Psychological adaptation in the info-communication society: The revised version of the Technology-Related Psychological Consequences Questionnaire

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The aim of the study is to consider technology-related changes in psychological needs and boundaries that affect one's personal adaptation to the info-communication society, as well as how they relate to problematic or excessive technology use. Based on the psychological model of the consequences of technology use, we've picked two forms of technology use (one related to mobile phones and the other related to the Internet) from a revised version of our Technology-Related Psychological Consequences Questionnaire. The new version includes nine questions: two assessing the excessive use of technology (the inability to resist using technology and subjective dependence), four assessing changes in psychological boundaries (boundaries extension and violation, easiness-related and opportunity-related preference for technology) and the other three measuring technology-related needs (functionality, convenience and image making). In the normative sample (N=132), appropriate reliability, factor validity and convergent validity were demonstrated in comparisons to the picture measure of the technology-related boundaries change. Based on hierarchical regression and moderator analysis, it was shown that changes in psychological boundaries affect the excessive use of technology (explaining an additional 17-27% of the variance) after adjusting for frequency of use and age group. The extension of boundaries and ease-of-use-related preference for mobile phones versus the Internet predicted satisfaction with life after adjusting for frequency of use, age group, inability to resist and subjective dependency respectively; however, the figures were not statistically significant. Thus, our data supports the hypothesis that there are different kinds of technology-related changes in psychological boundaries that manifest themselves in the subjective feeling of dependence on technology and the feeling that it is impossible to do without technology, which might in some cases be important for personal satisfaction with life.

Keywords: psychological consequences of technology, adaptation in the info-communication society, the revised version of the Technology-Related Psychological Consequences Questionnaire, the psychology of Internet use, the psychology of mobile phone use, excessive use of technology

The traditional focus of psychological studies of adaptation in the info-communication society is on problematic use or misuse (e.g., Bianchi, Phillips, 2005) and technology addiction (Griffiths, 2000, 2005). However even in the addiction studies, it remains clear that there are a plenty of technology-related psychological and social changes (e.g., in beliefs, expectations, personality, communication) that should be taken into account (How technology..., 2009, Larkin et al., 2006, Byun et al., 2009, Tian et al., 2009). The behavioral consequences are sometimes too ambiguous to allow one to distinguish between adaptation disorder and benign or beneficial adaptation, which raises questions with respect to the qualitative analysis of the psychological experience (Griffiths, 2010, Madell, Muncher, 2004). Population studies of Internet use in the EU (Livingstone, Haddon, 2009, Livingstone, Helsper, 2008) and in Russia (Soldatova et al., 2013, Soldatova, Zotova, 2012) have demonstrated a clear need for a shift in attention from the likelihood of risks connected with Internet use to the psychological (e.g., emotions, coping etc.) and social (e.g., parental mediation) factors underlying reactions, feelings and behavior.

The aim of this paper is to consider technology-related changes in psychological needs and boundaries that could affect personal adaptation to the info-communication society beyond and in interaction with problematic or "addictive" use. Based on the psychological model of the consequences of technology use (Emelin et al., 2012a), we have developed a revised version of the Technology-Related Psychological Consequences Questionnaire (Emelin et al., 2012b) and suggest some ways in which it may be applied to the psychological aspects of difficulty adapting to new technology.

Psychological model of consequences of technology use: a framework for empirical studies

According to the model (Emelin et al., 2012a) there are technology-related psychological transformations that are typical for a population which can mediate subjective well-being, technology use and technology-related emotional and behavioral problems. One possible transformation is the perception that gadgets or a new technology are necessary or even "too necessary" for a person. This hypothesis is in concordance with the data (Walsh, White, 2007) that technology use is closely related to subjective appraisals of its controllability and the development of a technology-related identity (self-identity, similarity with the prototype, emotional appraisal of the prototype). A similar idea was suggested by L. Srivastava (2005) in the concept of personalization. One criteria of excessive use is when people allow themselves to develop a mindset where personal gadgets (e.g., mobile phones) are indispensable and perceived as "always necessary". Another technology-related change involves one's perceived sphere of needs (e.g., Srivastava, 2005). Both technology and gadgets obtain some additional meaning for a person (e.g., "to have an expensive mobile phone" means "to look decent"), and the transformation of existing or creation of new needs (e.g., the need to own an impressive mobile phone). The third transformation was described by Marshall McLuhan (McLuhan, 1964) as a subjective extension of human boundaries. In the previous study, we suggested that a distinction be made between two aspects of this component. Due to a new technology, a person may reach and control many more objects and people than

earlier (boundaries extension) but has far more potential to be reachable by others (boundaries violation).

