Smartphone Interactions and Its Relationship With the Psychology of Time

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Abstract

Research has shown that smartphone usage can affect cognitive functions such as attention and memory. Previous literature has proposed that technology has formed its own concept of time where by natural temporal constraints don't exist, affecting the way we think about time and the value of our time. The current study aims to investigate the effect that mobile phone use has on the perceived duration of time, time structure and the perceived structured use of time, amongst a sample of 44 Irish students. The study uses a within-group correlational design, first investigating participants smartphone usage and their ability to accurately estimate time intervals. Secondly, we aim to investigate if smartphone usage is related to Time Structure scores on the TSQ and participants perceived Mobile Phone Involvement Questionnaire scores. Finally, investigating if mobile phone use recorded by an App and participants perception of mobile phone use recorded by self-report measure differ and if the degree of difference is related to an increase in phone use as well as time estimation abilities and scores on the Time Structure Questionnaire. We hypothesized that: students do not have an accurate perception of their smartphone use, that smart phone use is associated with a distorted perception of time and this may have an effect on the valued structured use of our time. Results showed no significant relationship between smartphone use as reported by students or as recorded objectively on an App and time estimation abilities. Similarly, no relationship was found between mobile phone involvement and time estimation trials. A positive significant relationship found was between Time Structure Questionnaire scores and app-reported phone use, however, a negative relationship was found between the frequency of phone use, such as the length of duration between each pick up and TSQ scores.

Introduction

Physical time is linear and fixed, measured in the speed of light and governed by the atomic clockwork of the universe, expressed in units down to the picosecond. For most of human existence time has been measured in the broad strokes of solar and lunar cycles, and, more recently, in the measurements of fractions of a solar day, in hours and minutes (Clock Time). However, this Physical Time is only one dimension of time. Perhaps as important to humans as the actual passage of physical time is the human perception of time. This has been defined as the experienced moments of continuous change in life, known as social time or life-experienced time (Cipriani, 2013). This perceived time is essentially a construction of the brain, and as such it can be manipulated and distorted in various ways (Le Poidevin, 1990). Psychological, neuroscience, physiological and sociological research has historically been interested in the concept of time and how it is perceived, the factors which facilitate its distortion and its effect on behaviour (Allan, 1979; Harrington, Haaland & Knight, 1998; Sherman, 1990; Thomas & Weaver, 1975).

Society and Time

The idea of time, what it is, how it is measured and described has been debated over thousands of years by many scientists and philosophers. Aristotle conceived a sense of time (in a period without clock time) that was non-material and completely subjective, supporting current views that time is socially created. Today, we use social life-experienced time to reference duration of time such as "for a semester", "for the duration of the working day", "during the whole time I saw her". Thus, time is measured and described as a social construct in many everyday situations. Our perception of time and its duration is accordingly varied across cultures and social groups. The pace at which we move, think and live is set by the nature of our environment (Cloville, 2016). For example, there are monochronic and polychronic cultures who experience time completely differently (Sorokin and Merton, 1937). Research has found that perceptions of time passing can be socially contagious. In one study, two groups of participants completed word puzzles. One group was interactive while the other was non-interactive. They found that in the interactive group there was a greater within group consensus regarding the perceived time speed (Conway, 2004). With new technologies and media, new ideas and trends come and go with increasing speed. Sociologist have proposed that we live in a world where words like “hectic”, “consumed” or “crazy” are increasingly used to describe people's life in an almost boastful fashion, as a proclamation of worth and success. Unlike physical time, our perception of time is changing faster now than ever before (Colvile, 2016). In Robert Colvile (2016) book “The Great Acceleration: How The World Is Getting Faster and Faster” he references research which found that when people who live in cities with a population more than a million listen to a particular length of story they will claim it has lasted twice as long compared to those from a farm or village. A study by Levine, 1999 found that the pace of life (as measured by the average walking speed in downtown locations) and work speed (as assessed by the time needed for postal clerks to complete a simple request), was significantly faster in cultures with a more advanced, productive and individualised economies. A study by Wiseman, 2007 found that when replicating Levine’s study from the 1990’s in 2006, the pace of life had sped up by 10-30%, with the greatest increase in the Asia. If we accept that the pace of life is accelerating then it may be reasonable to assume that the perception of time is also changing.

Theories on Interval Timing (Time Perception).

Theories on time perception include theories of complex cognitive functions such as memory and attention, as well as factors such as emotional state (Allan, 1979; Friedman, 1993; Thomas & Weaver, 1975). More recently, research has looked at how factors such as satisfaction, increased stimulation, arousal, culture and experience can also have an affect on our perception of time and its distortion (Chinchanachokchai, Duff & Sar, 2015; Gill &

Droit-Volet, 2012; Kern, 2003; Lee, Egleston, Brown & Gregory, 2007; Nowotny, 2018). Based on these theories and recent findings, studies have focused on the possible influence that factors such as web loading times, multitasking, and highly stimulating devices such as video games and modern technology have on our perception of time (Agarwal & Karahanna, 2000; Tobin & Grodin, 2009; Zhao et al., 2017; Nordin et al., 2013). There has been research on theories of increased technology use that include theories of attention, arousal, satisfaction, emotion and affective valence (Agarwal and Karahanna, 2000; Bikson & Gutek, 1983; Davis, 1989). However, there is a lack of literature, research and attention on the effect that these technology advances, such as ready and continuous access to smartphones, have on our cognitive functions such as our temporal experience.

Psychologists have argued that the human perception of time is not conceived as "flowing at a constant rate, unaffected by the speed or slowness of the motion and material" (Maxwell, 1879), as is Physical Time, but rather as a construct where the perceived duration of time is influenced by the number and value of events occuring in that particular moment under observation (Sorokin and Merton, 1937). Early theories of time perception have been based on information processing models, whereby temporal experiences are judged and can be distorted by the amount, value and manner of received information being processing within a specific duration or event (Guyau, 1988; McLoughlin, 2012; Ornstein,1969; Sinico, 1999). Current theories on the psychology of time have proposed that the perception of time is a function of an internal clock process whereby internal neural pulses are generated by a pacemaker which represent real time clock intervals, which are than sent to an accumulator which distributes such information (regarding the accumulated pulses) to reference and long term memory. This information facilitates the subjective judgment by which the passage of time is determined, thus any factors which affect cognitive functioning or the processing of the accumulated pulses of the internal clock in theory affect our perception of time (Blatchley et al., 2007; Gibbon, Church & Meck, 1984; Grondin, 2001; Treisman, 1963).

One of the most commonly used and accessed models used to explain the judgement of prospective time is the Scalar Expectancy Theory (Gibbon et al., 1984) which is based on an idea of an internal pacemaker proposed by Treisman (1963). It is theorized that when a duration is required to be timed, the switch that connects the pacemaker to the accumulator closes and allows neural pulses to flow to the accumulator. Once the duration is over, working and reference memory are compared to a duration related to the same number of pulses accumulated. Similarly, for the estimation of a preconceived duration, the accumulator compares working and reference memory to a binary process, such as a duration with the related number of pulses, which dictates responding and not responding, to terminate the interval once reached (Coelho et al., 2004; Gibbon, Church and Meck, 1984). Research has shown these internal pulses can be sensitive to arousal, where arousal results in the pacemaker firing more pulses at a faster pace (Jones, 2011; Jones, Allely, & Wearden, 2011; Penton-Voak, Edwards, Percival, & Wearden, 1996; McLoughlin, 2012). The other commonly used theoretical model used to explain prospective timing is the Attentional Gate Theory proposed by Block, 1990. Similar to to the Scalar Expectancy Theory, Attentional Gate Theory is based on the idea of an internal clock process. He proposes that attention can also affect the perception of time, such that when less attention is paid to the timing of a duration, less pulses are passed through to the switch by the pacemaker. Thus, the cognitive counter for the specific duration, increases much slower, creating a discrepancy between subjective time (perceived time) and objective time (clock time) compared to if attention was focused (McLoughlin, 2012). Other similar models have been proposed, such as the Hicks, Miller, Gaes & Bierman (1977) Attentional Model, which shows that the perceived duration of time decreases as processing demand increases. In this model, the quality and complexity of a stimuli requires greater attention and thus, less attention is focused on the amount of time passing. Both of these models can be used to explain why recent studies have found that time was perceived to “fly by” in highly-entertaining conditions compared to low-entertaining conditions (Xu & David, 2018). Explained in the common vernacular, these theories explain why “Time flies when you're having fun”. Though these theories don’t explain the cognitive processes behind retrospective timing, they offer an explanation as to how factors such as arousal, attention and felt experience can distort our perception of time, and offer a plausible explanation as to why two people experiencing the same objective duration of time can have alternative perceptions of time’s passing based on their own interpretations of its experience.

