Social context and Loneliness in an epidemiological youth sample using the Experience Sampling Method (accepted version)

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Abstract

Background

Previous research has shown the relationship between loneliness and affect, as well as the relationship between trait loneliness and state loneliness. However, none has investigated how social context affects the association between loneliness and affect. The current study aims to examine the association between trait loneliness, state loneliness and momentary affects in different social contexts.

Methods

Participants aged 15–24 were randomly recruited from a Hong Kong epidemiological study to participate in an Experience Sampling Method (ESM) study. The group was divided in two based on the mean trait loneliness score (UCLA Loneliness Scale) at baseline. State loneliness, momentary positive (PA) and negative affect (NA) and social context were assessed using ESM. Multilevel logistic regression was used to analyze the association between momentary affect, state loneliness and trait loneliness in various social contexts.

Results

HL (high lonely) and LL (low lonely) groups consisted of 79 participants (44.6%) and 98 participants (55.4%) respectively. HL group had lower PA and higher NA, as well as a higher state loneliness than LL group. HL group had a lower state loneliness when being with intimate company compared to alone. LL group only had a higher PA when being with intimate company compared to non-intimate company and alone respectively.

Conclusion

Adolescents with high level of trait loneliness experienced higher PA, momentary loneliness and lower NA compared to those with low level of trait loneliness. The quality of social company is crucial in allowing one to experience different degrees of PA and momentary loneliness.

Introduction

Loneliness is viewed as an unpleasant experience that is defined as the discrepancy between the social relationships one desires and what one actually achieves, either quantitatively related to the number of social companies or the quality of the social interactions (Perlman & Perlau, 1981). Where it is common for humans to have an intrinsic need and desire to belong (Baumeister & Leary, 1995; Bavel et al., 2020), loneliness is especially apparent in adolescents and youths as their social expectations, roles, relationship and personal identities are substantially shifting in this period (Sippola & Bukowski, 1999). Unlike adults, adolescents and youths often spend less time with family and more time with peers (Larson, 1999), which alter social companionship and change their expectations on relationships. While they are in the midst of understanding their own personal identities, they might experience a higher discrepancy between what they hope for relationally and what actually occurs. As such, adolescence and youth is considered to be a time with high risk for loneliness.

Loneliness and Affect

A plethora of studies have shown the association between loneliness and both positive and negative affect across age groups (Best et al., 2021; Hawkley et al., 2007; Steptoe et al., 2011; Van Roekel et al., 2013). Loneliness was related with lower positive affect and greater distressed affect in elderly (Steptoe et al, 2011), in adults (Best et al., 2021), and in adolescents (Hawkley et al., 2007; Van Roekel et al., 2013), and was related to lower positivity and higher negativity in both the perception of the social company adolescents were with (Van Roekel et al., 2013), and their interaction quality (Hawkley et al., 2007). Hawkley et al. (2007) further attributed these differences to the disparity of social interactions. Lonely individuals might choose or draw interaction partners that are conducive to negative social exchanges, indirectly contributing to one's lower positive affect and higher negative affect. Perceptual bias of lonely individuals could play a part, in which similar social interactions could be perceived more negatively for them than their socially connected counterparts. Compared to lonely individuals, socially connected individuals might experience a stronger and more persistent spike in mood after positive social interactions, and a weaker or temporary decrease in mood after negative social interactions. This would explain the higher average positive affect and lower average negative affect in these individuals across one week. In short, loneliness is shown to be related to affect in the literature.

Loneliness and Social Context

Various research has also delineated the association between loneliness and being in different social contexts. In adolescents, they were shown to experience a higher level of state loneliness when they were alone, compared to being with company (Van Roekel et al., 2015). When they were in company, higher levels of loneliness were experienced at school and with classmates as opposed to with friends or family (Van Roekel et al., 2015). Apart from physically being in different social contexts, the appraisal of social companies also plays a part in one's experience of loneliness. In one study conducted using a female population, an increase in negative appraisal of social company and higher frequency of being alone predicted state loneliness (Van Winkel et al., 2017). Negative appraisal of social company was also correlated with higher frequency of being alone subsequently (Van Winkel et al., 2017). Similarly, adolescents with

higher levels of trait loneliness experienced higher level of negative affect when with social companies that were negatively appraised, and higher level of positive affect when with positive company (Van Roekel et al., 2013). In short, there is an association between loneliness and being with different social companies as shown in previous studies.

