Exploring the Relationship between the Frequency Social Contact and the Evaluation thereof on PGD levels in Naturally Bereaved Individuals

Aron Rozendal (2586177)

First supervisor: Lieke Nijborg

Second supervisor: Justina Pociunaite

Department of Psychology, University of Twente

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Abstract

Background: In this study, the relationship between the frequency of social contact and Prolonged Grief Disorder (PGD) levels was examined. Besides, it was aimed to examine whether individuals' evaluations of social contact influences PGD levels and if this evaluation moderates the relationship between social contact frequency and PGD levels.

Methods: Experience Sampling Methodology (ESM) data from 50 naturally bereaved individuals were analyzed. PGD levels were assessed through telephone interviews. The data collection took place in three phases: Timepoint 1 (T1), the ESM-phase, and Timepoint 2 (T2). Participants were recruited through social media and bereavement support websites.

Results: while the evaluation of social contact was significantly associated with PGD levels (b = -4.43, 95% CI [-17.89, 9.04], p = .51), the frequency of social contact did not (b = -7.30, 95% CI [-10.80,-3.79], p < .001). Moreover, the interaction between the evaluation of contact and social contact was not significant (b = 5.44, 95% CI [-7.22, 18.11], p = .39), suggesting no significant moderating effect.

Discussion: These findings suggest that the quality of social interactions independently influences PGD levels. Positive evaluations of social contact are associated with lower levels of PGD, regardless of how frequently social interactions occur. This highlights the importance of the perceived quality of social support in the grieving process. The lack of a significant relationship between social contact frequency and PGD levels indicates that simply increasing social interactions may not be sufficient to reduce prolonged grief symptoms; the nature of these interactions might play a role here.

Keywords: *grief; bereavement; social contact; evaluation; prolonged grief disorder; experience sampling methodology*

Introduction

In times of personal crises, social connections – albeit from partners, family, or friends – are demonstrated to play a vital role in mitigating stress. Cohen (2004) and Uchino (2009) showed the positive effect of social support on individual well-being. In contrast, individuals who lack a supportive social network, exhibit adverse well-being outcomes. Evidence suggests that individuals who experience social isolation or loneliness have an increased risk of encountering physical health morbidities (Tomaka et al., 2006), increased psychological distress and depressive symptoms (Taylor et al., 2016), as well as accelerated cognitive decline and impairment (Shankar et al., 2013). On the other hand, social interactions are shown to exhibit a protective effect on well-being. Individuals who spend more time alone and find the presence of others less pleasant exhibit higher levels of general psychopathology and depression (Achterhof et al., 2022). Additionally, Holt-Lunstad and Steptoe (2022) demonstrated a direct correlation between social interactions and longevity. They showed that individuals with expansive social networks tend to live longer. This body of research supports the notion that social contact not only mitigates the adverse effects of stress. It also significantly contributes to overall health and longevity, which might be of importance even more when difficult life events occur.

An example of a difficult life event in which social support might be imperative, is the experience of losing a loved one. The grieving process following the loss can be experienced as substantially difficult, encompassing not only emotional distress but also cognitive responses (e.g., reduced functioning of working memory, slowed information processing; Atalay & Stenava, 2020) and physical responses (e.g., increased heartrate, increased blood pressure; Prigerson et al., 1997). Grief, as defined by Stroebe & Hansson (2008), encompasses the "primarily emotional/affective process of reacting to the loss of a loved one through death" (p. 62). Individuals typically navigate through their grief by adopting new social identities (e.g., becoming a widow(er)) and restructuring their lives in the absence of the deceased (Maciejewski et al., 2022). Research indicates that while grief intensity may peak shortly after the loss, it generally diminishes over several months, reflecting the natural course of grieving and adaptation (Prigerson et al., 2021). However, there are exceptions to this pattern, with some individuals experiencing grief symptoms a year after the loss (Nielsen et al., 2019).

When individuals experience symptoms such as intense emotional pain and feelings of meaninglessness almost every day for at least a month, these symptoms may be indicative of

Prolonged Grief Disorder (PGD) (American Psychiatric Association, 2022). The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision (DSM-5-TR), introduced by the American Psychiatric Association in 2022 (American Psychiatric Association, 2022), includes the disorder of PGD. According to Lundorff et al. (2017), approximately 7% to 10% of naturally bereaved people are affected by PGD, causing them to experience persistent and intense grief that interferes with their daily lives.

Typically, studies on PGD levels have been using surveys or interviews conducted at a single timepoint, asking participants to rate their grief over the past month (Treml et al., 2020). This retrospective method is prone to bias, as seen in depression research, where participants tend to make over- or underestimations of their depressive symptoms (Ben-Zeev & Young, 2010). This bias can be overcome using Experience Sampling Methodology (ESM). ESM is a data collection technique that involves answering questions, usually multiple times a day, over a certain period of time (Myin-Germeys, 2018). ESM has been shown to reliably track changes in symptoms and their contextual factors in disorders like depression (Pemberton & Fuller Tyszkiewicz, 2016). By having participants monitor their reactions multiples times a day, ESM reduces recall bias (Lenferink et al., 2022) and captures the interplay between cognitive, behavioral, and affective responses (Myin-Germeys et al., 2018).

