI= 0.854, TFI= 0.805, RMSEA= 0.120). All of the PTU items correlated positively with the latent variable (f), but the strength of the relationship between the latent factor (representing hypothesized levels of problematic tech use) and the individual items varied considerably in strength. Items 4 and 5 appear to be relatively strong indicators of the latent factor whereas items 2, 6, and 8 had a weak relationship with the latent factor (Table 6). Upon removing items 2, 6, and 8, the fit of the data vastly improved and there was no longer any evidence of model misspecification. The approximate fit indices indicated a close-fitting model (CFI= 1.000, TFI= 1,014, RMSEA< 0.001). In addition, all remaining items were strongly associated with the latent factor (Table 6). The remaining PTU items were graphed using item information curves, which show the amount of information captured by each individual item (Figure 5, Appendix B). Overall, questions 4 and 5 provided the most information, with all items provided capture the most information at average to high levels of the latent variable. Lastly, we ran a McDonald's omega, which estimates the proportion of total variation in the items accounted for by the latent variable. Using 95% confidence interval for the reliability estimate, the omega estimate was 0.69 [0.59, 0.76], with a typically "acceptable" Omega for research falling around 0.70.The remaining items of the PTU section were correlated with self-reported problematic technology use in the individual modules which suggest some validity. These correlations are summarized in Table 5. When converted into percentages, self-reported time spent on social media and video games differed significantly from initial percentages of use reported in the DOTUS ($p<0.001$). Though this was not a 1 to 1 comparison, these results suggest possible limits to reliability and validity.

Table 5

Spearman Correlations Between Items in the Problematic Technology Use Section of the DOTUS and Self-Reported Difficulties Caused by Technological Platforms

	Facebook	Instagram	Twitter	Snapchat	Blogs	Forums	Video Games	Health Technology
Friends and relatives worry[1]	0.034	0.267**	0.203	0.193**	0.465	0.040	0.363**	-0.287
Guilt over use[2]	-0.020	0.286**	0.150	0.242**	0.449	-0.031	0.160	-0.068
Causing problems with others[3]	-0.060	0.121	0.136	0.121	-0.212	0.084	0.080	-0.089
Relatives discuss tech use with others[4]	-0.127	0.100	0.160	0.048	0.109	0.282*	0.274*	0.159
Trouble at school or work[5]	0.085	0.262**	0.263*	0.179*	-0.519	0.004	-0.043	-0.027
Neglected obligations[6]	0.095	0.274**	0.202	0.216**	0.449	0.284*	0.379**	-0.263

*Indicates statistical significance $p<0.05$; **Indicates statistical significance $p<0.01$; ***Indicates statistical significance $p<0.001$
1-PTUS question #1, 2- PTUS question #3, 3-PTUS question #4, 4- PTUS question #5, 5- PTUS question #7, 6- PTUS question #9

Table 6

Item Level correlations with the Latent Factor (Problematic Technology Use) for the PTU Sub-Section of the DOTUS

Item Number	Model 1 Correlations†	Model 2 Correlations†
1	1.000***	1.000***
2	0.347*	-
3	0.655***	0.784***
4	1.000***	1.000***
5	1.000***	1.000***
6	0.656**	-
7	0.706***	0.771***
8	0.546***	-
9	1.000***	1.000***

*Indicates statistical significance $p<0.05$; **Indicates statistical significance $p<0.01$; ***Indicates statistical significance $p<0.001$. Model 1 refers to the initial analysis which included all PTU items. Model 2 refers to the analysis with items 2, 6, and 8 removed

Chapter 5

Discussion

Confirmatory Analyses: Schizotypy, Health Behaviors, and PTU

Consistent with our hypotheses, schizotypy had significant predictive power in regards to problematic technology use (PTU) and health behaviors. The model containing schizotypy explained roughly 10% of additional variation in our outcome variables above and beyond demographic variables. While this is a relatively small effect size, these findings do support previous research which found relationships between schizotypy and problematic technology use (Truzoli et al., 2016), schizotypy and health behaviors (Leas & Mccabe, 2007), and disorganized schizotypy as a predictor of problematic technology use (Massaro & Dinzeo, under review). The relationship between disorganized schizotypy and PTU may elucidate an unanticipated connection between how features of the internet interact with symptoms of schizophrenia. For example, disorganized symptoms can represent difficulty maintaining attention, which may translate to length of time on the internet, as there are endless ways to jump from topic to topic, resulting in large spans of lost time. This is just one way in which PTU may function as a relevant variable within the diathesis stress model of schizophrenia.

Interpersonal and overall schizotypy were correlated with self-reported preferences for non-face-to-face social interactions; providing some evidence for our aforementioned theory that individuals with schizotypy may prefer online social interactions where their symptomology is less apparent to others. For individuals high in interpersonal schizotypy, online interactions may serve as a “social armor”, creating a buffer between their symptom presentation and social interactions, thus limiting the detrimental effects of negative symptoms on socialization. Engagement in Massive Multiplayer Online Roleplaying Games (MMORPGs) in this population (Schimmenti et al., 2017) and the possible social motivators for this behavior (Yee, 2007) may support this theory. These games allow players to create an avatar which is used in game to interact with other players' avatars. The buffer created by this avatar may help to mitigate the effects of an individual's schizophrenia spectrum symptomology which would interfere with socialization. Despite this benefit in socialization, interpersonal schizotypy was predictive of decreased health behaviors, further highlighting the potential for technology to serve as a beneficial factor as well as a low-level stressor. With previous relationships supported, and new relationships identified, more research is ultimately needed to fully elucidate the nuances of these technology use and its relationship with schizotypy.

