Exploring the Impact of Pleasantness of Daily Activity and Frequency of Being with Others on Prolonged Grief Disorder Symptoms: A Study Using Experience Sampling Methodology

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Abstract

Introduction: Current research shows that engagement in pleasant activities has a positive impact on mental health. Examining the association between the pleasantness of daily activity and Prolonged Grief Disorder (PGD) may expand the field. Considering the frequency of being with others during activities might influence this relationship since evidence suggests that social support benefits those who cope with PGD symptoms. *Methods:* A combination of Experience Sampling Method (ESM) and interviews was used, to gather data about participants' daily experiences and PGD symptoms in their natural environment. Participants (N = 50) were recruited from websites related to bereavement and social media. These participants had lost a loved one, mostly due to natural causes. To test the hypotheses, a moderation analysis was performed. *Results*: There was a significant negative association between the pleasantness of daily activities and PGD symptoms (B = -0.22, t(46) = -2.55, p = 0.01). Thus, the more pleasant the activities were, the lower the reported PGD symptoms. However, the amount of frequency individuals were in the presence of others was not significantly associated with PGD symptoms (B = -0.21, t(46) = -0.99, p = 0.33), and did not moderate the relationship between pleasantness of daily activity and PGD symptoms (B = -0.21, t(46) = -0.99, p = 0.33). *Discussion*: This study offers insights into how the pleasantness of daily activity and frequency of being with others affect PGD symptoms. The findings suggest that engaging in activities perceived as pleasant might help with alleviating PGD symptoms, regardless of whether or not other people are present during this activity. Nevertheless, it is recommended to conduct future research.

Keywords: Prolonged grief, being with others, experience sampling methodology, daily activity, pleasantness, bereavement

Introduction

Losing a loved one is a universal aspect of life which can be incredibly challenging. The way people experience grief can be different for everyone and can vary in intensity and duration across different cultures and individuals (Zisook & Shear, 2009). In literature, the terms “bereavement” and “grief” are often used. “Bereavement” refers to the experience of the loss itself, while “grief” includes the emotional, cognitive, functional, and behavioural responses triggered by the death (Zisook & Shear, 2009). Typically, grief is most intense immediately after a loss and gradually diminishes over several months (Prignerson et al., 2021).

While many individuals navigate the period of grief without major problems, some struggle with intense grief reactions for a long time (Nielsen et al., 2019; Prigerson et al., 2021). If these grief reactions continue to significantly disrupt daily life for at least a month beyond the first year of bereavement, the individual may be diagnosed with Prolonged Grief Disorder (PGD) (American Psychiatric Association, 2022). Over time, different sets of criteria have been identified, for grief-related symptoms (Lenferink et al., 2021). The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision (DSM-5-TR) now includes PGD as a recognized condition (American Psychiatric Association, 2022). Symptoms of PGD include, but are not limited to, deep yearning (a strong desire to be reunited with the deceased, which causes both emotional and physical suffering (Prigerson et al., 2009)), emotional pain, and disbelief about the loss. Individuals with PGD symptoms might struggle to accept what happened, avoid anything that reminds them of their loved one, feel lonely, and question the meaning of life or their own identity. (Maccallum & Bryant, 2018, 2019). PGD affects 10% of naturally bereaved individuals (Lundorff et al., 2017).

Bereaved individuals commonly withdraw from social and daily activities, resulting in limited opportunities to confront negative emotions, while this confrontation is crucial in the process of grief. This withdrawal worsens feelings of grief because confronting these emotions is important in healing (Eisma et al., 2015). Participation in daily activities might be helpful for these individuals since the perceived pleasantness during these activities might result in the expression of a positive mood and improved mental health (Ferreira et al., 2015). Several activities such as cooking, dating, sports, playing instruments, reading, and volunteering have been proven in studies by Kreiss & Schnell (2022) to be both meaningful and pleasant to individuals. Meaningful activities are things that people do in their lives that

help shape who they are as individuals (Cruyt et al., 2023). For example, engaging in outdoor activities serves as a distraction from overwhelming emotions and evokes cherished memories, in turn enhancing the pleasantness of the activity (Derksen, 2016). Activities like watching a movie or eating fast food trigger the brain's reward system, releasing feelings of satisfaction, which enhances positive mood (Kreis & Schnell, 2022). Moreover, participation in physical activity has been shown to diminish symptoms of depression, anxiety, and post-traumatic stress disorder (PTSD) (Williams et al., 2021). In addition, physical activity helps with emotional expression and a distraction from grief by allowing bereaved individuals to manage their emotions and experience moments of relief and positivity (Williams et al., 2021). Emotional expression is a coping strategy to process and express emotions, which potentially reduces PGD symptoms (Eisma et al., 2023). Thus, engaging in various activities has been shown to improve mental health, such as fewer depressive and PTSD symptoms (Williams et al., 2021; Ferreira et al., 2015). However, there is limited research that examined the relationship between daily activities and PGD symptoms. This gap in research extends to the pleasantness of daily activities and its impact on PGD symptoms.

Whether a daily activity is perceived as pleasant may partially relate to whether another person is present or not during the activity (Jarosz, 2022). The microsociological theory of adjustment to loss, created by Maciejewski et al (2022), emphasizes the importance of social interaction. According to this model, losing a loved one may lead to social loss. This leads to a void where social needs remain unmet. While engaging with others might fill this void, leading to fewer PGD symptoms and an increase in social connection and well-being, regulating emotions during grief is reliant on interpersonal processes (Maciejewski et al., 2022). Exchanges with other people are said to shape experiences of bereavement, influencing how bereaved individuals manage and perceive their grief (Ratcliffe & Byrne, 2021). However, research from Eisma et al. (2015) mentioned that withdrawal from social activities is common among bereaved individuals. This withdrawal has been associated with a higher risk of exacerbating or developing grief symptoms. Therefore, encouraging bereaved individuals to take part in pleasant daily activities, particularly those that involve other individuals, may help reduce negative thoughts and enhance positive mood, potentially reducing PGD symptoms (Eisma et al., 2015; Maciejewski Et al., 2022). Although previous research underscores the importance of interpersonal relationships, engagement in activities, and the broader social context in struggling with grief, there is a lack of studies examining the

relationship between the pleasantness of daily activities, frequency of being with others, and PGD symptoms.

