



Adolescent Technology Use: Profiles of Distinct Groups and Associated Risky Behaviors

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Abstract

Introduction: Adolescents make regular use of a wide range of technologies, such as console video games, mobile phones and a variety of Internet applications. Although this usage is not problematic for most individuals, some adolescents do use them excessively.

Objective: The main objective of this article is to explore the presence of clusters within a sample of adolescents based on dimensions associated with risky behaviors (substance use, gambling and delinquency) and problematic use of technologies (Internet and console video games).

Methods: The sample consists of 1,870 adolescents in the 14-18 year age group who were recruited in French-language high schools in Québec (Canada).

Results: The main results showed that one in ten adolescents was a high Internet user. A cluster analysis identified three groups of participants: non-problematic boys, non-problematic girls, and adolescents with multiple problems. The latter group included all of the high Internet users and some high video game users. These participants had the highest severity scores for substance use and delinquency and received higher scores for psychological distress, impulsivity and sensation seeking.

Conclusions: These results support the presence of a subgroup of adolescents with high levels of co-occurring risky behaviors and suggest that excessive use of technology may also be a characteristic of this group.

Keywords: Internet addiction; Adolescent; Cluster analysis; Substance use; Gambling; Delinquency; Risk behaviors

Introduction

The expansion of the technology sector in recent years has led to a complete transformation of the entertainment activities available to adolescents. The variety of video game consoles and Internet applications, such as social networks, informational sites and blogs, has increased substantially [1]. Adolescents, who have grown up with these technologies, use the Internet [2,3] and video game consoles regularly [4,5]. Despite the abundance of technologies and availability of the Internet, a large proportion of youths (43%) are considered "low" Internet users (less than 10 hours per week) while 32% are "average" users (between 11 and 20 hours per week), and 25% are "high" users (20 hours or more per week) [6]. Although the use of technology is part of life and is pleasant for most youths, the high use made by some of them could be qualified as an Internet or technology addiction [7,8].

Since the mid-90s, various researchers and clinicians have emphasized the addictive potential of the Internet [9,10]. Twenty years later, there is still no consensus as to the very existence of this concept [11,12]. The DSM-5 [13] has not resolved this issue since the term

« Internet Gaming Disorder » has been listed as a disorder requiring further study. Three obstacles are possibly involved in the DSM-5 authors' decision. The first one concerns the difficulty in identifying the object or the specific application related to the Internet dependence [14,15]. The second obstacle relates to the nature and intensity of the consequences caused by this disorder. The third one concerns the many methodological limitations of the studies that have been done so far, as well as the lack of consensus on the diagnostic criteria [16].

While researchers believe it is premature to include Internet addiction in the DSM-5, people declare themselves cyber dependent and seek for help [17,18]. Internet addiction can be defined as an impulsive and uncontrollable need to use the Internet, causing functional difficulties or a clinically significant distress [16,19]. Internet addiction is particularly associated with excessive Internet use (sometimes measured in terms of hours), loss of sense of time, and the need to be online more often or for longer periods than what was originally planned [15,18,20]. Adolescents who are addicted to the Internet or to video games also report a variety of consequences, including isolation, difficulties in school, interpersonal problems as well as physical and psychological health problems [1,21,25-27]. Furthermore, they are more likely to engage in risky behaviors, such as substance use [22,28], gambling [23,29,30] or delinquency [28]. For

example, research by Desai et al. [21] shows that gaming problems among youths are associated with regular use of tobacco and drugs as well as being in serious fights. Villella et al. [23] found significant correlations between the scores for Internet addiction and for gambling problems. These studies suggest that problematic use of technology is associated with at least one risky behavior [21,23]. However, none of these studies consider all potentially addictive behaviors at the same time, which limits the scope of their conclusions.