The symptoms of PGD – including, but not limited to identity disruption, marked sense of disbelief, and attempting to avoid reminders of the deceased person (American Psychiatric Association, 2022) – can as well be categorised in the psychological domains of cognition, behavior and affect. An example of a symptom falling under the domain of cognition, is intense loneliness. Individuals who experience loss, often face a ‘social void’ in their lives that was previously filled by the deceased person, leading to feelings of loneliness (Maciejewski et al., 2022). Social contact – defined as the frequency of social interactions an individual has with others – might help bereaved individuals to restore social stability. However, this aspect has not received much empirical scrutiny. Considering intense loneliness as a symptom of PGD, it might be valuable to gain more insight into the effects of the frequency of social contact on PGD levels – which refers to the severity of PGD symptoms experienced by the individual. Therefore, the present study aims to investigate the relationship between the frequency of social contact and PGD levels. In order to achieve the first aim, the following research question has been formulated: “To what extent does the frequency of social contact influence PGD levels among

naturally bereaved individuals?" Prior research has explored various aspects of social interactions and their impact on health. Social interactions have been linked to improved mental health, as shown in studies by Dalgard and colleagues (1995) and Mathiesen and colleagues (1999). For bereaved individuals, social contact might help mitigate feelings of loneliness during the grieving process (Maciejewski et al., 2022). However, not all social interactions are beneficial; some may exacerbate feelings of loneliness or distress (Smith et al., 2020). Bereaved individuals may suppress their emotions in social settings due to fear of judgment or the belief that others cannot cope with their grief, leading to a preference for solitude over social engagement (Smith et al., 2020; Gupta & Bonanno, 2011). Despite these complexities, the majority of existing studies report a positive association between social contact frequency and mental health outcomes (Shor & Roelfs, 2015). Based on this body of research, it is hypothesized that the increased frequency of social contact is associated with a reduction in PGD levels among naturally bereaved individuals.

As a second aim, the study seeks to investigate whether the evaluation of social contact – specifically, how pleasant they found their social contact – affects PGD levels. Understanding the perceived quality of social interactions could provide deeper insights into how positive or negative social experiences influence the grieving process. This investigation is important because not all social interactions are beneficial; some may exacerbate feelings of loneliness or distress (Smith et al., 2020). Previous research has shown that negative social encounters can negatively impact bereaved individuals (Smith et al., 2020), potentially intensifying PGD levels. To achieve this second aim, the following research question has been formulated: "To what extent does the way in which bereaved individuals evaluate their contact relate to their PGD levels?" Bereaved individuals often judge social situations more negatively than those who are not experiencing grief (Dyregrov et al., 2018). This negative evaluation can be due to several factors, including the perceived lack of understanding from others and the pressure to conform to social expectations regarding the grieving process (Harris, 2010). Dyregrov et al. (2018) highlighted that many bereaved individuals encounter social interactions where acquaintances and friends are either afraid to say something hurtful or avoid the bereaved person completely. This might lead to more negative evaluations of social interactions. Additionally, bereaved individuals may feel pressure to meet their social network's expectations of rapid healing, which can further complicate their grieving process (Dyregov et al., 2018). Based on these insights, it is

hypothesized that negative evaluations of social contact are associated with increased PGD levels.

Aligned with the second aim, the moderating role of the evaluation of social conact in the relationship between the frequency of social contact and PGD levels is aimed to be examined. This investigation is found to be insightful for several reasons. First, it acknowledges that the evaluations of social contact could vary, with some interactions potentially being detrimental rather than supportive (Dyregrov, 2004). By investigating this moderation, it can be discerned whether either positive or negative evaluations mitigate or exacerbate the effect of social contact on PGD levels. Moreover, the scholars Uchino (2009) and Umberson et al. (2010) highlighted the necessity of exploring moderators for the relationship between social contact frequency and health. Understanding these intervening mechanisms and their impacts on health outcomes is crucial for designing effective interventions, which is why it is important to research (Gottlieb, 2000). By investigating Contact Evaluation as a moderator, this study aims to fill this research gap posed by Uchino (2009) and Umberson et al. (2010). The third research question addresses how Contact Evaluation moderates the relationship between the frequency of social contact and PGD levels: "To what extent does the evaluation of social contact moderate the relationship between the Frequency of Social Contact and the PGD levels among naturally bereaved individuals?". As stated before, the Frequency of Social Contact was hypothesized to be negatively related to PGD levels, meaning that an increase in social contact frequency would result in a decrease in PGD levels. The evaluation of social contact may moderate in this relationship. Dyregrov et al. (2018) found that bereaved individuals often felt pressure to meet social expectations regarding their emotional recovery, which could lead to negative evaluations of social interactions. We hypothesize that contact evaluation moderates the relationship between social contact frequency and PGD levels among naturally bereaved individuals. Specifically, positive evaluations are hypothesized to be enhancing the beneficial effects of social contact frequency on PGD levels, and negative evulations to be diminishing them.

Methods

Procedure

This study is part of a larger project titled “Grief in Daily Life” (Grief-ID), which aims to examine PGD symptoms in daily life. Moreover, the present study is a secondary analysis of data collected within this larger project. The data collection was structured into three distinct

phases: Timepoint 1 (T1), the ESM-phase, and Timepoint 2 (T2). Participants were recruited through social media advertisements shared within the research team's networks and by posting recruitment materials on websites that are dedicated to the support of bereaved individuals. To participate, individuals needed to be fluent in either Dutch or German and own a smartphone. Potential participants were excluded if they exhibited suicidal tendencies or had been diagnosed with a psychotic disorder, as was assessed with single items. After recruitment, participants received an information letter explaining the steps of the study. With the information letter, participants signed an informed consent form and were subsequently contacted by trained interviewer, who were master-level psychology students. At this point, the T1 telephone interview was scheduled. These T1 interviews lasted on average 47 minutes, and included the collection of demographic information and initial assessments. Upon completion of the T1 interviews, participants received an instructional video explaining how to install and use the Ethica app (www.ethicadata.com) for the ESM-phase.