Timing retrospect, such that the individual is unaware of the specific duration being timed, are most commonly explained by information-processing theories, such as Oreinstein’s (1969) Storage Size Model. He proposes that the amount of storage size information takes up effects the subjective experience of its duration, such that if we are familiar with something it takes up less storage and thus is perceived to pass quicker (McLoughlin, 2012). In contrast, tasks that are more complex appear to last longer than those of less complexity. Similarly, research found by Jones et al., 2011, proposes that the speed to which information is being processed can set the subjective experience of the speed of the pace of time. They found that an increase in the number of train clicks presented during a time interval, increased the pace to which participants perceived time to be passing, such they experienced time to be moving faster than the objective time on the clock. However, Block (1990; 1992) claims that complex tasks are not perceived to be longer, but rather remembered to be longer. This is thought to be due to the increased number of interpretations, such that it is the varied contextual associations in storage and recall that cause the effect of interpreted longer time. From this Block, 1992 formed the Contextual Change Model, used to explain retrospective temporal processing, proposing that is it the number of changes that occur during a duration which affect the subjective judgement of its retrospective duration. He proposes that whenever attention is paid to time the contextual representation for the previous acts of attention to time are automatically retrieved and a new time tag is formed. Thus, the perceived judgement of an interval is based on the total number of contextual associations encoded during the duration (Block & Zakay, 1996). This theory along with the theories highlighting the fundamental role of arousal, attention and information-processing, can be used to explain how something as familiar as smartphone use, which is widely accepted due to its perceived ease of use, is highly entertaining and a source of abundant and constant information and stimuli, may have an altering and lasting impact on user's cognitive processing of temporal experiences (Agarwal and Karahanna, 2000; Davis, 1989).

Technology and Cognitive Functions

Psychologists have been trying to understand the behaviours behind human-technology interactions since the 1990's. In this quest they developed constructs such as cognitive absorption in order to aid a better understanding of the human-technology interface. The state of absorption was first described as a person's experiences of deep involvement where all individual's attentional resources are consumed (Tellegen & Atkinson, 1974). Cognitive absorption is characterized by five dimensions. The first is "temporal dissociation", an inability to register the passing of time while engaging or interacting with the object. This is used as part of a theoretical model to explain user behaviour with information technology and as an explanation of the intrinsic motivations of technology usage (Kumar et al., 1996). Cognitive absorption is defined as a "state of deep involvement with software" and derived from three interrelated concepts, the dimension of absorption, state of flow and the notion of cognitive engagement (Agarwal & Karahanna, 2000). The concept of Flow, first develop by Csikszentmihalyi, 1990**,** describes the state to which people are so involved in an activity that they display intense concentration, a sense of being in control, a loss of self-consciousness and a transformation of time, which is proposed to occur in the pursuit of physical activity and interactions with symbolic systems, such as mathematics or computer language (Agarwal and Karahanna, 2000). This concept of Flow has been used to understand behaviour while engaging with technology, with studies by Trevino and Webster, 1992 and Webster, 1993, who propose that Flow plays a key role in human-interactions with technology and people's attitudes towards technology. However, there theorie of Flow and human interaction with technology do not include temporal dissociations, which is a key element of Csikszentmihalyi’s proposed description of the experience of Flow. From this Hoffman and Novak (1996) proposed a theory of Flow in human-technology interaction that does include elements of time distortion, however they describe Flow as a unidimensional, whereby time distortion is rather an antecedent of Flow not a core component. Based on Csikszentmihalyi’s 1990 notion, that Flow represents the experiential involvement where the autotelic nature of the task results in individuals losing sense of time while engaged in it, the dimension of time distortion was an explicit inclusion and important element of cognitive absorption (Agarwal and Karahanna, 2000). More recent studies have shown that Flow was a positive predictor for smartphone consumption and that an increased rate of Flow while on your smartphone is a positive predictor for an increased smartphone consumption (Zhang, Chen, Zhao and Lee, 2014).

Technology and Time Perception

If we accept the dimension of time that is socially created and a measure of experience, we accept that technological advances have created and redefined time and space simultaneously and in a social context (life-experienced content). This interaction with smartphone and technology creates a new socially created context of time. When we push buttons to communicate on our phone the physical distance between people is so far reduced that it is perceived to disappear into the virtual space of instant connection. By reducing the measure of distance in space to an almost non-existent state, such that people over 100,000 km away can be reached in a matter of seconds, not only do we transcend temporalities of body and nature but we create a sort of timescape, creating the context referred to as Network Time (Hassan, 2012). This timescape, has allowed us to accomplish more in less time and has hastened the pace of social domains, with the speed of email, instant messaging, twitter or facebook promoting constant connectivity and instant response (Wajcman, 2015**).** The speed and scale of this "real-time" communication technology has caused a shift in the way we think about time (Wajcman, 2015). In Judy Wajcman, 2015 book "Pressed for Time: The acceleration of life in Digital Capitalism" she states that the speed to which we can trade and communicate is now moving from milliseconds to microseconds. Within that context a 5 second pause can seem like a long time. Proposing that our sense of time has been altered by the convergence of modern technologies and "virtual" networks into a pervasive environment of instant and simultaneous information and communications, which results in changes in our "time-consciousness" and a new social order. Stating that this boardless space and instantaneous time has made the human and social time dimensions of everyday life to which individuals coordinate their time practises in the real-world, completely obscured.

Though advanced technology is used as a method of time saving, research has shown that this paradox has also increased the amount of perceived time pressure due to an increase pace of life (Chesley, 2010**).** Based on the expectation of how fast things have, should or can happen in the modern era, there is increasing perceived value of our time and decreasing patience threshold. Research found a third of a website's traffic was lost when webloads exceeded eight seconds in 1999 and then were reduced to four seconds in 2006 (Akamai, 2006; Zona Research, 1999). Amazon found that for every one second longer it took a page to load, sales decrease by 1% (Kohavi & Longbotham, 2007). Google found that a five second increase in search results display time resulted in decreased traffic and advertising revenues by 20% (Linden, 2006). Studies have also shown that those who are more heavily invested in mobile phone usage are correlated with a relatively weaker tendency to delay gratification, such that they were more inclined to accept a smaller, more immediate reward than to wait for a more substantial, however delayed, reward (Wilmer and Chein, 2016). This drastic reduction in tolerance and patience can possibly be explained by theories of subjective time. Elia, 1992, proposed that the experience of time is based on the timing standard that is set by two or more continuous sequence of changes; one setting the timing standard for the other. He proposes that time is established by two or more moments of change, one of which is used as a reference or standard for the other (Elia, 1992, p46). This is in similar agreement with the Scalar Expectancy Theory, whereby time is judged based on comparisons made between the number of internal pulses experienced against a binary standard of pulses in reference memory based on the previous number of pulses for a related duration (Gibbon, Church & Meck, 1984; Treisman, 1963). Now, we live in a world where the continua of change is so fast, where information can be accessed at such speed that it appears instantaneous, that the reference or standard to which we use as a measure of subjective time, has become so fast that anything longer that it may be perceived as “too long”.