While schizotypy is more enduring than a pure mood state, it also changes over time (Yi Wang et al., 2018). For example, the 10-week test–retest reliabilities of the positive and negative schizotypy dimensions are .81 and .82, respectively for the Wisconsin Schizotypy Scales (Gross, Silvia, Barrantes-Vidal, & Kwapil, 2015), and convergent, discriminant, and criterion validity are 0.70, 0.47, and 0.81 respectively for the SPQ-BR (Stefanis et al., 2006). At the same time, longitudinal research has identified varying stability and differing trajectories of schizotypy up to 18 months, with schizotypy remaining stable in some individuals and increasing or decreasing in others (Yi Wang et al., 2018). As such, the theoretical notion of schizotypy as a stable personality-like trait and our ability to measure these more stable traits are two different things. Especially with potential error from the SPQ-BR due to overlap in schizotypy symptoms and symptoms of anxiety and depression, our ability to measure the stability of schizotypy with the SPQ and the current methodology is limited. As such, longitudinal methodologies may present a useful tool to further replicate and explore our findings due to the complex, enduring, and flexible nature of schizotypy.

Confirmatory Analyses: Technology Use, Health Behaviors, and PTU

The data provided mixed support for hypothesis B, which predicted social media use would be associated with decreased health behaviors and increased PTU. Time spent on social media predicted decreased health behaviors, but did not predict problematic technology use. These findings support previous research (Buda et al., 2021; Vaterlaus et al., 2015) on the mixed effects of social media use in adolescents and emerging adults. Vaterlaus et al. (2015) outlines the potential for social media to contribute to decreased health behaviors in adolescents, while also being a useful tool to promote health behaviors in some cases. In our study, engagement in health behaviors was negatively correlated with Instagram and Snapchat use, supporting the possibility that these particular platforms may relate to decreased health behaviors in this population. However, these were the two most endorsed platforms in our sample, and we may have seen similar results if other platforms shared the high endorsement rates of Snapchat and Instagram. It should be noted that we cannot infer causality or directionality with these analyses, but they do highlight important relationships which may have a causal link yet to be elucidated. We encourage others to replicate these findings and for future research to delve into potential causal links between social media use and decreases in health behaviors. Once causal links are identified, researchers will be better equipped to develop interventions targeted at using these platforms to promote health behaviors.

The data provided mixed support for hypothesis C, which predicted video games would be associated with decreased health behaviors and increased PTU. Time spent playing video games predicted decreased health behaviors, but did not predict increased problematic technology use. These findings also support previous research (Busch et al., 2013) and invite a possibility for intervention. If individuals at-risk for schizophrenia are already engaging in video game use, and said use is associated with decreased health behaviors, it may be prudent to gamify health interventions for this population. Gamification involves the incorporation of video game mechanics into a treatment to promote behavior change and has already proven to be an effective strategy in behavioral interventions (Alahäivälä & Oinas-Kukkonen, 2016). It follows that gamification of interventions could then be an effective medium to promote behavior change in this population. These interventions can easily be targeted at promoting health behaviors when coupled with existing video games which incorporate aerobic exercise (LeBlanc & Chaput, 2017; Yim & Graham, 2007). We initially hypothesized that the association seen in our data is a result of time management and the more time individuals spend playing video games, the less time they can spend engaging in health behaviors. However, male participants endorsed greater time spent on video games compared to female participants and also endorsed greater health behaviors on average. Therefore, it is likely that individuals are able to manage their time in order to use technology and engage in health behaviors, and time management may not explain the association seen in our sample. Rather, the types of games being played or the function of gaming in an individual's life may be responsible for this relationship. If future research can identify a causal link between video game use and health behaviors or identify consistent motivators to video game use, this information can be used to more effectively inform future interventions.

Time spent on technological platforms predicted 2.6-3.7% of variation above and beyond schizotypy and demographic variables. In addition, the β values for the relationships between time spent on technological platforms and health behaviors are small; suggesting that, at best, a one unit increase in our video game subscore would predict a 0.11 unit (0.03%) decrease in overall health behaviors. Thus, in this cross-sectional view, these results may appear to have limited applications. However, these findings do invite two questions regarding changes in technology use and its impact on health behaviors and problematic use across the lifespan. First, though the β is small, it is unclear if the impact to physical and mental health will compound over time if these patterns of behavior persist. While potential PTU may not be associated with clinically significant impairment when examined cross-sectionally, it is possible that persistent minor impairment may serve as a low-level stressor akin to those outlined by Norman & Malla (1994) and that, overtime, the accrued impact may cause significant impairment in functioning or overall health. Second, it is possible that the demographics of our sample confer a buffer against significant effects of PTU. It follows that technology use in emerging adults who have enough financial stability to attend college and have a significant amount of free time due to their college enrollment, may not see impairment akin to individuals of lower SES and with less free time who spend equivalent amounts of time on technology. Therefore, it would be prudent to examine patterns of technology use over time and elucidate the effects of maintaining the levels of technology use seen in this sample across the lifespan and across diverse samples. Alternatively, the relatively low R^2 change and β values may suggest that the amount of time spent on a technological platform is not be the best predictor of the relationship between technologies, problematic technology use, and overall health behaviors. It is possible that other aspects of technology use have greater predictive power in regards to health behaviors and problematic use.

Exploratory Analyses: Active Technology Use

One such area of technology use which may hold predictive power is active technology use. Active technology use is again defined as active engagement with other individuals while on a technological platform (Escobar-Viera et al., 2018), and is most commonly seen on social media. The exploratory analyses related to active technology use bore some interesting results, and elucidated potential future avenues of research. Active use of health technologies was correlated with lower levels of overall schizotypy, greater time spent on health platforms and overall social media, and was also correlated with greater Instagram and Snapchat use. It is possible that individuals with higher schizotypy may not engage with health technologies for the same reasons they demonstrated decreased health behaviors. These reasons can range anywhere from their symptomology to a confounding variable which affects both health behavior and fosters risk towards schizotypy and schizophrenia. The active component of this connection is key, as individuals with high interpersonal schizotypy would be more likely to engage in social platforms which buffer against the negative effects of their symptomology (i.e platforms which provide a “social armor”). Seeing as health technologies usually do not allow for such a buffer, and in fact may invite greater scrutiny of an individual’s health behaviors, it follows individuals who are high on interpersonal schizotypy may prefer other catalysts to engagement in health behaviors. However, if we could apply the benefits of platforms individuals with schizotypy utilize (i.e. gamify a heath app) we may see greater engagement in health technology use and therefore improved health behaviors in this population.