During the ESM-phase, participants received five notifications per day for 14 consecutive days. The notifications were sent between 8.30 AM and 9.30 PM each day. The participants received notifications within the following time intervals: 8.30-9.30 AM, 11.30-12.30 PM, 2.30-3.30 PM, 5.30-6.30 PM, and 8.30-9.30 PM. If a participant had not completed the ESM-survey after 10 and 20 minutes, a reminder was sent. The participants had 60 minutes to complete each survey, which consisted of 17 ESM-items. Completing these items took approximately 1 to 2 minutes. If a participant missed more than half of the surveys on any given day, an interviewer contacted them via telephone or e-mail to encourage future participation.

Within two days after the completion of the ESM-phase, one of the researchers would call the participants to schedule the second telephone interview (T2). This interview was similar to the one carried out at T1, also including the measurement of PGD levels. In the present study, only the outcomes of the PGD levels measurement of T2 were used in the statistical analyses. Data collection took place from January 2022 until March 2022. For this study, ethical approval was received from the University of Twente (211101).

Participants

The participants were adults who had experienced the loss of a loved one (e.g., a participants' parent or friend) at least three months prior to the study. The initial sample

consisted of 80 participants. Since no participants were diagnosed with a psychotic disorder or exhibited suicidal ideations, the sample size remained unchanged. After excluding participants who did not complete the T2 phase, 75 participants remained. Further exclusion of those who did not finish at least 50% of the ESM questions resulted in a final sample of 50 participants. Some of this exclusion might possibly have been due to technical errors during data collection, such as participants not receiving notifications on their phones during one weekend of the data-collection phase and some participants receiving fewer than five measurements on the 14th day of the ESM phase.

Measures

PGD levels

At T2, PGD levels were assessed using the Traumatic Grief Inventory-Clinician Administered (TGI-CA). The TGI-CA was developed by Lenferink et al. (2023), and is an interview version of the 22 items self-report version of the Traumatic Grief Inventory Self-Report version (TGI-SR+) (Lenferink et al., 2022). Both are designed to assess PGD levels. An example of an item is: “In the past month, did you feel emotionally numb?”. The participants were asked to rate how often they experienced each PGD symptom during the past two weeks on a scale from 1 through 5 (1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always). The TGI-CA was used at both T1 and T2. In the present study, PGD levels were only measured at T2. Normally, the items ask about experiences in the past month. However, to align with ESM-phase, the time frame for measuring the PGD levels was adjusted to “past two weeks”. For analyzing PGD levels, a total PGD score was calculated for each participant. These values were added up, resulting in a total score for PGD levels. The TGI-CA is not an interview for formally diagnosing PGD. Rather, it was used to screen for probable PGD. Participants met the criteria for probable PGD when they scored a total score equal or higher than 71 (APA, 2022). As shown by Lenferink (2023), the TGI-CA has shown good psychometric properties. The internal consistency of the TGI-CA was examined using Cronbach's alpha. The scale demonstrated excellent internal consistency ($\alpha = 0.93$). The 95% confidence interval for Cronbach's alpha ranged from 0.90 to 0.96. Additional statistics indicated an average inter-item correlation of 0.39 and a signal-to-noise ratio of 14.

Frequency of Social Contact

During the ESM-phase, participants reported whether they were alone or with others during the activity they spent the most time on over the past three hours, responding to the question: “Were

you with other people?" with three possible answers: 1 = alone, 2 = with one other, 3 = with multiple others. Initially categorized as "alone," "with one other," and "with multiple others," these responses were dichotomized (0 = alone, 1 = social contact). A proportion score (i.e., range: 0 - 1) for the Frequency of Social Contact was then calculated by dividing the number of times a participant reported having social contact by the total number of times they filled in that question.

Contact Evaluation

During the ESM-phase, participants were asked the following question: "How did you find the contact?". Participants rated their social interactions on a scale from 0 (very unpleasant) to 6 (very pleasant). For each participant, a mean score was calculated. This mean score represented the average of all responses provided by a participant every time they filled in the question of Contact Evaluation, resulting in a single Contact Evaluation score for each participant.

Statistical analysis

The analysis for this study was conducted using RStudio (version 1.4.1106; see Appendix A for the RStudio script). Demographic characteristics were calculated using percentages for gender, home country, level of education, relationship with the deceased, and reason for the loss. For age of participants, age of the deceased loved ones, and time since loss, we computed absolute numbers, means, and standard deviations. Subsequently, statistical assumptions were tested for the variable of PGD levels. The assumptions of linearity, homoscedasticity, and independence of observations were met. However, the assumption of normality was violated.

Subsequently, the research questions were examined. Linear regression was conducted to address the first two research questions. For the first research question, "To what extent does the the frequency of social contact influence PGD levels among naturally bereaved individuals?", a linear regression model was created with the Frequency of Social Contact as the independent variable and PGD levels as the dependent variable. A scatterplot was created to visualise this regression model. For the second question, "To what extent does the manner in which bereaved individuals evaluate their social contact relate to PGD levels?", another linear regression model was conducted. Here, the evaluation of social contact served as the independent variable, and PGD scores were the dependent variable. A scatterplot was created to visualise this regression model. To address the third research question: "To what extent does the evaluation of social contact moderate the relationship between the frequency of social contact and PGD levels among

naturally bereaved individuals?", a multiple regression analysis was conducted. This analysis included the interaction term between the frequency of social contact and the evaluation of social contact, along with the main effects of social contact frequency and its evaluation on PGD scores.

