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Article

Social Expectancy Increases Skin Conductance Response in Mobile Instant Messaging Users

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ABSTRACT

Background: Society is witnessing two parallel phenomena: an increase in the number of mobile phone users worldwide and a growing concern about problematic smartphone use. Leading explanatory models suggest that social reward may explain some problematic smartphone use. Given that experimental evidence about the impact of social variables on problematic smartphone use is scarce, the impact of social expectancy on emotional arousal measured with skin conductance response (SCR) was analysed during instant messaging. **Method:** A sample of 86 undergraduate students were randomly assigned to two groups. Experimental group participants were instructed to send a social expectation-generating message to their more active contacts in their preferred social network. After experiencing a virtual reality distraction environment, participants' SCR was measured when they were allowed to use the smartphone and when it was withdrawn. **Results:** Participants in the experimental group showed a higher SCR response than the control group. Peaks analysis also showed that peak amplitude was higher in experimental participants when their smartphones were used and withdrawn. Experimental participants also showed a longer half recovery time when using the smartphone. **Conclusions:** Social expectancy is a critical variable in understanding problematic smartphone use and it should be considered in clinical contexts.

La Expectativa Social Incrementa la Respuesta Electrodérmica en Usuarios de Mensajería Instantánea Móvil

RESUMEN

Antecedentes: La sociedad está presenciando dos fenómenos paralelos: el incremento mundial de usuarios de teléfonos móviles y una preocupación creciente por el uso problemático de estos dispositivos. Los modelos teóricos explicativos sugieren que la recompensa social podría explicar parte del uso problemático del teléfono móvil. Dado que la evidencia experimental sobre el impacto que lo social tiene en este fenómeno es limitada, el impacto de la expectativa social sobre el *arousal* emocional fue analizada mientras se usó mensajería instantánea. **Método:** Una muestra de 86 estudiantes se asignó aleatoriamente a dos grupos. Los participantes del grupo experimental enviaron un mensaje generador de expectativa social a sus contactos más activos usando su red social preferida. Tras un periodo de distracción, a respuesta electrodérmica de la piel se midió al usar y retirar el móvil. **Resultados:** El grupo experimental mostró mayores niveles de *arousal*. El análisis de picos muestra una mayor amplitud en el grupo experimental cuando se usó y se retiró el móvil. Un tiempo de recuperación medio más largo se observó en el grupo experimental al usar el móvil. **Conclusiones:** La expectativa social es una variable crítica para conceptualizar el uso problemático del móvil y debería considerarse en contextos clínicos.

Palabras clave:
Rempensa social
Adicción conductual
Psicofisiología
Uso problemático del móvil
Desregulación emocional

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Human communication can be considered, in plain words and independently of the mean (speech, written words, puffs of smoke or a face-like emoticon on a screen), as a process by which "one mind can affect another" (Weaver, 1949, p. 11). Recent advances in computing science and telecommunications have brought us new methods to stay connected with relatives, friends, colleagues, or workmates. The smartphone is probably the most widely used device to communicate nowadays. Although the smartphone provide users with noticeably benefits, scientific concerns (Carbonell et al., 2012; De-Sola et al., 2016; Pedrero-Pérez et al., 2018) have also been raised to warn about the consequences of the "problematic smartphone use" (PSU). Young people are at a higher risk of suffering from PSU due to their ongoing brain development (Abrams, 2022; Tresáncoras et al., 2017; Wacks & Weinstein, 2021). A recent study (Pastor et al., 2022), for example, found that approximately 50% of teenagers needs to be regulated by others (i. e., parents) to use the smartphone healthily. Authors also claimed that 15% of adolescents experience severe problems to regulate their smartphone use.

There are plenty of published works studying PSU. However, there is still no consensus about how to conceptualize this phenomenon. For example, the concept of "smartphone addiction," despite being the more frequent when searching about this topic in scientific databases such as the Web of Science, is controversial for several reasons. Firstly, because defining addiction has been a matter of intense debate for decades and it is even more difficult when conceptualising behavioural addictions (Griffiths, 2005). It has been recently stressed that what really matters it is the where, the how and for what reasons the smartphone is used (Khalily et al., 2021; Panova & Carbonell, 2018; Roberts, Flagg, et al., 2022; Sultan, 2014; Veissière & Stendel, 2018). For example, as suggested by Odgers (2018) when analysing the negative consequences of smartphone use in adolescence, teenagers at risk of suffering problems due to smartphone abuse are those struggling to get rid of their pre-existing social and psychological vulnerabilities. It is not the smartphone itself what causes problems but some existent risks factors.