Health Technology, Health Behaviors, and PTU

The data did not support hypothesis A, which predicted the use of health technologies (e.g. Fitbit) would be associated with increased health behaviors and decreased PTU. Time spent on health technologies did not predict problematic technology use or health behaviors. However, our exploratory analyses identified a correlation between active health technology use and social media, specifically Snapchat and Instagram. It is possible that the correlation between health technology and Snapchat highlights commonalities in the nature of these platforms. Both Snapchat and health technologies augment existing interpersonal relationships. It would then follow, that individuals who spend more time on platforms like Snapchat, which supplements their existing friendships, might also engage in greater active use of health technologies, possibly with the same friends. The connection between active health technology use and Instagram is less clear, but may be elucidated by the hashtag "fitspo" on Instagram. Hashtags (#) allow individuals to link their social media posts to an overarching topic, trend, or community. #fitspo, is short for "fitspiration", and includes inspirational posts and videos surrounding physical activity and overall health. Individuals who engage in active health technology use may also be active with #fitspo and may even use Instagram to connect with other exercise enthusiasts. However, some studies have suggested that #fitspo utilizes negative body image and a "thin-ideal" to motivate health behavior change (Slater, Varsani, & Diedrichs, 2017; Sumter, Cingel, & Antonis, 2018). Time spent on health technologies and active health technology use did not predict and were not correlated with overall health behaviors in our sample, which gives reason for pause surrounding health technology use to benefit overall health. However, our findings speak to a social aspect of these technologies which can be utilized as a protective factor against negative effects of "thin ideal" internalization and body image concerns if coupled with research on self-compassion as a protective factor against these effects (Slater et al., 2017).

Exploratory Analyses: Technology Use and Schizotypy

While active video game use was not related to other technology use, problematic technology use, or health behaviors, it was correlated with schizotypy, specifically lower levels of interpersonal schizotypy, Furthermore, individuals who preferred single player game modes had higher levels of overall schizotypy on average. These findings are in line with previous research which suggests that individuals with schizophrenia are ten times more likely to also experience social isolation (Hayes, Hawthorne, Farhall, & O'hanlon, 2015); which, based on our findings, may have the potential to spread into online activities. However, previous research has demonstrated associations between video game use and decreased schizotypal symptomology (Schimmenti et al., 2017). It is possible that this relationship is two-fold, and that engagement in video games also decreases the impact of an individual's symptoms, allowing the individual to more easily engage with others on a gaming platform. However, there is a possible cutoff for the benefits of this platform wherein video game use is beneficial for individuals with moderate symptomology, but can be challenging for individuals with severe symptomology. Many modern video games include cooperative social mechanics, complex systems which player must learn in order to be successful in the game, or both. Therefore, an individual with high schizotypy and experiences cognitive impairment due to their symptoms (i.e inattention, disorganized thinking, etc.) may not be able to learn these systems and may not be able to effectively contribute to cooperative play, thus creating social ruptures which could exacerbate their existing symptomology. As this is conjecture, future work should focus on elucidating a potential causal relationship between video game use and schizotypy may assist in identifying either areas of intervention or mechanisms of intervention for social isolation in schizophrenia spectrum disorders.

Gender Differences in Technology Use and Health Behaviors

We noted a few significant gender differences in terms of endorsed use of technological platforms as well as average time spent on individual platforms per day. Male participants demonstrated greater endorsement of video game use with an average of 93 minutes per day compared to 8 minutes per day for female participants. Female participants endorsed an average of 394 minutes (6.5 hours) on social media per day, compared to male participants' 267 minutes (4.5 hours) per day. The amount of time spent on these platforms is consistent with our finding that time spent on social media predicted decreased health behaviors. Female participants also spent 12 minutes on average per day on health technologies, compared to male participants' 3 minutes per day spent on these technologies. Interestingly, female participants endorsed significantly lower health behaviors than male participants, despite female participants using greater health technologies. It would be prudent to explore not only how individuals utilize these platforms, but also what other risk and protective factors are correlated with social media use. Seeing as time spent on social media predicted decreased health behaviors, exploration of the aspects of social media which both interfere with engagement in health behaviors as well as aspects which keep individuals engaged with these platforms could inform future interventions. This is especially pertinent in the schizophrenia spectrum as schizophrenia spectrum disorders are already associated with decreased engagement in health behaviors (Leas & Mccabe, 2007). Based on the gender differences in technology use, gamification of interventions may prove to be more effective for men as these mechanics have already been proven to be reinforcing in their video game use. Additionally, socialization (i.e. social comparison, social support, etc.) may prove to be beneficial for intervention in this age group due to the significant amount of time spent on social media. However, far more research will need to be completed to expand these findings into reliable and effective interventions for those at risk for schizophrenia.

Psychometrics of the DOTUS

The psychometric analyses of the DOTUS provided differing levels of support for the validity and reliability of this new measure. In the initial latent factor analysis, the data fit poorly, which would suggest that the questions in the PTU section did not measure the latent variable of problematic technology use. However, once questions 2, 6, and 8 were removed, the data fit very well as the comparative fit index (CFI) and Tucker-Lewis Index (TFI) were both close to 1 and the Root Mean Square Error of Approximation (RMSEA) was close to zero. These values fall within the recommendations for indicators of good fit and demonstrated support that the remaining PTU questions do in fact measure the latent variable of problematic technology use, suggesting overall good reliability for this subsection of the DOTUS. The McDonald's Omega also fell just below the typically "acceptable" mark with the 95% confidence interval falling above this threshold, which also provides some support for the reliability of this PTU section. In addition, the item information curves indicated that this subsection provides the most information about individuals who have average-to-high level of problematic tech use. As such, it would be prudent to add items which can distinguish between individuals with only mild levels of PTU in the next iteration of the DOTUS.

The PTU section also demonstrated criterion validity in relation to problematic use of certain technological platforms. The platforms without significant correlation to PTU all appeared to be platforms which had the lowest endorsement rates in this sample. It is possible that with a larger sample, we may see significant correlations between these platforms and our measure of PTU. This may also suggest that the aforementioned section of the DOTUS may be an even more reliable predictor of problematic technology use for the most endorsed platforms when these values regress towards the population mean. In addition, the items which were removed involved "causing problems with others" and "losing a job". This may suggest that these questions are not valid measurements of problematic technology use, or that the patterns of use examined cause minor interference with functioning, rather than major interference (such as job loss). As this section of the DOTUS assesses problematic use across all platforms, the importance of establishing it as a reliable and valid addition to the DOTUS is imperative.