Studies have shown that it is this nature of smartphone use that allow time to be perceived as faster while engaged that promote its consumption and perceived enjoyment. A study by Chinchanachokchai, Duff & Sar, 2015 found that media technology, which allows people to frequently engage in multiple mediated tasks simultaneously (multitasking) and can be used as a way to split attention away from uninteresting or low stimulating tasks, affect evaluations of the tasks or task’s content. They found that participants who performed additional on-screen tasks while watching commercials perceived time to pass faster compared to when watching the ad on its own and reported greater overall enjoyment and evaluations of the ad. They found this increase in enjoyment to be mediated by the perception of how quickly time was passing while watching the ads. Studies have also found increased phone use being associate with greater boredom proneness scores, and phone use to be a means of stimulation (Pielot, Dingler, Pedro & Oliver, 2015).

Based on these theories, when intervals of equal duration are stored in memory under completely opposing standards of reference, a possible dissonance is created which may result in distorted time estimations. A recent study by Turel, Brevers and Bechara, 2018, found that participants with an increased risk of social media addiction showed increased time distortion when engaging in non-social media tasks. They found that those in the high-risk group had over-estimated time while doing non-social media tasks compared to those in the low-risk group who had a downward time estimation bias. Psychologists have found that time filled with varied and interesting experiences seems shorter in passing but longer when looking back, while on the other hand intervals of time that are empty seem long in passing but short in retrospect (James, 1992). Information technology, such as smartphones constantly offer a more interesting and faster experience than reality time. This experience and the concepts introduced by information-processing models and attentional model of time perception (Block, 1990; Hicks, Miller, Gaes & Bierman, 1977) explain why studies have found our perception of time to be distorted while engaged with our smartphone (Lin et al., 2014).

It is evident from the research that time distortion is understood as a key element of interacting with technology. Thus our ability to accurately estimate time is distorted while interacting with technology (Hoffman and Novak, 1996; Kwon et al., 2013; Lin et al., 2015). Some recent studies that have tested the factorial structure of smartphone assessment instruments have found many common variables acting as risk factors for smartphone addiction. One of these is time distortion when using a smartphone (Lin et al., 2014; Kwon et al., 2013). A study by Lin et al., 2015 found that participants self-reported smartphone use was significantly less than the actual total smartphone use time and that the degree of underestimation correlated with actual smartphone use. In another pilot study by Lin et al., 2017, they found that amongst a sample of college students, those who were unaware of overuse underestimated their usage time by 40%. However, there has been little research on the effect that this distortion of time while engaged with technology has on long term perception of the passing of time. Blatchley et al., 2007 assessed the direct effect of technology and the subjective experience of time. They found that increased computer use was related to a significant difference in accuracy for both time estimation task and time reproduction task compared to those with low computer use. They found that factors such as perceived time urgency was negatively correlated with errors in temporal task, such that the more time pressure people felt the more accurate they were at estimating intervals. Though this finding does not provide a cognitive explanation to the altering effects that technology may have on subjective temporal experiences, it does highlight core issues regarding the pace of modern life, subjective experiences and technology. A study by McLoughlin, 2012 investigated the relationship between modernisation, technology advances and altered psychology of time from a cognitive basis. They found a significant difference in time estimations between participants with a high use of technology and those with a low use. Participants had a general tendency to overestimate time intervals, such that their pace of time was moving faster than clock time. However, they found that on time reproduction task participants had a tendency to underproduce intervals. They also found in support of Scalar Expectancy Theory, Attentional-Gate theory and information processing theories (Gibbon, Church & Meck, 1984; Grondin, 2001; Ornstein, 1969; Treisman, 1963) that the duration of intervals of time which consisted of multiple stimulus (e.g. visual, auditory) were judged to be longer than those that did not. These finding suggests link between technology use and distortions in natural timekeeping.

Not all technology use is negative, studies have shown it to facilitate a sense of connectivity, perceived social interactions and is a source of information (Barr, Pennycook, Stolz & Fugelsang, 2015; Fonner and Roloff, 2012). However, it is this instant and constant connectivity that has created a blurred boundary between work and non-work related activities and has shown to affect daily functions such as productivity, organisation, academic performance and focus. Instant connectivity and increased temporal boundaries have reduced the need for detailed planning due a facilitated desire for direct organisation, as opposed to preconceived structured organisation (Prasopoulou, Pouloudi & Panteli, 2006). Research has proposed that this alters our ability to schedule (Srivastava, 2005) and this integration of work and non-work related activities disrupts the flow of effective productive work and consequently alters the perceived dimensions, pace of time and scheduling (Ballard & Seibol, 2004).

A study by Montag et al., 2015 found that amongst a sample of 2,418 smartphone users, education was negatively associated with daily smartphone usage. A study by Duke and Montag, 2017 also found amongst 262 participants, there was a moderate relationship between the Smartphone Addiction Scores (SAS) and self-reported decrease of productivity. They also found that higher SAS strongly correlated with negative effects that smartphone usage had on daily non-work related activities. They found SAS scores significantly predicted the number of work hours lost to smartphone use in the past seven days, with the number of daily interruptions significantly predicting and mediating the negative impacts of smartphone use on work productivity. Research has shown that the structured use of our time, such as the perceived purposive and effective use of our time, effects factors such as study habits and work methods (Bond & Feather, 1988). Less time structure has been negative related to boredom proneness scores (Vodanovich & Watt, 1999), which has been found to be largely predicted by increased mobile phones usage (Pielot, Dingler, Pedro & Oliver, 2015).

Rationale

The speed of technology significantly affects environmental factors such as the pace of life, absorption, instant reward and constant connectivity (Nah, 2004; Wiseman & Wiseman, 2007). Theories on time perception, have shown environmental factors such as arousal, attention and information processing alter our subjective experience of time (Coelho et al., 2004; Gibbon, Church and Meck, 1984, Ornstein, 1969) and while engaging with our smartphones, our perception of time is distorted (Kumar et al., 1996; Lin et al., 2015). Research has shown that the blurred boundaries of virtual connectivity of technology has created a permeable time where being present and absent become less clear (Wajcman, 2008). We experience a world where both network time and clock time are interspersed, however they are completely conflicting, distorting our expectations for the speed that we expect things to happen. This distortion of time affects how we balance between clock time and life-experienced time on our smartphones. Thus, gives rise to the question of not only is our whole perception of time and ability to accurately measure time distorted, but what effect does this have on our time management and structure? Wajoman, (2008) states that technology doesn't speed up or slow down time but starts to create new practises of time and new meaning of temporality. Moreover, it is important to understand the impact that this new context of time created by smartphones, where temporalities of time and space are transcended beyond human capabilities (Hasson, 2012), has on our perception of time as well as the perceived structured use of our time.

Aims and Objectives

This study investigates whether the amount of smartphone interaction that a person experiences in their day to day life is related to their perception of the duration of time and their perceived structured use of their time. This research is different to much of the previous mentioned literature. Based on the research and theoretical findings, we hypothesize that greater smartphone involvement, characterized under four measurable domains (smartphone usage, number of pickups, durations between each pickup, Mobile Phone Involvement Questionnaire), will be associated with greater error in time estimation tasks. We hypothesize that increased Smartphone involvement will be associated with less perceived time structure (TSQ). Smartphone interactions were measured as both a self-report and an actual-report (recorded by an app) in order to investigate both participant's ability to accurately estimate their own smartphone use as well as investigate a difference in perceived phone usage and actual phone usage on temporal abilities. We finally hypothesize that greater smartphone interactions will be related to less time structure with regards to each of its subscales; effective organisation, sense of purpose, structured routine, present orientation and persistence.