Momentary Loneliness

Numerous studies have shown the positive association between state loneliness and trait loneliness (McComb et al., 2020; Van Roekel et al., 2018). However, the differential reactivity hypothesis states that it is possible that loneliness is being sustained more in lonely individuals as they may respond differently to their environment compared to non-lonely individuals. This was supported in an adolescent study, where high lonely (HL) individuals experienced higher levels of state loneliness when they were alone compared to their low lonely (LL) counterparts (Van Roekel et al., 2018). In terms of the quality of the company, HL adolescents experienced less state loneliness when being with intimate company compared to being with non-intimate company, as opposed to LL adolescents, in which there was no significant difference in state loneliness between intimate and non-intimate company (Van Roekel et al., 2018). Hence, the quality of company does play a role in the positive association between state and trait loneliness.

Experience Sampling Method (ESM)

Experience sampling method (ESM) is a widely-adopted research methodology, and the aforementioned studies have all used ESM to investigate trait loneliness, state loneliness and social context, as it can accurately capture participants' subjective momentary experiences in everyday life (Csikszentmihalyi & Larson, 1987; Csikszentmihalyi et al., 1977; Myin-Germeys et al., 2018; Myin-Germeys & Kuppens, 2021; Shiffman et al., 2008). Compared to traditional cross-sectional or longitudinal research techniques, ESM offers several advantages that would be beneficial for the current study (Myin-Germeys et al., 2009). First, recall bias is minimized as ESM records the current experience of participants, participants do not have to rate their experiences retrospectively. Second, ecological validity is high as participants report their present experiences while physically being in them. Therefore, ESM would be an ideal methodology for this study, as it can measure accurately one's state loneliness, momentary affect and social context, and how they interact with trait loneliness.

As previous studies were conducted in an individualistic, western setting, loneliness level, as well as the experience of loneliness, may vary between individualistic and collectivistic cultures (Barreto et al., 2021), it is worth investigating the trait-state loneliness and loneliness-affect phenomena in a different setting, namely a collectivistic, non-western society, and observe whether it is replicable across cultures. Furthermore, studies have shown the relationship between trait loneliness and momentary affect, loneliness and social contexts, as well as trait and state loneliness. However, a three-level interaction between trait loneliness, affect and social contexts has yet to be investigated, namely how one's trait loneliness level influences one's affect in different social contexts remains unknown.

Therefore, the aims of this study are to investigate the possible association between loneliness and momentary positive and negative affect in various social contexts, and the possible association between trait loneliness and momentary loneliness in a collectivistic, non-western society. The hypotheses are as follows: (1) the high lonely group will have lower momentary positive affect and higher momentary negative affect than the low lonely group; (2) the high lonely group will have a higher momentary loneliness than the low lonely group; (3) when being with intimate company, the high lonely group will have the highest positive affect and lowest negative affect followed by being with non-intimate company, followed by alone (lowest positive affect and highest negative affect), whereas the low lonely group will have a similar phenomenon, albeit not as pronounced.

Method

Subjects

Participants in this study were recruited to the sub-phase study of Experience Sampling Method (ESM) from the Hong Kong Youth Epidemiological Study of Mental Health (HK-YES) from Dec 3 2019 to Jan 9 2021. The HK-YES is a population-based study which employed a multistage stratified design and randomly recruited young people aged 15-24 living in Hong Kong (Wong et al., under review). During the baseline interview, participants' sociodemographic, psychosocial and environmental characteristics, as well as general functioning, quality of life and level of distress were assessed by trained research assistants using rater-administered instruments. Participants were randomly recruited to the ESM phase after the baseline interview. Ethical approval was obtained from the Institutional Review Board of the University of Hong Kong/ Hospital Authority Hong Kong West Cluster. Informed consents were obtained from all participants and from their parents or legal guardians of those who were under the age of 18 at the time of recruitment.

Procedures

Prior to the ESM phase, research assistants conducted briefing sessions to ensure the participants understood the purpose and the procedures of the study. Participants who consented to join the study were given a smartphone (Nokia 6.1) pre-installed with "mobileQ" (https://mobileq.org/), a free, open-source ESM software developed by KU Leuven (Meers et al., 2020). The trial session was also administered to provide participants training in the study conduct.