To partially fill this gap in research, this study aimed to answer the following research question: “To what extent is the pleasantness of daily activity associated with PGD symptoms, and does this association vary depending on the frequency of being with others?” Based on prior literature (Jarozs, 2022; Williams et al., 2021; Eisma et al., 2015), it was hypothesized that; bereaved individuals who report lower levels of pleasantness in daily activity, regardless of the type of activity, report higher levels of PGD symptoms than those who report higher levels of pleasantness in daily activity. Moreover, it was expected that the influence of the frequency of being with others during daily activities would moderate this association. Specifically, it was expected that the amount of frequency of being with others during daily activity would strengthen the association between pleasantness of daily activity and PGD symptoms. To test these hypotheses, data from Experience Sampling Methodology (ESM) and interviews were analysed.

Method

Procedure

Previous research shows that PGD symptoms change over time on a daily basis (Lenferink et al., 2023). Traditional methods use surveys and interviews that are measured at one-time intervals to assess PGD symptoms. These methods often fail to capture changes due to recall bias, which is a phenomenon in which emotions experienced during an event do not match the feelings evoked by the associated memory (Colombo et al., 2020); for example, the intense sadness experienced after losing a loved one may be remembered less intensely or more intensely sometime later (Colombo et al., 2020). In contrast, ESM offers a more robust method to monitor symptoms, by recording symptoms in real-time, providing insight into how symptoms change in daily life and how contextual factors relate to these changes (Lenferink et al., 2022a). Moreover, ESM introduces new opportunities for treatment by incorporating interventions into daily routines. Nevertheless, it is important to acknowledge that ESM has its concerns, such as the potential burden on participants. Specifically, participants might experience the completion of multiple assessments per day as more difficult, particularly when assessments are too frequent, too long, or if items are perceived as irrelevant (Lenferink et al., 2022a). Reactivity effects are another concern in ESM research. To elaborate, participants may experience an increase in symptomatology due to constantly being reminded of their symptoms. Other potential concerns are difficulties in maintaining high compliance and retention rates (Lenferink et al., 2022a).

This study uses a secondary analysis of data collected by Lenferink et al (2022a). Data collection occurred between January and March 2022, individuals were recruited through bereavement-related websites and social media. The data collection process comprised three stages: Time point 1 (T1), the ESM phase, and Time point 2 (T2). Firstly, participants were asked to give informed consent. When participants gave consent, T1 could begin. Master-level psychology students, who were trained interviewers, contacted the participants to schedule a telephone interview. The length of the interviews in T1 was approximately 47 minutes. Participants were screened based on inclusion and exclusion criteria in the T1 interview. Subsequently, participants were asked to download the application Ethica on their smartphones, as this application was needed to collect ESM data. Participants received an email containing a video tutorial illustrating the installation and operation of the application for the subsequent ESM phase.

The ESM phase lasted a total of 14 days. During this phase, participants received five daily notifications prompting them to complete a brief survey. These surveys, typically comprising 20+ items, included inquiries about their PGD symptoms, daily activities, whether they engaged in these activities alone, with one other, or with multiple others, and their subjective pleasantness of the activity. The surveys contained questions such as “In the past 3 hours, what activity did you spend the most time on?”, and usually took 1-2 minutes to complete. For details regarding the development process of the ESM items see Lenferink et al. (2022a). All notifications were sent at semi-random time intervals, the first one being sent between 8.30 and 9.30 AM. Subsequent notifications were sent every three hours: between 11:30 AM - 12:30 PM, 2:30 - 3:30 PM, 5:30 - 6:30 PM, and 8:30 - 9:30 PM. Each survey had to be completed within 60 minutes. If participants did not respond to the notification, a reminder was sent after 10 and 20 minutes. If participants were found to miss more than half of the surveys in a day (i.e., > 3 surveys), they were contacted by interviewers by telephone or email to encourage future participation.

The second interview (T2) was arranged within two days after the ESM phase. In this interview, similar to T1, the PGD symptoms of the bereaved individuals were measured over the last two weeks. Upon completion of T2, participants had the opportunity to enter a €50 lottery. In this study, only the outcomes of T2 and ESM were used. The Ethical Committee of the University of Twente (number: 240816) gave ethical approval.

Participants

This study is part of the Grief in Daily Life (Grief-ID) project, which focuses on understanding and addressing PGD symptoms in daily life. The sample consisted of participants who had lost a loved one, such as a partner, family member, or friend at least three months before participating in the study. To participate, individuals needed to be fluent in either Dutch or German and have access to a smartphone. Those at risk of suicide or diagnosed with a psychotic disorder were not eligible to participate.

Initially, 80 bereaved individuals participated in the interview at T1 as well as in the ESM phase. Individuals who did not complete T2 were excluded from the analysis, resulting in the removal of five participants (6.2%). Additionally, 25 participants (33.3%) missed more than 50% of the ESM surveys and were, therefore, excluded from the analysis. The final sample consisted of 50 participants. None of the participants in the final sample had to be excluded due to a diagnosis of psychotic disorder or reported suicidal ideation.

Measures

Traumatic Grief Inventory-Clinician Administered (TGI-CA)

At T2, the variable PGD symptoms was evaluated using the Traumatic Grief Inventory-Clinician Administered (TGI-CA) (Lenferink et al., 2022b). The TGI-CA is a 22-item self-report tool designed to assess PGD symptom severity. Participants were asked to rate the frequency of experiencing each symptom (i.e., "I felt lonely and felt distant from other people") over the past two weeks. Each item represented a symptom, were participants rated each item on a scale from 1 (never) to 5 (always). For the interview at T2 in this study, all items from the TGI-CA were used to calculate a total score. Total PGD scores ranged from a minimum of 22 to a maximum of 110. A total score of 71 or higher indicates probable PGD (APA, 2022; Lenferink et al., 2022b). The internal consistency of all items was assessed using Cronbach's alpha. In this sample, the reliability was 0.9 at T2.