According to Turner, Ialomiteanu, Paglia-Boak and Adlaf [31], the correlations found between various risky behaviors (gambling, alcohol, drugs, delinquency) suggest the existence of a single underlying problematic population, meaning that those who are at high risk for one type of problem are also at high risk for other problems. The general deviance model supports this finding [32]. According to this model, problematic behavior during adolescence increases the risk of other problematic behaviors because of the associated contextual opportunities. For example, youths who take drugs soon turn to drug trafficking as a means to finance their use, or those engaging in deviant activities may purchase substances to deplete their income generated from crime without attracting attention [33]. However, even if the Internet is not in itself a risky behavior and that it can bring a lot of benefits, we do not know if high users of technology are part of this same group of problematic youths presenting multiple risky behaviors. The co-occurrence of the links between substance use, delinquent behaviors and gambling activities are well documented [34-37]. Fewer studies have integrated the use of video game consoles and the Internet in general as behaviors that could be associated with risky behaviors. Since some authors include technology addiction in the broad family of addictions [38], it would be relevant to take into account Internet and video gaming habits to better understand the constellation of all "at-risk" behaviors [32] in adolescence.

This article aims mainly at exploring the presence of clusters within a sample of adolescents according to the severity of risky behaviors (substance use, gambling and delinquency) including the use of technologies (Internet and console video games). The key question in the present study is whether or not adolescents who make high use of technology are all part of the same problematic group, or if they form a different subgroup.

Methods

Participants

A total of 1,878 French-speaking high school students completed the questionnaires voluntarily in their classroom, during a period dedicated to this research project. The participation rate was 96%. Eight participants were excluded because of missing data (>50%). The final sample consisted of 1,870 students (45.9% male, 54.1% female) aged 14 to 18 years (mean=15.43 years, SD=0.97). They were in grade 9 (33.2%), 10 (32.8%) or 11 (31.7%). Almost all the participants described themselves as being of Canadian/Québec origin (92.9%).

Procedures

Between April 2006 and May 2007, study interviewers recruited participants during regular visits to all major street youth agencies in Montreal (Canada). These included drop-in centers, emergency shelters, or outreach vans offering a range of services such as food, short-term housing, and social and preventive healthcare services. Visit frequency, based on the number of youth served by each agency,

ranged from once a month to three times a week. All youth present in the organization were invited to participate in the study. Those who accepted were given an appointment for their interview at the study office, located in the downtown area where most homeless youth hang out. The majority of interviews were done in the afternoon or early evening to minimize the possibility of participants being intoxicated. Interviews included the signing of a consent form, collection of contact information, and completion of an interviewer-administered questionnaire. Participants received a financial compensation (CAD \$30) at the end of the interview.

Materials

The study data were collected, during 2007 and 2008, from a larger cross-sectional study on Internet gambling among youths [37]. The study design conformed to the ethical standards for research with human subjects. The participants completed six questionnaires in class, under the supervision of a research assistant. They were administered a series of socio-demographic questions (age, gender, language spoken at home, ethnicity, school grade), as well as the following questionnaires:

A) **Gambling:** The Diagnostic and Statistical Manual of Mental Disorders-IV-Adapted for Juveniles (DSM-IV-MR-J) [39] include nine criteria related to pathological gambling. Referring to the past 12 months, participants were to indicate whether they had been affected by each of the criteria by indicating the frequency according to a 4-point Likert-type scale. Each answer was then converted into a dichotomous variable (0,1). The scale scores ranged from 0 to 9 points. A score of 0 or 1 point represents non-problem gamblers, a score of 2 or 3 points represents at-risk gamblers, and a score of 4 points or more represents probable pathological gamblers [39]. A score of zero was assigned to non-gamblers. In this sample, Cronbach's alpha is 0.75.