ESM assessments

The sub-phase study lasted for 6 consecutive days, participants were prompted by an electronic signal (beep) to complete self-reported questionnaires, ten times per day within 12 hours (set according to participant's bedtime), with a semi-random schedule. Each set of questionnaires lasted approximately two minutes, and participants had to respond to the prompt within 90 seconds, after which it expired. The minimum amount of time between consecutive signals was set to 60 minutes. At each signal, participants were asked to answer a series of ESM items, most of which were rated on a 7-point Likert scale (1 = not at all; 7 = very much). The remainder were context-based questions concerning the location and social context of that moment, for

which the participants were asked to select from a list of options. The same set of questionnaires was used throughout the study period.

Loneliness

Both trait loneliness and state (momentary) loneliness were assessed in this study. Trait loneliness was measured with the 20-item UCLA Loneliness Scale (Russell, 1996) at the baseline interview. The scale was rated on a 4-point Likert scale (1 = Never; 4 = Often). The total score was calculated by summing all 20 items after accounting for reversed items. The scale was shown to have high internal consistency (α=0.89 to 0.94) and high test-retest reliability (r=0.73) in previous studies (Russell, 1996), as well as high internal consistency for the current study (α=0.90) For the present study, the sample was split into two groups, in which participants scored 44 and above were defined as "high lonely group" and those scored below 44 were classified as "low lonely group". The score of 44 was used as a cutoff, as this is the median score of the UCLA Loneliness Scale in this study (mean=43.64; SD=8.65; with a range between 20 to 68). State loneliness was assessed with the item in ESM assessment ("I feel lonely") on a 7-point Likert scale (1 = not at all; 7 = very much).

Affect

Affective states were assessed with four positive affect items ('I feel cheerful', 'I feel satisfied', 'I feel relaxed', and 'I feel excited') and three negative affect items ('I feel irritated', 'I feel anxious', and 'I feel sad') on a 7-point Likert scale (1 = not at all; 7 = very much). Each participant's positive and negative affect scores were generated by calculating the mean of the four positive affect items and the three negative affect items respectively.

Social context and related stress

Ten social items were used to assess the social environment and momentary stress induced in everyday life. Participants were asked to indicate if they are alone or in company with "Who is with me?" (family, friends, relatives, classmates/colleagues, teachers/supervisors, strangers, alone). These categorical items (except for "alone") were then further grouped into intimate (i.e. family, friends and relatives) and non-intimate company (i.e. classmates/colleagues, teachers/supervisors and strangers).

Control variables

Age, gender, total years of education, momentary loneliness and depressive symptoms (using the depression subscale of the Depression Anxiety Stress Scale (DASS; Lovibond & Lovibond, 1995)) were controlled and adjusted in the models. They were selected as they potentially play a role in impacting the relationship between trait loneliness, affect and social context, as well as their respective level, and may pose as confounds.

ESM data processing and data analysis

Various data processing and cleaning procedures were performed prior to analysis, and entries were excluded accordingly (McCabe et al., 2012). First, entries with a mean completion time of fewer than 10 seconds (<0.5 seconds for each item) were classified as a non-compliant response (i.e., the participant tapped the answers without regard to the options to complete the

self-report in a speedy manner). Second, reports on which more than 90% of entries were identical were classified as invalid trials (Christensen et al., 2003). Third, participants who completed fewer than 80% of the data points (<48 self-reports out of 60) among the items of affect and symptom were classified as low compliance.

Analysis of the ESM data was performed using multilinear regression modeling (Fleeson, 2007). The ESM data have a hierarchical structure because multiple momentary observations (within-person level) are nested within participants (between-person level). Multilevel linear regression analyses were first conducted with affect (positive affect and negative affect in separate models) and momentary loneliness as the dependent variable and the measure of trait loneliness using a categorical group status (0 = LL group, 1 = HL group) as the independent variables. The models were then further adjusted for the control variables above. Finally, an interaction term (Social company × loneliness group) was added as an independent variable to examine whether the group moderated emotional reactivity and momentary loneliness to different social companies. Statistical analyses were conducted using the R 4.1.0.