Method

Participants

The sample population for the current study consisted of 44 students (*males* = 23, *female* = 21) predominantly from the National College of Ireland and the University College Dublin. Their ages ranged from 18-30 (M=21.91, SD=2.70). Participants were selected using convenience sample technique, such that participant were recruited based on their accessibility.

Measures/Materials

Time Estimation Task: The subjects were asked to partake in a Time Estimation Task on a laptop using Inquisit Lab 5. Inquisit lab 5 is a Millisecond Software, LLC program which permits precision psychological testing on dedicated computers. The task implements a Prospective Time Estimation procedure similarly to the one described by **Wittmann et al., 2007**. The task produces a time interval which is to estimated by the participant using both auditory and visual stimulus as indicators of when the interval to be estimated has started and ended. The length of time estimated by the participant was measured via a slider-response, such that the participants were asked to slide a point along a linear slider of 1 second increments ranging from 0-3mins. The participants subject number, their estimated time as well as the actual duration of the interval given was recorded and saved immediately to the summary data file.

Participants were asked to answer a short 8-item Mobile Phone Involvement Questionnaire (MPIQ) as a measure of mobile phone involvement which originally was based broadly on Brown's behavioural addiction components (1993, 1997) to form a 24 item questionnaire (Walsh et al., 2008), which was later revised to an 8 item questionnaire by **Walsh et al., (2010)**. Answers were scored and recorded on a 7 point likert scale 1 (*strongly disagree*) to 7 (*strongly agree*). An example of questions related to smartphone involvement are "*The* *thought of being without my mobile phone makes me feel distressed" and "I often use my phone for no particular reason".* The scale demonstrated satisfactory internal reliability with a reported Cronbach's alpha value of .76.

Time Structure Questionnaire (Feather and Bonds, 1988). Participants were then asked to complete a modified version of **Feather and Bonds (1983**), Time Structure Questionnaire (TSQ). Modified by Bond and Feather (1988) to include 10 new items and the removal of Item 1 following an item analysis of previous data. The new items were questions 7, 14, 15 and 20 through 26, which were included to lengthen the scale to such a manner that was compatible with the previous factor structure (Feather and Bond, 1983). The scale assesses the subjective experience of time use with the inclusion of five subscales; Effective Organisation (Items 1, 11, 12, 13) an example of these items is "*Do you take a long time to "get going"?"*; Sense of Purpose (Items 4, 8, 18, 19, 25) an example of these items is "*Do you often feel your life is aimless with no definite purpose?*"; Structured Routine (Items 3, 9, 15, 16, 20) sample question being "*Do you plan your activities from day to day?"*; Present Orientation (Items 5, 24, 26) *i.e. "Do you spend time thinking about opportunities that you have missed?"* and Persistence (Items 7, 14, 23) *i.e. "Do you have difficulty finishing activities once you've started them?"*. The 26-item TSQ was answered and scored on a 7-point scale with *Yes, always* and *No, never* being the endpoints with the exception of item 16 where the endpoints were *Would have no idea* and *Yes, definitely.* Item 20 endpoints where *No structure at all* and *Very structured*; Item 21 had endpoints of *Change very frequently* and *My important interests always stay the same*; and item 22, *No purpose and all* and *A great deal of purpose*. Intermediate scale points were not labeled and endpoints were assigned so that higher scores would display more time structure. Possible scores on the TSQ range from 26 – 182. The scale displayed a satisfactory internal reliability (.89), along with the subscales Effective Organisation (.79), Sense of Purpose (.78) and Persistence (.80). However, the

Structured Routine subscale (.51) and Present Orientation subscale (.57) displayed unsatisfactory internal reliability. When tested for validity the TSQ was found to have a coefficient α of 0.70 or greater when compared to the Time Management Behaviour Scale (TMBS).

Moments/Quality time App: Participants were asked to download a smartphone application accessible on either the App Store for apple phone users or the Google Play Store for android phone users. The app was used to monitor and record actual phone usage by recording the number of screentime hours spent on their phones each day as well as the number of times they unlocked or picked up their smartphone. This was used to determine the duration that people interact with their phone and the frequency of each interaction. The phone usage app downloadable for Android phone users is "Quality Time" which is created by a team of developers at NComputing Global Inc., based in Silicon Valley. The iOS app downloadable for iphone users is "Moment" created at Luna Bird LLC by **Holesh, 2018.**

Design

The current study was a quantitative cross-sectional non-experimental research design using self-report questionnaires, a smartphone application to objectively measure smartphone use and an objective time estimation task.

HO.1) A Spearman Rho was used to analyse research question one, analyzing the relationship between daily smartphone consumption and the direction of misestimated time intervals as well as its relationship with general time estimation errors.

HO.2) A Spearman Rho was also used to investigate research question two, analysing the relationship between daily smartphone interactions, i.e self-report (SR) and app report (AR) usage, number of pickups and intervals between each pick up and Time Structure Questionnaire (TSQ) scores.

HO.3) A Pearson's product correlation coefficient was used for research question three, to investigate the relationship between smartphone interaction and each of the time structure subscales; Effective Organisation, Sense of Purpose, Structured Routine, Present Orientation and Persistence.

HO.4) A Pearson's product correlation coefficient was used for research question four, to investigate the relationship between Mobile Phone Involvement Questionnaire (MPIQ) scores and TSQ scores along with each of the TSQ sub-sets.

HO.5) Finally, a Paired sample t-test was used for research question five, to investigate the difference between participants self-reported level of smartphone usage and their actual smartphone usage recorded by an app on their phone and if the misestimation of phone use is related to the misestimation of time intervals.

Procedure

Prior to study commencing, participants informed consent was obtained via a written consent form consisting of information regarding the current study. Participants were asked to sign the consent form to show they fully understood the nature of the study and agree to participate (see appendices for full details).

Participants were recruited using a random convenience sampling style and upon recruitment were asked to read and sign a consent form prior to participating in the study. Firstly, participants were asked to take part in a Time Estimation Task, where they were shown instructions on their display screen that were displayed in the form of an htm page and were asked to push "continue" once they understood the nature of the task. For the duration of the experiment participants were asked to put on headphones to block external noises. They were asked to estimate a time interval that starts with the presentation of a green circle and a recording saying "start" and ends with the presentation of a red circle and the sound of an alarm. After pressing the Spacebar to turn off the alarm, participants are asked to estimate the duration of the time interval on a slider with 1s increments (0-3min). Participants were played a tone for a set time interval that was editable. The first three participants underwent the default length interval of 53sec, participant 3 and 4 underwent an interval length of 105sec and the rest were asked to estimate an interval of 110 seconds. Afterwards they had to estimate the length of the time interval via a slider-response. After they completed the time estimation task they were asked their subjective judgement of the interval i.e. "1 - *Long,* 2 - *Moderately Long*, 3 - *Normal,* 4 - *Moderately Short,* 5 - *Short*"

After completing the Time estimation task participants were asked to answer a few short questions which included their 1)Age; 2) Gender; 3)"*On average, how many hours do you spend on your smartphone?"*; 4)"*On average, how many times you pick up your phone each day?";* 5)"*what is the average interval time between each pickup? E.G. every XX minutes?*".

