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What influences our recall of the use of social media and smartphones? An exploratory study based on a sample of Chinese iPhone users

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Abstract: Self-estimation of technology use is commonly applied in examining people's daily behaviour on social media. However, there has been criticism that retrospective self-estimation of social media use is inaccurate. This study investigates possible factors that might influence the recalling accuracy of social media and smartphone use. By comparing self-report data of social media and overall smartphone use with screen time data from a sample of 315 Chinese iPhone users, we find that the estimated usage is only moderately correlated with the actual usage. The longer time spent on social media or smartphones, the more inaccurate the self-report data would be. Several psychological factors are evidenced to be correlated with the inaccuracy of recall: loneliness is positively correlated with the discrepancies between estimated and actual use of social media. Respondents who report a higher level of loneliness are more likely to overestimate their social media use. Life satisfaction is negatively associated with the discrepancies between estimated

and reported actual use of both social media and smartphones. Respondents who report a higher level of life satisfaction are less likely to underreport their overall smartphone use.

Keywords: recalling accuracy; self-report measurement; digital technology; smartphone; social media.

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1 Introduction

It is difficult to imagine life without social media in today's world. To a considerable extent, social media is changing the way people communicate, forming our new habits, and reconstructing our daily routine. One significant change seen in the last decade is that fewer people are accessing social media via computers, with an increasing number of users now exclusively on mobile devices. According to a global digital annual report (Kemp, 2019), in January 2019, 3.26 billion people were using social media on mobile devices, with the growth of 297 million new users representing a year-on-year increase of more than 10%. Mobile phones now account for 48% of the time people spend on the internet, while this number in 2014 was only 26%. Apparently, people are spending a longer time on social media and their smartphones. Especially with the spread of the COVID-19 pandemic when many countries imposed lockdowns amidst the crisis, and offline physical interactions had become limited, social media played an increasingly important role in connecting people with the outside world.

To better understand social media's growing impact on our lives, there have been a growing number of studies concerning the interaction between users and digital

technology in recent years. Serving as a proxy for the intensity of use, time spent on social media is a frequently used construct in social science and psychology. Previous research regarding the effect of social media use on users' physical and psychological well-being relied heavily on retrospective self-reports of social media use. However, it has long been argued that recall bias exists, and the retrospective data is not always as accurate and reliable as expected (Araujo et al., 2017; Scharkow, 2016; Sewall et al., 2020). Many factors may influence the accuracy of recall, which cast some doubts on retrospective recall methods as valid measures of social media use.

Recently, many scholars have been trying to understand why users fail to remember faithfully their use of digital technology and figure out what factors may influence recall accuracy. For example, Boase and Ling (2013) compared respondents' self-reports of mobile phones with the server log data. They found that the criterion validity of self-report data was relatively low, and there was a gender difference in recalling the use of mobile phones. Araujo et al. (2017) also conducted research comparing respondents' self-reported internet use with automatic tracking data. They reported that the intensity of internet use was associated with the misestimation of internet use. Sewall et al.'s (2020) study comparing participants' self-reports with iPhone screen time data found that psychological well-being factors (i.e., depression, loneliness, and life satisfaction) were also correlated with recall bias. Despite the diversity in the research context and testing variables, findings in previous studies constantly suggest that studying self-assessments of time can provide insights into improving the accuracy and validity of media use measurements.

Thus far, much research in this area has been conducted in Western societies (Ohme et al., 2021; Rosenthal et al., 2021). We consider it is necessary to reproduce the experiment in the Chinese context for the following two reasons. First, Western and Eastern countries are diametrically different in key cultural dimensions such as individualism/collectivism and high/low context, which may have a great influence in terms of social media use and motivation (Kim et al., 2011). For example, social media researchers have noted that new media technologies are sometimes used for activities regarded as 'guilty pleasure', which appeals to one's desire for immediate pleasure rather than long-term benefits. Such types of social media use are correlated with users' feelings of guilt (Panek, 2014). Indeed, in the emotion and cross-cultural literatures, cultural differences play an important role in shame and guilt (Wong and Tsai, 2007). Previous empirical findings suggest that in US contexts, experiencing guilt leads to reparative action (Leith and Baumeister, 1998), yet this model has not been verified in the Chinese context. Therefore, in our case, we plan to examine whether the experience of guilt would affect people's recall of digital technology use. Second, according to a market report by Statista (2017), China is the country where people used the most iPhones. Yet, the daily use of social media are unique in Mainland China. Due to the Great Firewall, popular websites such as Facebook, Twitter, Instagram, and YouTube are blocked. People instead turn to WeChat and Weibo for social communication needs. This raises a worthwhile question about whether previous findings can be applied to the Chinese context.