A wide spectrum of activities can be done with smartphones, but the basic and original function of these devices is communicating. Although phone calls seem not to be a problem for smartphone users nowadays, mobile instant messaging (MIM) is currently seen as an activity of potential concern (Wang et al., 2021). For example, Grover et al. (2016) found that adolescents messaging after lights out were more likely to suffer from sleep problems and perform worst at school. Instant messaging can be seen as the evolution of text messaging, SMS (short message service) messaging or texting (Igarashi et al., 2008). However, MIM currently allows users to communicate without additional charges, write messages without characters limitation, share unlimited multimedia content or, amongst other things, transfer emotional-like messages by using emoticons (Sultan, 2014). Although instant messaging is useful to provide informal social support (i. e., González-Nuevo et al., 2022; Rosenbaum & Wong, 2012), research has also identified some key social and emotional features of this form of computer mediated communication (CMC) influencing human behaviour and potentially producing psychological damage under some circumstances.

Early theoretical proposals about PSU suggested that smartphone abusive use was critically related to social interaction. For example, Billieux (2012) noted that some cases of PSU are the product of the "relationship maintenance pathway". This pathway leading to PSU refers to the excessive smartphone usage to stay connected with partner, family, or friends. In fact, the only reported clinical case of smartphone addiction can be considered a case of social networks addiction. The case report stressed that the patient was afraid of losing all her friends in case she stopped to use social networks. These obsessive thoughts about social virtual interaction were considered to be one of the key roots of her problem (Körmendi et al., 2016). This clinical observation is congruent with research showing that ostracism and its negative consequences can be observed in a context of computer mediated interaction (Smith & Williams, 2004). A recent intervention study also found that participants who were asked to reduce their smartphone usage reported they critically missed to use social networks (Olson et al., 2022). Although some authors have suggested that social expectancy is a powerful rewarding phenomenon explaining smartphone addictive behaviours (Abrams, 2022; Veissière & Stendel, 2018; Wang et al., 2021), no experimental evidence has been provided to show social virtual networking is related to smartphone abusive use. For example, recent research by Thomson et al. (2021) studied whether social network notifications can produce a salience effect but failed to observe the typical attentional bias characterising substance addictions.

Theoretical contributions of problematic mobile phone use also notice that difficulties in emotional regulation is related to dysfunctional smartphone usage (Billieux, 2012; Panova & Carbonell, 2018; Squires et al., 2021; Suissa, 2015). Roberts, Flagg, et al. (2022) suggest that emotional dysregulation problems can be interiorised by children through development and additional research is needed to fully understand contextual factors leading to PSU because of a poor emotional regulation. It seems that the problem with emotional regulation is mainly related to the management of negative emotions. For example, Ruiz-Ruano et al. (2020) observed that the deliberate intention to avoid internal negative emotions was related to problematic smartphone use. Bernal-Ruiz et al. (2021) have also shown that social networking applications are used to escape from negative emotions or uncomfortable feelings. It has been shown that teenagers use their smartphone to effectively relieve their negative emotional states, but the positive effect of this strategy is limited to the short term (Dolev-Cohen & Barak, 2013). Marciano et al. (2022) have also recently shown that adolescents experience a small degree of well-being by using their smartphone, but this satisfaction is limited to the short-term. Therefore, negative emotional regulation becomes a critical point in the beginning and maintaining phases of PSU episodes (Suissa, 2015). If not treated properly, it can lead to pathological states due to a deficit of negative emotional management as seen in the psychology clinic (Körmendi et al., 2016).