Pleasantness of Daily Activity

During the ESM phase, participants were surveyed about the level of pleasantness they experienced during their daily activities (i.e., "How did you like the activity?"). The answer options were: 0 = very unpleasant, 1 = unpleasant, 2 = somewhat unpleasant, 3 = neither pleasant not unpleasant, 4 = somewhat pleasant, 5 = pleasant, 6 = very pleasant.

Frequency of Being with Others

During the ESM phase, participants were surveyed about how frequent they were with others. To assess the variable frequency of being with others, participants were asked questions about their social context (i.e., "Were you with other people?"). Answer options were: 1 = no I was alone, 2 = yes with one other person, 3 = yes with multiple others. This variable was converted into a dichotomous variable where participants engaging in activities alone = 0 and participants engaging in activities with other(s) = 1.

Statistical Analyses

Before conducting the analyses, several assumptions including normality, linearity, independence of observations, and homoscedasticity were checked. These checks are crucial for the reliability of the statistical outcomes, as failure to meet these assumptions could lead to Type I or Type II errors, as well as over- or under-estimation of significance or effect size (Osborne & Waters, 2019). The assumptions of normality, linearity, and independence of observations were met. However, due to observed heteroscedasticity in the variable PGD

symptoms, a logarithmic transformation was applied to this variable. These transformations helped with stabilizing the variance. Specifically, reducing the variability in the data points. The other variables met the assumptions so there was no need for transformation of these variables.

For all analyses, RStudio [Version 1.4.1106.] was used. The detailed R code and scripts can be found in Appendix A. Specifically, a moderation analysis was performed to determine whether the frequency of being with others (moderator) influenced the effect of pleasantness of daily activity (independent variable) on PGD symptoms (dependent variable). In the analysis, direct effects and interaction effects were examined. The direct effect refers to the association between pleasantness of daily activity and PGD symptoms and the association between frequency of being with others and PGD symptoms. The interaction effect assesses how the association between these variables changes depending on the frequency of being with others. The variable frequency of being with others was converted into a proportion (i.e., range: 0-1). This proportion was calculated by dividing the number of times a participant engaged in an activity with others by the number of times that participant filled in the question “Were you with other people?”. This proportion reflects how often participants were with others during their daily activities. For the pleasantness of daily activity, an aggregated score was created. For each participant, the scores on the questions were summed and divided by the number of times the participant filled in the question “How did you like the activity?”. This gave the mean score per participant. The significance level for all models was set at $\alpha = 0.05$.

Results

Sample Characteristics

Of the 50 participants, one (2%) scored above the cutoff score for potential PGD caseness. Table 1 shows the characteristics of this sample. The majority of the participants was female, with ages ranging from 21 to 75 years. Most participants originated from Germany, followed by the Netherlands., and most obtained a college or university degree.

The age of the deceased relatives varied from 6 to 91 years. Most participants experienced the loss of a loved one due to natural causes, such as illness. The time since loss varied from six months to 26 years. Regarding the relationship to the deceased loved one, most participants lost a parent.

Table 1

Characteristics of Sample (N = 50)

Characteristic	
Gender, *N* (%)	
Male	14 (28)
Female	36 (72)
Other	0 (0)
Age in years, *M* (*SD*)	40.92 (2.34)
Country of birth, *N* (%)	
Germany	28 (56)
The Netherlands	21 (42)
Other	1 (2)
Level of education, *N* (%)	
Lower than college/university	21 (42)
College/university	29 (58)
Cause of death, *N* (%)	
Natural cause	41 (82)
Suicide	4 (8)
Homicide	1 (2)

Accident	0 (0)
Other	4 (8)
Time since loss in years, *M* (*SD*)	6.33 (6.81)
Relation to the deceased, *N* (%)	
Parent	25 (50%)
Grandparent	7 (14%)
Partner/spouse	6 (12%)
Sibling	4 (8%)
Friend	2 (4%)
Grandchild	1 (2%)
Other	5 (10%)
Frequency of being with others *M* (*SD*)	0.71 (0.18)
PGD symptoms *M* (*SD*)	30.9 (10.96)
Pleasantness of daily activity *M* (*SD*)	4.36 (0.75)

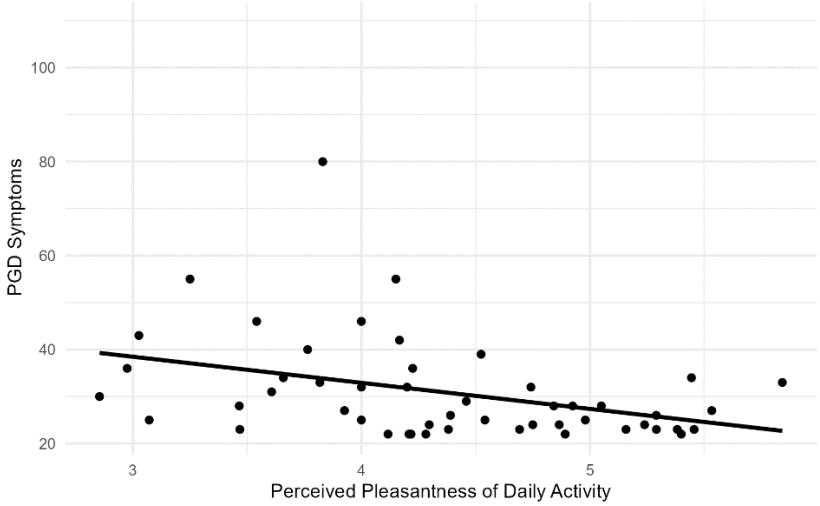
Moderating Effects of Frequency of Being with Others on the Relationship Between Pleasantness of Daily Activity and PGD Symptoms

The regression model was statistically significant ($F(3, 46) = 4.8$, $p = 0.005$). The direct effects of pleasantness of daily activity, frequency of being with others, and their interaction explained 23.9% of the variance of PGD symptoms ($R^2 = 0.239$, *adjusted* $R^2 = 0.189$). Specifically, at least one of the independent variables in this model had a significant relationship with PGD symptoms

The direct effect of the association between the pleasantness of daily activities and PGD symptoms was significant even when accounting for the interaction effect. Participants who perceived daily activities as more pleasant reported significantly lower PGD symptoms, $B = -0.22$, $t(46) = -2.55$, $p = 0.01$, 95% CI [-0.39, -0.05] (see Figure 1).