The current research represents a twofold effort. First, from a methodological point of view, we use the screen time feature on the iPhone to measure users' social media activities. By comparing the application-traced data with the retrospective recall of social media and smartphone use, this study aims to explore possible factors that may predict retrospective bias in reporting the use of digital technology in the interest of improving the accuracy in data collection. Second, this paper seeks to understand respondents'

recalling behaviour about digital technology use among a Chinese sample. By March 2020, there are more than 890 million mobile internet users in China (CNNIC, 2020). In the past decade, we have witnessed an increasing number of studies focusing on the digital technology use of this huge entity. However, research on retrospective recalling behaviour of the Chinese mobile internet users remains scarce. Hence, the findings of present study would extend this research field by providing empirical evidence on recall bias of social media use in Eastern societies.

2 Literature review

2.1 Self-report measures vs. screen time measures in social media research

Social scientists rely heavily on the self-report measures to capture and analyse the user's mobile communication activities. However, reporting on one's daily behaviour is not an easy cognitive task, and it has long been criticised that self-report measure lacks accuracy. Boase and Ling (2013) compared self-report mobile phone use (i.e., voice calling and SMS messaging) to mobile server log data among a nationally representative sample in Norway and found that the self-report data correlated only moderately with the server log data. Similarly, Scharkow (2016) conducted a study examining the accuracy of self-reported internet use. He also found that self-report measures were rarely accurate and their convergent validity with client log files was weak. Araujo et al.'s (2017) study compared the user's self-reported and actual internet use, and again confirmed the low accuracy of self-report measures.

Traditional self-report measures commonly quantify the use of social media and mobile devices in three dimensions: frequency of use (Hatchel et al., 2018), duration of use (Valenzuela et al., 2009; Valkenburg and Peter, 2007), and intensity of emotional connection with specific platforms (Chai et al., 2019). To respond to the frequency measures, normally, respondents are required to recall their activities in a certain period time (e.g., 'less than once a week', 'one to six times a week', 'several times a day', etc.). Duration questions often involve the use of multiple-choice questions to which respondents answer the estimated amount of time that they spend on specific platforms or devices in a single day (e.g., '0–30 minutes a day', '1–2 hours a day', etc.). Sometimes time diaries are also used in data collection (Giunchiglia et al., 2018), which require respondents to report how they allocated their time during the day in detail. As for the third type of measure, Likert-scales are used to assess respondents' emotional connection with specific devices or platforms.

Considering the format of those self-report questions mentioned above, it is very challenging for the researchers to obtain accurate information about respondents' actual usage behaviour in research. Given that, many attempts have been made to improve data accuracy, including improving survey design strategies and providing an anchor that facilitates respondents' estimation during the survey (Araujo et al., 2017). These strategies, to some extent, increase the accuracy of recall.

The use of objective measures is always considered as more reliable than self-reported measures. The Screen Time function on the iOS system has been introduced in previous studies to track people's device usage in a more accurate way (Sewall et al., 2020). Screen time was first announced as a new feature of Apple's iOS12 software in 2018. With screen time, users can access real-time reports about how much time they

spend on their iPhone, iPad, or iPod touch. It gives users detailed reports about how their devices are used, how much time they spend with single apps and predefined categories of apps (e.g., social networking, productivity, entertainment, etc.) and how many notifications they receive (Apple Inc., 2020). There are similar functions available for Android mobile devices. For example, the Digital Wellbeing application launched by Google enables users to get a daily view of their digital habits. However, there are two reasons that prevent us from applying Android users' screen time data in this study. First, as mentioned earlier, when the iPhone screen time function assort users' digital behaviour into several categories (i.e., social networking, productivity, entertainment), the Digital Wellbeing function only record the time users spend on each application. Therefore, it would be difficult to get the whole picture of users' overall usage of the device and may also affect the consistency of the research design. Second, the iPhone screen time is a built-in feature of mobile operating systems, yet Android users have to manually install such digital habits tracing applications on their devices. Considering the Google Play, on which digital wellbeing is available, is blocked in mainland China, it would be challenging to recruit a decent number of Android users who happen to have installed digital wellbeing or other similar applications on their smartphones. As such, this study plans to apply the objective measure of social media and smartphone use indicated by screen time reports on the iPhone. By comparing self-reports with application-tracked data, this paper seeks to examine the accuracy of retrospective self-reports of time use and to determine factors that may result in recall biases.

2.2 Retrospective biases in self-reports of time spent on social media

According to Boase and Ling (2013), there are three main reasons to question the validity of self-reports of time use: *conceptual validity*, *cognitive burden*, and *social desirability*. *Conceptual validity* refers to the extent to which researchers measure the concepts that they intend to measure. It would become a problem if, for example, researchers focus on social media and smartphone activity in a single day because it is unclear whether the activity occurring on that day is representative enough. A common solution is encouraging respondents to report their activities that are actually representative of more general levels. Therefore, in addition to time spent on smartphones and social media yesterday, which is a frequently used measurement of digital technology usage, we also introduced measurements of last week's smartphone activities and instructed respondents to report their screen time reports last week in this study.