From a methodological point of view, research on PSU is predominantly correlational, based on self-reports and cross-sectional (Marciano & Camerini, 2022; Marciano et al., 2022; Panova & Carbonell, 2018; Squires et al., 2021). Few studies have used experimental designs or non-self-report measures to analyse PSU. Electrophysiologic activity can be considered a self-report alternative to measure the physiological components of emotional activation when participants use their smartphone. For example, Clayton et al. (2015) observed an increase in self-reported anxiety, blood pressure and heart rate when participants were not allowed to answer their smartphones. Lin and Peper (2009) observed that skin conductance response (SCR) increases when participants exchange text messages through smartphone. It this context it is considered that SCR increase is an emotional-like response, and it seems that increase is produced by sensitivity to rewards. For example, Camerini et al. (2022) noticed that SCR increases in experimental participants after receiving smartphone messages containing positive content. Their study also showed that SCR increase is higher when messages are delayed (about seven minutes). The study by Machado Khoury et al. (2019) also reported a higher increase in SCR after rewards in a sample of participants classified as smartphone addicts when making decisions. The authors concluded that addicts to smartphone suffer decision making impairment similar to that observed in substance abusers. Hsieh et al. (2020) also studied the addictive characteristics of PSU by analysing the withdrawal effect amongst smartphone users. They observed that SCR increases after smartphone withdrawal, and the increase was even higher in young participants and women. Considered together, those studies analysing the relationship between smartphone usage and SCR have the drawback of not using a control group.

The purpose of this study is to test whether experimentally generated social expectancy during mobile instant messaging has an impact on SCR. As noted above, SCR increases during mobile texting (Lin & Peper, 2009), but we hypothesise that the increase will be higher when social expectancy has been experimentally generated. This would support the theoretically proposed (Suissa, 2015; Veissière & Stendel, 2018; Wang et al., 2021) and clinically observed (Körmendi et al., 2016; Olson et al., 2022) impact of social rewarding on PSU. To the best of our knowledge, there is no published papers addressing the impact of social expectancy on emotional response in smartphone users by using electrophysiological measures and an experimental design. Given that we used experimental methodology, our results are expected to shed light on causal mechanisms explaining PSU and, therefore, it can be considered to optimally develop therapeutic strategies to cope with PSU (Panova & Carbonell, 2018). Smartphone addiction scores and negative emotion avoidance will also be studied to test whether these variables interact with social expectancy to increase SCR.

Method

Participants

A sample of 86 undergraduate students (59 were self-defined as woman, 68.6%, and 27 self-identified as man, 31.4%) with ages ranging from 18 to 52 years (M = 22.47, SD = 5.66) participated in the experiment. Before running the experiment, a power analysis test was carried out to determine the minimum sample size to detect a medium-to-high standardized effect size (d = 0.6, p = .05, unilateral contrast) with a statistical power equal to .8. As a result, a sample size of 35 participants for control and experimental groups was considered appropriate. A hundred participants were recruited to avoid missing participants due to technical problems during SCR recording. Participants providing SCR time series with missing data due to technical problems or interferences during data collection were omitted from analysis. Consequently, 43 participants were included in control and experimental groups. Only data coming from those participants were analysed.

Instruments

The I-330-C2+ (J+J Engineering Inc.) biofeedback hardware was used to record SCR and USE3 Physiolab Software (J+J Engineering Inc.) was used to export skin conductance time series. Acquisition sampling rate was fixed at the maximum allowed by hardware but the average per second was exported and analysed.

The Spanish short version (López-Fernández, 2015) of the smartphone addiction scale (SAS-SV, Kwon et al., 2013) was used to measure smartphone addiction risk. The SAS-SV is a screening test designed to check for addiction-related symptoms based on DSM-IV diagnostic criteria for substance dependence and gambling disorder (American Psychiatric Association, 2000). It contains 10 items to be answered by using a 6-point Likert scale to express agreement with the statement (anchored to one with "strongly disagree" and six with "strongly agree"). Total scale score is computed by summing up all the items producing a value ranging from 10 to 60 and a higher value is interpreted as a considerable risk of smartphone addiction. A differential cut-off is used to classify men (31) and women (33) suspected of suffering smartphone addiction (Kwon et al., 2013). The items can also be grouped to obtain a measure of addiction symptoms (loss of control, cognitive disturbance, ignoring consequences, withdrawal, and tolerance). The SAS-SV Spanish adaptation showed acceptable internal consistency (α = .88) and we have observed a similar performance computing percentile-based bootstrapped versions of Cronbach's alpha (.83, 95% CI [.77, .88]) and McDonald's omega (.83, 95% CI [.76, .89]).

The Spanish version (Ruiz et al., 2013) of the Acceptance and Action Questionnaire (AAQ-II, Bond et al., 2011) was used to measure negative internal emotion avoidance. The test contains seven items and respondents must express their agreement with the item statement by using a 7-point Likert scale with 1 anchored to "*completely disagree*" and 7 anchored to "*completely agree*". Total test score is obtained by summing up the scores in all items which produces a value ranging from 7 to 49. A higher score refers to a higher level of negative internal emotion avoidance. The Spanish AAQ-II adaptation produced appropriate internal consistency measures ranging from .75 to .93. Here we found a similar behaviour by computing percentile-based bootstrapped versions of Cronbach's alpha (.93, 95% CI [.9, .95]) and McDonald's omega (.93, 95% CI [.9, .95]).