Figure 1

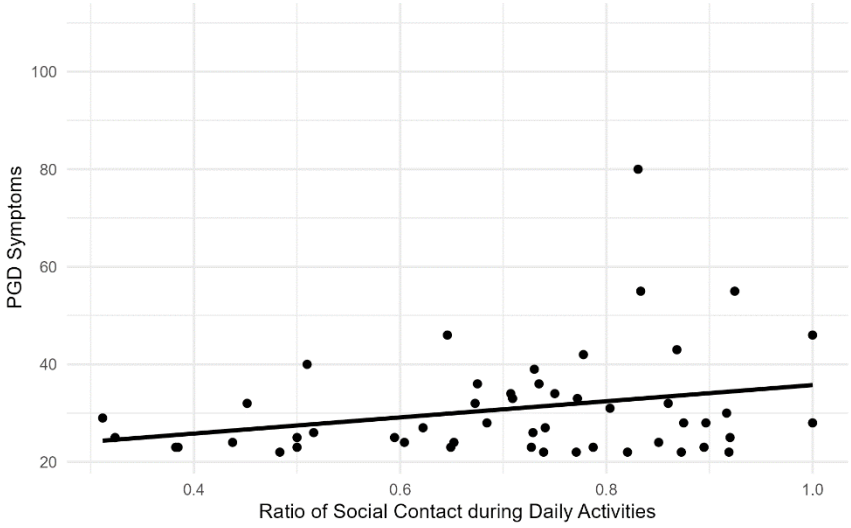
Relationship Between Pleasantness of Daily Activity and PGD Symptoms



The direct effect of the frequency of being with others during daily activities was not significantly related to PGD symptoms. Participants who were more frequently with others did not report significantly different PGD symptoms, $B = 1.16$, $t(46) = 1.22$, $p = 0.23$, 95% CI [-0.75, 3.08] (see Figure 2).

Figure 2

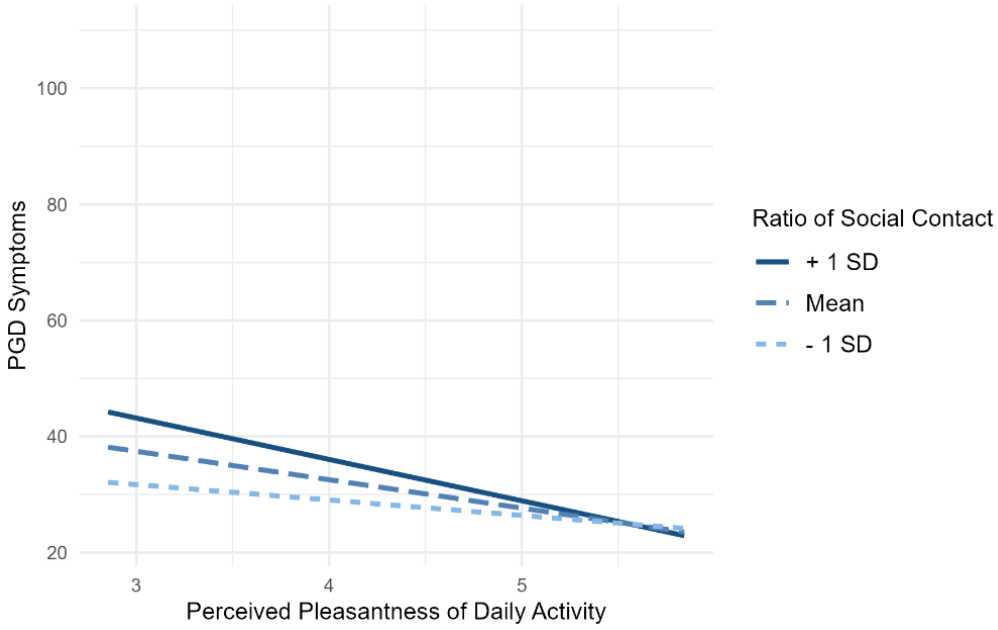
Relationship Between Frequency of Being with Others and PGD Symptoms



Additionally, the relationship between the pleasantness of daily activity and PGD symptoms did not significantly differ based on the frequency of being with others experienced during these activities. Regardless of how frequent participants were with others, the pleasantness of their daily activity had a similar influence on PGD symptoms, B = -0.21, $t(46)$ = -0.99, p = 0.33, 95% CI [-0.64, 0.22] (see Figure 3).

Figure 3

The Association Between Pleasantness of Daily Activity and PGD Symptoms Moderated by Frequency of Being with Others



Discussion

This study aimed to gain a better understanding of the relationship between pleasantness of daily activity, frequency of being with others, and PGD symptoms. This was examined among a sample of 50 bereaved individuals. The hypotheses stated that lower pleasantness in daily activity would be associated with more PGD symptoms and that the presence of another person (i.e. frequency of being with others) would moderate this relationship. We found that the pleasantness of daily activities relates to PGD symptoms, but this association does not vary depending on the frequency of being with others.

This study found a significant negative association between the pleasantness of daily activity and PGD symptoms. This finding suggests that engaging in activities perceived as pleasant might reduce PGD symptoms. Therefore, it seems that encouraging bereaved individuals to engage in pleasant activities might be beneficial. This aligns with previous research from Eisma et al. (2015) that suggests that engaging in pleasant activities helps with reducing negative thoughts and the enhancement of a positive mood which might contribute to reducing PGD symptoms. Although there is limited prior research on the impact of pleasantness of daily activities on PGD symptoms, it appears that engagement in daily activities perceived as pleasant may offer benefits to bereaved individuals. These benefits include a positive mood and improved mental health (Ferreira et al., 2015). Also, participation in daily activities may lead to feelings of relief and positivity (Williams et al., 2021). These improvements in mental health potentially play a role in alleviating PGD symptoms.