Examination of self-reported time spent on technological platforms (specifically social media and video games) was significantly different from self-reports at the beginning of the DOTUS. It should be noted that these questions do not align 1 to 1, as the question at the beginning of the DOTUS asks for the percentage of online time spent on “social media” rather than on each individual social media platform. It is therefore possible that this assessment is limited by the transformations needed to compare these two questions. It is possible that there are social media platforms which are not examined by the DOTUS which influenced participant’s self-reported time spent on social media (i.e. tik tok) and may therefore confound our measurements of validity and reliability. Lastly, the questions we utilized to assess the reliability and validity of problematic technology use do not account for multi-tasking or utilization of multiple platforms at once. These analyses may call suggest some limitations of the reliability and validity of this new measure, but they are by no means the end of the DOTUS. In the future, we aim to break down the initial question and ask about individual social media platforms in order to better align these two sections of the DOTUS. This new technology measurement is still developing and will continue to be explored and refined for as long as it is utilized in the field.

Additionally, this difference may shed light on patterns of technology use before the COVID-19 pandemic. Our sample’s greater technology use when compared to use in other studies (Przybylski & Weinstein, 2017; Vaterlaus et al., 2015), may be due to the pandemic providing easy engagement in technologies as a result of attending classes from home. Additionally, our sample demonstrated lower positive affect and equivalent negative affect compared to norms for this age group (Watson, Clark, & Tellegen, 1988), and were similar to mean scores from a study conducted during the pandemic (Yali

Wang, Jing, Han, Jing, & Xu, 2020). These differences highlight possible changes in emotion expression and mental health due to the stress of living through a pandemic.

This sample also reported greater levels of schizotypy compared to norms (Callaway, Cohen, Matthews, & Dinzeo, 2014), though this sample had lower mean interpersonal schizotypy and equivalent mean positive and disorganized schizotypy compared to previous studies in this population (Massaro & Dinzeo, in prep). This sample also reported mean levels of physical activity in line with the middle range of reported norms of physical activity (Dinzeo et al., 2014) and were in line with mean physical activity from other studies in this population (Pennacchi, 2017). One potential explanation for increased levels of schizotypy in this sample, compared to norms, may speak to error in the SPQ-BR. Due to the overlap between symptoms of schizotypy and those of anxiety, depression, and general stressors, it is possible that the SPQ-BR was picking up on increased levels of stress due to the global pandemic thus slightly, increasing mean scores compared to norms, rather than measuring a pure increase in schizotypy. The lack of difference in positive and disorganized schizotypy as well as physical activity in this population before and during the pandemic may suggest that the results of this study could be generalized to outside a pandemic period. However, the decrease in interpersonal (negative) schizotypy from a few years prior to the pandemic (Massaro & Dinzeo, in prep) to the pandemic (this sample) may highlight some protective factors which arose due to societal changes from the pandemic. For example, working from home may have removed barriers to motivation and decreased anhedonia for certain individuals. Though it should be noted this is speculative and would need to be explored with further research to identify any associations or causal links. Our research lab is conducting a study which aims to examine differences in schizotypy and other behaviors before and during the pandemic, and will examine many of the areas explored in this study. Overall, it may be prudent to replicate the findings of the current study outside of a pandemic setting or observe them longitudinally to assist in our understanding of the stability of both these findings and schizotypy in this population.

Interestingly, higher average problematic technology use prior to the pandemic may speak to the potential for the work-from-home lifestyle adopted by the majority of the country's (and the world's) population to buffer against the impact of PTU. It is possible that these same patterns of PTU would be associated with significant impairment when individuals were engaging in a pre-pandemic lifestyle (i.e. in-person work and socialization) and after these individuals began to work from home, this impairment was mitigated by differences in the work-from-home lifestyle. If an individual who engaged in PTU was suddenly given more time and a structure in which they could engage in personal technology use while also engaging in professional technology use, adverse effects of their PTU may not be as apparent as when the individual needed to commute to an in-person job or class. It is also possible that working from home may be associated with increased time spent on technology for non-professional purposes, and may bring with it unforeseen effects which have yet to be examined. For the time being, this is simply conjecture which we hope to explore in a future study. On a broader scale, additional analyses of the validity and reliability of the DOTUS with a larger sample would also be beneficial to the improvement of this section and the measure overall.

Limitations

This study had a few limitations in its design. First and foremost, while we initially wished to compare our findings to a sample of individual with schizophrenia spectrum diagnoses, we were unable to recruit individuals to our clinical sample during the COVID-19 pandemic and, as such, were limited to an examination of only our college sample. Many avenues in which individuals engage in health behaviors (i.e gyms, running outdoors, etc.) were inaccessible or challenging to engage with during the COVID-19 pandemic. Engagement in physical activity with other individuals would have also been severely limited during this time and it is possible that the stress of living through a global pandemic led to a number of lifestyle changes which may have influenced the health behaviors examined in this study.

Our survey in the college sample relied solely on self-report, which is vulnerable to the effects of performance biases, lack of insight, or inaccurate recollection of time spent on various technological platforms. In regards to our exploration of technology use in this sample, low endorsement of certain platforms (i.e. blogs, health technologies, etc.) suggests that some of our findings related to these areas may be limited. Due to an error on the part of our research team, one of our items examining active Instagram use was missing from the Qualtrics survey software on which this study was administered. As such, our findings regarding active Instagram use and active overall social media use may be limited, especially considering that Instagram was the most widely used technological platform we examined.

We did not apply Bonferroni corrections for multiple comparisons as this is largely an exploratory study and it was possible for such corrections to potentially limit our ability to elucidate meaningful relationships for future research. We were willing to tolerate a high rate of Type I errors with the hope that future studies will sort out any potential Type I errors through replication (or lack of replication).

Our reliability and validity analyses of the DOTUS provided varying levels of support which should be considered when interpreting our current findings. The results of this study should therefore should be verified and replicated by independent research groups.

