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Perceived loneliness in subjective time perception during the COVID-19 pandemic: the mediating role of negative affective states

**Authors: Fabbri, M.¹, Cosenza, M.¹, Sacco, M.¹, Ciccarelli, M.¹, Nigro, G.¹,
Pizzini, B.^{2*}**

¹ **Department of Psychology, University of Campania Luigi Vanvitelli, Caserta (CE), Italy**

² **Giustino Fortunato, Telematic University, Benevento (BN), Italy**

Short Title: Loneliness in time perception during the COVID-19

***corresponding author:**

Barbara Pizzini¹, PhD,

Giustino Fortunato,

Telematic University,

Viale Raffaele Delcogliano, 12, 82100, Benevento

Tel: +39-3935321659

¹ b.pizzini@unifortunato.eu

ABSTRACT:

Several studies highlighted how social isolation due to pandemic restrictions influenced subjective experience of solitude, negative affective states, and the subjective time awareness. The main aim of the present study was to investigate, for the first time, the interplay among social isolation due to quarantine, psychological distress, perceived loneliness, and the subjective perception of the passage of time during Covid-19 pandemic. A total of 810 participants, aged 18-60, were administered a set of socio-demographic questions, the University of California, Los Angeles, Loneliness Scale-Version 3 (for perceived loneliness), the Depression Anxiety Stress Scales (for general psychological distress), and the Subjective Time Questionnaire (for the subjective passage of time). Results revealed higher levels of psychological distress in participants in quarantine. Female gender, and both perceived loneliness and stress were significant positive predictors of time pressure. Furthermore, lower education level, younger age, quarantine, higher levels of loneliness, depression and anxiety, and lower levels of stress were significant predictors of time expansion. Lastly, **the mediation analysis showed** that the subjective experience of solitude indirectly affected time pressure through stress, and time expansion through depression, anxiety, and stress. Taken together these results demonstrated that the subjective experience of loneliness, but not social isolation *per se*, had an impact on individual experience of time, also acting indirectly through negative affective states. This study reveals how psychological variables impact on subjective experience of time

during specific trauma, but it also suggests how the changes of social environment impact on psychological distress and time perception.

Keywords: Loneliness; Psychological Distress; Subjective Time Awareness; COVID-19 Lockdown; Social Isolation.

1. *Introduction*

Although the subjective experience of time is a very important process for human beings, the subjective passage of time is still a less studied process about which a coherent conceptual system is still lacking (Thones & Stocker, 2019). The perceived speed of the passage of time, also called "perception of the passage of time" (Block, 1990; Wearden, 2005), is deeply related to environmental and contextual factors.

Individual and societal changes can alter our time perception, either speeding it up or slowing it down. Results from several studies demonstrated that subjective experience of passage of time (also called time awareness) is affected by several psychological factors, such as subjective emotional experience felt in the present moment and its variations in correspondence of changes of life conditions (Beracci et al., 2022; Buhusi & Meck, 2005; Cravo et al., 2022; Droit-Volet & Meck, 2007; Fabbri, 2023; Gil & Droit-Volet, 2012; Ogden, 2021; Sucala et al., 2011; Twenge et al., 2003). A recent meta-analysis conducted by Cui and colleagues (2023) confirmed these results, indicating a high influence of emotions on subjective time passage perception, with negative valence and increased arousal leading to overestimation of time.

Although these findings can be intuitively and easily explained by naïve theories, the understanding of underlying cognitive and emotional processes remains still unidentified (for reviews, see Droit-Volet & Meck, 2007; Droit-Volet, 2013). So far, researchers have mainly studied the role of emotional stimuli in time judgement tasks (Angrilli et al., 1997; Tipples, 2008; Yamada & Kawabe, 2011), without adequately

considering the subjective awareness of the passage of time. Droit-Volet and colleagues (2018), for example, have shown that emotional states modulate arousal levels, subsequently affecting perceptions of time, both in terms of time pressure and time expansion. Higher levels of boredom or negative emotions could result in a slower perceived time (Watt, 1991), as well as, in an opposite manner, having fun and positive emotions could lead to a faster perceived time (Sucala et al., 2010). Several authors explain these phenomena by taking into account corresponding physiological arousal of emotions and related attentional processes. Ogden and colleagues (2022) sustain that subjective passage of time is affected by objective measures of time. Similarly, Zakay (1992) proposed a theoretical model in which levels of attentional resources allocated for temporal information processing are determined by temporal relevance (the relevance of what we are waiting for) and temporal uncertainty (the certainty of the event's timing): higher levels of these two factors would increase the allocation of resources for temporal information processing, thereby extending prospective estimation durations. In other words, heightened emotional activation and physiological arousal may lead to greater attention directed towards the psychological mechanism of time perception, potentially resulting in a subjective experience of either time deceleration or acceleration (Zakay, 1992). The pacemaker-accumulator models suggest that heightened arousal can accelerate the pace of our internal timekeeping mechanism, leading us to perceive longer durations for emotional events compared to their actual length. This phenomenon results in the

overestimation of the time passed during emotional experiences (Lake, 2016).