B) **Internet and video game use:** The instrument used was a descriptive questionnaire asking the amount of time spent on the Internet for all applications combined (e.g. Facebook, Youtube, email, chat, school research) and of time spent playing console video games per week on average. The extreme scores were replaced with the highest acceptable value between 3.29 and 3.29 (Z-score distribution) [40]. This process was applied until all scores were located within this interval. High Internet users (HIUs) and low Internet users (LIUs) were divided according to their percentile rank. Adolescents who scored above the 90th percentile (25 hours per week or more) were categorized as HIUs with a rating of 1 (11.6% of the sample), whereas the LIU group received a rating of 0. The procedure was the same for video game use. Adolescents with scores above the 90th percentile (10 hours per week or more) were categorized as high video game users (HVGs) with a rating of 1 (11.3% of the sample). The low video game users (LVGs) were rated 0.

C) **Alcohol and drug use:** The Screening Grid for Detection of Alcohol and Drug Problems in Adolescents (DEP-ADO) [41] includes 17 items based on the following factors: frequency of use of various substances during the previous 12 months according to a 6-point Likert-type scale, age when the person started consuming alcohol or other drugs, whether the person takes intravenous drugs, whether he or she engages in binge drinking, as well as the consequences of the subject's substance use. The scale scores ranged from 0 to 79 points. Participants who received between 0 and 13 points are classified as no problem, between 14 and 19 points, as an emerging problem, (front-line intervention is deemed advisable) and 20 points or more, as an obvious problem (intervention by a specialized resource is

recommended). Because of missing data, the severity index could not be calculated for 199 participants. In this sample, Cronbach's alpha is 0.85.

D) **Delinquent behavior:** The delinquency subscale of the Measures of social and personal adaptation for Québec adolescents (MASPAQ) [42] consists of 27 items representing delinquent behaviors (e.g. theft, aggression, breaking and entering, illegal possession of firearms). The score takes into account the range of delinquent behaviors marking the participant's lifetime, together with the age at which any such behavior first occurred and its frequency in the year preceding the survey according to a 4-point Likert-type scale. Tables proposed by the author allow us to place scores on a continuum. A clinical score lower than 40 or higher than 60 revealed a problem. In this sample, Cronbach's alpha is 0.85.

E) **Psychological distress:** The Index of psychological distress from the Québec Health Survey (IDPSQ14) [43] is an abbreviated validated French version of the Psychological Symptom Index [43,44]. The 14-item scale examined four dimensions depression, anxiety, irritability and cognitive impairment. The scale scores ranged from 14 to 56 points. A score between 14 and 26 points represents "low distress," between 27 and 31 points, "average distress" and between 32 and 56 points, "high distress" [43]. In this sample, Cronbach's alpha is 0.91.

F) **Impulsivity and sensation seeking:** These dimensions were measured using an abbreviated version of the Eysenck Personality Questionnaire [45,46], validated in French for a Québec adolescent population [47]. The scores ranged from 0 to 5 points for both scales. Vitaro et al. [47] reported that participants below the 70th percentile present high impulsivity or high sensation seeking. In this sample, a score of 3 or more represents high impulsivity, whereas a score of 5 represents high sensation seeking. In this sample, Cronbach's alpha is 0.73 for the impulsivity scale and 0.67 for the sensation-seeking scale.

Statistical Analyses

An exploratory approach was used to identify groups of participants based on the "two-step cluster analysis" statistical procedure [48]. This approach is recommended for identifying distinct groups within large

samples and it can integrate the analysis of categorical, dichotomous and continuous variables [49,50]. The procedure automatically selects the optimal number of groups for the sample (SPSS, Chicago, Illinois, USA). This analysis consists of a procedure similar to a "k-means" cluster analysis that groups participants based on their similarities (Euclidian distance). A cluster analysis determines the mathematical proximity of cases and then groups those which are closest to the selected variables [51]. Second, the analysis uses a modified "hierarchical cluster" procedure that combines individuals sequentially to form groups (clusters) that are maximally homogenous. The optimal solution is automatically determined based on the Schwarz Bayesian Information Criterion (BIC) model fit index [50]. The solution is fixed when the BIC change between adjacent numbers of clusters is small [49]. The distance measure between the groups is also checked, a greater distance indicating a better solution [50]. Finally, chi-squared tests of association and analyses of variance (ANOVAs) are performed to compare the differences between the groups and to confirm the empirical value of the proposed solution.