A set of dichotomic questions (yes/no) to characterise the smartphone pattern of use were also asked to participants. Questions were based on the Körmendi et al (2016) description of a smartphone addiction case. The time spent using the smartphone, using social networks, browsing the Internet, watching films or series, gaming, listening to music, editing photos and phoning were registered. Participants were asked whether they preferred contacting friends by social networks instead of in person, whether they used their smartphone to avoid boredom, whether they thought they will be abandoned by their friends in case dropping out social networks, whether they were satisfied with their social relationships outside social networks, whether they felt accepted by peers and whether they felt lonely. Participants also reported which notifications were always active in their smartphone.

Nesplora Aquarium (Nesplora Giunti Psychometrics) virtual reality task was used as distraction task (Climent et al., 2019). This software provides a visual and auditory immersion in a virtual reality environment (an underground glass wall aquarium room). We used Samsung Gear VR virtual reality glasses, Samsung S7 smartphone (model SM-6930F) and corded over-ear headphones to immerse participants in the virtual environment. Participants were instructed to pay attention to instructions provided by headphones once the task was run.

Procedure

A random independent two-groups experimental design was used. Undergraduate students initially completed an electronic questionnaire to collect socio-demographic variables, their answers to the SAS-SV and AAQ-II scales, and information about their pattern of smartphone usage. They digitally signed an initial informed consent to participate in the study and provided their email addresses to be contacted for experimental protocol. Participants then were emailed and scheduled to visit the psychology lab. Upon arrival, participants were provided with the research information sheet as well as the printed version of the informed consent.

After signing informed consent, SCR electrodes were placed in the index and middle fingers of the participant's non-dominant hand. Electrodes were cleaned and prepared as recommended by hardware manufactured before recording participant's SCR. An impedance test was conducted before recording the conductance signal from each participant. Skin conductance was recorded for 120 seconds to establish a SCR base line and before experimental manipulation. Then, participants were randomly assigned to control and experimental group (no differences were observed between experimental and control group in terms of smartphone pattern of use or gender, see supplementary material available here: https://osf.io/m23pt). Control group participants were provided no additional instructions and directly, after switching off their smartphone notifications (sounds and vibrations) and placing it facing down on the table, began the virtual reality distraction task. Participants in experimental condition were asked to send the following message to their more active contacts in their preferred social network application (most experimental participants used WhatsApp, 93.02%, and the rest used Instagram): "Hey! I am going to participate in a virtual reality experiment at university. It is exciting! I tell you later." The laboratory researcher registered the number of people receiving the message from each. Participants in the experimental group were then asked to swich off all smartphone notifications. Experimental participants were instructed to put the smartphone screen down on the table before beginning the virtual reality distraction task. The laboratory researcher told all participants they will be allowed to use their smartphone later. Then, the researcher explained the distraction virtual reality task and helped participants to properly place the virtual reality glasses and headphones. Participants were involved in the distraction virtual reality task 18 minutes on average. Skin conductance was not recorded during this period. The virtual reality task was only used to allow participants to experience virtual reality and to generate the need to talk to their social network contacts about the experience. No participant reported having previously being assessed with Aquarium software or trying similar virtual reality glasses before.

After the distraction virtual reality task, SCR recording was resumed for all participants during the next 360 seconds. Participants were instructed to be in silence and just trying to keep their mind relaxed during the first 120 seconds. Participants were instructed to take and use their mobile phone as usual in second 121. Finally, participants were asked to put their mobile phones face down on the table in second 241. They were again instructed to keep silence and trying to relax their minds until the end of recording. When recording finished the researcher helped participants to remove SCR sensors and thanked participants for their collaboration. As a compensation for their participation in the research, participants were provided with the Nesplora automatically generated report of their attentional and executive functions (Climent et al., 2019).

Experimental protocol was approved by two host universities Bioethics Commissions (Refs. CE061817 and UALBIO2022/033) and the experimental procedure followed the guidelines proposed by the American Psychological Association (2017) Code of Conduct and the ethical principles for research involving human subjects provided by the Declaration of Helsinki (World Medical Association, 2013).