Above this, the surrounding environment is a relevant factor that could help explaining several psychological processes involved in the perception and awareness of the passage of time. On this perspective, the Covid-19 pandemic provided a unique and specific change in the normal environment due to social distancing countermeasures adopted by national governments (Adhikari et al., 2020; World Health Organization, 2020). Restrictions such as physical distancing from other human beings and quarantining, together with the nerve-wracking sequence of abnormal and unpredictable lockdowns, significantly impacted both economic and social life activities (Gössling et al., 2020; Lin, 2020) and individuals' psychological wellbeing (e.g., Knox et al., 2022). Italy was one of the country most severely affected by Covid-19, experiencing a total lockdown beginning on March 10, 2020. The worldwide psychological impact of this phenomenon has been reported by several studies (Chen et al., 2021; Fabbri, 2023; Rodríguez-Rey et al., 2020; Rossi et al., 2020; Wang et al., 2020; for a review, see Lee et al., 2021), most of them reported an increased depression, anxiety, and stress levels during the pandemic lockdowns. The pandemic crisis and the consequent lockdown countermeasures were severe and prolonged stressors for individuals and societies. So, it is not surprising that during Covid-19 lockdowns a worsening of mental health and an increase of psychological distress (such as higher levels of anxiety, stress-related symptoms, and depressive symptoms) has been reported (Bäuerle et al., 2020; COVID-19 Mental Disorders Collaborators, 2021; Shevlin et al.,

2020; for a review, see Prati & Mancini, 2021). Among several factors, Horesh and colleagues (2020) reported loneliness, age, gender, and health status as risk factors for psychological distress during the Covid-19 pandemic. Given that psychological distress may represent an adaptation to environmental threats (DeKloet et al., 2005), longitudinal studies have observed higher levels of psychological distress during the early phases of the pandemic lockdowns, with a return to pre-pandemic levels when the restrictive measures changed (Daly & Robinson, 2021; Fancourt et al., 2021). In the light of these premises, the present study specifically takes into account the psychological distress experienced during the Covid-19 lockdowns. Psychological distress should be considered not only as a measure of mental health during pandemic (Prati & Mancini, 2021), but also as a key factor in modulating the subjective passage of time (e.g., Cellini et al., 2020). With regard to subjective time perception, the studies reported a slowing down of the subjective time experienced during Covid-19 social isolation (Cellini et al., 2020; Cravo et al., 2022; Droit-Volet et al., 2020; Droit-Volet et al., 2021; Fabbri, 2023; Martinelli et al., 2021; Mioni et al., 2022; Micillo et al., 2022; Nowakowska, 2020; Ogden, 2020, 2021; Ogden & Piovesan, 2022; Kosak et al., 2022; Wessels et al., 2022; Wittmann, 2020). Most of these studies detected an increase in negative emotions and psychological distress levels, related to a slowing down of the perceived passage of time during quarantine. For example, Cellini et al. (2020) reported that higher levels of psychological distress (i.e., higher depression, anxiety, and stress) were associated with higher perceived expansion of time. Ogden and Piovesan (2022) found that the majority of their participants

perceived one year of pandemic as longer than twelve months, and that this was especially true for participants with higher levels of depression, anxiety, and dissatisfaction with social interactions. Since in retrospective judgements of time people need to take into account actually occurred and remembered contextual changes, **the under-demanding environment caused by social isolation and routine activities lead people to feel that time is passing slowly** (Wittmann, 2020). Effectively, as reported by both Droit-Volet and colleagues (2020, 2021) and Martinelli et al. (2021), the slowing of the perceived passage of time **due to the pandemic** was mostly explained by higher levels of boredom. In this respect, a recent longitudinal study of Wessels and colleagues (2022) found that at the beginning of the pandemic people reported higher levels of both boredom and negative emotional states, predictive of slower perceived passage of time (for similar results, see also Fabbri, 2023). A further support for this assumption could derive from Ogden (2020) who **found a faster passage of time when participants had several things to do throughout the day, reporting more satisfaction** in their social interactions.

Related to this last point, loneliness could affect social interactions, whereas social isolation could impair human interactions (e.g., Liebertz et al., 2021). Although social isolation and loneliness are different theoretical constructs, there are similarities between them (Ernst et al., 2022). Perceived loneliness specifically refers to the perception of a discrepancy between one's social needs or expectations and real-life social relationships (Cacioppo et al., 2009). This specific feeling of subjective loneliness has several implications on

psychological well-being (Cacioppo & Hawkley, 2009), generally being related to higher levels of negative mood, anxiety, anger, and depressive symptomatology (Santini et al., 2020). Some studies highlighted that social isolation due to the Covid-19 pandemic contributed to increase perceived feelings of loneliness (for reviews, see Pai & Vella, 2021; Ernst et al., 2022).