Participants were then asked to answer both an 8-item Mobile Phone Involvement Questionnaire (MPIQ) and a 26-item Time Structure Questionnaire. Finally, participants were asked to download a screen time monitoring app either from the Google Play Store or the App store dependant upon the type of phone used by the participant. They were asked to leave their email on the consent form for the sole purpose of retrieving the data recorded by the app in one weeks time in order to obtain their average daily phone usage habits recorded over the course of the week. This data is used to compare it with self-reported phone usage as well as time estimation abilities and TSQ scores. All together the study took on roughly 10 minutes to complete. Data was scored and then transcribed onto a Microsoft Excel sheet which was then transported into an SPSS data file for further analysis.

Results

Descriptive statistics

Descriptive statistics for each of the measured variables in the current study are presented in Table 1 and 2. A preliminary analysis was run to test for normality. The Q-Q plots, histograms, standardized skewness and Shapiro-Wilks test indicated that most of the measured variables were approximately normally distributed ($p > 0.05$), with the exception of self-report (SR) phone use, number of pickups (SR), App report (AR) phone use, the percentage to which participants mis-estimated their phone use and the subjective judgment of the time interval, which were not statically normal ($p < 0.05$). After inspection for outliers and extreme scores, using the descriptive statistics of the time estimations, one participant was removed from analysis regarding time estimation trials.

Table 1: Frequencies for the current sample of student each demographic variable (N = 44)

Descriptive statistics of all categorical variables

Variable	Frequency	Valid Percentage
Gender		
Male	23	52.3
Female	21	47.7
Time Judgement for Interval		
1 Long	23	52.3
2 Moderately Long	12	27.3
3 Normal	6	13.6
4 Moderately Short	3	6.8
5 Short	0	0

Over 70% of participants judged the interval to be moderately to "Long".

Table 2: *Descriptive statistics of all continuous variables (n = 44; n = 32)*

	Mean (95% Confidence Intervals)	Std. Error Mean	Median	SD	Range
App Phone Usage(min)	260 (210.11-309.89)	24.46	204.50	138.36	100-618
SR_Phone_Usage(min)	257 (218.94 – 294.92)	18.84	240	124.96	100-600
No. of pickups(SR)	51.59 (39.98 – 63.20)	5.76	50	38.2	5-200
No. of pickups(App)	103 (77.21-129.23)	12.73	88	72.14	22-386
Duration_Between_pickup (Min).	24.50 (18.54-30.45)	2.95	20	19.59	3-90
Misestimate Intervals (%)	13.04 (3.32-22.78)	4.82	9	32	-48.2-123
Misestimated Phone Use(%	13.45 (-10.20-39.10)	11.60	-11	65.59	-75.7-180
MPIQ	33.66 (30.94-36.38)	1.35	34	8.95	19-53
TSQ	105 (97.69-111.49)	3.42	102	22.71	59-157
Effective Organisation	16.14 (14.37-17.90)	.87	16	5.80	5-26
Purpose	21.22 (19.33-23.13)	.94	21	6.25	9-35
Structured Routine	21.93 (20.45-23.41)	.74	22	4.88	12-35
Present Orientation	8.55 (7.53-9.56)	.51	9	3.35	3-16
Persistence	14.61 (13.45-15.78)	.58	15	3.82	4-21
Age	21.91(21.09-22.73)	.41	22	2.70	18-30

The mean self reported smartphone usage was 4 hours and 17 minutes with the average app reported phone usage being 4 hours 20 minutes. The average percent participants misestimated their actual phone use showed that participants overestimated their phone use by 13% (M=13.5, SD=65.59). The mean percent of general phone estimation error was 25%

(M=25.05, SD=23.58). The descriptive statistics also showed that on average participants overestimated the tasks time interval by 13% (M=13.04, SD=32). The mean percent of general time estimation errors, i.e. either over or underestimated, was 24% (M=24.04, SD=24.65).

Inferential statistics

Table 3: *Correlations between all continuous variables*

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Phone Use(App)	1												
2. Phone Use(SR)	.22	1											
3. IBP (SR)	-.03	-.09	1										
4. Task estimation errors	-.12	-.20	-.05	1									
5.Misestimate_PhoneUse	.52**	-.67**	.02	-.05	1								
6. Judgement	.04	-.16	-.18	.02	.17	1							
7. MPIQ score	-.17	.07	-.46**	.04	-.11	.17	1						
8. TSQ score	.39*	.04	.29	-.08	-.02	-.13	-.42**	1					
9. Effective Org	.27	.23	.34*	-.14	.05	-.22	-.41**	.85**	1				
10. Purpose	.42*	-.07	.17	-.04	-.24	-.14	-.29	.84**	.59**	1			
11. Structure Routine	.25	-.19	.23	-.13	-.05	.09	-.13	.66**	.43**	.53**	1		
12. Present Orientation	.13	-.13	.33*	-.16	-.05	-.16	-.35*	.57**	.48**	.32**	.21	1	
13. Persistence	-.01	.22	.07	-.15	.27	.04	-.15	.54**	.43**	.48**	.16	.12	1

Note. Statistical significance: *p < .05; **p < .01; ***p < .001. Phone Use/Intervals: SR = Self-report, AR= App report. IBP = Interval Between Pick-up.

Hypothesis 1

The relationship between daily smartphone usage and accuracy in time estimation trials. As well as the relationship between MPIQ scores and accuracy in time estimation trials.

This relationship was investigated using a Spearman's Rho correlation analysis, as the preliminary analysis showed that participants daily smartphone usage, both self-reported and App reported, violated the assumptions of normality, linearity and homoscedasticity. An Alpha level of 0.05 was used for all statistical tests.

There was a negative correlation of no statistically significance between App reported smartphone usage and time estimation error (r_s=-.12 [95% cl= -.49 - .25, n=31, p>0.05). Similarly, there was a negative non-statistical significant relationship between self-report phone usage and the percentage of error of time estimations (r_s=-.15 [95% cl= -.46 - .20], n=43, p>0.05). The Spearman Rho test found a non-significant positive correlation between the self-report phone usage and the misestimation of time intervals (r_s=.01 [95% cl= -.34-.33, n=43, p>0.05) and a positive correlation of no statistical significance between app report phone usage and the misestimation of time intervals (r_s=.12 [95% cl= -.26 - .45], n=31, p>0.05) such that greater reported phone usage was associated with the overestimation of time intervals.

A Spearman' correlation found a positive non-statistically significant relationship between MPIQ scores and time estimation errors (see, Table 3). There was a non-statistically significant positive relationship between MPIQ scores and the misestimation of time intervals (rs=.13, n=43, p>0.05). The results indicate that greater mobile phone involvement is somewhat associated with overestimating time intervals and greater estimation errors, but to no statistical significance.

Hypothesis 2

The relationship between smartphone interaction and Time Structure Questionnaire Scores.

This relationship was investigated using a Spearman's Rho correlation analysis, as the preliminary analysis showed that participants daily smartphone usage and number of pickups, both SR and AR, violated the assumption of normality, linearity and homoscedasticity.

A Spearman Rho test found there to be a positive correlation of statistical significance between app-reported phone usage and TSQ scores (r_s=.39 [95% cl= 0.8 - .67], n=32, p<0.05). This indicates that the two variable share approximately of 16% of variance in common. The results indicated that higher scores on the time structure questionnaire are associated with higher app reported phone usage. There was a positive non-significant correlation between self-report phone usage and TSQ scores (r_s=.04 [95% cl: -.27 - .33], n=44, p>0.05).

The results showed non-statistically significant positive relationship between TSQ scores and the number of SR pick-ups (r_s=.01 [95% cl= -.32 - .44], n=44, p>0.05) and the number of AR pick-ups (r_s=.05 [95% cl= -.32 - .39], n=32, p>0.05). There was a moderate, positive relationship between TSQ scores and the length of intervals between each pick-up, however was of no statistical significance (r_s=.29 [95% cl= .01 - .55], n=44, p=0.06). This indicated that the two variables share approximately 9% of variance in common.