Results

Cluster analysis and follow-up analyses

The following variables were introduced into the model to group the participants according to the following criteria: gender, Internet user category (HIU or LIU), video gamer category (HVG or LVG) and severity of substance use, gambling habits and delinquency. The bivariate correlation analysis indicated that the associations between these variables were not collinear. The correlations between the variables were low to moderate and ranged from $r=0.05$ to $r=0.54$ (Table 1). The two-step cluster analysis highlighted a three-group solution with a BIC fit index of 6434.252; the distance measure ratio was 2.262, compared to 1.763 (two-group solution) or 1.365 (four-group solution). The following three groups were identified: 888 of the participants (47.5%) were non-problematic girls (NPGs), 695 of the participants (37.2%) were non-problematic boys (NPBs), and 289 of the participants (15.1%) were adolescents with multiple problems (AMPs).

	1	2	3	4	5	6
1) Gender	--					
2) Age	-0.05*	--				
3) Internet	-0.06*	0.04	--			
4) Video games	-0.34***	0.05*	0.19***	--		
5) PSU	-0.06*	0.23***	0.04	0.07*	--	
6) PG	-0.12***	0.09***	0.09***	0.09***	0.27***	--
7) Delinquency	-0.07***	0.04	0.10***	0.07***	0.54***	0.25***

Table 1: Pearson bivariate correlation matrix; problems with substance use (continuous score); gambling problems (continuous score); <0.001

The NPG group consisted of female adolescents who did not make high use of the Internet or video game consoles. They were significantly younger than the members of the AMP group but were similar in age to the NPB group. The NPGs' scores for substance use, gambling and delinquency were significantly lower than the AMPs' scores but were comparable to those of the NPBs.

The NPB group consisted of male adolescents and their average age was comparable to that of both the NPGs and the AMPs. All the NPBs were categorized as LIUs, while 18.4% were classified as HVGs and represented 61% of the latter group. The NPBs' scores for substance use, gambling and delinquency were similar to those of the NPGs and lower than those of the AMPs.

The AMP group consisted of both female (43.5%) and male (56.5%) adolescents. Members of this group tended to be older than the members of the NPG group, but similar in age to the members of the NPB group. This group included all the HIUs. Moreover, 29% of these adolescents were classified as HVG group members and represented 39% of the HVGs. The AMPs also had higher scores for substance use, gambling and delinquency compared with the NPGs and NPBs. This group differed from the two others in that they exhibited multiple problems (Table 2).

	NPG n=888	NPB n=695	AMP n=283	χ ² (df)
Gender	0%	100%	56.5%	1585.88*** (2)
Male	100%	0%	43.5%	
Female				
Internet use	100%	100%	24.0%	1359.24*** (2)
Average	0%	0%	76.0%	
High user				
Video games	100%	81.6%	71.0%	237.30*** (2)
Average	0%	18.4%	29.0%	
High user				
	Mean (SD)	Mean (SD)	Mean (SD)	F
Age	15.37 ^a (0.96)	15.43 ^{ab} (1.00)	15.58 ^b (0.93)	4.84*
PSU	5.39 ^a (6.00)	5.41 ^a (5.82)	10.09 ^b (10.74)	56.00***
PG	0.07 ^a (0.30)	0.13 ^a (0.40)	0.71 ^b (1.60)	115.40***
Delinquency	49.08 ^a (6.15)	49.68 ^a (6.37)	58.44 ^b (14.04)	165.21***

Table 2: Variables used in the clustering analysis; Notes: Means that do not share the same superscript letter were significantly different based on the Scheffé test (p<0.05). PSU=problems with substance use (continuous score). PG: gambling problems (continuous score); NPG: non-problematic girls; NPB: non-problematic boys; AMP: Adolescents with multiple problems. *p<0.05, ***p<0.001

With regard to video games, the AMPs reported spending an average of 5.5 hours per week, compared with an average of 4.4 hours per week for the NPBs and an average of 1.2 hours per week for the NPGs (F (2,1863)=240.36, p<0.001) (Table 3).