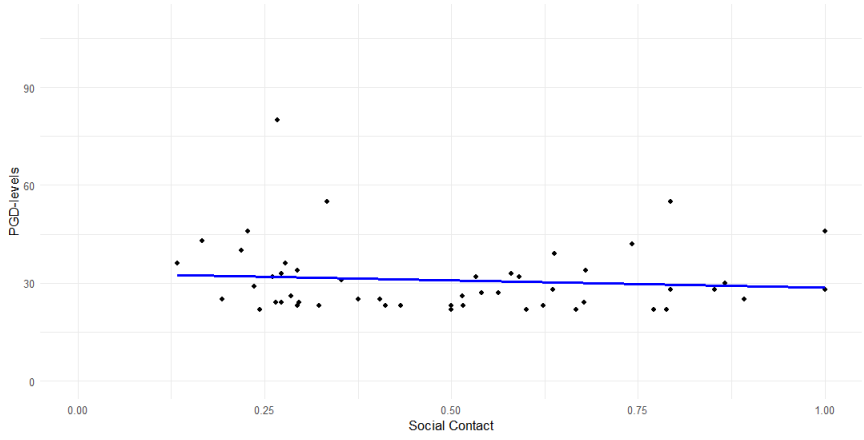
Results

Age of participants ranged from 21 to 75 years (M = 40.92, SD = 16.52). Most participants were female (72%, N = 36) and were from Germany (56%, N = 28) or the Netherlands (42%, N = 21), and indicated that college or university was their highest level of completed education (58%). Age of deceased loved ones ranged from 6 to 91 (M = 59.36 , SD = 19.11). Most of the deceased persons were a participants' parent (50%, N = 25) and passed away due to a physical disease (82%, N = 41). The time since loss varied from half a year to 26 years (M = 6.33, SD = 6.81). Within this final sample, 1 participant (2%) met the criteria for probable PGD.

After the sample characteristics were established, the regression analyses could be conducted. In order to examine the association between the Frequency of Social Contact (M = 0.49, SD = 0.24) and PGD levels (M = 30.90, SD = 10.96), a linear regression analysis was conducted. The results showed that this relationship was not significant (p = .51) with an R^2 of .01. The intercept was 33.09 (SE = 3.66, 95% CI [25.74, 40.43]), indicating the estimated PGD score when the Frequency of Social Contact would be zero. The slope of Frequency of Social Contact was equal to -4.43 (SE = 6.70, 95% CI [-17.89, 9.04]), which was not statistically significant (p = .51). This suggests that there was not a significant association between the Frequency of Social Contact and PGD levels (see Figure 1).

Figure 1

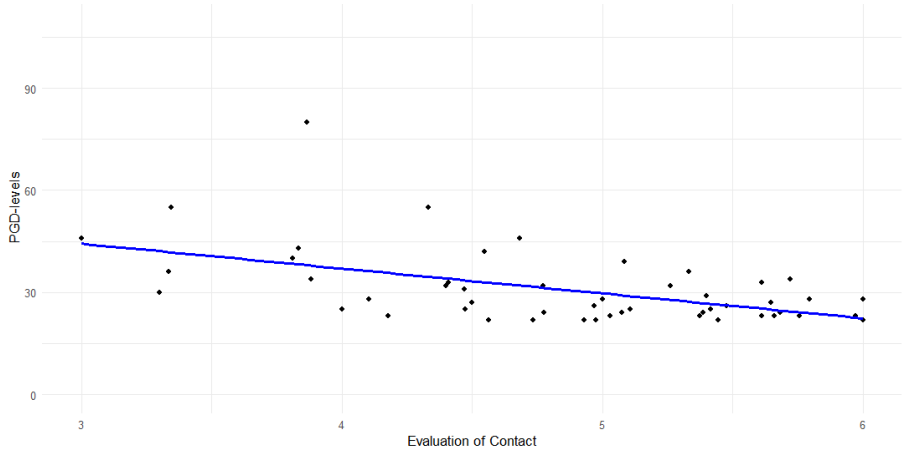
Relationship between Frequency of Social Contact and PGD levels



In order to examine the association between Contact Evaluation (M = 4.84, SD = 0.78) and PGD levels, a linear regression was conducted. The results showed that this relationship was negative and significant ($p < .001$), with an R^2 of .27. The intercept was 33.09 (SE = 3.66, 95% CI [25.74, 40.43]), indicating the estimated PGD score when Contact Evaluation would be zero. The slope for Contact Evaluation was -7.30 (SE = 1.74, 95% CI [-10.80, -3.79]), which was statistically significant ($p < .001$). This suggests that higher scores of Contact Evaluation is associated with lower PGD levels (see Figure 2).

Figure 2

Relationship between Contact Evaluation and PGD levels



In order to examine the interaction between Contact Evaluation and Frequency of Social Contact on PGD levels, a moderation analysis was conducted. The results showed that the regression model was significant (p = .001, with R^2 = .28). This means that approximately 28% of the variability in PGD scores was accounted for by the model. The adjusted R^2 was .24. The direct effect of Contact Evaluation on PGD levels was significant. On the other hand, the direct effect of Frequency of Social Contact on PGD levels was not significant. The interaction term between Contact Evaluation and Frequency of Social Contact was also not statistically significant (b = 5.44, 95% CI [-7.22, 18.11], p = .39). When taking the effect of the Frequency of Social Contact into account, the association between Contact Evaluation and PGD levels remains significant, suggesting that this association does not depend on the Frequency of Social Contact.

Discussion

This study had three main aims: (1) to investigate the relationship between social contact frequency and PGD levels, (2) to examine whether the evaluation of social contact affects PGD levels, and (3) to explore the moderating role of Contact Evaluation in the relationship between Frequency of Social Contact and PGD levels. To this end, we analyzed data collected through Experience Sampling Method (ESM), resulting in 3500 datapoints from 50 bereaved individuals.