Generally speaking, loneliness has consistently showed a significant and positive association with mental illness symptomatology (Pai & Vella, 2021). During the acute phase of the Covid-19 outbreak, Luchetti and colleagues (2020) reported an increase in older adults' feelings of loneliness, measured with University of California, Los Angeles (UCLA) Loneliness Scale. Nowakowska (2020) found that higher levels of loneliness reported by individuals separated from their social network were predicted by negative beliefs about the past. Lastly, Okruszek et al. (2020) confirmed the association between loneliness (assessed with UCLA Loneliness Scale) and negative affectivity, and also demonstrated the impact of initial affective response to the Covid-19 on subsequent levels of perceived loneliness.

To the best of our knowledge, only Cravo et al. (2022) addressed in detail the relationship between subjective loneliness and time awareness during the COVID-19 lockdowns and subsequent social isolation. The authors found that time awareness was strongly associated with psychological factors such as loneliness, stress, and positive emotions. Specifically, participants reported time expansion in association with decrease of positive emotions, increase of negative emotions, and high feeling of loneliness. For time pressure, the main

predictors were lower scores on personal care, increased hours of work and study, higher perceived stress and higher presence of positive emotions. Although some studies explored interrelation among social isolation, negative affective states and perceived passage of time during the COVID-19 pandemic (Cravo et al., 2022; Kosak et al., 2022; Ogden, 2020, 2021; Ogden & Piovesan, 2022), no studies have so far deeply investigated the specific role of these variables, and their putative interrelation, on subjective perception of the passage of time.

Based on the reported literature, the present study mainly aimed to jointly investigate, for the first time, the role of psychological distress and perceived sense of loneliness on the subjective perception of the passage of time during the Covid-19 pandemic.

Specifically, the following aims were pursued:

- a. analyzing the interrelations between perceived sense of loneliness, psychological distress and the passage of time, with a specific focus on the role of the forced social isolation on them;
- b. exploring the possible predictors influencing time expansion and time pressure, testing, in addition, a mediation model in which perceived feelings of loneliness during the Covid-19 lockdowns increase the psychological distress, which, in turn, affect the subjective time perception.

2. Material and Methods

2.1 Participants and procedure

A link of an online survey, implemented on Google Moduli, was shared on different online platforms and social media to recruit the sample. The shared link was accompanied by a text containing information about general aims of the study. The study was carried out in a period ranging between February and March 2022. At that time, there was not a strict lockdown, epidemic showed decreasing trend in incidence, transmissibility and also in the number of hospitalizations. However, recommended individual and collective behavioral measures were still in place, such as interpersonal distancing, use of masks, ventilation of rooms, hand hygiene, reduction of contact occasions, and special attention to assemblage situations (text obtained from https://www.salute.gov.it/portale/news/p3_2_1_1_1.jsp?lingua=italiano&menu=notizie&p=dalministero&id=5814 accessed January 2024). Individuals who agreed to participate in the study signed an electronic informed consent form. The online survey started with several questions about socio-demographic variables. Participants then completed a set of psychometric instruments. To successfully submit the survey, all questions needed to be completed, therefore no missing data were recorded. Participation in the study was voluntary, confidential, and anonymous. The survey took approximately 20 minutes to complete. The procedure was approved by the Ethical Committee of the Department of Psychology of the University of Campania Luigi Vanvitelli (protocol number: 5/01.03.2022) and was in accordance with the Declaration of Helsinki.

A total of 810 Italian adults (27.5% males) aged from 18 to 60 years ($M = 32.25$ years; $SD = 11.90$ years) took part in the study. In the

sample, 2.96% referred an eighth-grade diploma, 58.89% reported a high school diploma, and 38.15% reported a bachelor's or master's degree. Among participants, 65.19% reported being single/unmarried, 30.86% reported being married, and the remaining 3.95% reported being separated or divorced. Of the total sample, 74.20% reported that they had no children, while 25.80% reported that they had. Regarding employment status, 46.80% had a job (employee or self-employed), 41.60% were students, 7.90% were not employed at the time of the survey, and the remaining 3.70% were retired or other.

On the total sample, 67.41% have reported they have not been infected with the Covid-19 virus, while 53.33% reported having been forced to quarantine themselves because of having contracted the virus or having come into contact with someone who had contracted it.

2.2 Measures

2.2.1 Socio-demographic information

In the first part of the study, participants had to fill a simple set of questions regarding socio-demographic information, such as gender, age, education level (eighth-grade diploma, high school diploma, bachelor's or master's degree), marital status (being single/unmarried, married, separated or divorced), having child or not, employment status (students, not employed, employee/self-employed, retired), having done a period of quarantine consisting in 15 days of forced home confinement and social isolation due to having contracted the virus or coming in contact with someone contracted it (yes/not).