Results

Participant characteristics

177 participants were recruited to take part in this ESM study, in which 79 of them (44.6%) were categorized as the high lonely group and 98 (55.4%) were categorized as the low lonely group. There was no significant difference in age, sex and total years of education between the ESM sample and the whole HK-YES sample. After data processing using procedures aforementioned, a total of 3064 (out of 12240 trials) was deemed to be invalid, while 698 trials was deemed to be quick completion, and 24 participants were rated as low compliant. All of them were excluded in the analysis. The mean completion time of included participants is 32.77 (ranging from 10.40 to 332.40 seconds), while the mean compliance rate is 82.4% (49.44 out of 60 trials; ranging from 33.33% to 100% or 20 to 60 trials). **Table 1** depicts the sociodemographic, residential and clinical characteristics of the sample. The mean age for this sample was 19.90 (SD=2.76). Around two-third of the sample were female (61%) and most of the participants had an upper secondary education or above (92.1%). The mean depressive score (as measured by DASS-D) is 6.03 (SD=6.57), ranging from 0 to 28. There were no significant differences of age, gender, years of education, education level, employment status and living situation found between lonely groups. However, HL group has a significantly higher depressive score (as measured by DASS-D) and loneliness score than LL group.

Momentary Positive Affect and Momentary Negative Affect

The mean of momentary positive and negative affect are 3.15 (SD=0.98) and 1.71 (SD=1.85) respective, with both range from 1 to 7. **Table 2** lists the effects of variables on momentary positive affect and momentary negative affect. For positive affect, there was a significant difference between HL and LL groups, in which participants in HL group were more likely to experience less momentary positive affect than those in LL group (b=-0.21, p<0.001). Similarly, participants in HL group were more likely to experience higher negative affect than their counterparts in LL group (b=0.13, p=0.017).

Momentary Loneliness

The mean of momentary loneliness is 1.57 (SD=1.18) with a range from 1 to 7.The difference in momentary loneliness between HL group and LL group is also listed in **Table 2**. HL group was more likely to experience higher momentary loneliness than the LL group (b=0.27, p<0.001), evident in all three social contexts shown in post-hoc (**Table 3**). Further analysis was carried out to examine momentary loneliness between different social companies in each lonely group (**Figure 1**). Being with non-intimate company had significantly higher momentary loneliness compared to being with intimate company and alone (b=0.11, 95% CI [0.004, 0.22], p=0.041). There was also no significant interaction between loneliness group and social company on momentary loneliness (p>0.05). No significant differences in momentary loneliness could be found in both lonely groups across different social companies except for being with intimate company (including family, friends and relatives) and being alone in the HL group (mean difference=0.12, p<0.001), where being with intimate company resulted in lower momentary loneliness compared to being alone.

Momentary Affect in Different Social Company across Lonely Groups

Multilevel logistic regression analysis revealed similar results in the models of both momentary positive and negative affect (**Table 3**). For positive affect, participants when alone experienced less positive affect compared to being with non-intimate and intimate company (b=-0.12, 95% CI [-0.16, -0.08], p<0.001). Similarly, when being with non-intimate company, they experienced less positive affect compared to being with intimate company and alone (b=-0.16, 95% CI [-0.23, -0.09], p<0.001). However, there was no significant interaction between loneliness group and social company on positive affect (p>0.05). Specifically, the LL group experienced a significantly higher positive affect than HL group when being with intimate company and when being alone (mean difference=0.20, p<0.001; mean difference=0.24, p<0.001). However, when being with non-intimate company (including classmates/colleagues, teachers/supervisors and strangers), no difference was observed between groups (mean difference=0.13, p=0.099).

For negative affect, there was no significant main effect of social company, as well as the interaction between loneliness group and social company (p>0.05). However, an opposite effect was found in negative affect compared to positive affect in post-hoc, where HL group experienced a significantly higher negative affect than LL group when being with intimate company, and alone (mean difference=0.14, p=0.003; mean difference=0.12, p=0.02), but not when being with non-intimate company (mean difference=0.09, p>0.05)

When comparing momentary affect between different social companies in each lonely group separately, no significant differences in negative affect can be observed across, and it is consistent across both lonely groups (**Figure 1**). However, for momentary positive affect, in the LL group, being with intimate company is related to a significantly higher positive affect than both non-intimate company (b=0.16, p<0.001) and alone (b=0.12, p<0.001), but the same cannot be said when comparing being with non-intimate company and alone (b=0.04, p=0.284). In the HL group, there was only a significant difference between being with intimate company and being alone, where being with intimate company had a higher positive affect than being alone (b=0.15, p<0.001), no other differences between social companies can be observed.