Data Analysis

Skin conductance response time series were mean centred, and variance constrained considering average mean and standard deviation in base line for each participant. To compare SCR measures coming from control and experimental groups classical t-test and Bayes Factors favouring the alternative hypothesis were used because the latter have been suggested to complement the former in recent simulation studies (Ruiz-Ruano & Puga, 2018). The classically used .05 cut-off was used to interpret *p*-values and the Jeffreys' (1948) labelled intervals were used to interpret Bayes Factors. Although some simulation studies suggest certain priors are balanced for a wide range of situations (see Jeon & De Boeck, 2017), a sensitivity test to priors was used to check the stability of the computed Bayes Factors by following Kruschke (2021) recommendations. Four different priors were considered (BFn: "narrow" with prior fixed at $\frac{\sqrt{2}}{4}$, *BFm*: "medium" with prior fixed at $\frac{\sqrt{2}}{2}$, *BFw*: "wide" with prior fixed at 1, and BFu: "ultrawide" with prior fixed at $\sqrt{2}$) and the BayesFactor (version 0.9.12-4.2) R package was used to compute Bayes Factors.

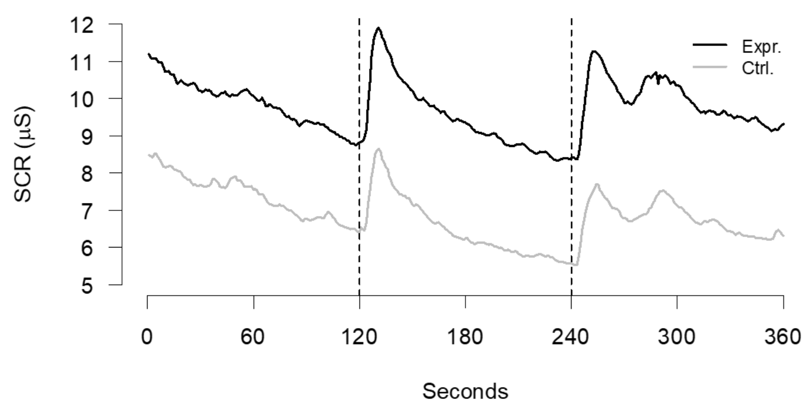
Dissimilarity measures to compare time series based on cross-correlation distances were also used to explore differences between experimental and control group SCR (Montero & Vilar, 2014). The TSdist package (version 3.7) for R was used to compute time series dissimilarity measures (Mori et al., 2016). The SCR time series were also analysed considering typical peaks characteristics (Braithwaite & Watson, 2015; Vila & Guerra, 2009) and non-normally distributed variables were log transformed before analysis. To extract peak characteristics, time series were smoothed with the Nadaraya-Watson kernel regression procedure and a bandwidth 10 seconds wide. R source code, variables map, and data files to replicate all analysis, tables and graphs are available in the following Open Science Framework repository: https://osf.io/rg9wd/.

Results

Figure 1 shows the SCR time series for experimental and control group after participants finished the virtual reality task. As can be seen, experimental group produced a higher physiological signal across the recording period. Considering the whole time series, experimental group was 2.86 microsiemens on average above the control group, $t(359) = 160.8$, $p < .001$ level, $d = 16.97$, 95% CI [15.70, 18.22], unilateral contrast. Figure 1 also shows a linear-like decrease in SCR for both groups during the resting state (the first 120 seconds of recording). It is also shown a steep increase in SCR for both experimental and control group when smartphone is allowed to use and when participants were instructed to put it on table face-down (after second 120 and 240).