2.2.2 Perceived loneliness

The Italian version of the University of California, Los Angeles, Loneliness Scale-Version 3 (UCLA LS3; Russell, 1996; Italian version: Boffo et al., 2012) was administered. It is a 20-item self-report assessment instrument. Each item is to be rated on a four-points Likert scale ranging from 1 (*never*) to 4 (*always*). The scale assesses perceived loneliness and the frequency and quality of social relationships. Nine items are positively worded, and reverse scored (e.g., "*How often do you feel close to people?*") and 11 items are negatively worded (e.g., "*How often do you feel lonely?*"). After reversed scores of 9 items, a total score is obtained by summing the scores of each item. Higher scores reflect a greater degree of perceived loneliness. **The Cronbach's alpha coefficient of the scale was .92.**

2.2.3 Psychological distress

The Italian version of the Depression Anxiety Stress Scales (DASS-21; Henry & Crawford, 2005; Italian version: Bottesi et al., 2015) was administered. It is a 21-item self-report assessment tool, and the items are rated on a four points Likert scale ranging from 0 (*did not apply to me at all*) to 3 (*applied to me very much, or most of the time*). The scale assesses emotions and mood states in the past two weeks, with seven items for each of the three dimensions: Depression (e.g., "*I could see nothing to be hopeful about*"), Anxiety (e.g., "*I felt scared without any good reason*") and Stress (e.g., "*I tended to over-react to situations*"). Higher scores on each of the subscales reflect higher levels of Depression, Anxiety or Stress respectively. In addition, an overall

measure of general psychological distress can be calculated by summing the scores of all 21 items. The Cronbach's alpha coefficients of DASS-21 subscales were: Depression subscale $\alpha = .91$; Anxiety subscale $\alpha = .89$; Stress subscale $\alpha = .92$. Moreover, the Cronbach's alpha coefficient of the DASS-21 total score was $\alpha = .96$.

2.2.4 *Subjective passage of time*

The Subjective Time Questionnaire (STQ; Wittmann and Lehnhoff, 2005; Italian version: Torboli et al., 2023) was administered. It consists of two main parts: I) items regarding the retrospective judgments of the passage of past time intervals; II) items regarding the subjective passage of time typically experienced. In the present study, only the second part was considered. Participants were requested to indicate their feeling of time pressure (TP, 5 items, e.g., “*I often think that time is running out*”) or their feeling of time expansion/boredom (TE/B, 5 items, e.g., “*My time is not filled*”) by using a five-points Likert scale ranging from 0 (*strong rejection*) to 4 (*strong approval*). For each feeling, a mean score was computed and higher scores on each subscales indicated higher levels of that feeling. The Cronbach's alpha coefficients of STQ subscales were: STQ-TP $\alpha = .82$; STQ-TE/B $\alpha = .77$.

2.3 *Data Analysis*

Statistical analysis was performed using SPSS 18.0 Statistical Package for the Social Sciences (Armonk, NY, USA), with a significance level of $p < .05$. All variables were initially screened for distribution abnormalities and outliers (Tabachnick & Fidell, 2019).

Descriptive statistics for perceived loneliness, psychological distress (and every subscale) and subjective passage of time were computed. For the each aim the following analyses were performed: a) between-subjects t-test grouping samples into participants forced to quarantine and those not forced on every scale administered (UCLA LS3, DASS-21, STQ-TP and STQ-TE/B); b) Pearson correlations among the examined variables were performed; c) hierarchical linear regression analysis was used to examine the independent contributions of socio-demographic variables, perceived loneliness (UCLA LS3) and psychological distress (DASS-21) in predicting Subjective Time Perception (STQ-TP and STQ-TE/B); d) a mediation analysis assessed whether psychological distress mediated the relationship between perceived loneliness and subjective passage of time through macro Process from SPSS (Model 4; Hayes, 2018). For the regression analysis, to control for the presence of multicollinearity, the variance inflation factors (VIF) was calculated before interpreting the regression coefficients. In the present study, the VIF was below the recommended cut-off of 10 (Ryan, 1997), indicating no issues with multicollinearity. As regards the mediation analysis, the Process command generate bootstrap confidence intervals (95% CI) for all indirect effect using 5000 bias-corrected bootstrap samples. The alpha level was equal to 0.05.

3. Results

All the descriptive statistics and demographic information are resumed in the Table 1.

[PLEASE INSERT TABLE 1 ABOUT HERE]

Between-subjects t-tests performed on the two sub-sample, divided on the basis of having forced to quarantine or not, revealed significant differences for **time expansion**, STQ-TE/B ($t(808) = -4.717$, $p = .0001$), DASS-21 Depression subscale ($t(808) = -2.594$, $p = .010$), DASS-21 Anxiety subscale ($t(808) = -2.652$, $p = .008$), **DASS-21 Stress subscale** ($t(808) = -2.683$, $p = .008$), and DASS-21 total score ($t(808) = -2.876$, $p = .004$). Results showed higher levels of time expansion/boredom, depression, anxiety, stress and a general level of psychological distress, in participants forced to social isolation due to having contracted the virus or having come into contact with someone who had contracted it.

The results of Pearson correlation analysis are reported in Table 2. They revealed positive correlations between all variables, suggesting that higher levels of time pressure and time expansion were related to higher scores of general psychological distress (as well as higher scores of depression, anxiety, and stress) and perceived loneliness.

[PLEASE INSERT TABLE 2 ABOUT HERE]

The hierarchical linear regression analysis was conducted on STQ-TP, by inserting as predictors all socio-demographic variables (that is gender, age, education level, quarantine yes/not) in the first step, UCLA LS3 total score in the second step and the three DASS-21 subscales (Depression, Anxiety and Stress) in the third step. As reported in Table 3, results revealed that, along with female gender, high scores on perceived loneliness (UCLA LS3) and stress (DASS-21 Stress subscale) were significant predictors of time pressure (STQ-TP). The

overall model explained about the 14% of the total variance of the STQ-TP ($R^2_{adj} = 0.14$; $F_{3,809} = 46.191$; $p < .001$).