As stated previously, we cannot infer directionality or causality through regression. While regression interpretations often use words such as “predict”, this states that when a predictor variable changes, there are also changes in the outcome variable. Regressions do not allow us to infer causality or directionality to these identified relationships. As such, additional research is needed to elucidate the nature of these relationships, whether it be causal, reciprocal, or influenced by a third variable.

Conclusions

This study sought to examine relationships between time spent on technology, problematic technology use, and health behaviors. Our goal was to establish a groundwork upon which future research can build, and identify possible avenues for said research. Consistent with previous research (Truzoli et al., 2016), schizotypy predicted problematic technology use and reduced health behaviors. In addition, social media use and video game use predicted decreased health behaviors. The limited clinical significance of the technology related findings may suggest that time spent on a technological platform is not the best predictor of the effects of technology use, but rather how technological platforms are used can better predict the effects of technology use.

Among potential avenues of exploration, active technology use was found to be a promising starting point for future research examining the ways in which technology use can support or hinder functioning. We identified patterns of internet use in individuals with schizotypy to inform future avenues for research into technology use in this population, specifically surrounding Instagram use, health technology use, and video game use. Lastly, our novel technology use measure was found to demonstrate good validity and reliability, and continued exploration and refinement of this measure will likely improve these aspects of the DOTUS. It should be noted once again that the primary motivation for development of the DOTUS was to create a measure which would be easily adapted to new technological trends. Even in the time needed to conduct this study, we saw the explosion in popularity of Tik Tok, a previously unheard-of platform at the time of designing the DOTUS. While this platform is not currently included in the DOTUS, its rapid growth illustrates the need for a modular and flexible technology measure in psychology research. It would be prudent to continue examination of this section of the DOTUS to make adjustments which can improve the reliability and validity of our measure. One such area would be to validate the DOTUS on a larger sample in order to more reliably examine the platforms in the DOTUS which had low endorsement rates in this sample. In addition, validation of the DOTUS in a diverse sample would allow for greater representation of diverse populations not examined by this study, which is an especially important aspect of developing measurements. We will continue to rigorously examine the validity and reliably of the DOTUS framework and will incorporate new technologies into the next iteration of this measure. We encourage other researchers to replicate our work, to build upon the findings of this study, and to continue to explore both the detrimental and the beneficial effects of technology use in the schizophrenia spectrum and beyond.

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Appendix A

Purpose, Hypotheses, and Methods Sections for Our Clinical Sample

Hypotheses

In terms of specific facets of technology use, we hold three hypotheses (denoted a-c) for each sample. In our clinical sample, where baseline levels of physical activity and cognitive functioning tend to be lower, we hypothesize that (a) greater use of health technologies will predict increased levels of physical activity and decreased internet addiction scores; (b) greater use of social media will predict increased levels of physical activity and decreased internet addiction scores; and (c) greater use of video games will predict increased levels of physical activity and decreased internet addiction scores. Although we have stated hypotheses, we also acknowledge that studying technology use comes with a myriad of unforeseen variables which may influence the relationships between technology use and our outcome variables. Therefore, the influence of social media and video game use on physical activity and internet addiction in both of our samples will likely vary contingent on the type of platform and manner in which the platform is used, in ways we are likely unable to predict at this time.

Procedure

This study will use a cross sectional design in two samples. Participants in the non-clinical sample will complete a 30-minute online questionnaire through Qualtrics survey software as part of an hour and half long research paradigm examining cognitive functioning, sexual behavior, lifestyle habits, and technology use.

Participants in the clinical sample will receive the same questionnaire (with different measures examining symptom severity) as part of a larger clinical intake interview for a smoking cessation study. Interested participants will be given basic information about the study and the opportunity to ask questions, after which the participant will be asked for permission to consult their treatment team and medical records. If approved, eligibility will be determined based on a medical record review and a conversation with the participant's psychiatrist or case manager. If eligible, the participant will be given the opportunity to schedule a consenting and intake session, during which the measures for this study will be administered.

Participants

Non-clinical sample

We aim to recruit 250 undergraduate students from Rowan University in Glassboro NJ for our non-clinical sample. Undergraduate participants will be recruited over the course of at least one year as part of a larger study via the Rowan University Psychology Subject Pool system (SONA). Participants must be Rowan University students over the age of 18 and eligible to receive credit through SONA in order to participate. These participants will be compensated with research credit for their introductory psychology courses.

Clinical Sample

We aim to recruit approximately 30 individuals with a diagnosis of schizophrenia from the Department of Psychiatry at Cooper Medical School of Rowan University (CMSRU) in Camden, NJ. Participants will be a part of a larger clinical trial examining the efficacy of a smoking cessation program.

The smoking cessation trial has a number of inclusion and exclusion criteria. Participants must: (a) be diagnosed with schizophrenia or schizoaffective disorder (i.e. a schizophrenia-spectrum disorder -SSD) by a board-certified psychiatrist, confirmed by a Structured Clinical Interview for DSM-5 (SCID), (b) be stable outpatients, including those who are have not been hospitalized in the past 6-months and have evidence of symptom stasis (c) be ages 19 to 65 years old, (d) smoke > 5 cigarettes per day, (e) have an initial CO reading > 8 ppm, (f) engage in regular smoking for > 2 years, (g) have a desire to quit smoking, and (h) be able to complete the training procedures. Participants will be allowed to continue any smoking cessation pharmacotherapy (e.g., nicotine replacement, Chantix) from the time of enrollment. Participants will be excluded from the clinical trial if they: (a) report smoking other combustible products > 2 times per month, (b) report medical conditions that might interfere with the intervention due to CO contamination (e.g., asthma, COPD), (c) report unavoidable exposure to second hand smoke, (d) have an inability to learn how to use the smartphone applications independently.

Measures

Symptom Severity Measures for the Clinical Sample

The Structured Clinical Interview for DSM-5 (*SCID-5; First, Williams, Karg, & Spitzer, 2016*) is a semi-structured interview guide for making DSM-5 diagnoses. The SCID-5 can be used in the context of a clinical intake interview, in which questions are provided in accordance with DSM-5 criterion. This diagnostic tool contains questions for diagnosis of most mental illnesses presented in the DSM-5 (including schizophrenia spectrum disorders). The SCID-5 has good internal consistency ($\alpha > 0.80$) as well as test-retest reliability, concurrent, and predictive validity (Shankman et al., 2018).