Contrary to expectations, how frequently participants were with others during daily activities was not significantly related to PGD symptoms. This finding contradicts earlier research emphasizing the positive impact of social contact on mental health outcomes among bereaved individuals (Jarosz, 2022; Maciejewski et al., 2022). This discrepancy may arise because the aforementioned studies and this study focused only on the amount of frequency of being with others, without considering how individuals experienced this contact. Research by Holt-Lunstad et al. (2010) suggests that individuals find the quality of social contact more important than the mere presence of others. Bereaved individuals might find a specific type of social contact more helpful in alleviating PGD symptoms. For instance, the bereaved individual may not always make use of the opportunity to disclose emotions; one could do so with certain people but not with everyone, which makes the perceived quality of contact

different for these individuals (Stroebe et al., 2005). Mueller et al. (2022) also suggest that the quality of social contact impacts mental health outcomes, by reducing feelings of loneliness and suicidal thoughts and behaviours.

Moreover, this study did not find evidence to support the idea that the frequency of being with others moderates the relationship between the pleasantness of daily activity and PGD symptoms. This suggests that the relationship between the pleasantness of daily activity and PGD symptoms is not influenced by how frequently bereaved individuals were with others during these activities. It seems that the pleasantness associated with the activity themselves plays a more crucial role in reducing PGD symptoms than whether someone was present or not during the activity. The findings support prior research by Ferreira et al. (2015) who found that pleasantness experienced during daily activities is crucial as it leads to positive emotions and improves mental health. The hypothesis that the frequency of being with others moderates the relationship between the pleasantness of daily activity and PGD symptoms may be contradicted by the tendency of bereaved individuals to withdraw from social activities (Eisma et al., 2015). When someone loses a loved one a void potentially arises (Maciejewski Et al., 2022). Engaging with others might fill this void. However, research from Dahlberg (2007) suggests that people can still experience loneliness even with others. This means that being with other people might not make activities more pleasant or reduce PGD symptoms since feelings of loneliness can still be present.

This study has several limitations that should be considered. One major limitation is that self-selection bias may have skewed the results, as individuals who volunteered for the study might differ from those who did not. In general, individuals actively seeking support are more likely to participate, potentially affecting the representativeness of findings (Keiding & Louis, 2016). One variable that was not controlled for but is relevant is cultural background. People from different cultures have different ways of how they experience and express grief (Rosenblatt & Wallace, 2021). There are also differences regarding social contact. Collectivistic cultures are associated with high social needs, while individualistic cultures prefer limited social contact (Barreto et al., 2021). These differences in social needs may lead to one cultural group experiencing greater benefits from social contact in alleviating PGD symptoms than other cultures. Considering that the participants in this study were mainly Dutch and German, which are relatively individualistic cultures, it is important to note that the findings may not generalize to collectivistic cultures. Lastly, the small sample size of

50 participants increased the risk of Type II errors, possibly leading to false negatives, reducing the statistical power of the results (Akobeng, 2016).

On the other hand, this study has several strengths. Firstly, the study makes use of ESM, which contributes to the fact that the experiences and symptoms of the participants were captured in their natural environment, minimizing recall bias (Stone et al., 1998). Also, the use of ESM provided participants with insights into their grief by letting them reflect on their symptoms multiple times a day, enhancing self-monitoring. Research by Van Os et al. (2017) suggests that the self-monitoring of symptoms leads to reduced symptomatology. Self-monitoring helps individuals better understand their experiences regarding their symptomatology. This self-awareness might lead to changes in behaviour, which potentially helps reduce symptoms (Van Os et al., 2017). Moreover, this study examines the role of social contact (i.e., frequency of being with others) as a variable in the context of PGD symptoms. While there is substantial research on grief and withdrawal from social contact (Eisma et al., 2015), the role of social contact in alleviating PGD symptoms remains unexplored. This study contributes to filling that gap by examining the effectiveness of social contact in reducing PGD symptoms.

Future research should examine whether certain activities are more beneficial than others for individuals experiencing PGD symptoms. Considering the limited research on daily activities and PGD symptoms, as well as the small sample size of our study, we focused on daily activities in general. Therefore, it is recommended to delve deeper into specific types of activity. Another interesting path to explore is the effectiveness of online social contact compared to face-to-face social contact. As known, bereaved individuals who lost a loved one tend to withdraw from social contact, experience feelings of loneliness, and find it hard to seek social support (Maccallum & Bryant, 2018; Eisma et al., 2015). Today's society offers many easily accessible online platforms, of which the effectiveness of online social support groups on PGD symptoms could be explored. This could be especially helpful for individuals who live far away from others or lack close personal connections in their immediate environment. Evidence from Lestienne et al (2021) and Bartone et al (2017), which investigated online social support amongst individuals bereaved by suicide suggests that participating in online social support reduces PGD symptoms, thereby positively impacting mental health. Participants in the study by Bartone et al (2017) mentioned that online support groups had several advantages, including easy accessibility and availability.

Also, these individuals found that support from family and friends was not always helpful, which made them prefer online support.

Overall, this study offers valuable insights into the association between pleasantness of daily activity, frequency of being with others, and PGD symptoms among bereaved individuals. It highlights the importance of engaging in pleasant daily activities for alleviating PGD symptoms, regardless of how frequently others are present. In conclusion, this research contributes to a growing body of evidence suggesting that paying attention to the pleasantness of daily activities is crucial in alleviating PGD symptoms.