A second hierarchical linear regression analysis was conducted on STQ-TE/B by inserting as predictors all socio-demographic variables in the first step, UCLA LS3 total score in the second step and the three DASS-21 subscales in the third step. As reported in Table 3, results revealed that lower education level, younger age, having done a period of quarantine, higher levels of perceived loneliness (UCLA LS3), Depression (DASS-21) and Anxiety (DASS-21) and lower levels of Stress (DASS-21) were significant predictors of time expansion (STQ-TE/B). The overall model explained about the 28% of the total variance of the STQ-TP ($R^2_{adj} = 0.28$; $F_{7,809} = 45.884$; $p < .001$).

[PLEASE INSERT TABLE 3 ABOUT HERE]

Furthermore, two mediation models were tested, one for each time awareness scale (i.e., time pressure, STQ-TP and time expansion, STQ-TE/B). The first mediation analysis tested whether the effect of perceived loneliness (UCLA LS3) on time pressure (STQ-TP) was mediated by Stress (DASS-21 subscale). On the base of the regression results, gender was putted in the model as covariate. The hypothesized model was significant ($R^2 = .15$, $F_{3,806} = 46.191$, $p < .001$). Results confirmed the hypothesis that perceived loneliness (UCLA LS3) indirectly affects time pressure through Stress (DASS-21 subscale) (indirect effect = .070, lower limit of 95% CI = .041 and upper limit of 95% CI = .101). Specifically, perceived loneliness (UCLA LS3) led the Stress (DASS-21 subscale) to increase, which in turn led time pressure to increase. These double positive effects resulted in a positive indirect

effect, which led time pressure to increase via Stress (DASS-21 subscale) (for results see Figure 1).

[PLEASE INSERT FIGURE 1 ABOUT HERE]

The second mediation analysis was carried out to test whether the effect of perceived loneliness (UCLA LS3) on time expansion (STQ-TE/B) was mediated by the three DASS-21 subscales (Depression, Anxiety and Stress). On the base of regression results, age, educational level and having done a period of quarantine were putted in the model as covariates. The hypothesized model was significant ($R^2 = .29$, $F_{7,802} = 45.884$, $p < .001$). Results confirmed the hypothesis that perceived loneliness (UCLA LS3) indirectly affects time expansion through all DASS-21 subscales: Depression (indirect effect = .164, lower limit of 95% CI = .104 and upper limit of 95% CI = .223), Anxiety (indirect effect = .046, lower limit of 95% CI = .008 and upper limit of 95% CI = .087) and Stress (indirect effect = -.078, lower limit of 95% CI = -.122 and upper limit of 95% CI = -.039). Specifically, perceived loneliness (UCLA LS3) led the Depression and Anxiety (DASS-21 subscales) to increase, which in turn led time expansion to increase. These double positive effects resulted in two positive indirect effects, which led time expansion to increase via Depression and Anxiety (DASS-21 subscales). Moreover, a negative indirect effect of perceived loneliness (UCLA LS3) on time expansion passed through Stress (DASS-21 subscale) was also revealed. That is, perceived loneliness (UCLA LS3) led the Stress (DASS-21 subscale) to increase, which in turn led time expansion to decrease. The multiplication of positive and negative effects resulted in

a negative indirect effect, which led time expansion to decrease via Stress (DASS-21 subscale). For results see Figure 2.

[PLEASE INSERT FIGURE 2 ABOUT HERE]

4. Discussion

The aims of the present study were: to assess the impact of forced social isolation due to Covid-19 quarantine on perceived loneliness, psychological distress, and subjective time awareness; to examine the interrelations between study variables, including to investigate the predictors for changes in time pressure and time expansion/boredom; to test a mediation model explaining how loneliness could affect time awareness through the mediation role of psychological distress.

Results mainly confirmed the research hypotheses. First of all, we found higher levels of depression, anxiety, stress and general psychological distress among individuals who reported being in quarantine due to Covid-19 contagion or being in contact with someone who had contracted the virus, compared to individuals who have not been in forced quarantine. These findings showed that the experience of quarantine was emotionally demanding for people, whom self-reported high levels of anxiety, depression, and stress, confirming unpleasant mood derived from quarantine experience (for a review, see Rajkumar et al., 2022). Interestingly, this finding is broadly in line with results reported among individuals quarantined during outbreaks of SARS and MERS (e.g., Hull, 2005, Lee et al., 2018).

In addition to confirming the presence of changes in time experience during Covid-19 (Beracci et al., 2022; Cellini et al., 2020;

Droit-Volet et al., 2020; Fabbri, 2023; Martinelli et al., 2021; Ogden, 2020), the present cross-sectional study also demonstrated a positive association between time awareness (both time pressure and time expansion/boredom), psychological distress and feeling of loneliness. Hierarchical regression analyses clarified these associations, highlighting specific predictors for the two opposite passage of time perceptions.