Measurement of technology-related changes in needs and psychological boundaries

In accordance with the theoretical paradigm, methodological studies either focus on the measurement of the epidemiology of technology use, technology-related risks and factors that decrease them (Livingstone, Haddon, 2009) or on problematic use or technology addiction (Griffiths, 2000, Bianchi, Phillips, 2005, Rutland et al., 2007, Widyanto et al., 2008). While totally sharing the understanding of the importance of such studies, here we would concentrate on the topic of other technology-related psychological consequences, using some components of excessive use as dependent and control variables.

In accordance with this framework, we developed a Technology-Related Psychological Consequences Questionnaire (Emelin et al., 2012b). This is a screening instrument which measures three variants of technology dependency (for the internet, for mobile phones and for computers) and consisting of seven scales. Each scale uses a 4-rating Likert scale to appraise attitudes towards three items. Two of the questions pertain to excessive use: inability to refuse ("I can't imagine my life without a mobile phone") and subjective dependence ("I spend more time on the Internet than I would like to"). Two questions focus on changes in psychological boundaries: boundaries extension ("If a person with whom I talk via the Internet isn't online for a long time, I worry") and boundaries violation ("I'm concerned that my personal information may be available to anyone on the Internet"). Three more questions are about technology-related needs: functionality ("I like that I can use the Internet at any time to send a message to anyone I need to contact, wherever I am and wherever they are"), convenience ("All I need in a computer is for it to be reliable and easy to use") and image making ("I prefer to buy expensive, stylish mobile phones").

In the normative Russian sample (Emelin et al., 2012b) Cronbach's alpha for all the scales except convenience varied across scales and test versions from .61 to .80, except for the convenience scale. Analysis revealed the expected factor structure for the questionnaire, and differences between age groups in technology-related psychological changes as well as a pattern of correlation with respect to frequency of technology use.

However, there were major limitations which motivated us to continue work on the questionnaire:

1. First, despite clear content validity and well-reproduction in factor analysis, the responses to the question dealing with technology-related changes in needs (convenience) had a rather low consistency (.46-.54 for different forms). With respect to Internet use, the consistency of the responses to the question regarding boundaries violation was even lower (.38). In the revised version, these items were reformulated.

2. Second, technology-related changes in psychological boundaries were assessed via two items – one dealing with the extension of boundaries and the

other dealing with boundary violations. The boundaries extension scale included expectations that the use of technology makes other people always available and results in worry and anger when they are not. The boundaries violation item characterized conscious concerns about the loss of privacy due to technology and social demands to always stay in touch. However, the phenomenon of extended boundaries reflects expectations regarding the controllability of the whole world. It reflects the attitude that not only other people but also information is perceived as always being available, while more conventional "off-line" ways of achieving the same goals (paper letters, libraries etc.) are appraised as difficult and unnecessary. Another important component of boundaries extension is a belief in the indispensability of technology due to new opportunities for activity. There are data that one possible factor reflecting the subjective importance of mobile phones is that they offer a unique opportunity for personalization (Srivastava, 2005, Tian et al., 2009). Personalized gadgets are perceived as being a part of person's identity and the loss of them becomes especially traumatic. In studies using youth focus groups (Madell, Muncer, 2007), it was demonstrated that the main subjective reason for the frequent use of Internet and mobiles is that they allow users to control their social interactions. In particular, young people don't feel that a difference exists between on-line, mobile and personal communication and prefer text messages to calls and personal meetings because it allows them to hide their emotions, to resolve conflicts, and to keep messages and reread them later. Thus, we have divided the boundaries extension scale into three scales: a communication-related extension of boundaries, a preference for technology related to ease of use (e.g., "lots of hobbies and real-life activity can be replaced with Internet use", "For me it's easier to text someone than to talk in person") and an opportunity-related preference for technology (e.g., "It's important that mobile phones make it easy for me to distract myself from unpleasant conversations or events", and "the main feature of the Internet is the universal availability of information").