The first research question that was investigated is as follows: "To what extent does the frequency of social contact influence PGD levels among naturally bereaved individuals?". The results showed that there was no significant association between the frequency of social contact and PGD levels. While prior research suggested that social interactions in general contribute to better well-being outcomes (Dalgard et al., 1995; Mathiesen et al., 1999), and can help to mitigate feelings of loneliness during the grieving process (Maciejewski et al., 2022), this study did not find evidence to support the notion of social contact significantly impacting PGD levels. Smith et al. (2020), pointed out that not all social interactions are beneficial, which might be important to consider. Although sometimes social contacts do not decrease one's feelings of loneliness, at other times it might exacerbate feelings of loneliness or distress (Smith et al., 2020). Moreover, bereaved individuals might sometimes suppress their emotions in social settings due to fear of judgment or the belief that others cannot cope with their grief, leading to a preference for solitude over social engagement (Smith et al., 2020; Gupta & Bonanno, 2011). Considering these findings, there seems not to be a clear consensus on the possible relationship between social contact and PGD levels. This might explain the insignificance of our results. Thus, the hypothesis that increased frequency of social contact is associated with a reduction in PGD levels among naturally bereaved individuals is rejected based on the findings of this study.

Subsequently, the study sought to answer the research question: "To what extent does the manner in which bereaved individuals evaluate their social contact relate to their PGD levels?" The results showed a significant relationship between the evaluation of social contact and PGD levels. More specifically, it was demonstrated that higher evaluations of social contact were associated with lower PGD levels. These results align with prior research. Namely, according to Dyregrov et al. (2018), bereaved individuals often judge social situations more negatively than those not experiencing grief. These negative evaluations might stem from perceived misunderstandings from others and the experienced pressure to conform to conform to societal expectations regarding the quickness with which bereaved individuals go through the grieving

process (Harris, 2010). Furthermore, while frequent social contact is generally associated with better mental health outcomes (Shor & Roelfs, 2015), the quality of these interactions is crucial. Superficial and unsatisfying social contacts may still leave individuals feeling lonely despite being frequently surrounded by others (Shor & Roelfs, 2015). Thus, the hypothesis that negative evaluations of social contact are associated with increased PGD levels is supported. The way in which bereaved individuals evaluate their social contact is significantly associated with their PGD levels.

Lastly, the study sought to answer the research question: "To what extent does the evaluation of social contact moderate the relationship between the frequency of social contact and PGD levels among naturally bereaved individuals?" The results showed that although the evaluation of social contact significantly predicted PGD levels, social contact frequency itself did not. Moreover, it was found that the interaction between the evaluation of contact and social contact were not significantly associated with PGD levels, which indicates that there was no moderating effect of contact evaluation on the relationship between social contact frequency and PGD levels. This was in contrast with our hypothesis. While it was hypothesized that positive evaluations would enhance the beneficial effects of social contact frequency on PGD levels, and negative evaluations would diminish them, the outcomes of the study did not support this interaction effect. Instead of that, the findings suggest that the quality of social contact, independently influences PGD levels irrespective of the amount of social contact. Looking at prior research, solitude has been linked to an increased preoccupation with the deceased, and more frequent feelings of loss, particularly when compared to engaging in social interactions (Snippe et al., 2016). This underscores the potential mitigating effects of favorable assessments of social interactions on PGD levels, supporting our findings that the quality of these interactions likely has a more substantial impact on grief outcomes than their frequency alone. Furthermore, literature indicates that enjoyable social environments can enhance mood, while less pleasant ones might intensify feelings of depression, reinforcing the importance of the quality of these interactions (Pemberton & Fuller Tyszkiewicz, 2016). High-quality interactions often reflect a strong social support system, which has been associated with less severe PGD in cross-sectional studies (Cacciatore et al., 2021). Engaging in positive social activities may also divert attention away from grief, potentially reducing the prevalence of ruminative thoughts known to exacerbate PGD (Eisma & Stroebe, 2021). Such ruminative behaviors are also linked with increased

negative emotions and reduced positive emotions among the bereaved, as reported in daily diary studies (Eisma et al., 2022). The lack of a moderating effect in our research may suggest that although the evaluation of social contact is pivotal, its interplay with the frequency of contact does not significantly change PGD levels, illustrating the complexity of these dynamics. This indicates that the intrinsic quality of social interactions, rather than how often they occur, might be vital in moderating grief outcomes. These findings prompt a deeper examination of the quality of social support during bereavement, rather than focusing solely on the quantitative aspects of social engagement.

Several strengths can be identified. First, a notable strength is the methodology with which data was collected. As shown by Lenferink and colleagues (2022), ESM allows to collect real-time data, while minimizing a recall bias. Instead of asking participants to recollect events, feelings of actions from the distant past, this study asked participants to report on these aspects within a much shorter timeframe. Because of this minimized recall bias, the variables Contact Evaluation and the Frequency of Social Contact were potentially measured more accurately. The second strength lies in the use of social contact frequency as a main research construct. Most prior research in the field has been conducted including subjective measures of social support, for example measuring their experienced support. These constructs can vary widely as they are based on individual perception (Shor & Roelfs, 2015). In the present study, the relatively objective measure of social contact frequency was used. Because of this, there might have been more construct validity.