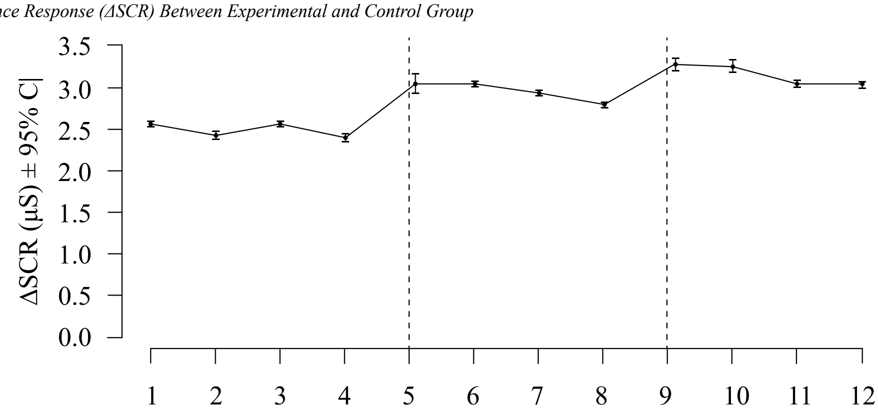
In Figure 2 control SCR time series was subtracted to experimental SCR time series and the resulting time series was clustered in blocks of 30 seconds. Table 1 shows that experimental group significantly produced a higher SCR signal than control group for all time frames. Notice that all computed Bayes Factors are in the range 30-100 which means that data provide strong evidence towards the hypothesis that experimental and control groups produce statistically different time series. As can be seen, the Bayes Factors are practically, in terms of statistical implications, insensitive to prior change which converges with test *p*-values. There is a statistically significant increase in the differential SCR from the fourth block to the fifth block, $t(41.92) = 11.45$, $p < .001$ level, $d = 3.54$, 95% CI [2.56, 4.50], unilateral contrast. It means that using the smartphone in the experimental group significantly increased the electrophysiological activation as compared to control group. Experimental group also significantly increased SCR signal from the eighth block to the nineth considering the differential time series of control group, $t(34.28) = 8.32$, $p < .001$ level, $d = 2.84$, 95% CI [1.88, 3.78], unilateral contrast. This suggest that stopping to use the smartphone also produces a significant increase in electrophysiological activation as measured with SCR. It can be noticed (Table 1), however, that the smaller differences in SCR between experimental and control group appear when participants are allowed to use their smartphones and when they are told to stop using it.

Figure 1
Skin Conductance Response (SCR) for Experimental (Expr.) and Control (Ctrl.) Groups



Note. From second 1 to 120 participants were resting after the virtual reality distraction task. In second 120 participants were instructed to grab their smartphone and use it normally. They were using their smartphone until second 240. In second 240 participant were ordered to put their smartphone on the table screen-down.

Figure 2
Difference in Skin Conductance Response (ΔSCR) Between Experimental and Control Group



Note. From block 1 to block 5 participants were resting after the virtual reality distraction task. At the beginning of block 5 participants were instructed to grab their smartphone and use it normally. They were using their smartphone until block 9. At the beginning of block 9 participants were ordered to put their smartphone on the table screen-down.

Table 1
Skin Conductance Response Mean Differences (ΔM) Favouring the Experimental Group for Each Time Block (TB)

TB	*ΔM*	*t*	*BFn*	*BFm*	*BFw*	*BFu*	*TSD*
1:30	2.55	144.50	89.24	89.93	90.28	90.62	8.67
31:60	2.42	95.27	77.60	78.29	78.64	78.98	18.98
61:90	2.54	193.81	97.45	98.14	98.49	98.83	7.11
91:120	2.39	106.36	80.67	81.36	81.71	82.05	10.90
121:150	3.04	58.15	63.85	64.54	64.88	65.22	4.48
151:180	3.05	197.84	98.02	98.72	99.06	99.41	10.76
181:210	2.93	191.99	97.18	97.88	98.22	98.57	9.37
211:240	2.79	167.07	93.29	93.99	94.33	94.68	13.59
241:270	3.27	59.29	64.39	65.08	65.42	65.76	5.05
271:300	3.24	91.71	76.54	77.23	77.57	77.92	14.77
301:330	3.03	155.99	91.38	92.07	92.41	92.76	8.18
331:360	3.03	118.68	83.73	84.43	84.77	85.12	17.48

Note. TB: time block, *TSD:* time series distance. All contrasts were unilateral and computed using 29 degrees of freedom. All *p*-values are less than .001 and estimated R^2 are greater than .99 in all cases.

As can be seen in Table 2, peaks analysis revealed that peak log-transformed amplitude in experimental group (M = 0.80, SD = 0.70) was more than five time higher than peak amplitude in control group (M = 0.15, SD = 1.08) when participants were allowed to use their smartphones after resting phase. It means that experimentally generated social expectancy increased arousal when participants had the opportunity to use their smartphone. Skin conductance response peak amplitude was also higher in experimental group (M = 0.81, SD = 0.67) as compared to control group (M = 0.38, SD = 0.86) when participants were asked to put their smartphone on table face-down. It suggests social expectancy increases the arousal measured by SCR when smartphone has been withdrawn. It also was observed that half recovery time was longer for experimental group (M = 2.96, SD = 0.80) than for control group (M = 2.60, SD = 0.67). This means that participants who were socially expectant were significantly in a higher-level arousal for a longer period after the peak maximum. Experimental and control groups did not differ in peaks rise time, number of peaks when using and stopping to use the smartphone. No differences were also observed in half recovery time during withdrawal phase (see Table 2).