3. Another concern was related to the question of convergent validity. Most of the existing instruments measure different aspects of problem use, the misuse of technology and technology addictions. Moreover, most of them only address the effects of the Internet. To our knowledge, there is no instrument measuring technology-related changes in needs and psychological boundaries that could be used to assess the convergent validity of the questionnaire. As an indirect support for it, we found expected patterns of relationships between frequency of use, age and technology-related changes. Nevertheless, there is a clear need for other conceptually-related instruments that we intended to overcome in this study.

4. Finally, the original version of the Technology-Related Psychological Consequences Questionnaire suggested that all of the items are correlated but equally important in terms of their impact on the distant psychological and behavioral consequences of technology use. However, the model implicitly suggests that changes in needs and psychological boundaries could be an explanatory mechanism leading to the development of dependence beyond the frequency of tech-

nology use and - moreover - leading to changes in well-being beyond subjective dependency. A hierarchical regression analysis supports the first hypothesis; it demonstrated that subjective dependency on mobile phones and the Internet can be predicted by an increase in boundaries extension and image-making, while subjective dependency from computers is predicted by the feeling that one's boundaries are being violated (Emelin et al., in press). Further analysis revealed that a subjective inability to resist technology and gadgets is predicted by boundaries extension and the subjective importance of technology-related convenience and image making. All of the effects remained significant after adjusting for age, gender and frequency of technology use. In partial support of the second hypothesis, preliminary data (Emelin et al., 2013) demonstrate that changes in needs and psychological boundaries are predictors of a worsening quality of life, worsening health and emotions, and a downturn in communications. Thus preliminary data support the idea that the psychological consequences of technology are hierarchically organized.

Our study was focused on the following tasks:

1. To test the psychometric properties of the revised version of the Technology-Related Psychological Consequences Questionnaire in two main spheres (Internet and mobile phone use) and to compare them to the original version. Specifically, we concentrated on the problem of the validity of the questionnaire. Due to an absence of conceptually close methods (see below) convergent validity could not be tested directly. Theoretically, there are two possible ways to test the validity of the instrument. First, we could use non-standardized (e.g., qualitative) instruments. Second, some empirical criteria could be tested (we could not provide experimental studies in Russia because Internet and mobile phone use are wide-spread, but we could use age or frequency of technology use as criteria for hypothesized differences). As in the earlier study (Emelin et al., 2012b) both age and frequency of use were found to correspond to empirical criteria, helping to differentiate between people whose use of technology had resulted in different psychological consequences; in this study we implemented the first approach. For this, a new picture method for the assessment of technology perception was developed (see below) that operationalized the problem of psychological boundaries in terms of physical distance.

2. To reveal the role of young age in determining the psychological consequences of technology use. It was hypothesized that youth could have a direct impact on the characteristics of excessive technology use (subjective dependence and inability to resist technology) but also moderate the impact of technology-related psychological changes on excessive use and subjective well-being (satisfaction with life).

3. To study the possible hierarchical structure of technology-related psychological changes. According to the framework, we suggested that changes in psychological boundaries have an effect on the excessive use of technology beyond age, gender and actual frequency of use. Also, we expected that changes in psychological boundaries would predict satisfaction with life beyond the effects of excessive technology use.

Participants

132 people (29 males, 103 females) 17-70 years old (mean age 25.8±11.8) participated in the study. 46 (34.8%) had a higher grade education, others (86, 65.2%) had completed school educations and were either students or worked. 38 (29.3%) were married or lived with partner, 84 (64.6%) were not married and 8 (6.2%) were divorced; 25 (19.2%) had children.