First, we found that female gender, higher levels of perceived loneliness, and higher levels of stress predicted higher time pressure. Regarding results concerning the effects of perceived loneliness and psychological distress on time passage perception, our results are in line with results obtained by Hawkley and Cacioppo (2010). In their study they demonstrated that feelings of loneliness reduce self-regulation, and self-regulation, in turn, represents a key factor in subjective time awareness during waiting situations. Namely, less self-regulation is related to less awareness of time (Witowska et al., 2020). Since time awareness about speed of time passage is conceivable as the capacity to perceive the passing of time accurately, our results seem to confirm the effect of perceived loneliness also on subjective awareness of time, in addition to the objective perception of time. Our results then gave a relevant highlight on the role of feeling of loneliness, and not the isolation *di per se*, on negative affectivity and, in turn, on time awareness.

Furthermore, the relationship we found between perceived stress and time pressure confirmed the results reported by Cravo et al. (2022), but also those found by Ogden (2020): increasing task load is associated

with a perception of a faster passage of time. Moreover, the association between time pressure and perceived stress could be explained by considering the influence of arousal on time judgments (Droit-Volet et al., 2018). We suggest that the Covid-19 lockdown affected individuals' emotional states, which, in turn, increased the levels of arousal determining a feeling of time pressure. **Lastly, we found a gender effect on time pressure. Specifically,** gender roles have undergone significant changes over the last decades, at least in Western society, with women increasingly participating in a wide range of time-regulated activities (Hancock & Rausch, 2010). In addition, differential attention functioning in time estimation between sexes has been posited (e.g., Coull et al., 2004), although the scientific literature has not definitively reached a conclusion on this matter.

On the opposite side of time experience, our results showed that time expansion/boredom is predicted by age, educational level, quarantine experience, perceived loneliness, and negative affectivity. This result appears in line with previous studies suggesting that a variety of socio-demographic and psychological factors influence feelings of boredom and dilatation of time (e.g., Cravo et al., 2022; Fabbri, 2023). These results indicated that the slowdown of the passage of time is influenced by factors such as lack of satisfaction with social interaction (perceived loneliness), increase of negative emotions (depression and anxiety) and lower perceived stress (Ogden, 2020, 2021).

More interestingly, in our opinion, the results derived from mediation analyses showed a specific pattern of relation among study variables. As regards time pressure, our findings indicate that feelings of

loneliness resulting from social constriction heightened negative emotions due to the fear of contagion (i.e., an increase in perceived stress and arousal state), which, in turn, determined a feeling that time was passing more quickly. These data may be discussed within the Craig's model (Craig, 2009) suggesting that time is perceived to accelerate during activation of the sympathetic neuron system (SNS), associated with the activation of the right anterior insula cortex (AIC). In other words, the temporal judgment and the passage of time (Craig, 2009; Ogden et al., 2022) are both affected by objective measures of physiological arousal. The novelty of the present study lies in demonstrating how perceived loneliness could influence stress reactions (potentially affecting arousal states) in a particular stressful scenario, such as the Covid-19 lockdown.

As regards time expansion/boredom, results of the mediation analysis showed that loneliness increased negative emotions (depression and anxiety) which, in turn, heightened the feeling of time passing more slowly. In line with Cacioppo et al. (2006), we found that feelings of loneliness and a lack of social connection, due to forced home confinement, result in a dilatation of perception of time and an increase of sense of boredom, through a reduction of perceived stress and an increase in depressive and anxiety symptoms. These findings confirmed what has been repeatedly found in the literature about the passage of time during the Covid-19 lockdown (Cellini et al., 2020; Cravo et al., 2022; Droit-Volet et al., 2020; Fabbri, 2023; Martinelli et al., 2020; Martinelli et al., 2021).

These data could not only contribute to a clearer understanding of subjective time perception during extremely demanding or traumatic situations, but could also detail the influence of key psychological variables, such as perceived loneliness, on subjective awareness of time. All the more so since the subjective feeling of loneliness is an increasingly common experience in our contemporary society (Hawkley & Cacioppo, 2010).

As already said, the subjective passage of time is still a less studied process about which a coherent conceptual system is still lacking (Thones & Stocker, 2019). In our opinion, the relevance of the results from both mediation models should be understood by considering Zakay's model (Zakay, 1992; Block & Zakay, 1997). According to this model indeed, waiting times are judged along the two dimensions of temporal relevance and temporal uncertainty, which influence how much attention individuals give to time (i.e., time awareness). It is the "amount" of attention that determines how slowly time seems to pass. Any changes in these two dimensions lead to a slowing down of time. Thus, an increase in negative affectivity and a higher level of perceived loneliness were associated with a sense of slower time. In contrast, an increase in arousal level due to an increase in perceived stress was associated with a feeling of faster time.