The Brief Psychiatric Rating Scale (BPRS; Overall & Gorham, 1962) is a clinical rating scale used to measure symptom severity of depression, anxiety, hallucinations, and bizarre or unusual behavior. A total of 24 symptoms are rated by a clinician or interviewer on a 7-point scale. This measure is shown to have good internal consistency (α = 0.76-0.91) (Nicholson, Chapman, & Neufeld, 1995).

Positive and Negative Syndrome Scale (PANSS; *Kay, Fiszbein, & Opler*, *1987*) is used to measure symptom severity of individuals with schizophrenia spectrum disorders. Individuals are rated using a 7 point scale on 30 different symptoms during a clinical interview (and sometimes based on reports of family members or hospital workers). Symptom ratings are clustered into a “positive scale”, a “negative scale” and a “general psychopathology scale”. Each scale has demonstrated good internal consistency (α= 0.73, 0.83, and 0.79; for positive, negative, and general, respectively) (Kay et al., 1987).

Analysis of the Clinical Sample

In approaching confirmatory analysis in our clinical sample, we acknowledge that our sample size (n=30) is far too small to conduct a sound regression. Therefore, we must take a slightly different analytic approach in our confirmatory analyses with this sample. We will conduct a Bayesian analysis using the descriptive statistics from our non-clinical sample as our “priors”: estimations of the “true” means and deviations of our parameters of interest. We will then use AIC and BIC, estimators of the quality of statistical models, to make our statistical inferences in the Bayesian model comparison. We will compare AIC and BIC between our three models (demographics only, demographics and clinical symptoms, and full model) to make inferences about the predictive power of our models on each of our outcome variables (physical activity and internet addiction). A model with a lower AIC or BIC is seen as a model that better captures the relationships in the data, compared to other models tested.

For our exploratory analysis, we will conduct a factor analyses to identify the main areas of technology use, then we will use bivariate correlations and graphical methods to elucidate relationships between specific symptom presentations and technology utilization. Specifically, we wish to examine relationships between specific technological platforms, active and passive technology use, health technology, and schizophrenia spectrum symptomology.

Appendix B

Supplemental Tables and Figures

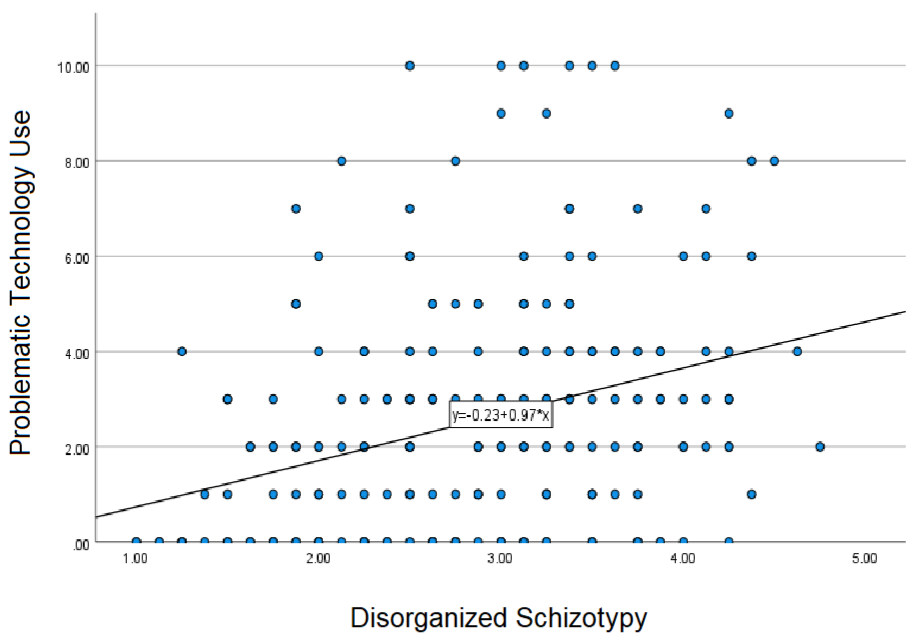
Table B1

Representation of racial groups in the sample of college students (N=227)

Race	Frequency	Percent of Sample
White	138	60.8%
Latino/Latina	17	7.5%
Black	41	18.1%
Native American	2	0.9%
Asian American/Pacific Islander	8	3.5%
Mixed Race	17	7.5%
Other	4	1.8%

Figure B1

*Scatterplot of Disorganized Schizotypy and Problematic Technology Use**



*Problematic Technology Use was measured by the PTU subsection of the DOTUS, which was modeled on the MAST (Selzer, 1971)

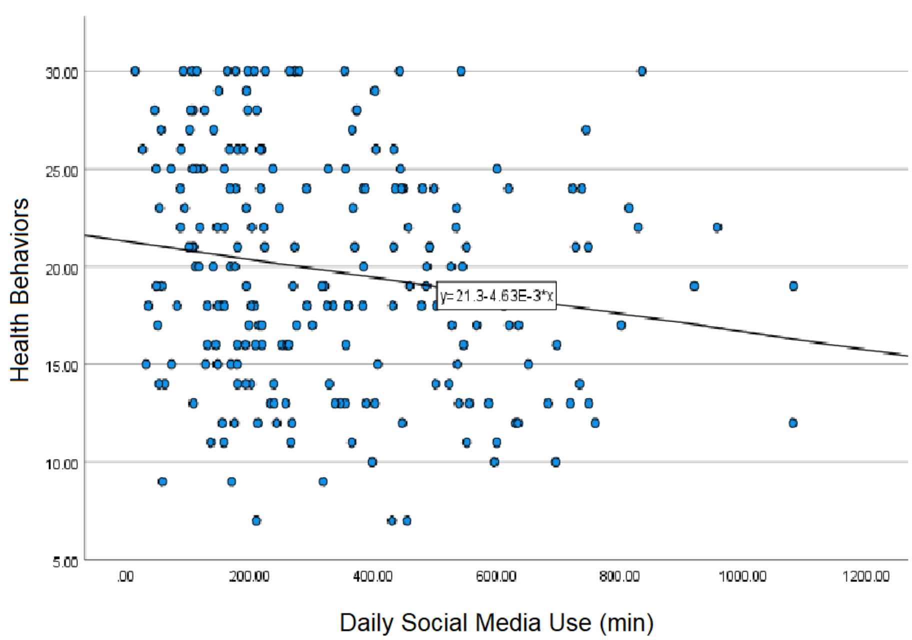
Figure B2

*Scatterplot of Interpersonal Schizotypy and Health Behaviors**

*Health Behaviors are measured by the health subsection of the Lifestyle Habits Questionnaire (LHQ)