Schwarz and Oyserman (2001) explained the *cognitive burden* that may lead to recall failure in the following three perspectives. First and foremost, memory fades over time, even when the event is relatively essential and distinctive. Second, when asking respondents about frequent behaviour, they are unlikely to have detailed representations of numerous individual episodes of that behaviour. Given that using smartphones and social media has now become a frequently repeated activity that is integrated into our everyday lives, it is difficult to recall the amount of time spent on mobile devices accurately. The longer the time spent on that behaviour, the more difficult the recall might be. Third, autobiographical knowledge is stored in a hierarchical network with specific events (e.g., mundane routine of every life) at the lowest hierarchy level. Searching for events that are stored in low-level hierarchy in memory might be time-consuming, and the outcome is likely to be haphazard. Most trivial events, like picking up smartphones and using social media seem insignificant, which might not be

thoroughly searched through the hierarchical network of autobiographical memory when answering the questionnaire survey. From the preceding theoretical discussion, it is thus hypothesised that:

H1a Self-reports of overall social media use are inaccurate. Respondents with higher amounts of actual overall social media usage are more likely to demonstrate significant discrepancies between estimated and actual use.

H1b Self-reports of overall smartphone use are inaccurate. Respondents with higher amounts of actual overall smartphone usage are more likely to demonstrate significant discrepancies between estimated and actual use.

Social desirability is another common source of bias affecting the validity of self-reports. It is defined as "a tendency to deny socially undesirable traits and to claim socially desirable ones, and the tendency to say things which place the speaker in a favourable light" [Nederhof, (1985), p.264]. When answering the survey, respondents might hesitate to report their answers candidly and deliberately 'edit' their answers for the consideration of self-presentation by providing socially desirable responses to threatening questions (Schwarz and Oyserman, 2001). As overuse of social media is often linked with Internet addiction and self-control problems, therefore, in our case, asking about how much time the respondents spend on the social media yesterday and last week in research may turn out to be threatening for some of them.

Earlier research found that the overuse of leisure media during unstructured time may create a sense of 'guilty pleasure' (Panek, 2014). On the one hand, using leisure media gives users tangible short-term gratification. On the other hand, eschewing present tasks in favour of immediate pleasure because of deficits in self-control also gives rise to a feeling of guilt. Guilt indicates that the individual is aware that they have lost control (LaRoseand Eastin, 2002). Said differently, when spending a long time on social media, the individual may struggle with an emotional push-and-pull battle between media temptation and self-control. Following this line, it is reasonable to assume that those who feel guilty about spending a long time on social media may be prone to edit their answers when estimating their use of these applications in order to present a more socially desirable trait of themselves. In other words, respondents who have a higher level of guilt about social media use may be more likely to misestimate their usage. To test this assumption, the following hypotheses are suggested:

H2a Respondents' sense of guilt is positively associated with amounts of actual social media use.

H2b The stronger guilt respondents report, the larger the discrepancies between their estimated and actual social media use.

2.3 Psychological well-being factors affecting the accuracy of self-reports

From a psychological perspective, there are also possible factors that may affect the accuracy of self-report. Specifically, Sewall et al.'s (2020) study suggests that the respondent's loneliness and life satisfaction is associated with the amount of inaccuracy in estimated social media and overall smartphone use. Loneliness is defined as "the unpleasant experience that occurs when a person's network of social relations is deficient in some important way" [Perlman and Peplau, (1993), p.31]. Consulting from previous

literature, we concluded that loneliness may influence people's cognitive ability to accurately estimate time spent on technology for the following three reasons. First, it has been determined that lonely individuals are more likely to use online social media to compensate for the lack of offline relationships (Skues et al., 2012). When people with a higher level of loneliness are prone to use more social media as compensation, recalling the use of social media may become even more challenging, as a result, the estimation of time spent on social media and smartphones may be less accurate. Second, many studies indicate that mood is related to our awareness of the passage of time, and negative emotional stimuli are likely to induce arousal effects and influence our time judgments (Droit-Volet, 2013; Gil and Droit-Volet, 2012). Third, a previous study has found that general belongingness has significant effect on social information processing. Considering that belonging is a primary goal of all human beings, when belongingness needs are unmet, greater processing of social information in the environment ensues. As a result, the recall of social events may be biased by the extent of social information processing that allows for belongingness needs to be fulfilled (Gardner et al., 2000). Thus, it is reasonable to infer that when people have a higher level of loneliness, they may be more likely to misestimate the time they spend on their phones and social media. Based on this analysis, we put forward the following hypothesis:

H3a Respondents who report a higher level of loneliness are more likely to demonstrate significant discrepancies between their estimated and actual use of social media.