Hypothesis 3

The relationship between smartphone interaction and each of the TSQ subscales.

Sub-scales and phone usage: Spearman's correlation found a positive correlation of no statistical significance between SR phone usage and effective organisation (r_s=.23 [95% cl= -.07 - .49], n=44, p>0.05). This indicated that the two variables only share a 5% of variance in common. There was a negative non-significant relationship between SR phone usage and the rest of the subscales (see table 3). The results found a moderate, positive correlation between AR phone usage and a sense of purpose (r_s=.42 [95% cl= .07 - .68], n=32, p<0.05). This indicated that the variables share 18% of variance in common. Results indicate that greater AR phone usage is associated with higher sense of purpose scores. Results found a positive relationship of no statistical significance between AR phone usage and each of the other sub-scale, except for persistence which showed a non-statistically significant negative relationship with AR phone usage of (see, Table 3).

Sub-scales and number of pickups: Spearman's correlation found a negative non-statistically significant relationship between SR number of pickups, structured routine (r_s=-.15 [95% cl= -.50 - .23], n=44, p<0.05) and persistence (r_s=-.02 [95% cl= -.43 - .38], n=44, p>0.05). The results found a positive relationship of no statistical significance between SR number of pickups and effective organisation (r_s=.12 [95% cl= -.15 - .36], n=44, p>0.05), a sense of purpose (r_s=.19 [95% cl= -.11 - .39], n=44, p>0.05) and present orientation (r_s=.15 [95% cl= -.20 - .43], n=44, p>0.05). Spearman's correlation found a positive non-statistically significant relationship between AR number of pickups and effective organisation (r_s=.05 [95% cl= -.30 - .42], n=32, p>0.05). There was a positive non-statistically significant relationship between AR number of pickups and structured routine (r_s=.12 [95% cl= -.22 - .46], n=44,p>0.05). There was a negative non-significant relationship between AR number of pickups and sense of purpose (rs=-.06 [95% cl=-.37-.29], n=32, p>0.05), similarly there was a negative non-significant relationship between AR number of pickups, present orientation (r_s=-.13 [95% cl= -.44 - .24], n=32, p>0.05) and persistence (r_s=-.22 [95% cl= -.50 - .01], n=32, p>0.05).

Sub-scales and length of interval between pickups: This was investigated using a Pearson's Product correlation coefficient. A preliminary analysis was performed to ensure there was no violation of normality, linearity and homoscedasticity. There was a weak to moderate positive correlation between the SR length of intervals between each pickup and effective organisation (r=.34, n=44, p<0.05). This indicates that the two variables have 12% of variance in common. The results indicate that the greater the interval length between each pick up is associated with greater effective organisation. The results also found a weak to moderate positive correlation between the SR length of interval between each pick up and present orientation scores (r=.33, n=44, p<0.05). This indicates that the two variable share 11% of variance in common. The results indicate that the greater the interval length between each pick up, is associated with greater present orientation. The results found a positive correlation of no statistical significance between SR intervals between each pick up and each of the other subscales (see, Table 3).

Hypothesis 4

The relationship between scores MPIQ and TSQ scores and each of the TSQ sub-scales.

This was investigated using a Pearson's Product correlation coefficient. A preliminary analysis was performed to ensure there was no violation of normality, linearity and homoscedasticity. There was a moderate negative correlation between MPIQ scores and TSQ scores (r=-.42, n=44, p<0.01). This indicated that the two variables share 18% of variance in common. The result indicate that greater mobile phone involvement is associated with lower time structure.

The results found that there was a weak to moderate negative correlation between MPIQ scores and present orientation scores (r=-.35, n=44, p<0.05). This indicates that the 12% of variance is explained between the two variables. The results indicated that greater mobile phone involvement is associated with less present orientation. Results indicated a non-significant negative relationship between MPIQ scores and each of the other sub-scales (see, Table 3).

Hypothesis 5

The difference between participants self-reported (SR) and app reported (AR) smartphone usage and the misestimation of phone use and its relationship with the misestimation of time intervals.

A Paired samples t-test to evaluate the difference between participants self-reported mobile phone use and actually mobile phone use recorded by the app. There was no significant increase in amount of phone usage from self-report (*M*= , *SD*=) to app-report (*M*= , *SD*=), t(31) = -.68, $p>0.05$ (two-tailed). The mean increase in reported phone use was -18.28 (95% confidence intervals ranging from -72.92 to 36.36). A Spearman's Rho found a non-statistically significant negative relationship between the misestimation of phone use and the misestimation of the times interval (r_s=-.12, n=31, $p>0.05$). There was also a non-significant negative relationship between general phone use estimation errors and general time trial estimation errors (r_s=-.07, n=31, $p>0.05$).

Discussion

It is evident from the research that environmental factors can influence our perception of time, with theories detailing the effect of arousal, attentional demand, memory and emotional state on the psychology of time (Allan, 1979; Friedman, 1993; Thomas & Weaver, 1975; Chinchanachokchai, Duff & Sar, 2015; Gill & Droit-Volet, 2012; Kern, 2003; Lee, Egleston, Brown & Gregory, 2007; Nowotny, 2018). Research has similarly shown how advanced technology has created an environment in which these influencers are becoming predominantly more present in our everyday life (Flynn, 2014**;** McLoughlin, 2012). The primary objective of the current study was to investigate the effect that the pervasive use of mobile information technology, explicitly smartphones, have on temporal perceptions. Previous studies on the effect of technology on temporal experiences have shown that an increased use in technology has been related to an increase in time estimation errors of temporal tasks and a greater tendency to overestimate time intervals (McLoughlin, 2012). This study aims to examine the possibility of a similar effect specifically applied to smartphones. Smartphone interaction was examined both as a self-report and actual report, across four measurable domains; daily usage, number of pickups, length of intervals between each pickup and perceived Mobile Phone Involvement scores, with the intention to investigate the relationship between smartphone interactions, across all its measurable domains, and the perceived duration of empty time intervals and participant's perceived structure of time.

The present sample used their phone for an average 4 hours and 20 min, this is higher than the statistical average of 3 hours and 57 minutes found by Luna Bird LLC (2018) as a calculation of the average Moment app users screen time. We hypothesised that intense smartphone usage would result in a deterioration in the ability to accurately judge the passage of actual time. However, the findings from the current study found no significant relationship between smartphone usage and time estimation abilities. The study found there to be a negative, non-significant, relationship between actual smartphone usage and time estimation errors and the direction of mis-estimated time trials. These results infer that greater phone usage was associated with lower estimation errors and had a tendency to underestimate time trials, thus their internal pace of time was slower than that of the clocks. However, any association was so small that no real significance was found. This finding not only is in disagreement with the original hypothesis and is in direct contrast to the literature, which found that an increase in the use of technology resulted in a greater error in time estimation trials (McLoughlin, 2012). However, these results are supportive of the research by Blatchley et al., 2007 which found greater computer use to be related to greater accuracy in time trials. A possible explanation for this finding is observable by theories of time perception, which propose that time intervals which evoke little arousal are judged as less than those that are highly arousing (Jones, 2011; Penton-Voak, Edwards, Percival, & Wearden, 1996). This finding may also be explained by attentional theories of time perception, which propose that intervals that are "filled" require more attention on information processing and thus less attention is paid to the passing of time, resulting in time intervals appearing as faster in retrospect compared to intervals that are "empty" (Block, 1990; Hicks, Miller, Gaes & Bierman, 1977). As a result participants may have been able to estimate intervals with more accuracy due to an increased awareness to time passing and less arousal or attentional demands. However, it is important to note that for intervals with an average of 105 seconds (M=105.27, SD=16.82), over 70% of participants judged that as "Long", suggesting that though estimation were accurate the felt duration of 1 min 50 seconds was perceived as "Long". There was a positive, non-significant, relationship found between perceived mobile phone involvement, as measured by the Mobile Phone Involvement Questionnaire, and time estimation abilities and tendencies. This indicates that an increase in perceived mobile phone involvement was somewhat related to overestimated time intervals and increased errors in time estimation tasks, however to no significant effect. This result rejects the previously stated hypothesis, however we may have seen results of greater significance with a larger sample population.