Discussion

The current study examined the association between trait and momentary loneliness, momentary affect and social contexts in adolescents using ESM. Results showed that HL adolescents had lower momentary positive affect and higher momentary negative affect than LL adolescents. In terms of momentary loneliness, HL adolescents significantly experienced higher state loneliness than those in the LL group. When examining different social companies, the results offered a different picture from what we hypothesized. Only differences between social companies were observed in momentary positive affect and momentary loneliness, not in momentary negative affect. Young people feeling less lonely had the highest positive affect when they were with intimate company compared to with non-intimate company, and alone. Those who felt lonelier experienced a higher positive affect and lower momentary loneliness when they were with intimate company compared to being alone. There were no differences in both positive affect and momentary loneliness when comparing being with non-intimate company with either being alone and with intimate company.

Lower momentary positive affect and higher momentary negative affect found in HL adolescents is in line with previous related studies either using the ESM method (Hawkley et al., 2007; Steptoe et al., 2011; Van Roekel et al., 2013) or with cross-sectional measures (Aanes et al., 2009; Best et al., 2021; Forbes et al., 2004; Joiner, 1997; Larsen & Ketelaar, 1991; Mehrabian & Stefl, 1995). One of the reasons for this is that loneliness, itself seen as unpleasant (Perlman & Peplau, 1981), is normally associated with experiences that evoke high negative affect and low positive affect. Loneliness was shown to highly correlate with neuroticism, which is also related to negative affect (Abdellaoui et al., 2019; Ikizer et al., 2022; Larsen & Ketelaar, 1991). Therefore, adolescents with higher loneliness would experience higher momentary negative affect and lower momentary positive affect.

Likewise, higher state loneliness that was experienced by HL participants can be seen in other studies (Hector-Taylor & Adams, 1996; Van Roekel et al., 2018), in which high correlation can be found on state and trait loneliness scores. As high level of trait loneliness would indicate that feelings of loneliness are part of one's personality and characteristics, and one would attribute this feeling to who they are, it could be assumed that the feeling will permeate and affect one's level of loneliness at every moment. Hence, the effect of different environments and experiences is negligible on these individuals in influencing their high level of state loneliness.

The finding that HL adolescents experienced lower positive affect when being alone compared to being with intimate company, but no differences between being with non-intimate versus intimate company and versus alone, may suggest that they treasure the quality of the company. The level of satisfaction and sense of belonging vary depending on who one is with, where one would enjoy being with intimate company more than being with non-intimate company. Interestingly, LL adolescents experienced a significantly higher positive affect with intimate company than with non-intimate company, which could not be found in HL adolescents. This indicates that quality of company plays a more influential role in LL adolescents compared to their HL counterparts. The fact that there was no significant difference between being alone and

being with non-intimate company in LL adolescents may imply that the level of enjoyment these adolescents have in those two instances were the same. Being with people would not necessarily induce a positive experience, only being with people one is close with will. This corresponds to the idea that loneliness is independent of social isolation, where being socially isolated does not necessarily induce loneliness, and being with people can still allow one to feel lonely (Bamps et al., 2022; Tam & Chan, 2019). This explains why when HL adolescents were alone, they experienced lower positive affect compared to being with intimate company, but not when being with non-intimate versus intimate company and versus alone.

Results that showed HL adolescents experiencing a bigger difference in positive affect between being alone and being with intimate company compared to LL adolescents were in line with related studies, in that lonely adolescents benefited more from being with intimate or positively-perceived company compared to non-lonely adolescents (Van Roekel et al., 2013, Van Roekel et al., 2018). This suggests a stronger desire or craving for social connection and intimacy in HL adolescents compared to LL adolescents. One study examined the role of ventral striatum (VS) in loneliness and discovered that stronger feelings of loneliness were linked to lower ratings of one's feelings of connection, as well as greater neural activity in the VS when lonely individuals viewed images of their close ones, sugggesting its role for "social craving" (Inagaki et al., 2016). Hence when lonely adolescents have their desire for social connection fulfilled by being with intimate company, their difference in positive affect between being alone and with intimate company will be greater than non-lonely adolescents.
In general, the results from the current study, which was conducted in a collectivistic, non-western setting, could replicate those from previous studies that utilized western study sample. This would indicate that the trait-state loneliness and loneliness-affect relationships are cross-cultural, and the phenomena are not specific to one cultural setting.