H3b Respondents who report a higher level of loneliness are more likely to demonstrate significant discrepancies between their estimated and actual use of smartphones.

Life satisfaction is another commonly adopted measure of subjective well-being. It refers to "a global assessment of a person's quality of life according to his chosen criteria" [Shin and Johnson, (1978), p.478]. Sewall et al. (2020) find that life satisfaction significantly predicts the retrospective self-report bias, and higher levels of life satisfaction are associated with greater inaccuracies in estimated social media use. In line with this finding, we hypothesised that:

H4a Respondents who report a higher level of life satisfaction are more likely to demonstrate significant discrepancies between their estimated and actual use of social media.

H4b Respondents who report a higher level of life satisfaction are more likely to demonstrate significant discrepancies between their estimated and actual use of smartphones.

3 Methods

3.1 Procedure

To test these hypotheses, a web-based survey was conducted between June 4th and June 11th of 2020. All respondents were recruited from the *51Diaocha* online panel (the Chinese equivalent of Qualtrics), a professional online survey company managing

national samples of Chinese Internet users. Numerous consumer-behaviour-related questionnaire surveys have been conducted on this platform (Carroll et al., 2019). Ethics approval for this study was obtained from the ethics committee of the host university. Before the survey, all participants were informed that only information regarding time spent on their smartphones and social media would be required. Considering privacy and personal data protection, no screenshot of the screen time was required. Informed consent was obtained from all participants.

Participants should meet the following three requirements: iPhone users over 18 years old, smartphone software had been updated to iOS13 or later, Mandarin speakers. The scales were originally developed in English and then translated to Chinese by the author. A back translation was performed by another translator who was not involved in the original translation and had no prior knowledge of the objectives to ensure that the translated version was accurate and valid.

3.2 Participants

In total, 327 respondents completed the questionnaire. We excluded 12 respondents who reported higher yesterday social media use than yesterday's overall smartphone use, yielding a final sample of 315 respondents. The demographic characteristics of the sample are as follows: 48.3% (n = 152) of the participants are female and 51.7% (n = 163) are male; 14.9% (n = 47) of the participants are students and 57.5% (n = 181) are employed; 92.1% (n = 290) of the participants hold a college degree or above. The age of the participants ranges from 18 to 56 years (M = 28.4, SD = 4.825).

3.3 Measures

3.3.1 Estimate usage

The estimated usage included two dimensions to measure the intensity of both smartphone and social media use. The first is designed to estimate how much time people spent on smartphones *yesterday* and *last week*. *Yesterday usage* was measured with the following items: "Before consulting screen time, please estimate the total amount of time you spent on your smartphone yesterday", and "Before consulting screen time, please estimate the total amount of time you spent on social media on your smartphone yesterday." Participants were instructed to fill in blank fields corresponding to the number of hours and number of minutes. Last week usage was also measured with two fill-in-the-blank questions: "Before consulting screen time, please estimate the total amount of time you spent on your smartphone last week", and "Before consulting screen time, please estimate the total amount of time you spent on social media on your smartphone last week." Participants were instructed to enter a response in blank fields corresponding to the number of hours and number of minutes.

3.3.2 Actual usage

Correspondingly, the actual usage measures were also divided into two parts: *yesterday usage* and *last week usage* for overall smartphone use and social media use. The social media use can be found from the social networking category on the screen time report by default. In addition to the well-known social networking apps (e.g., Facebook, Instagram,

Twitter, LINE, etc.), we also inspected what kind of Chinese social media apps were categorised as Social Networking on the screen time before conducting the survey. The following popular apps are identified as social networking: WeChat (the Chinese equivalent of WhatsAPP), Weibo (the Chinese equivalent of Twitter), QQ (the Chinese equivalent of LINE), Zhihu (a question-and-answer website), Tieba (the Chinese equivalent of Tumblr), and Lofter (a blog site). Respondents were asked to report their use of smartphones and social media at the end of the questionnaire survey by checking on the screen time report on their iPhones. Pictorial instructions about how to read the screen time report were provided.

3.3.3 Discrepancies

To examine the extent of misestimation, we created additional variables describing the difference between estimated self-report data and screen time data by recording the absolute value of the estimated usage and actual usage. These variables were termed as *discrepancy*. Consulting from previous literature (Araujo et al., 2017), we subtracted the actual usage from the respondents' self-estimated usage and extracted the absolute value (i.e., $\text{discrepancy}_{\text{measure}} = |\text{self-estimated}_{\text{measure}} - \text{actual usage}_{\text{measure}}|$) to assess the bias of estimation. In total, there were four discrepancy variables: the discrepancy of yesterday's phone use; the discrepancy of yesterday's social media use; the discrepancy of last week's phone use; and the discrepancy of last week's social media use.