Based on the earlier study (Emelin et al., 2012b), we expected age-based differences in the psychological consequences of technology, so it was crucial to divide participants into their age groups. The most widely used theory in the classification of ages is generation theory (Howe, Strauss, 1991, 1993). According to this theory, people under 70 may be divided into generational groups: Baby-boomers (50-70 years old), Generation X (29-49 years old), Generation Y (13-28 years old, sometimes called millennials), and Generation Z (under 13 years old). We didn't base our analysis on this classification system for three main reasons. First, generation theory is based on an analysis of the culture and history of the USA. Boundaries between groups are blurred and authors of different papers suggest different age cohorts. On one hand, technological progress is only one of several factors taken into account in the theory. This fact leads to uncertainty as to whether this sociological and cultural theory may be applicable to the psychological study of technology. On the other hand, it seems doubtful that US history has the same criteria for generations as Russian history, and even the fruits of technological progress have become available at different times (for example, unlimited high-speed internet access first became available in select American cities in 1998, and was not widely available in Russia outside Moscow and St. Petersburg until 2008). Second, our aim was to reveal differences between younger people and adults, so it seemed reasonable to use social criteria to determine who was "young": university students and people at the beginning of their careers (18-22 years old). Third, we could not study older adults in detail because of our sample structure - and this is an important dimension for further studies.

As a result, we set up our typical social criteria to differentiate between younger and older participants in Russia. There were young people: university undergraduate-aged participants (18-22 years old, students, N=82); and older adults (23-70 years old, older adults, N=50). Due to the small subsample sizes, we could not further differentiate among the group of older adults in this study. Further research is needed to clarify the role of age in adults when measuring the psychological consequences of technology.

Methods

The study had a cross-sectional design. Participants completed:

1. **The revised version of the Technology-Related Psychological Consequences Questionnaire**[*]. This is a screening instrument that exists in two forms (one applies to the Internet and the other to mobile phones). Items in different forms

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[*]   The revised version of the Technology-Related Psychological Consequences Questionnaire and further details on its structure and items are available from corresponding author.

include minor reformulations (e.g., "I can't imagine my life without Internet access" or "I can't imagine my life without a mobile phone"). There are nine questions (items) in each form: seven from the earlier version (Emelin et al., 2012b) and two new items. Earlier scales included the inability to refuse access to technology, subjective dependence, the extension of boundaries, the violation of boundaries, functionality, convenience, image making (see examples for each question earlier in the text). Comparing to the original version, the questions which referred to the convenience boundaries and violation of boundaries (only in the Internet form) were slightly reformulated in order to achieve better consistency.

Two more items were added to the revised version which characterized easiness-related (item examples: "lots of hobbies and real-life activity can be replaced with Internet use", "For me it's easier to text someone than to talk in person") and opportunity-related preferences for technology (item examples: " It's important that mobile phones make it easy for me to distract myself from unpleasant conversations or events", "the main feature of the Internet is the universal availability of information").

Each scale is tested using three items, which are appraised using a 4-point Likert scale.

2. **Picture method for the assessment of technology perception**. To study the convergent validity of the questionnaire, the picture method for the assessment of technology perception was developed. Participants were given a sheet of paper with a circle 5 cm in diameter in the center and a list of different objects. Three of the objects were technology-related (Internet, mobile phone, TV) and the others were distracters (family, friends, work / learning, personality traits, interests, values). The instructions were: "Imagine that this sheet of paper is your life and whatever is around you. The circle in the center represents you. There is a list of objects below — please draw a circle for each of them (with a number) on this sheet where you want. Try to draw the first thing that comes to your mind. The quality of the picture and what kind of circles you draw doesn't matter". For each circle, the distance from the center ("Self" circle) and the diameter were calculated.

Comparing the existing technology questionnaires using the picture method allows participants to concentrate: not on problem use or dependency but on the change in boundaries. Consequently, it is preferable for testing the convergent validity of our questionnaire. Although there are no studies using this method for technology perception, it is widely used in identification (Swann et al., 2009, Gomez et al., 2011) and illness representation (Buchi, Senski, 1998, 1999) research.