However, some results from the current study could not replicate those of previous related studies. For instance, one study revealed that adolescents with more depressive symptoms experienced a lower negative affect and higher positive affect when being with company they perceived as intimate (Brown et al., 2011). Although similar patterns regarding the differences in positive affect could be found in the current study, patterns in negative affect were different. The discrepancy might be due to the disparity between constructs of trait loneliness and depression, where differences between negative affect can be detected in participants with depressive symptoms but not in one with various loneliness levels. This might imply that negative affect is more stable and does not change drastically between different social companies, unlike positive affect, where changes are detectable. Another explanation could be that there was possible response bias when using self-report measures of negative affect, such as ESM (Bardwell & Dimsdale, 2001). Negative affect states might be masked by participants to present oneself as socially acceptable (Bardwell & Dimsdale, 2001).

Similarly, results regarding momentary loneliness could not fully replicate those of previous studies. One study showed a higher level of state loneliness in non-lonely adolescents when being alone compared to when being with intimate company as well, and in lonely adolescents when being with non-intimate company compared to intimate company (Van Roekel et al.,

2018). This might be partially related to the insignificant results found in momentary negative affect, as state loneliness is associated with an unpleasant feeling at the moment, hence is intertwined with emotional negativity.

Strengths, Limitations and Suggestions for Future Research

The present study utilized the ESM method, in which bias that could potentially arise from retrospective reporting could be minimized, as well as changes in mood, physical and social contexts could be tracked throughout the day, allowing for a more accurate depiction of one's response compared to a traditional cross-sectional design. Also, the sample was recruited randomly from a community-based study, in which they are representative of the population, ranging from healthy participants to those suffering from psychological distress, providing a full picture of the phenomenon, and adding strength to the current study.

However, there were few limitations to note. First, the grouping of intimate and non-intimate companies is entirely based on the assumption that one is intimate with family, friends and relatives and not intimate with classmates/colleagues, teachers/supervisors, and strangers. It is completely plausible that one is not close to their relatives but deems their classmates/colleagues as an intimate relationship, in which the role of different social companies on the interaction between trait loneliness and momentary affect will be inaccurate Further research can include an additional question to clarify the extent of intimacy one has with the people they are currently with to allow for a more accurate outcome. Second, the item "Who is with me?" only allowed for a single-choice response. It is possible that the person the participant is with has multiple identities in relations to the participant (e.g. is both a friend and a classmate). The current study relied on the interpretation of the participant in judging the identity of his/her company. It is also possible that the participant was with both groups of social company (e.g. with both family and classmates), and there is no way to ascertain the number of occurrence of these two possibilities, which would also affect the accuracy of examining the role of different social companies on trait loneliness and momentary affect. Further studies can clarify in the question for participants to choose the primary identity they regard the company as, or simply allow for an option for multiple choice. Third, the current study was conducted during the COVID pandemic, in which everyone's lifestyles were drastically changed, with lockdowns implemented, schools were shut down and people working from home. Hence, the time spent with various social companies would be different compared to before COVID, so would one's affect when being with social company, resulting in different and possible incomparable findings from pre-COVID times. Adolescents could experience a higher positive affect when being with social company compared to before COVID after staying at home for an extensive period of time. Further research can replicate the current study and compare the current phenomenon between COVID times and post-COVID times.

For future studies, one can take into account the various activities one is conducting with different social companies. The amount of exercise and physical exertion might be a significant predictor of one's affect in relation to their loneliness level, and the people they do it with might play a role as well. Also, the idea of solitude can be further explored as well. As some people choose to be alone for purposes such as meditation and reading, and might actually induce a

higher positive affect and lower negative affect. People with different personalities such as introversion might enjoy being alone, and similarly would have a higher positive affect when compared to being forced to interact with people. The idea of enjoying being alone may differ from people who have high level of loneliness and low level of loneliness. Furthermore, it is worth investigating the relationship between state loneliness and momentary affect, and how it is influenced by various social context, as the interaction and trajectory between state loneliness and momentary affect at each timepoint would be noteworthy and could provide new insight to the phenomenon. As social media and electronic devices are becoming more and more prevalent nowadays, the usage of these leading to possible social withdrawal from company and social isolation, and whether this affects one's loneliness level and momentary affect could be an interesting phenomenon to further investigate (as discussed in studies such as Green et al. (2020), Kliestik et al. (2020), Lazaroiu et al. (2020) and Porter et al. (2020)) . Nonetheless, the current study provides insights regarding the importance of the quality of social company and the influence being with intimate company has in allowing one (especially individuals more prone to loneliness) experience positive affect, as well as supporting the existent findings in the literature regarding the loneliness-affect, trait-state loneliness and loneliness-social context phenomena. This may pave a way to providing a suitable intervention for lonely people in terms of effective social support, where they are encouraged to be in close physical proximity with positively-appraised, intimate company for one to experience higher positive affect.