	NPG n = 888	NPB n = 695	AMP n = 283	F	Partial η ²
	Mean (SD)	Mean (SD)	Mean (SD)		
Internet (hours/ week)	8.01 ^a (5.60)	8.94 ^b (5.86)	27.40 ^c (11.84)	881.55***	0.488
Video games	1.16 ^a	4.40 ^b	5.53 ^c	238.73***	0.205

(hours/ week)	(1.29)	(4.46)	(5.61)		
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Table 3: Technology use by the three adolescent groups

Discussion

The objective of this study was to explore the presence of groups to determine if high technologies use is associated with co-occurring risky behaviors among adolescents. The cluster analyses revealed the presence of three distinct groups (AMPs, NPGs and NPBs) that differed in terms of many variables, such as gender, technology use, and addictive and delinquent behaviors. These groups also show differences according to the psychological dimensions. First, the NPG group, which consisted entirely of non-problematic female adolescents, and the NPB group, which consisted entirely of non-problematic male adolescents, exhibited variability that would generally be expected based on adolescent gender differences. The NPGs were characterized by a higher level of psychological distress, but the NPBs' sensation-seeking mean score exceeded that of the NPGs. Many studies have documented these characteristic differences between females [52-54] and males [55,56] during adolescence.

Psychological dimensions

The NPB group received an average score for psychological distress of 24.23. This score was significantly lower than the NPGs' average score (28.82), which was similar to that of the AMPs (29.54) (F (2, 1845)=97.50, p<0.001). The AMPs' average impulsivity score of 2.40 was significantly higher than the average score of 1.73 for the NPBs and that of 1.64 for the NPGs (F (2, 1832)=23.97, p<0.001). Finally, the NPGs' average sensation-seeking score of 3.56 was lower than the NPBs' average score of 3.89, which was similar to the AMPs' average score of 3.92 (F (2, 1837)=13.57, p<0.001) (Table 4).

	NPG n=888	NPB n=695	AMP n=283	F	Partial η ²
	Mean (SD)	Mean (SD)	Mean (SD)		
Psychological distress	28.83 ^b (7.20)	24.25 ^a (6.66)	29.53 ^b (8.03)	94.46***	0.095
Impulsivity	1.64 ^a (1.59)	1.73 ^a (1.55)	2.40 ^b (1.79)	23.97***	0.025
Sensation- seeking	3.56 ^a (1.43)	3.89 ^b (1.35)	3.92 ^b (1.40)	13.57***	0.015

Table 4: Psychological dimensions of the three adolescent groups; Notes: Means that do not share the same superscript letter were significantly different based on the Scheffé test (p<0.05). NPG: non-problematic girls; NPB: non-problematic boys; AMP: Adolescents with multiple problems. ***p<0.001

With respect to risky behaviors, the NPGs and NPBs were similar in terms of substance use, gambling and delinquency, but not in terms of technology use. The NPGs did not devote a great deal of time playing console video games, and the NPB group was distinguished by its number of high video game users. However, it is important to specify that the average number of hours per week that high video game users spend on video games is relatively low. Although some adolescents

stand out from the average due to a higher number of hours, this is not necessarily indicative of an addiction. The time devoted to playing video games might be regarded as an integrative practice at this stage of development. This would be especially true for boys. Kutner and Olson [57] and Desai et al. [21] claimed that, in contrast with female adolescents' activities, video games are a normative activity for male adolescents that might be central to their social life. Furthermore, when examining these activities, one must consider the developmental transition that makes adolescents more likely to engage in behaviors that may appear to involve an addiction but that do not typically endure over time [1,58,59].