In our sample, Cronbach's alpha for the distance of the six distracters was .79; for diameters, it was .83. The consistency of the distances for three technology-related objects was .66 and .89 for their diameters. Thus, primary data supports the hypothesis that the picture method could be reliably used in studies of technology-related psychological changes.

3. **Actual frequency of technology use** was measured by one item related to Mobile phones and one item for the Internet form assessed on the 4-point Likert scale (never / almost never, rarely, sometimes, frequently / almost always).
4. **Satisfaction with life scale**. This screening instrument was developed by E. Diener et al. (1985) and is widely used in studies of the cognitive component of subjective well-being.

Results

Item reliability

According to item reliability analysis (Table 1), Cronbach's alphas are rather close to the alphas in the original version of the validation sample (Emelin et al., 2012b). However, the Internet subjective dependence, Internet image making and Mobile phone functionality scales were less reliable than in the previous study. While there were no changes in these items, the decrease in reliability could be explained by occasional variations in the samples. The Alpha for the Internet boundaries violation question increased, reaching the appropriate level for the 3-item question. For convenience, the scale results were inconsistent: item reformulation led to an increase in consistency for the Internet form but a decrease for the Mobile phone form.

Consistencies for the easiness-related preference for technologies were appropriate, while consistencies for the opportunities-related preference for technology was low for the Internet question and appropriate for the Mobile phone form.

Table 1. Consistency (Cronbach's alphas) of the scales for the Mobile phone and Internet versions of the questionnaire

Technology-related changes	Mobile phone form	Internet form
Psychological dependence		
Inability to resist	.81 (.80)	.75 (.61)
Subjective dependence	.66 (.68)	.57 (.71)
Change of psychological boundaries		
Communication-related boundaries extension	.77 (.75)	.74 (.71)
Easiness-related preference of technologies	.67 (N/A)	.67 (N/A)
Opportunities-related preference of technologies	.61 (N/A)	.54 (N/A)
Boundaries violation	.62 (.64)	.62 (.38)
Change in needs		
Functionality	.58 (.65)	.73 (.78)
Convenience	.33 (.54)	.67 (.46)
Image making	.76 (.80)	.49 (.72)

Note: There are alphas for the original version in the brackets (Emelin et al., 2012b).

Inter-scale correlations and factor structure of the questionnaire

None of the inter-scale correlations were higher than .60, proving that scales represent different constructs. In the next section, we present correlations of new scales with others. From a theoretical perspective, we suggested that any kind preference for technology could be related to subjective dependence and boundaries extension.

As shown in Table 2, an easiness-related preference for the Internet is related to both components of psychological dependence as well as communication-related boundaries extension and the image-making function of the Internet. However, it is negatively correlated with the boundaries violation scale. Surprisingly, an easiness-related preference for mobile phones was only positively related with the boundaries violation query. What this means is that people are more likely to appraise mobile telephony as easier for them than meeting in person because they have more worries about compromising their privacy via mobile phone.

Opportunity-related preferences for technology correlate positively with most of the other query answers except violation of boundaries, as well as subjective dependency on the Internet and the convenience query in the Mobile version. It's important to mention that both latter scales have rather low reliability in our sample, which explains the lack of correlation.

Table 2. Correlations between the easiness-related and opportunities-related preferences for technology query answers, with the questions from the original version of the questionnaire

Scales	Mobile phone form		Internet form	
	Easiness-related preference for technology	Opportunities-related preference for technology	Easiness-related preference for technology	Opportunities-related preference for technology
Inability to resist	−.03	.40**	.43**	.33**
Subjective dependence	.04	.42**	.25**	.15
Communication-related boundaries extension	−.09	.23**	.36**	.21*
Boundaries violation	.27**	.12	−.22*	−.06
Functionality	−.02	.25**	.17	.36**
Convenience	.08	.12	.11	.40**
Image making	.06	.41**	.30**	.29**