However, this study also had a few noteworthy limitations. A first limitations was that the assumption of normality was violated. As indicated by the Shapiro-Wilk normality test, the variable of PGD levels did not follow a normal distribution. Still, it was chosen to use parametric tests, which might have affected the statistical power and generalizability of the regression analyses. A second limitation was that there might have been a selection bias, as some of the participants were recruited through social media and support website. As a result of using this recruitment strategy, the sample of this study might not adequately represent the population of naturally bereaved individuals. This might limit the generalizability of the findings. A third limitation is that there were technical issues in the data collection phase. Some participants did not receive notifications or received fewer than the planned five measurements on some days. These issues might have impacted the completeness of the data collection, which has possibly

affected the reliability of the study. A fourth limitation of this study is the possible influence of individual differences that might have impacted the investigated associations, but have not been taken into account. Individual differences in the enjoyment and evaluation of social interaction may be attributed to character traits, such as introversion or extraversion (Segel-Karpas & Lachman, 2016). While these traits might have affected how social contact is evaluated, this study did not account for these variables. This potentially limited the extent to which the findings can be understood.

For future research, it is recommended to include a larger sample size. The final sample size of this study consisted of 50 participants, which may have limited the generalizability of the findings and reduced the statistical power of the investigated effects. A more solid basis for the conclusion would be created by increasing the sample size and increasing the reliability of the results. Additionally, it might be valuable to incorporate more questions about social interactions in the ESM-phase so that more insights are gained on impact of social interactions on PGD levels. This might be achieved by asking participants about the nature of their interactions, such as whether the participant was listened to when sharing their feelings by the conversation partner, or was offered practical help (e.g., chores and running errands). Evaluating the contents of interactions beyond general satisfaction might help to create a more complete picture of what type of social interaction may reduce PGD levels.

In conclusion, the extent to which bereaved individuals evaluate their social contact as pleasant is likely to affect their PGD levels. Individuals who indicated their social contact to be more pleasant on average, exhibited lower levels of probable PGD. However, whether or not bereaved individuals had social contact with others did not seem to have influence on these PGD levels. Individuals who, on average, had more social contact did not exhibit significantly different PGD levels compared to those who had on average less social contact. Furthermore, the quality of the social interactions, as perceived by the bereaved, independently impacts their grief symptoms, regardless of the frequency of social contact. With these findings, this study provided insights into social aspects of bereavement. Ultimately, we anticipate that more research on this topic will benefit people who experience a loss and may need help in coping with it. In this way, the grief of bereaved individuals might be minimized as much as possible.