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Appendix A

R Code

```
install.packages('lubridate')

#load packages

library(tidyverse)

library(foreign)

library(broom)

library(modelr)

library(dplyr)

library(lubridate)

library(haven)



Dat1 <- read_sav("Dat1.sav")

View(Dat1)



#excluding people that have suicidal thoughts and/or psychotic disorder#

Dat1 <- Dat1[!(Dat1$T1_Ex._psychotic == "Ja" & !is.na(Dat1$T1_Ex._psychotic)), ]



save(PercentRemoved, file = "PercentRemoved.R_original.R")

load("PercentRemoved.R_original.R")
```

```
save(PercentRemoved, file = "my_variables.R original.R")

load("my_variables.R original.R")

save(PercentRemoved, file = "my_variables_means.R original.R")

load("my_variables_means.R original.R")

save(PercentRemoved, file = "my_variables_wide.R original.R")

load("my_variables_wide.R original.R")


saveRDS(PercentRemoved, "Cleaned_Data.rds")

saveRDS(my_variables, "R_original.rds")

saveRDS(my_variables_means, "R_original.rds")

saveRDS(my_variables_wide, "R_original.rds")


#to know how many people were excluded due to psychotic disorder

participants_beforePsy <- Dat1 %>%

  distinct(QualtricsID) %>%

  nrow()

participants_afterPsy <- Dat1 %>%

  distinct(QualtricsID) %>%

  nrow()
```

```
#removing participants that have not done T2

WithoutT2 <- Dat1 %>%

  filter(!is.na(T2_StartDate))



save(WithoutT2, file = "WithoutT2.Clean data.R")

load("WithoutT2.Clean data.R")



#removing participants that have more than 50% of missing data

missing_percent2 <- WithoutT2 %>%

  group_by(QualtricsID) %>%

  summarize(missing_percent2 = mean(is.na(ESM_WhereWereYou)) * 100)

PercentRemoved <- WithoutT2 %>%

  group_by(QualtricsID) %>%

  filter(!(QualtricsID %in% missing_percent2[missing_percent2$missing_percent2 > 50,

]$QualtricsID))



save(missing_percent2, file = "missing_percent2.Clean data.R")

load("missing_percent2.Clean data.R")



# Calculate PGD score at T1
```

```
PercentRemoved$PGD_score <- rowSums(PercentRemoved[, c("T1_TGI_CA_1_1",
"T1_TGI_CA_1_2", "T1_TGI_CA_1_3", "T1_TGI_CA_1_4", "T1_TGI_CA_1_5",
"T1_TGI_CA_1_6", "T1_TGI_CA_1_7", "T1_TGI_CA_1_8", "T1_TGI_CA_1_9",
"T1_TGI_CA_1_10", "T1_TGI_CA_1_11", "T1_TGI_CA_1_12", "T1_TGI_CA_1_13",
"T1_TGI_CA_1_14", "T1_TGI_CA_1_15", "T1_TGI_CA_1_16", "T1_TGI_CA_1_17",
"T1_TGI_CA_1_18", "T1_TGI_CA_1_19", "T1_TGI_CA_1_20", "T1_TGI_CA_1_21",
"T1_TGI_CA_1_22")])

Dat1$PGD_score_T1 <- rowSums(Dat1[, c("T1_TGI_CA_1_1", "T1_TGI_CA_1_2",
"T1_TGI_CA_1_3", "T1_TGI_CA_1_4", "T1_TGI_CA_1_5", "T1_TGI_CA_1_6",
"T1_TGI_CA_1_7", "T1_TGI_CA_1_8", "T1_TGI_CA_1_9", "T1_TGI_CA_1_10",
"T1_TGI_CA_1_11", "T1_TGI_CA_1_12", "T1_TGI_CA_1_13", "T1_TGI_CA_1_14",
"T1_TGI_CA_1_15", "T1_TGI_CA_1_16", "T1_TGI_CA_1_17", "T1_TGI_CA_1_18",
"T1_TGI_CA_1_19", "T1_TGI_CA_1_20", "T1_TGI_CA_1_21", "T1_TGI_CA_1_22")])

# Count participants above the cut-off score
above_cutoff_T1 <- sum(PercentRemoved$PGD_score_T1 > 71)

# Check the first few rows
head(mean_PGD_per_participant)

# Check if all participants from T1 also participated in the ESM phase
```

```
participants_T1 <- unique(Dat1$QualtricsID[Dat1$T1_Finished == 1])

participants_ESM <- unique(Dat1$QualtricsID[!is.na(Dat1$ESM_WhereWereYou)])


all_participants_in_ESM <- all(participants_T1 %in% participants_ESM)


if (all_participants_in_ESM) {
  cat("All participants from T1 also participated in the ESM phase.")
} else {
  cat("Not all participants from T1 participated in the ESM phase.")
}


#grouping of gender
gender_counts <- PercentRemoved %>%
  group_by(T1_Gender) %>%
  summarize(count = n())
gender_counts$count


summary(gender_counts$T1_Gender)
#summary of gender
summary(PercentRemoved)
```

```
summary(PercentRemoved$T1_Gender)

gender_counts <- PercentRemoved %>%
  group_by(T1_Gender) %>%
  summarize(count = n())
gender_counts$count


summary(gender_counts$T1_Gender)


#merge both columns to calculate age
calculating_age <- data.frame(
  date_of_interview = PercentRemoved$T1_Date_of_interview
)


calculating_age2 <- data.frame(
  date_of_birth = PercentRemoved$T1_DoB
)


calculating_age$date_of_interview <- calculating_age2$date_of_birth
calculating_age$age <- as.numeric(difftime(calculating_age$date_of_interview,
calculating_age$T1_DoB, units = "days")/365.25)
```

```
# Create a new dataset with unique participants and their date of birth
calculating_age3 <- PercentRemoved %>%
  distinct(QualtricsID, .keep_all = TRUE) %>%
  select(QualtricsID, T1_DoB, T1_Date_of_interview)  # Select only the QualtricsID and
T1_DoB columns

#correct one of changing dates to correct format
calculating_age3$T1_Date_of_interview <- case_when(
  grepl("/", calculating_age3$T1_Date_of_interview) ~
dmy(calculating_age3$T1_Date_of_interview),   # DD/MM/YYYY format
  grepl("-", calculating_age3$T1_Date_of_interview) ~
dmy(calculating_age3$T1_Date_of_interview),   # DD-MM-YYYY format
  grepl("\\.", calculating_age3$T1_Date_of_interview) ~
dmy(calculating_age3$T1_Date_of_interview), # DD.MM.YYYY format
  TRUE ~ NA_Date_                                  # For other formats, set to NA
)

calculating_age3$T1_DoB <- case_when(
  grepl("/", calculating_age3$T1_DoB) ~ dmy(calculating_age3$T1_DoB),   #
DD/MM/YYYY format
```

```
  grepl("-", calculating_age3$T1_DoB) ~ dmy(calculating_age3$T1_DoB),   # DD-MM-
YYYY format
  grepl("\\.", calculating_age3$T1_DoB) ~ dmy(calculating_age3$T1_DoB), #