Author contributions

WCY Tang, CSM Wong and EYH Chen conceptualized and designed the study. CSM Wong contributed to the acquisition of data and oversaw data analysis. WCY Tang and TY Wong conducted data cleaning and data analysis. WCY Tang and CSM Wong interpreted the results and wrote the first draft of the manuscript. All authors contributed to the interpretation of results, contributed to the revision of manuscript drafts, reviewed and approved the final manuscript.

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Declaration of competing interest

The authors declare that they have no competing interests.

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Table 1. Comparison of sociodemographic characteristics between high lonely and low lonely group (n=177)

	High Lonely (n=79)	**Low Lonely (n=98)**	
Variable	Mean±SD / n(%)	Mean±SD / n(%)	Sig.
Age	20.1±2.5	19.7±2.8	0.291
Gender			0.709
Male	32 (40.5)	37 (37.8)	
Female	47 (59.5)	61 (62.2)	
Years of education	13.7±2.3	13.5±2.4	0.535
Level of education			0.507
No schooling or primary	1 (1.3)	0 (0.0)	
Lower secondary	4 (5.1)	9 (9.2)	
Upper secondary	46 (58.2)	54 (55.1)	
Post-secondary	28 (35.4)	35 (35.7)	
Being employed			0.126
Yes	43 (54.4)	42 (42.9)	
No	36 (45.6)	56 (57.1)	
Living Situation			0.105
Living alone	4 (5.1)	0 (0.0)	
Living with one other person	11 (13.9)	6 (6.1)	
Living with two other people	22 (27.8)	27 (27.6)	
Living with three other people	26 (32.9)	42 (42.9)	
Living with four other people	10 (12.7)	15 (15.3)	
Living with five other people	6 (7.6)	8 (8.2)	
Depressive symptoms (DASS-D)	13.8±9.6	4.9±5.2	**<0.001**
Loneliness (UCLA)	51.5±5.1	37.3±5.0	**<0.001**

DASS = Depression Anxiety Stress Scales (D-Depression); UCLA = UCLA Loneliness Scale

Table 2. Different effects on momentary positive affect, momentary negative affect and momentary loneliness (n=177)

Positive Affect					Negative Affect					Momentary Loneliness				
	b	SE	Sig.	Adj. Sig.[a]		*b*	SE	Sig.	Adj. Sig.[a]		*b*	SE	Sig.	Adj. Sig.[a]
Intercept	1.95	0.22	<0.001	**<0.001**	Intercept	-0.12	0.17	0.465	0.465	Intercept	0.68	0.23	0.003	**0.005**
Age	-0.04	0.02	0.022	**0.041**	Age	-0.01	0.01	0.465	0.465	Age	-0.05	0.02	0.027	**0.041**
Sex (female)	-0.15	0.06	0.008	**0.023**	Sex (female)	0.01	0.04	0.861	0.861	Sex (female)	-0.1	0.06	0.088	0.132
Total years of education	0.02	0.02	0.310	0.310	Total years of education	0.02	0.02	0.257	0.310	Total years of education	0.04	0.02	0.048	0.144
Momentary loneliness	-0.008	0.01	0.227	0.227	Momentary loneliness	0.16	0.01	<0.001	**<0.001**	Momentary loneliness	/	/	/	/
Depressive symptoms (DASS_D)	-0.0003	<0.001	0.131	0.243	Depressive symptoms (DASS_D)	<0.001	<0.001	0.646	0.646	Depressive symptoms (DASS_D)	-0.0003	<0.001	0.162	0.243
Lonely group	-0.21	0.06	<0.001	**<0.001**	Lonely group	0.13	0.05	0.017	**0.017**	Lonely group	0.27	0.07	<0.001	**<0.001**
Time	-0.002	<0.001	<0.001	**<0.001**	Time	<0.001	<0.001	0.885	0.885	Time	-0.0007	<0.001	0.363	0.544
Lonely group x Time	<0.001	<0.001	0.999	0.999	Lonely group x Time	<0.001	0.001	0.985	0.999	Lonely group x Time	-0.0003	0.001	0.789	0.999
DASS = Depression Anxiety Stress Scales (D-Depression)					DASS = Depression Anxiety Stress Scales (D-Depression)					DASS = Depression Anxiety Stress Scales (D-Depression)				