Nevertheless, the present study is not exempt of limitations. Although a large sample size could prevent from a type II statistical error, the effect size found was not so large. Probably, the cross-sectional nature of the study as well as the variability experienced during the pandemic isolation could explain the small effect size reported. Future

studies should reproduce our study in an experimental study in which a major control is recommended. Another limit was related to a nonuniform distribution of male and female. This aspect could have limited the impact of female gender as significant predictor of time pressure, in the hierarchical regression analysis. Furthermore, as our sample mainly consisted of young university students, mainly single/unmarried, they possibly were alone and engaged in several university activities during the lockdown. These conditions may have influenced the participants' awareness of time with a different day schedule. Lastly, this was a cross-sectional study and no casual assumptions could be made, although our data are consistent with what has been observed in longitudinal studies. Related to this point, it is important to discuss our cross-sectional study's results by keeping in mind that it was conducted about two years after the first Italian lockdown and possibly the participants had learned to cope with these type of stressful situations (Droit-Volet et al., 2021).

To conclude, the present study showed that, during the Covid-19 lockdowns, both feelings of loneliness and psychological distress impact on individuals' experience of time awareness. These findings are relevant when considering both the impact of stressful and forced waiting situations (i.e., traumatic conditions) on psychological well-being and time awareness, and the importance of improving the social environment in our modern society by fostering conditions for a rich social life and reducing social isolation. Future studies should replicate our data in real social situations, specifically investigating the impact of social media (or

alternative worlds) in terms of perceived loneliness, psychological distress and time awareness.

5. *References*

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Table 1*Descriptive statistics of measures of interest*

Variable	Min	Max	Mean (SD)	Mean (SD)	Mean (SD)	Cohen's d
	Total sample (N=810)		Social isolated (N= 432)		Not social isolated (N= 378)	
1. STQ-TP ^a	0	4	2.59 (.88)	2.62 (.84)	2.55 (.93)	0.08
2. STQ-TE/B ^b	0	4	1.20 (.87)	1.34 (.90)	1.05 (.81)	0.34*
3. UCLA LS3 ^c	20	74	45.00 (10.09)	45.40 (9.92)	44.54 (10.27)	0.09
4. DASS-21 ^d Depression	0	21	7.71 (6.07)	8.22 (5.99)	7.12 (6.13)	0.18*
5. DASS-21 Anxiety	0	21	6.00 (5.72)	6.49 (5.70)	5.43 (5.69)	0.19*
6. DASS-21 Stress	0	21	9.81 (6.19)	10.35 (5.93)	9.19 (6.42)	0.19*
7. DASS-21 total score	0	63	23.51 (16.54)	25.07 (16.00)	21.73 (16.98)	0.20*

Note. ^a Subjective Time Perception – Time Pressure; ^b Subjective Time Perception – Time Expansion; ^c University of California, Los Angeles, Loneliness Scale-Version 3; ^d Depression Anxiety Stress Scales-21. * represents significant differences between Social isolated and Not social isolated groups, calculate through t-test.

Table 2*Pearson correlation coefficients among the study variables (N= 810)*

	1	2	3	4	5	6
1. STQ-TP ^a	-					
2. STQ-TE/B ^b	.042	-				
3. UCLA LS3 ^c	.340*	.375*	-			
4. DASS-21 ^d Depression	.292*	.429*	.523*	-		
5. DASS-21 Anxiety	.222*	.352*	.385*	.743*	-	
6. DASS-21 Stress	.296*	.297*	.413*	.792*	.769*	-

Note. * $p < .01$. Bold values represent significant correlation coefficients.

^a Subjective Time Perception – Time Pressure; ^b Subjective Time Perception – Time Expansion; ^c University of California, Los Angeles, Loneliness Scale-Version 3; ^d Depression Anxiety Stress Scales-21

Table 3

Summary of hierarchical linear regression analyses with STQ-TP^a and STQ-TE/B^b as dependent variables

Independent Variable	Dependent Variable	B	R ²	ΔR^2	β	<i>t</i>	<i>p</i>
<i>STQ-TP^a</i>							
<i>Step 1</i>							
Gender		.215	.011	.011	.109	3.113	.002
<i>Step 2</i>							
Gender		.161	.120	.109	.081	2.453	.014
UCLA LS3 ^b		.029			.333	10.071	.000
<i>Step 3</i>							
Gender		.091	.144	.024	.046	1.381	.168
UCLA LS3		.023			.263	7.372	.000
DASS-21 ^c Stress		.025			.176	4.814	.000
<i>STQ-TE/B^b</i>							
<i>Step 1</i>							
Education level		-.315	.067	.067	-.261	-7.694	.000
<i>Step 2</i>							
Education level		-.274	.114	.047	-.227	-6.791	.000
Age		-.016			-.222	-6.634	.000
<i>Step 3</i>							
Education level		-.266	.121	.007	-.221	-6.599	.000
Age		-.015			-.202	-5.889	.000
Quarantine		.159			.091	2.679	.008
<i>Step 4</i>							
Education level		-.213	.218	.097	-.177	-5.551	.000
Age		-.012			-.160	-4.919	.000