3.3.4 Loneliness

Participants responded to six items (ULS-6) from the UCLA loneliness scale, Version 3 (Russell, 1996) scored on a four-point Likert scale (1 = *Never* to 4 = *Often*), with higher scores indicating higher levels of loneliness. The ULS-6 showed good construct validity and good internal consistency with an alpha = 0.809 in this study.

3.3.5 Life satisfaction

The satisfaction with life scale (Diener et al., 1985) is a widely used measure of subjective well-being. It assesses an individual's cognitive judgement of his/her life as a whole. Items were scored on a scale of 1 (*not at all true of me*) to 5 (*extremely true of me*), with higher scores indicating higher well-being levels. This index showed excellent reliability (alpha = 0.840) in this study.

3.3.6 Guilt

Consulting from previous literature (Panek, 2014), we designed a three-item scale to assess guilt. Participants were asked to rate how well the following three statements can be used to describe their own situations (from 1 = *not at all true of me to* 5 = *extremely true of me*): "I often feel guilty about the amount of time I spend on social media"; "I often feel guilty about the amount of time I spend on my phone"; "I often feel guilty about having engaged in certain activities on social media." These questions measured guilt associated with the amount of social media consumption and smartphone use. Higher scores indicate stronger guilt about social media use. Overall, the scale had good construct validity and good internal consistency with an alpha = 0.872.

4 Results

The survey data analyses were implemented by applying the SPSS version 20.0. Descriptive statistics for the estimated and application-tracked smartphone and social media usage are presented in Table 1. According to the *yesterday* measures, participants spent an average of 8.15 hours (SD = 3.13) on their phones, of which 4.14 hours (SD = 2.13) were spent on social media. As for the *last week* measures, it shows that the average time spent on smartphones in one week was 54.86 hours (SD = 20.79), with 29.78 hours (SD = 15.41) on the social media.

Table 1 Summary statistics for primary measures (N = 315)

	Number of items	*Mean*	*Median*	*SD*
Estimate yesterday use (hours)				
Phone		7.94	7.72	3.02
Social media		4.31	3.83	2.20
Actual yesterday use (hours)				
Phone		8.15	7.81	3.13
Social media		4.14	3.55	2.13
Estimate last week use (hours)				
Phone		52.57	50	20.65
Social media		29.45	26	15.71
Actual last week use (hours)				
Phone		54.74	51.42	20.77
Social media		29.99	29.05	15.39
Loneliness	6	12.05	12	3.80
Life satisfaction	5	15.97	16	4.19
Guilt	3	7.90	8	2.82

According to Table 1, respondents tended to underestimate their yesterday's overall phone use, last week's overall phone use, last week's social media use, but overestimate their yesterday's social media use. Paired-sample t-tests were conducted for the estimated measures and application-tracked measures.

Paired-sample t-tests were conducted to test whether the discrepancies were statistically significant or not. To better control for the influence of outliers, we performed logarithmic transformations on the time-related variables. As shown in Table 2, the mean of the estimated yesterday's social media use was significantly higher than the mean of the actual yesterday's social media use ($p < 0.05$). This result indicated that respondents tended to overestimate the time they spent on social media yesterday. In terms of last week's overall phone use, the estimated measure's mean was significantly lower than the application-tracked measure ($p < 0.01$). Namely, respondents were prone to underestimate the overall time they had spent on their phones last week. Meanwhile, Table 2 also shows that the discrepancy of yesterday's phone use and that of last week's social media measures were not statistically significant.

Table 2 Paired-sample t-tests comparing estimated and actual usage (N = 315)

	Estimated		*Actual*		μ_{M1-M2}	*df*	*t*	*p*
	M_1	SD_1	M_2	SD_2				
Yesterday phone use	0.867	0.172	0.878	0.176	–0.010	314	–1.534	0.126
Yesterday SM use	0.580	0.225	0.554	0.246	0.025	314	2.439	0.015**
Last week phone use	1.685	0.182	1.707	0.174	–0.021	314	–2.710	0.007**
Last week SM use	1.407	0.240	1.413	0.245	–0.005	314	-0.435	0.664

Notes: 1. SM = social media; 2. All variables are log-transformed.
*$p < 0.05$. **$p < 0.01$.

Pearson correlations were then performed to assess the relationships among the primary variables. Loneliness, life satisfaction, and guilt were standardised to avoid the differences in the ranges of initial features from causing biases. The results of this analysis are presented in Table 3.

As shown in Table 3, the correlations between the yesterday estimate questions and the application-tracked measures were 0.766, $p < 0.01$, for overall phone use, and 0.692, $p < 00.01$, for social media use. The correlations between the last week's estimate questions and the application-tracked measures were 0.695, $p < 0.01$, for overall phone use, and 0.621, $p < 0.01$, for social media use. In sum, correlating estimate measures to the Screen Time data indicated that the retrospective recall of time spent on smartphones and social media was only moderately similar to the tracking data.