The AMPs were markedly different from the NPGs and NPBs. First, the AMPs consisted of both female and male adolescents; therefore, both genders were found to be at risk of engaging in problematic behaviors. This finding is consistent with the results of other studies that have investigated problematic behaviors, such as substance use [60,61]. According to Cazale et al. [60], the proportion of female and male adolescents who exhibited substance use problems was equivalent in their last survey. With regard to delinquency, the differences between males and females also appear to be decreasing. Some studies have found an increase in violent crimes among female adolescents, although male adolescents have a tendency to commit more serious crimes than female adolescents [62].

Second, the AMPs were distinct both in their Internet use and in exhibiting multiple problems. The AMP group reported using more Internet applications and spending three times more hours per week using the Internet and playing console video games compared with the other two groups. All of the adolescents who made high use of the Internet were found in this group. The AMPs also exhibited the highest scores for severity of substance use, gambling and delinquency, as well as higher levels of impulsivity. However, the AMP group exhibited the same level of psychological distress as the NPG group and the same level of sensation-seeking behavior as the NPB group. The identification of a group of adolescents with multiple problems confirms the findings of Desai and Krishnan-Sarin [21], who reported that adolescents addicted to technology were more likely to engage in risky behaviors, including the use of tobacco and drugs, and were more likely to suffer from depressive symptoms. This relatively small group of participants exhibited the most severe problems and risky behaviors. Other studies that have investigated addiction without considering Internet use have also reported subgroups of adolescents with multiple problems [34,63]. This article shows that high users of technology seem to be part of this same multi-problem subgroup. Several theories can explain this clustering of problematic behaviors. Thus, for Jessor and Donovan [32] as well as for Vitaro et al. [34] the existence of common risk factors may contribute to the presence of multiple problems in adolescents. For Kardefelt-Winther [12], excessive Internet use would be a way to compensate for different psychosocial problems, a way to cope with problems. This conception of the excessive use of Internet as a coping strategy for life problems is similar to Davies' [64] idea regarding the function of substances. Suddenly, alcohol, gambling, and now the Internet, could all be conceptualized as coping strategies. Although the present research cannot provide causal explanations, the results support the importance of evaluating the technology use of adolescents who exhibit other problematic behaviors.

The limitations of the current study must be considered when interpreting the results. First, the scope of the results is limited by the lack of use of a validated questionnaire allowing for the establishment

of a diagnosis of Internet Addiction. In fact, it is important to point out that the categories of Internet and video game users were determined according to the number of hours spent per week on the activity. Although the questions on time spent are correlated with Internet addiction, it cannot be interpreted as a diagnosis of a technology addiction [4,21,25]. Further studies using validated diagnostic instruments like the Internet Addiction Test10 should be performed. Secondly, the data were collected from 2007 to 2008 when social networks were just beginning to gain in popularity and when electronic tablets (Ipad) and smart phones did not yet exist. Since that time, the technology sector has developed exponentially. Thus, the cut-off point, in terms of hours spent, that was used in this study is probably no longer valid. However, the Internet use presented by the youths in the AMPs group was three times higher than that of other groups. Future studies should therefore take into account both, the previous studies that have been done, as well as the new norms regarding Internet use that evolve very quickly. Finally, the questionnaires administered to the youths addressed sensitive topics (alcohol and drug consumption, delinquent behavior). It is possible that the most problematic adolescents refused to answer, not allowing the taking into account of the gravity of the problem as a whole. In addition, it is also possible that the responses were influenced by social desirability.

Despite these limitations, the current study identified a group of adolescents who exhibited a constellation of risky behaviors that include high Internet use. Further studies are needed to conduct empirical verifications of the evolution of the multi-problem youths' trajectories. Studies in the field of addiction and delinquency have shown that the passage into adulthood marks a decrease in risky behaviors [63]. However, it is difficult to say whether excessive technology use in adolescence will have an impact on the configuration of problematic trajectories in the longer term. This is why new longitudinal studies are needed.

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