Interestingly, a significant positive relationship was found between app-reported phone use and perceived time structure. Though a significant relationship was found between actual phone use and time structure this finding is not in the predictive direction as previously hypothesised. This result suggests that an increase in the number of hours spent using your phone a day is associated with greater perceived time structure, further inferring that the more participants use their phone the more they perceive their daily use of their time to be useful and purposeful. This positive relationship between phone usage and TSQ score was also found for self-reported phone use, however it was not statistically significant. This finding is in part, in contrast to the literature which found increased phone use as a reliable indication for boredom proneness, used as a form of stimulation and escape from boredom and procrastination (Pielot, Dingler, Pedro & Oliver, 2015; Vodanovich & Watts, 1999) and it is somewhat consistent with the research evidence which found participants rely on their smartphones as an extension of the mind and for information in their everyday lives (Barr, Pennycook, Stolz & Fugelsang, 2015), thus for purposeful and useful means.

There was no significant relationship found between the number of times participants picked up their phone a day and their perceived use and purpose of their time. There was also a moderate non-statistically significant positive relationship between the length of interval between each pick up and time structure scores, however was significant to the $p<0.10$ level. This finding shows a possible association between a the length of time between each interaction with their phone and the perception of their time use as useful and structured. This rejects our hypothesis due to a lack of statistical significance, but does give moderate support to the view that increased frequency of phone use can be associated with a lack of purpose and structured use of time, and is consistent with the findings that smartphones phones can be used as a breakup of attention and as a form of procrastination (Vodanovich & Watts, 1999). These findings, indicated that those who spent more time using their phone reported the use of their time to be more structured, yet the greater the length of time between each interaction was also related to a greater perceived structured use of time. This may be, an indication that the amount of time spent on your phone does not depict a negative perceived structured use of your time but rather the pattern of your phone use can dipicit how structured and purposeful you feel the time you spend to be.

The findings show self-reported phone usage was not significantly correlated with any of the time structure variables, indicating that, within the current sample, the participant's perceived smartphone usage was not associated with their perceived structured use of time under any of the subscales (effective organisation, sense of purpose, structured routine, present orientation and persistence). Interestingly, a positive correlation was found between app-reported phone use and sense of purpose. This finding indicates that those who spent a greater number of hours using their phone a day have greater sense of purpose and direction with their day to day use of time. This finding is supportive to the literature which finds technology use to facilitate a sense of connectivity, perceived social interactions and is used as a source of information (Barr, Pennycook, Stolz & Fugelsang, 2015; Fonner and Roloff, 2012). The self-reported and app-reported number of pickups showed no significant correlation with any of the time structure subscales, however a positive relationship was found between the length of time between each smartphone interaction and time structure subscales, effective organisation and present orientation scores. This indicates that the shorter the interval between each interaction with the smartphone the less subjects perceive the daily use of their time to be effectively organised, such that they drifted aimlessly from activity to activity, display difficulty to effectively organize their day to day activities and are slow to begin productive work (Bond & Feather, 1988; Mudrack, 1997). This is supportive of the research by Duke and Montag, 2017 which found that greater Smartphone Addiction Scale scores was significantly predictive of a loss in work productivity, whereby the degree of this effect was mediated by of the number of interruptions cause by smartphone interaction, such that individuals may find it more difficult to organise their time effectively due to the constant distraction of instant connectivity and social interactions facilitated by their smartphones. Participants with less effective organisation may also engage with their smartphone more frequently due to its perceived ease of use, sense of control and usefulness, as established by the Technology Acceptance Model, to which their day to day activities may not provide for them or lack (Davis, 1989). The results also indicate that the shorter the intervals between each pickup the less presently orientated they are, such that the more they tend to focus on missed opportunities or daydream about the future. These finding give support to literature that states phone use, as an act to escape temporal demands and boundaries focusing attention to more stimulating consent, as participants who tended to daydream about the future and focus on missed opportunities tended to engage with their phone more often (Pielot, Dingler, Pedro & Oliver, 2015; Vodanovich & Watts, 1999). This can possibly be explained by the impact that technology has had on pace of life and change. Both these finding infer, that the number of hours participants use their phone isn't related to how they utilize their time but rather the pattern of phone use is related to such negative temporalities.

Mobile Phone Involvement Questionnaire (MPIQ) scores was also compared with Time Structure Questionnaire (TSQ) scores in order to get a broader understand of the effect that mobile behaviour has on our perception of time, with regards to our perceived structured and purposive use of time. A negative association was found between MPIQ and TSQ scores, indicating that an increased perceived mobile phone involvement is associated with a decrease in the perceived structured use of time. A negative correlation was also found between MPIQ scores and participants present orientation, indicate that the greater perceived involvement one has with their phone the less presently orientated they are. These findings accept our hypothesis that the greater mobile phone involvement is related to less perceived structured use of time and lower present awareness. This is consistent with the literature, which proposes that those who scored high on the smartphone addiction scale had a reduced ability to achieve a state of productive flow when focusing on work related activity (Lee, Cho, Kim & Noh, 2015). It is also consistent with research that shows smartphones change the structural processes of socio-temporal order, such that instant connectivity and increased temporal boundaries reduces the need for detailed planning due a facilitated desire for direct organisation, as opposed to preempted organisation (Hislop et al, 2017; Prasopoulou, Pouloudi & Panteli, 2006). The research proposes that this not only alters our ability to schedule but also alters the segregated boundary between work and non-work activities (Srivastava, 2005) which further disrupts the flow of work and consequently alters the perceived dimensions, pace of time and scheduling (Ballard & Seibol, 2004).

There was no significant difference between self-reported phone usage and app reported phone usage. This finding is in disagreement with the research by Lin et al., 2017 which found participants to significantly underestimated there actually phone use, especially those who were unaware they overused their phone who were found to underestimate their phone use by 40%. This finding adds conflicting evidence to the existing literature, however due to a small sample size it is not generalisable to a general population.

Implications

The current study did not find any relationship between the amount one uses their phone and time estimation abilities, within its current sample. This finding offers an alternative perspective to the literature which found technologies such as computers, video games and virtual reality to alter and distort temporal process. It may indicate that smartphone use is somehow different, such that the level of smartphone interaction does not have any longer term effect on subjective temporal experience as found by other studies (Blatchley et al., 2007; Mcloughlin, 2012). The current research addresses the effect of the level of smartphone interaction on our ability to estimate prospective time intervals and the perceived structured use of our time. The only aspect that smartphone interaction had on our temporal processes, was on the interpreted structured use of our time. This findings may be useful in a workplace environment or non-bureaucratic organisations such as universities, as the more often one engages with their phone the less effective time spent during the day and less goal focused time spent on productive work. This could suggest the implication of work/study areas with a no phone policy so that productivity is not distracted by the temptation of small interactions with phones but rather controlled increment such as when they leave or go on break. This research offers a better insight into the effect of daily smartphone interactions on temporal process amongst a population where smartphone use is a predominant feature of everyday life. This finding is also useful as time structure has been associated with many psychological well-being and personality factors. Subscales such as effective organisation, which is defined in terms of getting involved in a directed activity and organized time being associated with traits such as hopelessness, study habits, work methods, neuroticism and anxiety (Bond and Feather, 1998). Due to the nature of the study it is impossible to determine causation of the findings however the relationship cna raise questions and red flags regarding technology use and the factor which may increase its dependence or are a result of more frequent use.