Note: * — p<.05, ** — p<.01

The factor structure of the revised Technology-Related Psychological Consequences Questionnaire was tested using a confirmatory factor analysis. In consistency with the theoretical framework (Emelin et al., 2012a), different types of technology-related psychological changes could be related to each other and the whole structure of changes could not be well-differentiated, while different types of

changes are not fully mentioned and distinguished by participants. So we allowed in the model for between-factors covariance as well as covariance between some conceptually flawed items. A decision about the conceptual relationship between items loading on different factors was made by a panel of experts in cases where their content was clearly explained. For instance, the item "It's important for me than the access to the Internet was easy and quick" refers to the convenience scale, while the item "If the person whom I sent the e-mail don't answer, I think that he doesn't want to speak with me" refers to communication-related boundaries extension. However, both items are also about the inability and reluctance to wait for some time and the drive to achieve goals quickly.

Typical criteria suggested for the model's goodness of fit are: comparative fit index, CFI is higher than .90 (some authors consider as appropriate range of .85 – .90), root mean-square error of approximation, RMSEA is less than .05 (with the appropriate range of 0.06 – 0.08) and χ^2/df is around 2 (Brown, 2006).

Both forms have shown good fit with the framework with CFI = .96, RMSEA = .04 (90% CI = .01 – .05) and $\chi^2/df = 307/263 = 1.17$ for Mobile phone form and CFI = .94, RMSEA = .04 (90% CI = .02 – .05) and $\chi^2/df = 325/272 = 1.19$ for the Internet form. Thus our data support the factor validity of the revised Technology-Related Psychological Consequences Questionnaire Mobile form and Internet form.

Table 3. Correlations of picture method for technology use and the revised Technology-Related Psychological Consequences Questionnaire

Scales	Mobile phone form		Internet form	
	Distance from the "Self" circle	Diameter of the circle	Distance from the "Self" circle	Diameter of the circle
Inability to resist	−.33**	.00	−.23**	−.11
Subjective dependence	−.09	−.02	−.19*	−.01
Communication-related boundaries extension	−.28**	.08	−.19*	−.01
Boundaries violation	.25**	−.07	.05	−.11
Easiness-related preference of technologies	.01	−.09	−.30**	.03
Opportunities-related preference of technologies	−.15	.04	.03	−.12
Functionality	−.21*	−.02	.00	−.08
Convenience	−.02	.09	−.08	.00
Image making	−.16	.02	−.15	−.15

* - p<.05, ** - p<.01

Psychological consequences of technology and the picture method for technology use

Measures of the distance from Self, but not the diameter of the circles, correlated significantly with some scales of the revised Technology-Related Psychological Consequences Questionnaire (Table 3). First, a higher distance of the Internet and mobile phones was related to a higher subjective possibility of refusing to use

technologies and a lower communication-related boundaries extension. For mobile phones, distance from the Self correlated with boundaries violation and lower change in the need of the functionality of the phone while in the Internet version in was related to lower praise for the Internet's ease of use. As expected, there were no or low correlations between the distances and subjective dependence scales.

Changes in psychological boundaries as a predictor of subjective dependency and well-being

To reveal the impact of technology-related changes in psychological boundaries on subjective dependence and quality of life, a series of hierarchical regression and moderator analysis was used (Chaplin, 2007). There were three hypothesis. First, we suggested that technology-related changes in psychological boundaries would have an impact on subjective dependence and inability to resist after adjusting for age group and frequency of technology use. Gender was excluded from all models; in our sample it had no impact on dependent variables. Second, it was hypothesized that age could function as a moderator of the relationship between changes in psychological boundaries and different aspects of excessive use. For instance, boundaries extension could have a prominent link to subjective dependence, but only in young participants and not in older adults. Third, we supposed that changes in psychological boundaries would have their main interaction (with age group), impact on satisfaction with life, beyond frequency of use and subjective dependence.