Figure B3

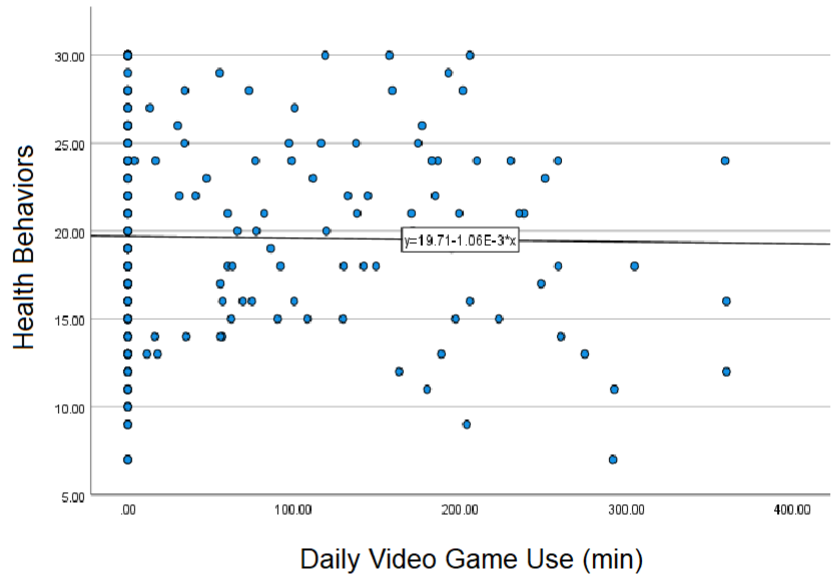
*Scatterplot of Daily Social Media Use and Health Behaviors**



*Health Behaviors are measured by the health subsection of the Lifestyle Habits Questionnaire (LHQ)

Figure B4

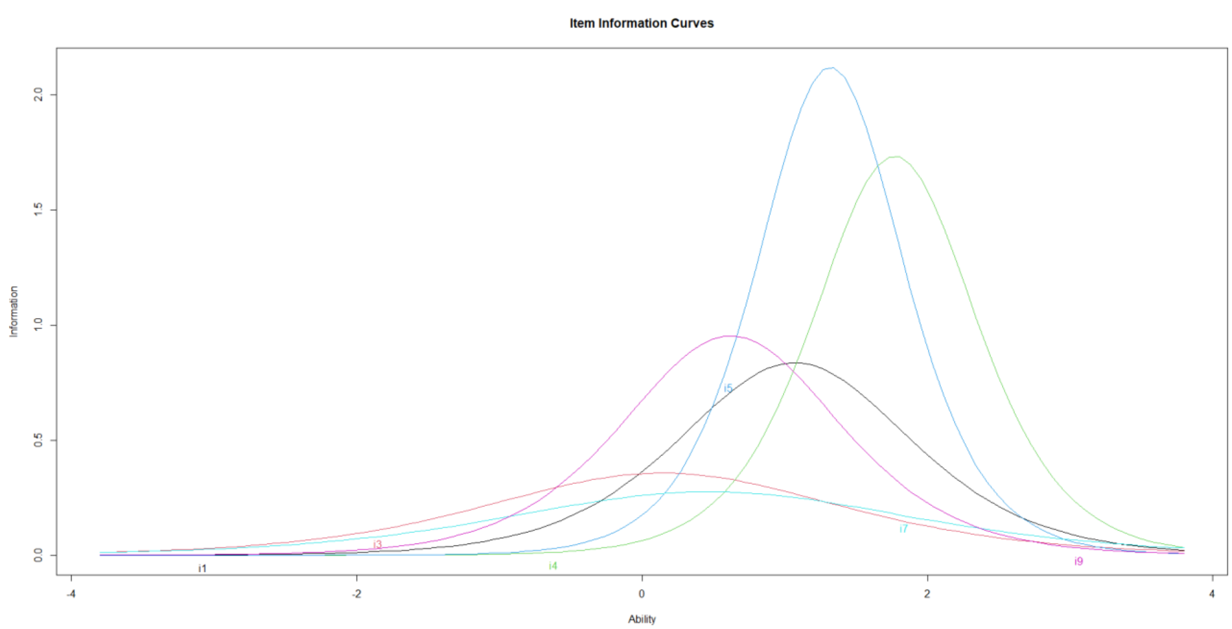
*Scatterplot of Daily Video Game Use and Health Behaviors**



*Health Behaviors are measured by the health subsection of the Lifestyle Habits Questionnaire (LHQ)

Figure B5

Item Information Curve for the Remaining PTU Items in the DOTUS



Appendix C

Domains of Technology-Use Survey (DOTUS) Items Used in This Study

The following items ask questions about your technology and internet use. Please note that when we ask for the amount of minutes spent on a certain site or app, we are asking for the total time spent in an entire day, not at one time. Please respond regarding your typical use, not during times of atypical use (i.e., more time spent online due to holiday or birthday shopping, etc.). There are no right or wrong answers.

1. How many days off (days in which you don't have obligations like class or a job) do you have in a typical work and/or school week? ______

2. How often do you find yourself scrolling through social media when you should be studying or doing homework?

   Never **Rarely** **Sometimes** **Often** **Always**

3. Do you find yourself going onto social media apps to refresh your feed even though only a few minutes have passed and nothing new has been posted?

   Never **Rarely** **Sometimes** **Often** **Always**

4. Do you use or view Facebook at least once a month?

   YES **NO**

   How many minutes do you spend per day on Facebook <u>on an average work or school day</u>?