The discrepancy of yesterday's overall phone use was positively correlated with actual yesterday overall phone use ($r = 0.115$, $p < 0.05$). In the same vein, yesterday's social media use discrepancy was positively correlated with actual yesterday social media use ($r = 0.141$, $p < 0.05$). As for last week usage, it was also found that the discrepancy of last week overall phone use was positively correlated with actual last week overall phone use ($r = 0.140$, $p < 0.05$), while the discrepancy of last week social media use was positively correlated with actual last week social media use ($r = 0.169$, $p < 0.01$). Said differently, the longer time spent on smartphones and social media, the less likely the estimated usage would be accurate. Therefore, H1a and H1b are supported.

Guilt was positively correlated with actual yesterday social media use ($r = 0.157$, $p < 0.01$) and actual last week social media use ($r = 0.129$, $p < 0.05$), whereas no statistically significant correlations were found between guilt and estimated use of social media. Namely, being aware of the actual time that has spent on social media might give respondents a sense of guilt, and the longer the time spent, the stronger the feelings of guilt would be. Therefore, H2a is supported. However, the correlations between guilt and discrepancy variables were weak and not statistically significant. Hence, H2b is rejected.

Table 3 Zero correlations among social media and smartphone use variables and well-being variables (N = 315)

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	Estimate yesterday phone use	1														
2	Estimate yesterday SM use	0.647**	1													
3	Estimate last week phone use	0.782**	0.516**	1												
4	Estimate last week SM use	0.555**	0.756**	0.674**	1											
5	Actual yesterday phone use	0.766**	0.516**	0.613**	0.449**	1										
6	Actual yesterday SM use	0.482**	0.692**	0.358**	0.573**	0.545**	1									
7	Actual last week phone use	0.577**	0.384**	0.695**	0.500**	0.645**	0.387**	1								
8	Actual last week SM use	0.392**	0.507**	0.390**	0.621**	0.390**	0.674**	0.591**	1							
9	Discrepancy of yesterday phone use	0.049	0.126*	–0.038	0.052	0.115*	0.108	0.064	0.052	1						
10	Discrepancy of yesterday SM use	0.128*	0.278**	0.085	0.179**	0.174**	0.141*	0.150**	0.087	0.590**	1					
11	Discrepancy of last week phone use	0.098	0.061	0.038	0.034	0.139*	0.037	0.140*	0.051	0.480**	0.422**	1				
12	Discrepancy of last week SM use	0.103	0.153**	0.082	0.160**	0.151**	0.116*	0.130*	0.169**	0.303**	0.330**	0.477**	1			
13	Loneliness	0.100	0.127*	0.100	0.100	0.051	0.007	0.120*	0.044	0.079	0.158**	0.096	0.133*	1		
14	Life satisfaction	–0.023	–0.054	0.019	0.002	–0.080	–0.017	–0.074	0.000	–0.138*	–0.135*	–0.150**	–0.111*	–0.305**	1	
15	Guilt	0.028	0.072	–0.011	0.023	0.023	0.157**	0.001	0.129*	–0.012	0.092	0.001	0.004	0.380**	–0.044	1

Notes: 1. SM = social media; 2. Time measures are log-transformed; 3. Loneliness, life satisfaction, and guilt scales are standardised.
*$p < 0.05$. **$p < 0.01$.

Table 4 Regression analysis of over-reporting and under-reporting of social media and overall smartphone use

	Social media use				*Overall phone use*			
	Yesterday		*Last week*		*Yesterday*		*Last week*	
	Under report	*Over report*	*Under report*	*Over report*	*Under report*	*Over report*	*Under report*	*Over report*
Actual use	1.343**	0.034	1.799**	–0.300	1.044**	–0.380	1.693**	–0.866*
Loneliness	0.003	0.126**	–0.029	0.164*	–0.046	0.045	–0.009	0.109
Life satisfaction	–0.007	–0.056	–0.061	–0.060	–0.092*	0.016	–0.166**	0.087
Guilt	0.048	–0.016	0.007	–0.117	–0.002	–0.014	–0.018	–0.006
Constant	–1.646**	1.603	–3.748**	3.328**	–1.104	2.662**	–3.679**	5.557**
R^2	0.301	0.087	0.236	0.097	0.124	0.019	0.176	0.104
Adjusted R^2	0.279	0.061	0.219	0.068	0.099	–0.015	0.161	0.067
N	133	146	185	129	149	120	213	101

Notes: 1. Actual use means yesterday's and last week's actual use of social media and smartphones indicated by screen time report, respectively; 2. All time variables are log-transformed; 3. Loneliness, life satisfaction, and guilt scores are standardised.
*$p < 0.05$. **$p < 0.01$.