Hierarchical regression was repeated for both the Mobile phone and Internet forms of the questionnaire, for three dependent variables: subjective dependence on technology, inability to resist technology, and satisfaction with life. There were three steps of regression for subjective dependence and inability to resist, and four steps - for satisfaction with life. For all the models at the first step, age group and frequency of use were included in the model. For subjective dependence and inability to resist, on step 2 we added changes in psychological boundaries variables to the model. Only variables that significantly correlated with dependent variables were included. At step 3, products of the group and each of the changes in psychological boundaries were added. Thus the significant change of the R^2 at step 2 means that changes in psychological boundaries explain some of the parameters of excessive use of technology beyond frequency of use and age. A significant change of the R^2 at step 3 evidences that there is a significant interaction effect modifying the impact of changes in psychological boundaries in different age groups. For satisfaction with life, step 2 included subjective dependency and inability to resist, while step 3 added changes of psychological boundaries variables. Step 4 was similar to the step 3 of two previous models.

As shown in Table 4, data supports the hypothesis about the main effects of changes in psychological boundaries on the excessive use of technologies after adjusting for frequency of use and age group (explaining additional 17-27% of variance) from the inability to resist technology is predicted by boundaries extension and opportunities-related preference for technology (both for mobile phones and Internet) and by easiness-related preference (for Internet only). A feeling of subjective independence from mobile phones is related to boundaries violation and

opportunities-related preference. Subjective dependence from the Internet correlates to boundaries extension, violation and easiness-related preference.

The hypothesis of the moderator effect of the age was partly confirmed only for the Inability to resist the internet: it was dependent on the interaction between age group and opportunity-related preference for the internet. In youth, an opportunities-related preference for the internet is a stronger predictor of inability to resist than in older adults (r=.39, p<.01 and r=.27, p<0.10 respectively).

Table 4. Technology-related changes in psychological boundaries as predictors of excessive technology use: results of hierarchical regression and moderator analyses

Variables in the model	Mobile phones from		Internet form	
	β	R^2	β	R^2
Dependent variable: **inability to resist technology**				
Step 1				
Frequency of use	.42**	.22**	.37**	.16**
Age group	−.14[T]		−.09	
Step 2				
Frequency of use	.36**		.27**	
Age group	−.08	.40**	−.09	.43**
Boundaries extension	.26**		.26**	
Easiness-related preference	n.s.[1]		.25**	
Opportunities-related preference	.29**		.22**	
Step 3				
Frequency of use			.27**	
Age group			.80*	
Boundaries extension		n.s.[1]	.27**	.45**
Easiness-related preference			.26**	
Opportunities-related preference			.34**	
Age*Opportunities-related preference			−.93*	
R^2 change				
Step 2	.18**		.27**	
Step 3	n.s.[1]		.02*	
Dependent variable: **subjective dependence**				
Step 1				
Frequency of use	.23*	.06*	.14	.11**
Age group	−.03		−.28**	
Step 2				
Frequency of use	.22*		.07	
Age group	−.01		−.19*	
Boundaries extension	n.s.[1]	.26**	.18*	.28**
Boundaries violation	.21*		.28**	
Easiness-related preference	n.s.[1]		.23*	
Opportunities-related preference	.38**		n.s.[1]	
R^2 change				
Step 2	.20**		.17**	
Step 3	n.s.[1]		n.s.[1]	

Note: 1 — the effect of the variable was not statistically significant (p>0,1, n.s.) so either variable or the last step of regression were excluded from further analysis; T - the effect was marginally significant (p<0,1); * — p<0,05; ** — p<0,01.

Subjective dependence and inability to resist mobile phones in our sample were not related to a decrease in satisfaction with life. However, after adding boundaries extension to the model and easiness-related preference, the scales did improve the model ($\Delta R^2=.07$, p<.05; $\beta=-.19$ and $-.15$ boundaries extension and easiness-related preference scales respectively, p<0.10) adjusting for the frequency of use, age group, inability to resist and subjective dependency. However the whole model failed to reach statistical significance (F=1.93, p<.10). Neither of the scales in the Internet form of the questionnaire correlated with the satisfaction with life scale, so for the Internet the last hypothesis was not proved.