Correlations between skin conductance response peak amplitude, half recovery time during smartphone usage as well as SCR peak amplitude after smartphone withdrawal, smartphone pattern of use variables, SAS-SV scores, and AAQ-II scores were estimated. Holm-Bonferroni family-wise error free comparisons showed no significative relationships between SCR peak characteristics, smartphone pattern of use variables, SAS-SV scores, and AAQ-II scores. A set of linear regression models were also estimated to search for interaction effects between experimental group and smartphone pattern of use on SCR peak characteristics, but no statistical interactions were observed (these supplementary analyses are available at https://osf.io/shcyj). It was also observed that participants classified as having a high or low risk of suffering smartphone addiction (by considering SAS-SV cut-offs) produced similar skin conductance responses even after controlling for experimental condition (control versus experimental). However, a significant correlation was observed between SAS-SV score and AAQ-II score (r = .32, p = .002, unilateral contrast). There was also no correlation between the number of people receiving the message sent by participant and SCR peak characteristics (all correlations were not greater than .001 in absolute value).

Table 2
Inferential Statistics to Compare Peak Characteristics Differences Between Experimental and Control Group After Second 120 (Smartphone Use) and 240 (Smartphone Withdrawal)

	t	*df*	*p*	*d*	*r*	*BFn*	*BFm*	*BFw*	*BFu*
Smartphone use									
Amplitude	3.31	71.98	<.001	0.78	.36	20.81	22.90	20.98	17.64
Rise time	0.62	75.59	.733	0.14	.07	0.44	0.27	0.20	0.14
HRT	2.25	81.64	.014	0.50	.24	2.35	1.99	1.64	1.28
Peaks	0.21	83.93	.416	0.05	.02	0.39	0.23	0.17	0.12
Smartphone withdrawal									
Amplitude	2.60	79.28	.006	0.58	.28	4.38	4.06	3.47	2.77
Rise time	0.61	77.67	.273	0.14	.07	0.44	0.26	0.20	0.14
HRT	0.53	83.87	.300	0.11	.06	0.43	0.25	0.19	0.14
Peaks	1.43	83.30	.078	0.31	.16	0.80	0.55	0.43	0.32

Note. HRT: half recovery time, Peaks: number of peaks during the 120 second's period. All contrasts are unilateral.

Discussion

The main objective of this research was to experimentally evaluate the impact of social expectancy on arousal response while mobile instant messaging. As expected, results show that social expectancy is a key variable to explain emotional response (measured by SCR) when using instant messaging technology with the smartphone. As far as we know, there is not any previous experiment showing the critical impact social expectancy has on arousal when using the smartphone to interact by using instant messaging. Our results suggest, like previous research and theoretical developments on problematic smartphone posit, that social expectancy is one of the relevant variables to understand problematic or abusive use of smartphone (see, for example, Abrams, 2022; Billieux, 2012; Körmendi 2016; Olson et al., 2022; Roberts; Tifft et al., 2022; Suissa, 2015; Veissière & Stendel, 2018; Wang et al., 2021). It seems that the social expectancy we experimentally generated increased the potential reinforcement of social interaction through instant messaging. In other words, participants in the experimental group sent a message to their more active contacts in their preferred social network which started to increase their expectancy of being replied. The high levels in SCR for experimental group after the distraction task can be considered as the outcome of this increase in emotional arousal (see Figure 1, 2 and Table 1). The big effect sizes we observed might be due to the long delay period from sending the message and backing to the smartphone again. For example, Camerini et al. (2022) noticed the longer the delay while instant messaging, the higher the emotionally dependent conductance response. Igarashi et al. (2008) also provided evidence in the same sense when studying text messaging.