DD.MM.YYYY format
  TRUE ~ NA_Date_                                  # For otdher formats, set to NA
)

calculating_age3$age <- as.numeric(difftime(calculating_age3$T1_Date_of_interview,
calculating_age3$T1_DoB, units = "days")/365.25)

calculating_age3$age <- floor(calculating_age3$age)
summary(calculating_age3$age)

summary(calculating_age3$age)

#SD of age
sd_of_mean_age <- sd(calculating_age3$age) / sqrt(length(calculating_age3$age))

#Home country
country_counts <- PercentRemoved %>%
```

```
  distinct(QualtricsID, .keep_all = TRUE) %>%
  count(T1_Home_country)

summary(country_counts$T1_Home_country)

#kinship
kinship_counts <- PercentRemoved %>%
  distinct(QualtricsID, .keep_all = TRUE) %>%
  count(T1_kinship)
summary(kinship_counts)

#how long ago was death
Date_of_death <- PercentRemoved %>%
  distinct(QualtricsID, .keep_all = TRUE) %>%
  count(T1_DoD)
summary(Date_of_death)

Date_of_death$T1_DoD <- case_when(
  grepl("/", Date_of_death$T1_DoD) ~ dmy(Date_of_death$T1_DoD),   # DD/MM/YYYY
format
```

```
  grepl("-", Date_of_death$T1_DoD) ~ dmy(Date_of_death$T1_DoD),   # DD-MM-YYYY
format
  grepl("\\.", Date_of_death$T1_DoD) ~ dmy(Date_of_death$T1_DoD), # DD.MM.YYYY
format
  TRUE ~ NA_Date_                                  # For other formats, set to NA
)

Date_of_death$year <- as.numeric(difftime(calculating_age$date_of_interview,
Date_of_death$T1_DoD, units = "days")/365.25)
summary(Date_of_death)

#SD of how long ago the death was
sd_of_mean_dod <- sd(Date_of_death$year) / sqrt(length(Date_of_death$year))

# Create a new variable representing the total score of the 22 items
PercentRemoved$PGD_score <- rowSums(PercentRemoved[, c("T2_TGI_CA_1_1",
"T2_TGI_CA_1_2", "T2_TGI_CA_1_3", "T2_TGI_CA_1_4", "T2_TGI_CA_1_5",
"T2_TGI_CA_1_6", "T2_TGI_CA_1_7", "T2_TGI_CA_1_8", "T2_TGI_CA_1_9",
"T2_TGI_CA_1_10", "T2_TGI_CA_1_11", "T2_TGI_CA_1_12", "T2_TGI_CA_1_13",
"T2_TGI_CA_1_14", "T2_TGI_CA_1_15", "T2_TGI_CA_1_16", "T2_TGI_CA_1_17",
"T2_TGI_CA_1_18", "T2_TGI_CA_1_19", "T2_TGI_CA_1_20", "T2_TGI_CA_1_21",
"T2_TGI_CA_1_22")])
```

```
library(dplyr)


# Create a function to calculate PGD score for each participant
calculate_PGD_score <- function(PercentRemoved) {
  # Sum the scores of items 1 up to and including 22 for each participant
  PercentRemoved$PGD_score <- rowSums(select(PercentRemoved,
starts_with("T2_TGI_CA_1_"))[, 1:22])
  return(PercentRemoved)
}


library(dplyr)


# Remove NA values from specific variables and retain all answers per participant
my_variables <- PercentRemoved %>%
  filter(!is.na(ESM_WithOthers) & !is.na(ESM_QualityActivity))


# View dataframe
print(my_variables)
```

```
# Apply the function to calculate PGD score for each participant
my_variables <- PercentRemoved %>%
  group_by(QualtricsID) %>%
  do(calculate_PGD_score(.))

save(my_variables, file = "my_variables.Clean data.R")
load("my_variables.Clean data.R")

library(dplyr)
# Calculate PGD_score
my_variables <- PercentRemoved %>%
  group_by(QualtricsID) %>%
  do(calculate_PGD_score(.)) %>%
  ungroup() %>%
  mutate(PGD_score = as.numeric(PGD_score))

my_variables <- my_variables %>%
  filter(!is.na(ESM_WithOthers) & !is.na(ESM_QualityActivity)) %>%
  mutate(
```

```
  ESM_WithOthers = factor(ESM_WithOthers, levels = c(1, 2, 3), labels = c("alone", "with one other", "with multiple others")),
  ESM_QualityActivity = factor(ESM_QualityActivity, levels = 0:6, labels = c("very unpleasant", "unpleasant", "somewhat unpleasant", "neither pleasant nor unpleasant", "somewhat pleasant", "pleasant", "very pleasant")),
  ESM_QualityActivity_num = as.numeric(ESM_QualityActivity) - 1 # Convert factor to numeric using underlying levels
 )

my_variables <- my_variables %>%
 mutate(ESM_WithOthers = ifelse(ESM_WithOthers == "alone", 0, 1))
# Recode ESM_WithOthers to 'alone' for 0 and 'social contact' for 1
my_variables <- my_variables %>%
 mutate(ESM_WithOthers = ifelse(ESM_WithOthers == 0, "alone", "social contact"))

summary_counts <- my_variables %>%
 group_by(QualtricsID) %>%
 summarise(
  alone_count = sum(ESM_WithOthers == "alone"),
  social_contact_count = sum(ESM_WithOthers == "social contact")
 )
```

```
saveRDS(summary_counts, "R_original.rds")


# Summarize the counts of 'alone' and 'social contact' for each participant and calculate the total frequency
summary_counts <- my_variables %>%
  group_by(QualtricsID) %>%
  summarise(
    alone_count = sum(ESM_WithOthers == "alone"),
    social_contact_count = sum(ESM_WithOthers == "social contact"),
    total_frequency = n()
  ) %>%
  mutate(ratio_social_contact = social_contact_count / total_frequency)
# Join the mean scores with the summary_counts dataset
summary_counts <- summary_counts %>%
  left_join(mean_scores, by = "QualtricsID")


# Calculate the mean and standard deviation for the specified variables
summary_statistics <- summary_counts %>%
  summarise(
```

```
    mean_ratio_social_contact = mean(ratio_social_contact, na.rm = TRUE),
    sd_ratio_social_contact = sd(ratio_social_contact, na.rm = TRUE),
    mean_mean_PGD_score = mean(mean_PGD_score, na.rm = TRUE),
    sd_mean_PGD_score = sd(mean_PGD_score, na.rm = TRUE),
    mean_mean_ESM_QualityActivity_num = mean(mean_ESM_QualityActivity_num, na.rm
= TRUE),
    sd_mean_ESM_QualityActivity_num = sd(mean_ESM_QualityActivity_num, na.rm =
TRUE)
  )

# Print the summary statistics
print(summary_statistics)