Loneliness turned out to be positively correlated with estimated yesterday social media use ($r = 0.127$, $p < 0.05$) and actual last week overall smartphone use ($r = 0.120$, $p < 0.05$). Loneliness was also positively associated with discrepancy of yesterday social media use ($r = 0.158$, $p < 0.01$) and discrepancy of last week social media use ($r = 0.133$, $p < 0.05$). In other words, respondents who reported a higher level of loneliness would estimate their social media use less accurately. On this account, H3a and H3b are supported.

Life satisfaction was negatively correlated with all the discrepancy variables, which means when respondents have a higher level of life satisfaction, the estimation of social media and overall smartphone use would be more accurate. Accordingly, H4a and H4b are rejected.

We also conducted a multivariate analysis to explore potential factors associated with under- and over-reporting that occurred when respondents estimated their use of social media and smartphones. We used a dichotomous variable to indicate under- and over-reporting that occurred when respondents reported their use that was differed from the actual use indicated by the screen time data. The results of this analysis are presented in Table 4.

This multivariate analysis shows that only a few factors were significantly associated with under- and over-reporting. Actual use measures are significantly and positively associated with all the underreport variables. The longer time spent on social media and smartphones, the more likely respondents will underreport their use.

Loneliness is only positively associated with over-report of yesterday's social media use ($p < 0.01$) and over-report of last week's social media use ($p < 0.05$). Said differently, respondents who reported a higher level of loneliness tended to over-report their social media use. Life satisfaction is significantly and negatively correlated with underreport of yesterday's overall phone use ($p < 0.05$) and underreport of last week's overall phone use ($p < 0.01$), which indicated that respondents who reported a higher level of life satisfaction were less likely to underreport their overall phone use. Guilt did not significantly predict under-/over-report of social media nor overall smartphone use, which was in line with the Pearson correlation analysis.

5 Discussion

The present research aims to examine the accuracy of self-reported social media measures and smartphone use and explore possible factors that may affect recall bias. Comparing self-reported data with application-tracked data recorded by Screen Time on iPhone, there are four major findings.

First and foremost, our analysis shows that estimates of social media and smartphone use are inaccurate, and only moderate associations between retrospective estimates and reported actual use are examined, with Pearson correlations ranging from $r = 0.621$ to $r = 0.766$. This finding is in line with earlier studies (Araujo et al., 2017, Sewall et al., 2020; Scharkow, 2016), indicating that retrospective estimates of use are not always reliable in media use studies. In fact, previous studies concerning the correlations between digital technology use and subjective well-being using retrospective self-report measurements should be understood as *perceived* use, rather than *actual* use.

Second, it is determined that actual use of social media and smartphones strongly predicts the discrepancy between estimated and reported actual use. The longer time people spent on social media and smartphones, the more likely that they will underestimate their use. One possible explanation is that frequency illusions occur at some stages of cognitive processing. It has been demonstrated that people tend to underestimate frequent events and overestimate rare events (Fiedler and Armbruster, 1994). Given that social media and smartphones are so frequently used in everyday lives, the respondent's temporal judgment on time spent on the smartphone and social media may be influenced, and such influence may increase as the use time increases.

Third, two psychological well-being variables, *loneliness* and *life satisfaction*, are significantly correlated with misestimation of the use of social media and smartphones. On the one hand, respondents with a higher level of loneliness became less accurate in recalling their social media use for yesterday and last week. The multivariate analysis demonstrates that a higher level of loneliness is associated with an overestimation on their yesterday's and last week's social media use. There are several possible explanations for these findings. First, Pearson correlation analysis suggest that loneliness is positively correlated with estimated yesterday social media use. Said otherwise, respondents who report a higher level of loneliness are more likely to believe that they spent a longer time on social media yesterday. Individuals place different values on their daily behaviour, and those who report a higher level of loneliness may weigh social media use more important than other activities given that using social media helps to ease the feelings of loneliness. When estimating the intensity of social media use, their judgments might be distorted. As a result, these respondents are likely to overestimate their social media use. Second, some scholars suggested that our emotions alter our sense of time, and time can be distorted to appear shorter or longer than it really is (Droit-Volet and Meck, 2007). At the present stage of research, we conjecture that loneliness, as an unpleasant emotional valence, might alter our sense of time, and consequently, respondents who report a higher level of loneliness may recall their social media use less accurately. On the other hand, life satisfaction is significantly and negatively correlated with discrepancy variables, which means that those who report a higher level of life satisfaction will have fewer discrepancies in estimating their use of social media and smartphones. According to the multivariate analysis, it is noticed that when respondents report a higher level of life satisfaction, they are less likely to underreport their yesterday's and last week's overall phone use.