[a] The *p*-values of the three models (between model) are adjusted for using the false discovery rate (fdr)

Table 3. Comparison of momentary positive affect, momentary negative affect and momentary loneliness in different social company between high lonely and low lonely group (n=177)

	Positive Affect			Negative Affect				Momentary Loneliness			
	High Lonely (n=79) Estimated Mean±SE	Low Lonely (n=98) Estimated Mean±SE	Sig.		High Lonely (n=79) Estimated Mean±SE	Low Lonely (n=98) Estimated Mean±SE	Sig.		High Lonely (n=79) Estimated Mean±SE	Low Lonely (n=98) Estimated Mean±SE	Sig.
Intimate	1.02±0.04	1.22±0.04	**<0.001**	Intimate	0.29±0.03	0.15±0.03	**0.003**	Intimate	0.48±0.05	0.25±0.04	**<0.001**
Non-intimate	0.94±0.06	1.07±0.05	0.090	Non-intimate	0.32±0.06	0.23±0.06	0.243	Non-intimate	0.56±0.06	0.36±0.06	**0.023**
Alone	0.87±0.04	1.11±0.04	**<0.001**	Alone	0.26±0.04	0.14±0.04	**0.020**	Alone	0.60±0.05	0.30±0.04	**<0.001**

Intimate = Family, Friends, Relatives; Non-intimate = Classmates/colleagues, Teachers/supervisors, Strangers

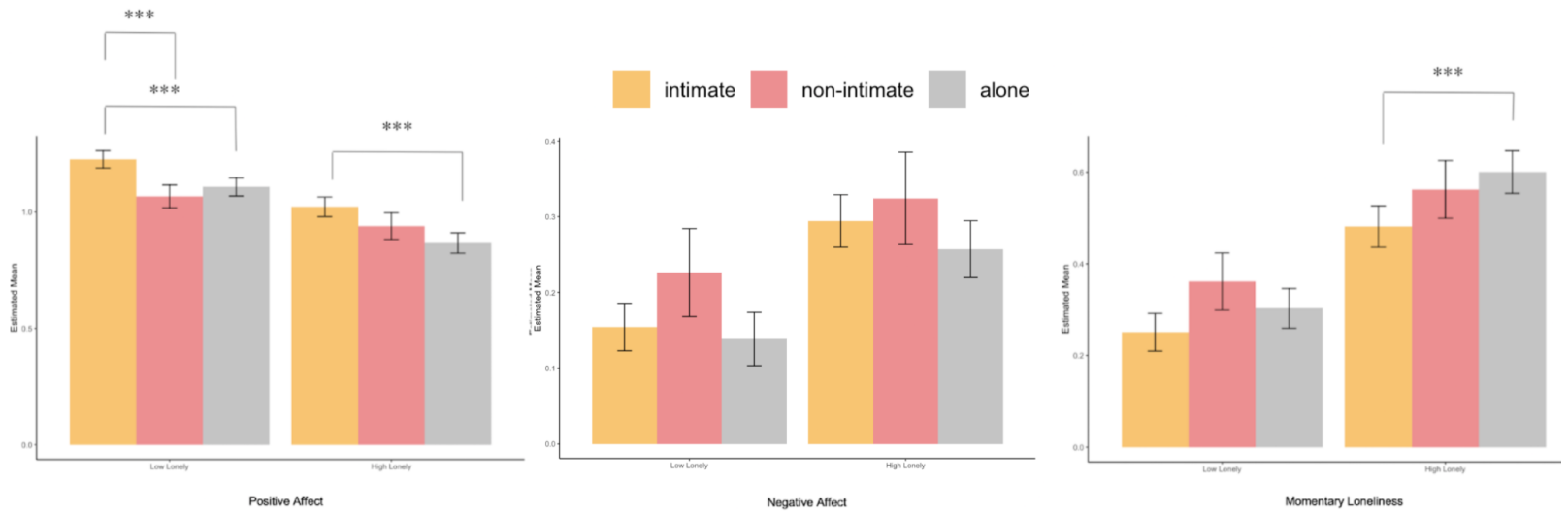

Fig 1. Comparison of momentary positive affect, momentary negative affect and momentary loneliness in low and high lonely groups between different social companies (***$p < .001$)