# Fit the moderation model
moderation_model <- lm(mean_PGD_score ~ mean_ESM_QualityActivity_num *
ratio_social_contact, data = summary_counts)

library(car)
# 1. Linearity of Variables
# Scatterplot of independent variables against dependent variable
```

```
plot(mean_PGD_score ~ mean_ESM_QualityActivity_num, data = summary_counts)

plot(mean_PGD_score ~ ratio_social_contact, data = summary_counts)



# 2. Normality of Residuals

# Plot histogram of residuals

hist(residuals(moderation_model))



# Normal probability plot of residuals

qqnorm(residuals(moderation_model))

qqline(residuals(moderation_model))



# 3. Homoscedasticity

# Plot residuals against predicted values

plot(residuals(moderation_model) ~ fitted(moderation_model))



# Plot residuals against each independent variable

plot(residuals(moderation_model) ~ mean_ESM_QualityActivity_num, data =

summary_counts)

plot(residuals(moderation_model) ~ ratio_social_contact, data = summary_counts)

# Fit the model using log-transformed PGD score
```

```
modelfinal <- lm(log(mean_PGD_score) ~ mean_ESM_QualityActivity_num *
ratio_social_contact, data = summary_counts)


# 1. Linearity of Variables
# Scatterplot of independent variables against dependent variable
plot(mean_PGD_score ~ mean_ESM_QualityActivity_num, data = summary_counts)
plot(mean_PGD_score ~ ratio_social_contact, data = summary_counts)


# 2. Normality of Residuals
# Plot histogram of residuals
hist(residuals(modelfinal))


# Normal probability plot of residuals
qqnorm(residuals(modelfinal))
qqline(residuals(modelfinal))


# 3. Homoscedasticity
# Plot residuals against predicted values
plot(residuals(modelfinal) ~ fitted(modelfinal))
```

```
# Plot residuals against each independent variable

plot(residuals(modelfinal) ~ mean_ESM_QualityActivity_num, data = summary_counts)

plot(residuals(modelfinal) ~ ratio_social_contact, data = summary_counts)

summary(modelfinal)

# Calculate 95% confidence intervals

conf_intervals <- confint(modelfinal, level = 0.95)

results <- cbind(estimates, conf_intervals)



# Display the results

Results

library(ggplot2)

install.packages("cowplot")

library(cowplot)

# Adjust x-axis and y-axis limits based on the data range

x_range_activity <- range(summary_counts$mean_ESM_QualityActivity_num, na.rm =
TRUE)

x_range_social_contact <- range(summary_counts$ratio_social_contact, na.rm = TRUE)


# Scatter plot with regression lines for Pleasantness of Daily Activity

plot1 <- ggplot(summary_counts, aes(x = mean_ESM_QualityActivity_num, y =
mean_PGD_score)) +

  geom_point() +  # Simple scatter plot

  geom_smooth(method = "lm", se = TRUE, col = "black") +  # Linear regression line with
confidence interval
```

```
  labs(
    title = "Relationship between Pleasantness of Daily Activity and PGD Symptoms",
    x = "Perceived Pleasantness of Daily Activity",
    y = "PGD Symptoms"
  ) +
  scale_x_continuous(limits = x_range_activity) +
  scale_y_continuous(limits = c(22, 110)) +
  theme_minimal() +
  theme(
    text = element_text(family = "Arial", size = 10),  # Sans-serif font and appropriate size
    plot.title = element_text(size = 12),
    axis.title.x = element_text(size = 10),
    axis.title.y = element_text(size = 10)
  )

# Save the first plot
ggsave("Pleasantness_Daily_Activity_Fina;.png", plot1, width = 6, height = 4, bg = "white")

# Scatter plot with regression lines for Social Contact
plot2 <- ggplot(summary_counts, aes(x = ratio_social_contact, y = mean_PGD_score)) +
  geom_point() +  # Scatter plot points
  geom_smooth(method = "lm", se = TRUE, col = "black") +  # Linear regression line with confidence interval
  labs(
    title = "Relationship between Frequency of Social Contact and PGD Symptoms",
    x = "Ratio of Social Contact during Daily Activities",
    y = "PGD Symptoms"
  ) +
  scale_x_continuous(limits = x_range_social_contact) +
  scale_y_continuous(limits = c(22, 110)) +
  theme_minimal() +
```

```
  theme(
    text = element_text(family = "Arial", size = 10),  # Sans-serif font and appropriate size
    plot.title = element_text(size = 12),
    axis.title.x = element_text(size = 10),
    axis.title.y = element_text(size = 10)
  )

# Save the second plot
ggsave("Social_Contact_Final.png", plot2, width = 6, height = 4, bg = "white")

# Define x_range_activity based on your data
x_range_activity <- range(summary_counts$mean_ESM_QualityActivity_num, na.rm =
TRUE)

# Create the interaction plot
interaction_plot <- interact_plot(
  moderation_model,
  pred = "mean_ESM_QualityActivity_num",
  modx = "ratio_social_contact",
  x.label = "Perceived Pleasantness of Daily Activity",
  y.label = "PGD Symptoms",
  legend.main = "Ratio of Social Contact"
) +
  scale_x_continuous(limits = x_range_activity) +
  scale_y_continuous(limits = c(22, 110)) +
  theme_minimal() +
  ggtitle("Pleasantness of Daily Activity and Frequency of Social Contact on PGD") +
  theme(
    text = element_text(family = "Arial", size = 10),  # Sans-serif font and appropriate size
    plot.title = element_text(size = 12),
    axis.title.x = element_text(size = 10),
```

```
    axis.title.y = element_text(size = 10),
    legend.text = element_text(size = 10),
    legend.title = element_text(size = 10)
  )

# Save the plot
ggsave("Interaction_Final.png", interaction_plot, width = 6, height = 4, bg = "white")
```