Quarantine				.161		.092	2.873	.004	
UCLA LS3 ^c				.028		.319	10.043	.000	
<hr/>									
<i>Step 5</i>									
Education level				-.183	.267	.050	-.152	-4.901	.000
Age				-.010			-.131	-4.111	.000
Quarantine				.145			.083	2.673	.008
UCLA LS3				.016			.188	5.299	.000
DASS-21 ^d Depression				.038			.268	7.439	.000
<hr/>									
<i>Step 6</i>									
Educational level				-.186	.274	.007	-.154	-4.996	.000
Age				-.010			-.138	-4.349	.000
Quarantine				.148			.085	2.732	.006
UCLA LS3				.016			.187	5.302	.000
DASS-21 Depression				.055			.382	7.266	.000
DASS-21 Stress				-.021			-.146	-2.971	.003
<hr/>									
<i>Step 7</i>									
Education level				-.181	.280	.006	-.150	-4.870	.000
Age				-.010			-.138	-4.361	.000
Quarantine				.145			.083	2.692	.007
UCLA LS3				.016			.188	5.343	.000
DASS-21 Depression				.048			.335	6.062	.000
DASS-21 Stress				-.030			-.209	-3.834	.000
DASS-21 Anxiety				.020			.131	2.632	.009

Note. B: unstandardized coefficient; ΔR^2 : R square change; β : standardized regression coefficient.

^a Subjective Time Perception – Time Pressure; ^b Subjective Time Perception – Time Expansion/Boredom;

^c University of California, Los Angeles, Loneliness Scale-Version 3; ^d Depression Anxiety Stress Scales

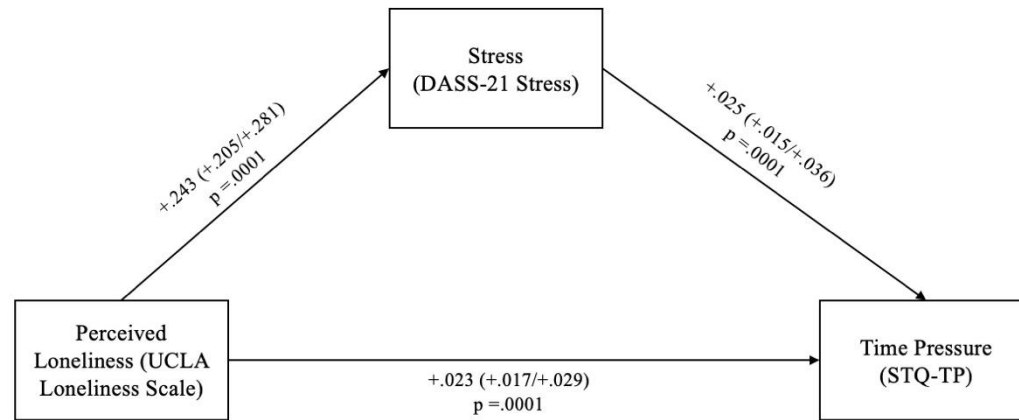


Figure 1. The mediation model hypothesized. The model tested the direct effect of the perceived loneliness (UCLA score in the Figure) on Time Pressure (STQ-TP score in the Figure), as well as indirect effects through the mediation role of stress (DASS-21 Stress).

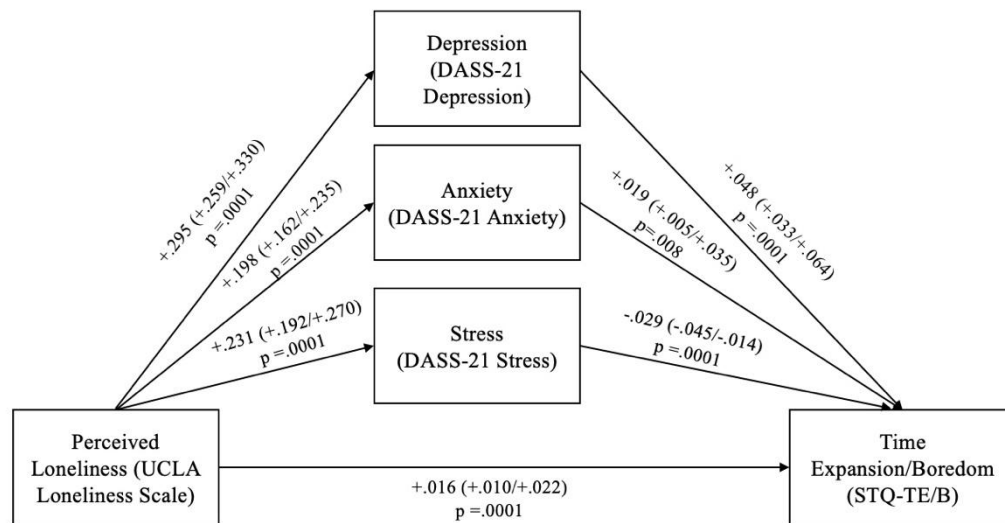


Figure 2. The mediation model hypothesized. The model tested the direct effect of the perceived loneliness (UCLA score in the Figure) on Time Expansion/Boredom (STQ-TE/B score in the Figure), as well as indirect effects through the mediation role of depression, anxiety and stress (DASS-21 Depression, DASS-21 Anxiety and DASS-21 Stress).