Limitations and Future Research

The novelty of this study contributes to the existing literature offering a new perspective to both research on the effects of human-technology interactions and research on human perceptions of time, however, it is not without its limitations. There were several limitations of this study, the first being the sample size, which subsequently affected the external reliability, generalisability and statistical power of the current findings. The current study would have benefited from a larger sample population. The second limitation to the study was the self-reporting nature of the measures regarding participant perceptions. This relies on participants honest and introspective opinion of their personal smartphone use, involvement and their perceived purposive and structured use of their time. When measuring participants personal perception it is difficult to ensure validity in the response, such that it is an accurate representation of the truth. Though self-report data is the most reliable source for assessing individuals thoughts and inner motivations behind their behaviour (Wang, Jome, Haase & Bruch, 2006), such measures are susceptible to; Acquiescence responses such that when in doubt participant tend to response in the affirmative or to indicate a positive connotation, with the statement regardless of its content (Messick, 1967). This may happen due to an imbalance in the number of negative and positive worded items, a lack of understanding or fatigue (Watson, 1992; Pearce, 2018). Self-report measures are also susceptible to response bias due a lack of attention which can reduce the validity and reliable of the data (Krosnick, 1990). Though each of the measured variables were recorded and stored anonymously, they are remain susceptible to social desirability, such that participants may have not been completely honest regarding the daily habit due a reluctance to present themselves in a negative light e.g. unmotivated, unorganised, lack of a sense of purpose or an intense phone user. This reduces the reliability and validity of the data due to the bias of participants not wanting to producing themself in a socially undesirable way (Van de Mortel, 2008). This can also be explained by the response bias due to respondents knowledge, such that participant may not be aware of their false self-image or usual behaviours and habits and may view it as an accurate representation or guess based on desirability (Van de Mortel, 2008).

To account for all these biases, participants actual phone use was recorded using an application downloaded to their devices, which they were requested to leave running in the background and report the accumulated results via email at the end of the week. However, due to some participants lack of response to the follow up email regarding the actual recorded phone use 12 participants had to be excluded from the analysis which required app-reported phone use. This reduced the reliability when examining how the self-report phone use data corresponded with temporal processing as opposed to the app-reported use due to an inconsistent sample size. This also further reduced the sample size for analysis which included actual recorded data.

The third limitation is the correlational cross-sectional nature of research design, used due to the resources and time made available to perform the current research. This reduces the reliability of the findings, as they are subject to a specific group of people at one specific point in time. It also reduces the external validity of the research findings as a correlation between two continuous variable does not infer cause and effect. Further research should consider a longitudinal research design in order to gain a greater insight and representation of the true cause and effect behind daily smartphone use and habits and our temporal processes. Future research might also consider the inclusion of a control group, however due to the vast growing population of in-depth daily smartphone users this may prove to be difficult.

Another limitation regarding the design was the measurement for the number of times participants interact with their phone a day, which was measured and represented by the number of reported pickups recorded by the app. This however may not have been representative of true interactions as research has shown that mobile phones are the primary time keeping device individuals use in their daily life and have been found to be the prefered method for checking the time, over a watch and clock (Mcloughlin, 2012).

The strength of the current research is the novelty and uniqueness that it brings to the literature. There is a limited amount of research on the effect that advanced technology has on the perception of time (Blatchley et al., 2007; Lin et al., 2014; McLoughlin, 2012; Turel, Brevers & Bechara, 2018) and none with the specific regard to smartphone use. This study opens the examination of the perception of time and the factors which influence its processing, in a new and relevant perspective of technology. The current study focused on participants prospective timing abilities, however future research might examine both prospective and retrospective timing, where participants are unaware of the interval being judged in order to get a deeper understanding of the effect that smartphones may have on our temporal processes. Participants were also asked to estimate empty time intervals which allow for confounding variable such as boredom, lack of arousal and focused attention which can make the interval feel as time is passing slower (Block, 1990; Hicks, Miller, Gaes & Bierman, 1977; Flaherty, 1993). Future research may consider this and implicate both empty and filled intervals or intervals of time where participants are allowed use their phones during intervals under estimations. Future research might also consider a waiting room experiment whereby half of the participant sample are allowed use their phone and the other half are not, and when called into to the experiment room by the researcher to complete the prospective time estimation task they are asked to estimate how long they perceived to have been waiting for. This both examines their retrospective and prospective timing abilities and the effect smartphones may have on our perception of time passing while engaged and as a long term effect. However, factors such as participants checking the time on their phones would need to be controlled.

Conclusion

Contrary to our hypothesis, we found no relationship between smartphone interaction and time estimation abilities. We did find that there was some statistically significant effects on the perceived structured use of our time which related to the frequency of phone usage as measured in phone pickups and app-reported phone usage. This would imply that more daily phone usage is related to greater perceived purposeful and structured use of time, however the pattern of phone use such as the frequent access to a smartphone may be an indicator of inattention or boredom. It also may be supportive of prior studies which showed that we prefer to engage in tasks which allow us to switch between real time activities and smartphone interaction and find stimuli more enjoyable if allowed to interact with our smartphone, due to the perceived effect that time is passing faster (Chinchanachokchai, Duff & Sar, 2015).

While the finding are non-generalizable due to the small sample size and correlational nature of the design, it is possible that the prior studies related to human interface with technology which showed that such interfaces distorted time perceptions, are not applicable to smartphone use, which is constantly connected and a virtual extension of the user. It also may be that the sample for this study was made up of habitual smartphone users whose sense of time was intrinsically intertwined with use and access to smartphone technology. A larger subject group with a more diverse set of participants may have demonstrated a very different set of results.

It is important to further study the implications of social and temporal interactions of mobile communications and information technology given the increasing ubiquity of such devices with regard to its effect on our cognitive process and subjective experiences, and increasing popularities from smartphones to smart watches to smart cars and smart appliances.

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Appendix

CONSENT FORM

This study is being conducted as part of my undergraduate thesis through the School of Business at the National College of Ireland under the supervision of Dr. Fearghal O'Brien (fearghal.obrien@ncirl.ie).

You are invited to participate in this research project investigating the effects of smartphone interaction on time perception and time management skills. The survey includes a Mobile Phone Involvement Questionnaire, a Time Structure Questionnaire and three short questions on your smartphone usage. You will also be asked to participate in a Time Estimation Task today. In total, the questionnaire and task will take you about 10 minutes.

In addition to these tasks, you are required to download an App to your phone which will monitor your phone usage. This app is downloadable on the Apple store or Google play store. All information obtained by the app, regarding smartphone usage, is only accessible by the participant and is not monitored by any third party persons. You are asked to keep this app on your phone for seven days in order to obtain an accurate recording or your average smartphone usage over the course of a week. At the end of these seven days, you will receive an email asking you for some of the information recorded by the app.

Participation is ENTIRELY VOLUNTARY and you are free to withdraw from the study at any time without prejudice. Every response is CONFIDENTIAL and recorded ANONYMOUSLY. The only identifiable information requested of you is your email, which is solely for the purpose of collecting data recorded by the app. Once the app data is obtained, your email will be discarded and the data will be stored anonymously in a password protected file. By signing this form, you are consenting to participate in this study.

Signature ____________________________

Date ________________________________

Email: ______________________________