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Appendices

Appendix A

RStudio Script

```
#load necessary libraries
library(lubridate)
library(readr)
library(haven)
library(tidyverse)
library(dplyr)
library(foreign)
library(broom)
library(modelr)
library(lmtest)
library(psych)
library(car)
library(ggplot2)

#import dataset
data <- read.csv("ESM1_T1_ESM_T2.csv")
View(data)

## Dataset prep ##

#excluding suicidal/psychotic people
data <- data[!(data$T1_Ex._psychotic == "Ja" & !is.na(data$T1_Ex._psychotic)), ]

#excluding people who didn't do T2
T2_exluded <- data %>%
  filter(!is.na(T2_StartDate))

Number_T2excluded <- T2excluded %>%
  distinct(QualtricsID, .keep_all = TRUE) %>%
  count(QualtricsID)

#excluding people missing more than 50%
perc_excluded <- T2_excluded %>%
  group_by(QualtricsID) %>%
  summarize(perc_excluded = mean(is.na(ESM_WhereWereYou)) * 100)
def_dataset <- T2_excluded %>%
  group_by(QualtricsID) %>%
  filter(!(QualtricsID %in% perc_excluded[perc_excluded$perc_excluded > 50, ]$QualtricsID))

#number of participants after implementing exclusion criteria
NO_participants <- length(unique(def_dataset$QualtricsID))

## Descriptive Statistics ##

#number of participants having a PGD score higher than 71
high_PGD_scores <- wide_variables_def %>%
  filter(PGD_score >= 71)

#gender
number_gender<- def_dataset %>%
```

```
  group_by(T1_Gender) %>%
  summarize(count = n())
number_gender$count
summary(number_gender$T1_Gender)

#age
age1 <- def_dataset %>%
  distinct(QualtricsID, .keep_all = TRUE) %>%
  select(QualtricsID, T1_Date_of_interview, T1_DoD)

age1 <- def_dataset %>%
  mutate(T1_Date_of_interview = dmy(T1_Date_of_interview),
         T1_DoD = dmy(T1_DoD)) %>%
  mutate(Age_at_Interview = interval(T1_DoD, T1_Date_of_interview) / years(1)) %>%
  select(QualtricsID, T1_Date_of_interview, T1_DoD, Age_at_Interview)

age1 <- data.frame(
  date_of_interview = def_dataset$T1_Date_of_interview
)

age2 <- data.frame(
  date_of_death = def_dataset$T1_DoD
)

age1$date_of_interview <- age2$date_of_death
age1$age <- as.numeric(difftime(age1$date_of_interview, age1$T1_DoD, units = "days")/365.25)

age3 <- def_dataset %>%
  distinct(QualtricsID, .keep_all = TRUE) %>%
  select(QualtricsID, T1_DoD, T1_Date_of_interview)

age3$T1_Date_of_interview <- case_when(
  grepl("/", age3$T1_Date_of_interview) ~ dmy(age3$T1_Date_of_interview),
  grepl("-", age3$T1_Date_of_interview) ~ dmy(age3$T1_Date_of_interview),
  grepl("\\.", age3$T1_Date_of_interview) ~ dmy(age3$T1_Date_of_interview),
  TRUE ~ NA_Date_
)

age3$T1_DoB <- case_when(
  grepl("/", age3$T1_DoD) ~ dmy(age3$T1_DoD),
  grepl("-", age3$T1_DoD) ~ dmy(age3$T1_DoD),
  grepl("\\.", age3$T1_DoD) ~ dmy(age3$T1_DoD),
  TRUE ~ NA_Date_
)

age3$age <- as.numeric(difftime(age3$T1_Date_of_interview, age3$T1_DoD, units = "days")/365.25)

age3$age <- floor(age3$age)

sd_of_mean_age <- sd(age3$age) / sqrt(length(age3$age))

#level of education
number_education <- def_dataset %>%
  distinct(QualtricsID, .keep_all = TRUE) %>%
  count(T1_Education)
summary(number_education)
```

```
rate_education <- table(number_education$T1_Education)
perc_education <- prop.table(rate_education) * 100

#home country
number_country <- def_dataset %>%
  distinct(QualtricsID, .keep_all = TRUE) %>%
  count(T1_Home_country)

summary(number_country$T1_Home_country)

number_country$T1_Home_country <- tolower(number_country$T1_Home_country)
rate_country <- table(number_country$T1_Home_country)
perc_country <- prop.table(rate_country) * 100

#unexpectedness of death
unexpected <- def_dataset %>%
  distinct(QualtricsID, .keep_all = TRUE) %>%
  count(T1_A_un_expected)

rate_unexpected <- table(unexpected$T1_A_un_expected)
perc_unexpected <- prop.table(rate_unexpected) * 100

#age of deceased
age_deceased <- def_dataset %>%
  distinct(QualtricsID, .keep_all = TRUE) %>%
  count(T1_age_deceased)
summary(age_deceased)

mean(age_deceased$T1_age_deceased)
sd(age_deceased$T1_age_deceased)
min(age_deceased$T1_age_deceased)
max(age_deceased$T1_age_deceased)

#kinship
text_kinship <- def_dataset %>%
  distinct(QualtricsID, .keep_all = TRUE) %>%
  count(T1_kinship_8_TEXT)
summary(text_kinship)

rate_kinship <- table(text_kinship$T1_kinship_8_TEXT)
perc_kinship <- prop.table(rate_kinship) * 100

#cause of death
cause_of_death <- def_dataset %>%
  distinct(QualtricsID, .keep_all = TRUE) %>%
  count(T1_cause)

rate_cause <- table(cause_of_death$T1_cause)
perc_cause <- prop.table(rate_cause) * 100

text_cause <- def_dataset %>%
  distinct(QualtricsID, .keep_all = TRUE) %>%
  count(T1_cause_5_TEXT)
summary(text_cause)
```

```
rate_cause <- table(text_cause$T1_cause_5_TEXT)
perc_cause <- prop.table(rate_cause) * 100

## PGD LEVELS ##

#creating total PGD-score
def_dataset$PGD_score <- rowSums(def_dataset[, 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")])

#creating function for PGD-score
calculate_PGD_score <- function(def_dataset) {
  def_dataset$PGD_score <- rowSums(select(def_dataset, starts_with("T2_TGI_CA_1_")))
  return(def_dataset)
}

variables_def <- def_dataset %>%
  group_by(QualtricsID) %>%
  do(calculate_PGD_score(.))

#WithOthers & QualityContact into factors
variables_def <- variables_def %>%
  mutate(ESM_WithOthers = factor(ESM_WithOthers, levels = c(1, 2, 3), labels = c("alone", "with one other", "with
multiple others")),
         ESM_QualityContact = factor(ESM_QualityContact, levels = 0:6, labels = c("very unpleasant", "unpleasant",
"somewhat unpleasant", "neither pleasant nor unpleasant", "somewhat pleasant", "pleasant", "very pleasant"))) %>%
  ungroup()

#WithOthers into nominal variable
variables_def <- variables_def %>%
  mutate(ESM_WithOthers = case_when(
    ESM_WithOthers == "alone" ~ 0,
    TRUE ~ 1
  ))

#QualityContact into ordinal variable
variables_def$ESM_QualityContact <- factor(variables_def$ESM_QualityContact,
                                           levels = c("very unpleasant", "unpleasant", "somewhat unpleasant",
                                                      "neither pleasant nor unpleasant", "somewhat pleasant",
                                                      "pleasant", "very pleasant"),
                                           ordered = TRUE)