Discussion

According to L. Tian et al. (2009), any technology makes information quickly and easy achievable, reducing feelings of uncertainty and increasing feelings of safety. Our data supports the idea that the experiences of controllability and indispensability could make an important contribution in the explanation of technology's use and technology-related adaptation. First, we found that there are different changes in psychological boundaries (communication-related boundaries extension, easiness-related and opportunities-related preferences for technologies, as well as boundaries violations) that are conceptually and empirically distinct and could be reliably measured in the questionnaire. Interestingly, by using the picture measure of technology-related boundaries changes, we found that psychological distance or "incorporation" of technology into Self could be interpreted in the measurement as a perceived distance between technology and Self. Our data supplement the theory of the transformation of human boundaries (McLuhan, 1964) by suggesting that boundaries extension is only one possible variant of technology-related boundaries changes. In the contemporary world, technology should not be considered a "virtual world" that augments the "real world" but as a world changing the structure of all human activities (Soldatova et al., 2013). In this context, an understanding of human activity (Soldatova et al., 2013), needs (Tian et al., 2009), beliefs and expectations (How technology…, 2009), communication in this world and with this world (Larkin et al., 2006) and even "digital citizenship" (Mossberger et al., 2008, Soldatova et al., 2013) become a prominent focus for psychology. We believe that in further analyses, it could be helpful to distinguish between actual boundaries changes and reflections on these changes. The latter could have a buffer effect on the relationship between boundaries changes and maladjustment, allowing for conscious control over the negative psychological effects of technology use. We have suggesteda boundaries violation scale as a measure of emotional reaction to the awareness of technology-related privacy loss and illusory boundaries extensions. In line with the buffer hypothesis of reflection, this scale predicted a feeling of subjective dependency (that is based on reflection) but not the inability to resist technology.

Second, we found support for the hypothesis that changes in psychological boundaries predict some components of the excessive use of technology beyond frequency of use, gender and age. Further studies could test this hypothesis using other instruments developed to measure technological addictions. However even for two aspects of excessive use - subjective dependency and the inability to resist technology - we found results that are in agreement with psychological discussion of what

in technologies and people make them potentially "addictive". M. Griffiths (2005) in his bio-psychosocial model of addictions suggests that any activity is potentially "addictive" if it provides short-term benefits and long-term negative consequences. Thus, if there is a dispositional or situational deficit of self-regulatory and reflective capacities (Hall, Fong, 2007), technology-related psychological changes are either perceived as an opportunity (as it was formulated in the boundaries extension, easiness-related and opportunity-related preference scales of the questionnaire) or as a failure (leading to distress because of loss of control). Further research could study this suggestion by designing an experiment, for instance, of the self-control paradigm (Baumeister et al., 2007).

It should be noted that the easiness-related preference of technology scale had different patterns of correlations with the other scales and the picture measure of a change in boundaries boundaries in the Mobile phone and Internet forms. The reason is that based on qualitative data (for instance, Madell, Numcher, 2007) for the mobile phones, the concept was operationalized as a preference (because of its easiness) of mobile communication while for Internet form it captured a preference of Internet as a source of information and place to share the information.

Third, we aimed to study the age-related moderator effect on the relationship between psychological boundaries changes and the excessive use of technology but found only partial confirmation for inability to resist the internet, which was strongly predicted by an opportunity-related preference for the internet in youth but not in older adults. It could be that the "digital" gap between people of different ages is not as wide as is commonly discussed. However, final conclusions demand that this hypothesis be tested on samples that are more representative in terms of the age. Finally, the hypothesis about prediction of satisfaction with life based on boundaries changed was only marginally supported for mobile phone use but not for the internet. These data are inconsistent with our previous study (Emelin et al., 2013) that used a Quality of life and Enjoyment scale and could be explained by the use of overly generalized characteristics of well-being, and not allowing to study satisfaction in different spheres (health, emotions, communication etc.).

From a methodological point of view, the new contribution of our study is in the revision of the instrument for measuring different aspects of technology-related psychological changes that is brief (three items per scale) and could be used across several technologies. The revised version of Technology-Related Psychological Consequences Questionnaire was found to be a reliable and valid research instrument in terms of factor, convergent validity and empirical relationships with age and frequency of use. Further population studies are needed to reveal the instrument's properties in psychodiagnostics.

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