Peaks analysis also revealed that experimentally generated social expectancy acutely increases arousal when using the smartphone after the virtual reality distraction task. Both peak amplitude and half recovery time were higher for those participants in experimental group. A bigger peak amplitude in SCR was also observed in experimental group upon smartphone withdrawal. The phasic increase in physiological arousal when using the smartphone support the hypernatural monitoring theory of smartphone addiction (Veissière & Stendel, 2018). In short, this theory posits that “there is nothing inherently addictive about mobile technology” but it is the “social expectation and rewards of connecting with other that induce and sustain addictive relationships with smartphones” (p. 1). In the same vein, as suggested by Wang et al. (2021), we could conclude that the problem with problematic or addictive smartphone use can be interpreted in terms of social dynamic instead of a pathological phenomenon caused by the smartphone itself (Panova & Carbonell, 2018). Communicative social expectation is a natural and desirable phenomenon because it is the essence of human understanding and communication, but like other social phenomena (for example, the negative social influence of authority in war crimes) it entails some risks. If we consider the current use of social networks, it seems that some people are at risk of being powerfully affected by the social expectancy generated when using mobile instant messaging applications. Future research should identify the critical aspects of social expectancy, or individual vulnerabilities, leading to problematic smartphone use.

Results also show that an arousal increase follows smartphone withdrawal. We did not assess the valence of this physiological response as Camerini et al. (2022) did, but it can be thought this physiological behaviour is analogous to substance-like withdrawal responses. Hsieh et al. (2020) also observed a similar withdrawal effect in smartphone users, but they did not include a control group as we did. Those results are also congruent with prior research showing that not allowing participants to use their smartphones when ringing increases blood pressure and heart rate (Clayton et al., 2015). Previous studies have also tried to experimentally observe substance-like symptoms in relation to smartphone use. For example, Thomson et al. (2021) failed to observe salience in an experiment designed to ascertain whether social networks notifications produce attentional bias in a simulated smartphone screen. Contrarily to our design, Thomson et al. (2021) used simulated notifications not contingent to participant behaviour. Maybe that was the reason why social expectation was not generated and, as a result, salience effect was not observed.

Significant relationships between SCR, smartphone pattern of use, SAS-SV and AAQ-II were not observed, but SAS-SV scores and AAQ-II appeared to be correlated as observed in previous studies (García-Oliva & Piqueras, 2016; Ruiz-Ruano et al., 2020). This result agrees with those suggesting problematic smartphone use is related with a deliberate trend to avoid internal negative emotional states (Dolev-Cohen & Barak, 2013; Marciano et al., 2022). It also agrees with previous studies showing that emotional regulation is critical to understand PSU (Bernal-Ruiz, 2021; Körmendi, 2016; Suissa, 2015). Additionally, it also highlights the critical role of emotional response to understand underlaying mechanisms of PSU.

Our study comes with some limitations future studies should address. Firstly, we did not measure subjective sensation after using and withdrawing the smartphone. Assessing the valence of SCR increase would shed light on the direction of emotional response when using the smartphone (see Camerini et al., 2022). Secondly, although the SAS-SV is one of the most currently used scale to measure smartphone addiction (Marciano & Camerini, 2022; Olson et al., 2022; Ruiz-Ruano et al., 2020; Squires et al., 2021), using a scale to measure problematic mobile instant messaging would have been a better option to shed light on the relationship between experiential avoidance, social expectation, and PSU. Additionally, future research should clarify whether social expectation can explain the problematic use of virtual social networks. Thirdly, the original cut-off points to classify participants as having a high risk of suffering smartphone addiction were used (Kwon et al., 2013). However, those cut-off points might be not justified because of cultural differences. Given that no valid classification points have been derived for Spanish population, future research should focus on that objective. Finally, positive, and negative mood were not measured to study possible mediation effects of those variables between arousal increase and PSU. Future experimental studies should block mood, experiential avoidance and problematic smartphone use to more clearly test whether social expectation is the genuine cause of SCR increase.

The research presented here is the most basic experimental study that can be done to uncover the impact social expectation and social rewarding have on emotional response while using the smartphone to exchange instant messages. It has recently been shown that preference for online social interaction and emotional self-regulation deficits can explain the negative consequences of smartphone usage (Pastor et al., 2022). Therefore, our results can be useful to include the emotional component in new or available intervention programs (i. e., Olson et al., 2022; Khalily et al., 2021) as well as to improve theories about the social elements related to PSU (Roberts, Tifft, et al., 2022; Veissière & Stendel, 2018; Wang et al., 2021). After all, mobile phones are here to stay and we must learn how to healthily use those devices instead of banning or avoiding them (Roberts, Flagg, et al., 2022).

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