variables_def$ESM_QualityContact <- as.integer(variables_def$ESM_QualityContact) - 1

# Removing NA values for WithOthers, QualityContact and PGD-score
variables_def <- na.omit(variables_def[, c("ESM_QualityContact", "ESM_WithOthers", "PGD_score")])

# Calculating scores
variables_def <- def_dataset %>%
  group_by(QualtricsID) %>%
  do(calculate_PGD_score(.)) %>%
  ungroup() %>%
  mutate(PGD_score = as.numeric(PGD_score))
```

```
variables_def <- variables_def %>%
  filter(!is.na(ESM_WithOthers) & !is.na(ESM_QualityContact)) %>%
  mutate(
    ESM_WithOthers = factor(ESM_WithOthers, levels = c(1, 2, 3), labels = c("alone", "with one other", "with
multiple others")),
    ESM_QualityContact = factor(ESM_QualityContact, levels = 0:6, labels = c("very unpleasant", "unpleasant",
"somewhat unpleasant", "neither pleasant nor unpleasant", "somewhat pleasant", "pleasant", "very pleasant")),
    ESM_QualityContact_num = as.numeric(ESM_QualityContact) - 1
  )

variables_def <- variables_def %>%
  mutate(ESM_WithOthers = ifelse(ESM_WithOthers == "alone", 0, 1))

# Aggregation of data
variables_def <- variables_def %>%
  group_by(QualtricsID) %>%
  summarize(
    across(everything(), ~ if (is.numeric(.)) mean(., na.rm = TRUE) else first(.)) +
      mean_WithOthers = mean(mean_WithOthers, na.rm = TRUE) +
      mean_QualityContact_num = mean(ESM_QualityContact_num, na.rm = TRUE) +
      .groups = 'drop'
  )

# Social contact recoding
variables_def <- variables_def %>%
  mutate(ESM_WithOthers = ifelse(ESM_WithOthers == 0, "alone", "social contact"))

summary <- variables_def %>%
  group_by(QualtricsID) %>%
  summarise(
    alone_count = sum(ESM_WithOthers == "alone"),
    social_contact_count = sum(ESM_WithOthers == "social contact")
  )

summary <- variables_def %>%
  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)

# Calculate the mean PGD-score and QualityContact for each participant
mean_scores <- variables_def %>%
  group_by(QualtricsID) %>%
  summarise(
    mean_PGD_score = mean(PGD_score, na.rm = TRUE),
    mean_QualityContact_num = mean(mean_QualityContact_num, na.rm = TRUE)
  )

# Mean scores matched with other dataset
summary <- summary %>%
  left_join(mean_scores, by = "QualtricsID")

## Assumptions Testing ##
```

```
## Normality tests for each variable
par(mfrow = c(3, 2))

# PGD score
hist(variables_def$PGD_score, main = "Histogram of PGD Score", xlab = "PGD Score")
qqnorm(variables_def$PGD_score, main = "Q-Q Plot of PGD Score")
qqline(variables_def$PGD_score, col = "red")
print(shapiro.test(variables_def$PGD_score))

# ESM_QualityContact_num
hist(wide_variables_def$mean_QualityContact_num, main = "Histogram of Quality Contact", xlab = "Quality
Contact")
qqnorm(wide_variables_def$mean_QualityContact_num, main = "Q-Q Plot of Quality Contact")
qqline(wide_variables_def$mean_QualityContact_num, col = "red")
print(shapiro.test(wide_variables_def$mean_QualityContact_num))

# ESM_WithOthers
hist(variables_def$mean_WithOthers, main = "Histogram of With Others", xlab = "With Others")
qqnorm(variables_def$mean_WithOthers, main = "Q-Q Plot of With Others")
qqline(variables_def$mean_WithOthers, col = "red")
print(shapiro.test(variables_def$mean_WithOthers))

# Plot
ggplot(wide_variables_def, aes(x = mean_WithOthers, y = PGD_score)) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE) +
  labs(title = "PGD Score vs. Social Contact")

# Plot
ggplot(wide_variables_def, aes(x = mean_QualityContact_num, y = PGD_score)) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE) +
  labs(title = "PGD Score vs. Quality Contact")

## Homoscedasticity and linearity checks after fitting the models
model1A <- lm(PGD_score ~ mean_WithOthers, data = wide_variables_def)
model2A <- lm(PGD_score ~ mean_QualityContact_num, data = wide_variables_def)

par(mfrow = c(2, 2))
plot(model2A)
par(mfrow = c(1, 1))

# Breusch-Pagan test for homoscedasticity
bptest_result2 <- bptest(model2A)

plot(model1A$fitted.values, model1A$residuals,
    main = "Residuals vs Fitted Values",
    xlab = "Fitted Values",
    ylab = "Residuals",
    pch = 20,
    col = "blue")
abline(h = 0, col = "red")

## Independence of observations
durbin_watson1 <- durbinWatsonTest(model1A)
```

```
print(durbin_watson1)

durbin_watson2 <- durbinWatsonTest(model2A)
print(durbin_watson2)

# Reliability (Cronbach's Alpha)
CA1 <- psych::alpha(wide_variables_def[, 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")])

## Descriptive Statistics of Important Variables ##
mean_sd <- wide_variables_def %>%
  summarise(
    mean_WithOthers_mean = mean(mean_WithOthers, na.rm = TRUE),
    mean_WithOthers_sd = sd(mean_WithOthers, na.rm = TRUE),
    mean_QualityContact_num_mean = mean(mean_QualityContact_num, na.rm = TRUE),
    mean_QualityContact_num_sd = sd(mean_QualityContact_num, na.rm = TRUE),
    PGD_score_mean = mean(PGD_score, na.rm = TRUE),
    PGD_score_sd = sd(PGD_score, na.rm = TRUE)
  )

## Linear Regression Models ##
model1A <- lm(PGD_score ~ mean_WithOthers, data = wide_variables_def)
summary(model1A)

model2A <- lm(PGD_score ~ mean_QualityContact_num, data = wide_variables_def)
summary(model2A)

## Scatterplots ##

# First plot: Social Contact and PGD Score
ggplot(wide_variables_def, aes(x = mean_WithOthers, y = PGD_score)) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE, col = "blue") +
  labs(title = "Relationship between Social Contact and PGD Score",
       x = "Mean Social Contact",
       y = "PGD Score") +
  xlim(0, 3) +
  ylim(0, 110) +
  theme_minimal()

# Second plot: Quality of Social Contact and PGD Score
ggplot(wide_variables_def, aes(x = mean_QualityContact_num, y = PGD_score)) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE, col = "blue") +
  labs(title = "Relationship between Quality of Social Contact and PGD Score",
       x = "Mean Quality of Social Contact",
       y = "PGD Score") +
  xlim(0, 6) +
  ylim(0, 110) +
  theme_minimal()

## Moderation Analysis ##
```

```
mod_model <- lm(PGD_score ~ mean_QualityContact_num * mean_WithOthers, data = wide_variables_def)
model_summary <- summary(mod_model)
conf_intervals <- confint(mod_model)

# Compute Cook's distances
cooksd <- cooks.distance(mod_model)
influential_points <- which(cooksd > 4 / nrow(summary_counts))
```