Less than 5 minutes ---Over 6 hours a day

On average days off?

Less than 5 minutes ---Over 6 hours a day

In regards to your Facebook use, how regularly do you submit posts or submit comments on someone else's post?

Never **Rarely** **Sometimes** **Often** **Always**

In regards to your Facebook use, how regularly do you just view your newsfeed or like someone else's post without commenting?

Never **Rarely** **Sometimes** **Often** **Always**

5. Do you use or view Instagram at least once a month?

YES **NO**

How many minutes do you spend per day on Instagram <u>on an average work or school day</u>?

Less than 5 minutes ---Over 6 hours a day

On average days off?

Less than 5 minutes ---Over 6 hours a day

In regards to your Instagram use, how regularly do you submit posts or submit comments on someone else's post?

Never **Rarely** **Sometimes** **Often** **Always**

In regards to your Instagram use, how regularly do you just view your feed or like someone else's post without commenting?

Never **Rarely** **Sometimes** **Often** **Always**

6. Do you use or view Twitter at least once a month?

YES **NO**

How many minutes do you spend per day on Twitter <u>on an average work or school day</u>?

Less than 5 minutes --Over 6 hours a day

On average days off?

Less than 5 minutes --Over 6 hours a day

In regards to your Twitter use, how regularly do you submit posts, retweet someone else's tweet, or comment on someone else's post?

Never Rarely Sometimes Often Always

In regards to your Twitter use, how regularly do you just view your Twitter feed or like someone else's post without commenting?

Never Rarely Sometimes Often Always

7. Do you use or view Snapchat at least once a month?

YES NO

How many minutes do you spend per day on Snapchat <u>on an average work or school day</u>?

Less than 5 minutes --Over 6 hours a day

On average days off?

Less than 5 minutes --Over 6 hours a day

In regards to your Snapchat use, how regularly do you send pictures:
Never Rarely Sometimes Often Always

In regards to your Snapchat use, how regularly do you post to your story:

Never Rarely Sometimes Often Always
In regards to your Snapchat use, how regularly do you view a friend's story:

Never Rarely Sometimes Often Always

In regards to your Snapchat use, how regularly do you view a discover story:

Never Rarely Sometimes Often Always

In regards to your Snapchat use, how regularly do you respond to other people's pictures:

Never Rarely Sometimes Often Always

How often do you respond to other people's pictures with a (percent response):

Picture Comment I do not respond to pictures

8. Do you use or view blogs at least once a month? (including, but not limited to: Tumblr, WordPress, Blogger, etc.)

YES NO

How many minutes do you spend per day on blogs <u>on an average work or school day</u>?

Less than 5 minutes ---Over 6 hours a day

On average days off?

Less than 5 minutes ---Over 6 hours a day

In regards to your blog use, how regularly do you post to your blog, reblog a post, or submit comments on someone else's post?

Never Rarely Sometimes Often Always

In regards to your blog use, how regularly do you just view your newsfeed or like someone else's post without commenting?

Never Rarely Sometimes Often Always

9. Do you use or view forum based websites at least once a month? (including, but not limited to: reddit, 4chan, Pinterest, etc)

YES NO

How many minutes do you spend per day on forum based websites <u>on an average work or school day</u>?

Less than 5 minutes ---Over 6 hours a day

On an average day off? _____

Less than 5 minutes ---Over 6 hours a day

In regards to your use of forum based websites, how regularly do you submit posts or comment on someone else's post?

Never Rarely Sometimes Often Always

In regards to your use of forum based websites, how regularly do you just view your feed or like (upvote/downvote) someone else's post without commenting?

Never Rarely Sometimes Often Always

10. Do you play video games at least once a month?

YES NO

If yes,
What is your primary gaming platform? Enter the percentages to each of the following categories indicating how you typically game (should add to 100%)

PlayStation (i.e. PS3, PS4) Nintendo (i.e. DS, Gamecube, Switch) Xbox (i.e. Xbox One)

PC (Laptop or desktop) Mobile Device (i.e. smartphone)

How many minutes do you spend per day playing video games <u>on an average work or school day</u>?

Less than 5 minutes --Over 6 hours a day

On average days off? _____

Less than 5 minutes --Over 6 hours a day

Specify console(s) ____________________

Specify game(s) ____________________

What types of games do you typically play: (textbox)

Are you able to communicate with friends or other players on these games? (e.g., Xbox live, etc).

YES **NO**

If yes how often do you: choose to communicate with other players?

Never **Rarely** **Sometimes** **Often** **Always**

Do you prefer multi-player or single player gaming modes?

MULTI-PLAYER **SINGLE PLAYER** **DEPENDS ON GAME**

How often do you play console video games with people that you know?

Never **Rarely** **Sometimes** **Often** **Always**

11. Do you use health-based technology (i.e. Fitbit) or health based mobile apps (i.e. Health, Fitocracy, Habitica, Track My Run, etc.) at least once a month?

YES **NO**

How many minutes do you spend per day on health-based technologies or apps <u>on an average work or school day</u>?

Less than 5 minutes --Over 6 hours a day

On average days off?

Less than 5 minutes ---Over 6 hours a day

How often do you use health-based technologies or apps with other people (i.e. competing to get more steps, exercising or tracking food together, etc)?

Never **Rarely** **Sometimes** **Often** **Always**

12. Has a close relative or friend every expressed worry or complain about your technology use?

    Yes **No**

13. Can you stop using the technology you use the most without difficulty? (e.g., stop for a week)

    Yes **No**

14. Do you ever feel guilty about your use and time spent on technology?

    Yes **No**

15. Has your use or time spent on technology created problems between you and a close relative or friend?

    Yes **No**

16. Has any close relative or friend ever discussed your use and time spent on technology with others?

    Yes **No**

17. Have you ever lost friends because of your use and time spent on technology?

    Yes **No**

18. Have you ever gotten in trouble at school or work because of your use of technology?

    Yes **No**

19. Have you ever lost a job because of your use or time spent on technology?

Yes **No**

20. Have you ever neglected your obligations, family, or work because of your use and time spent on technology?

    Yes **No**