These findings are somewhat in conflict with Sewall et al.'s (2020) study, in which the researchers find that higher levels of loneliness are associated with more significant inaccuracies in estimated overall phone use, but not estimated social media use; whereas higher levels of life satisfaction are associated with greater inaccuracies in estimated social media use, but not overall use. Also, higher levels of respondent depression are associated with greater inaccuracies in estimated overall use and estimated social media use. There are a few possible explanations. On the one hand, existing literature has shown that depressed individuals are likely to have different feelings regarding time passage (Droit-Volet, 2013). Given that we did not include depression in our model, the findings might be different. On the other hand, in that previous work, although the actual weekly overall phone use and social media use were reported according to the screen time data, the calculation method of screen time was different at that time: the screen time feature tracked the duration of time that specific applications were used or the overall phone use over the past seven days. When we conducted our study, Screen Time data over the past

seven days was no longer available. Instead, the new calculation method reports screen time week by week from Sunday to Saturday. In most cases (if respondents did not happen to answer the questionnaire on Sunday), the *last week's report* would be different from the *past seven days' report*, which may also influence the results.

Last but not least, this study introduces *guilt* to examine whether using social media would generate a feeling of guilt and whether the guilty feeling would drive respondents to edit their answer to the survey for the sake of social desirability. Pearson correlation analysis shows no significant association between the estimated use of social media and the sense of guilt, and the correlation between discrepancies variables and guilt is not significant neither. Nevertheless, both yesterday's and last week's actual use of social media are positively correlated with the sense of guilt, and the correlation between yesterday's social media use and guilt ($r = 0.157$) is slightly stronger than the one with last week's social media use ($r = 0.129$). That is to say, being aware of spending great effort and extended time on social media may be accompanied by a sense of guilt. The longer the time is, the stronger the feeling would be. However, such a feeling of guilt does not have long term effects on people's well-being, given that the association between guilt and life satisfaction was not significant. Also, we did not found any statistically significant correlation between recall discrepancies and guilt, which means guilt is not the reason for the respondents to edit their answers during the survey. Nevertheless, in Panek's (2014) study regarding guilty pleasure media use and time management, it is suggested that users are aware of the overuse of leisure media because of deficits in self-control, and the level of self-control is a more accurate predictor of the amount of social media use. Future studies can address self-control as another possible factor in explaining the retrospective bias of social media and smartphone use.

In sum, our exploratory study links a few behavioural and psychological traits to under- and over-reporting of social media and smartphone use. However, these factors do not explain a large amount of variance in the models, which suggests that additional mechanisms may be at work when recalling the use of social media and smartphones. It is still unclear how other factors, such as personality traits and self-control, may be associated with the accuracy of the retrospective estimates of social media and smartphone use. This is a fruitful topic for future research.

This study has several limitations. First, the *share across devices* function is now available on screen time, which means that user can enable this function on any device signed to the same iCloud account to report the combined screen time, so the actual reported time spent on social media and smartphone may be the combined time, rather than time spent merely on the phone. It is worth applying screening questions before the questionnaire survey to ensure that the *share across devices* function is turned off, and the Screen Time only reports smartphone use.

Another limitation is that there might be potential differences between online penal informants and the general population. In this study, we only recruited iPhone users and discussed their digital technology use and recalling behaviour. We cannot verify whether the results of this study among a specific group can be applied to the general population. Given that there are similar functions on the Android system recording users' daily behaviour on smartphones, future work is clearly needed to include other smartphone systems to represent the population better.

The third limitation of this study is that our study was conducted exclusively with a limited number of Chinese users. Findings in this study could have been further strengthened by including more representative samples in other cultural settings.

Finally, the actual use measurements in this study still rely on respondent's self-report of screen time. It is doubtful whether every individual respondent reported their actual use precisely as what was shown in the screen time report. One way to address this issue in future research is to require respondents to upload a screenshot of their Screen Time reports.

6 Conclusions

This research again finds that the traditionally used self-report measure of digital technology use is not accurate. The longer people using smartphones and social media, the more inaccurate that self-report would be. From a psychological perspective, loneliness and life satisfaction are important factors that might influence the accuracy of recall: respondents with a higher level of life satisfaction might have a more accurate recall of overall smartphone use. In comparison, those who reported a higher level of loneliness were prone to have more considerable discrepancies in recalling social media use.

Screen time, as a function designed to curb users' smartphone dependency, aims to help users regain control or at least make them aware of the amount of time they are spending on their devices. From a researcher's perspective, the Screen Time data improves the accuracy of measure and fends off unwanted under-reporting of usage. Overall, using more standard and accurate data about people's daily behaviour on smartphones and social media would be precious for future research efforts relating to the impacts of digital technology use. This study suggests the importance of applying a standard time perception approach to time-use studies since the common practice in social media behaviour of measuring time-based on subjective feeling about it is somewhat challenged. With the fruitful information available on the screen time report (i.e., time duration, pickups, most used applications, and notifications), in the future, it is worth applying this novel research strategy to communication studies, cognitive psychology, and neuropsychology.

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