Investigating the relationship between self-monitoring satisfaction and prolonged grief disorder symptoms in bereaved individuals

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Abstract

Introduction. A minority of bereaved individuals experiences intensified grief that impairs them in daily life for a longer period of time, known as Prolonged Grief Disorder (PGD). Several studies indicate the potential benefits of using Experience Sampling Methodology (ESM) to assess PGD. As ESM is a form of self-monitoring, it is also suggested that it could have similar therapeutic potential as self-monitoring, which was associated with reduced symptomatology in some samples. It is also suggested that self-monitoring satisfaction may be related to the efficacy of self-monitoring. As this relationship is yet undefined in the context of PGD, this study aimed to investigate the influence of self-monitoring satisfaction on PGD levels. *Methods.* Sixty-nine bereaved individuals' PGD levels before and after self-monitoring and their satisfaction with self-monitoring were assessed. The association between self-monitoring satisfaction and PGD levels was examined using a linear regression model. Two additional linear models were created which added a control variable each, first number of observations and finally initial PGD levels. *Results.* Results showed that self-monitoring satisfaction was positively associated with PGD levels. Number of observations was not related to PGD levels and did not significantly alter the association between self-monitoring satisfaction and PGD levels. When initial PGD levels were controlled for, self-monitoring satisfaction no longer predicted PGD levels. Initial PGD levels did strongly predict PGD levels after self-monitoring. *Conclusion.* The findings indicate that self-monitoring satisfaction did not seem to be related to PGD levels through an influence on the efficacy of self-monitoring. It is possible that self-monitoring satisfaction was found to be higher for individuals with higher PGD levels due to an increased motivation or perceived need for self-monitoring. This relationship should be investigated further in future research.

Introduction

Experiencing psychological and physiological symptoms is a natural response to the loss of a loved one and is a common process known as grief (Lundorff et al., 2017). According to research by Jordan and Litz (2014), grief symptoms are high in the early stages of the grieving process and gradually decrease over time. A study by Bonnano et al. (2002) found that in 45% of a sample of bereaved individuals, grief symptoms had largely subsided within 18 months after the loss. Other research suggested that for some bereaved people, PGD symptoms remain relatively stable after the loss and may persist for a longer period of time (Djelantik et al., 2022; Pociunaite et al., 2023). Despite the impact of a loss, most bereaved individuals are capable of managing their grief and adjusting to life without their loved one by picking up their daily life routine, responsibilities and pleasurable activities after some time (Lundorff et al., 2017; Jordan & Litz, 2014). In some instances, however, individuals can experience higher levels of grief symptomatology which impairs them in different areas of functioning for a longer period of time (Szuhany et al., 2021). Researchers suggested that these characteristics were not part of the usual grieving process and could point to the presence of a prolonged grief disorder (PGD) (Prigerson et al., 2021).

In November of 2022, the DSM-5-TR included PGD into their inventory of mental disorders (American Psychiatric Association [APA], 2022). PGD symptoms include an intense and persistent longing for the deceased and a preoccupation with the deceased and/or the circumstances surrounding their death (Djelantik et al., 2020). These, along with other PGD symptoms, cause the bereaved individual significant impairment in social, occupational and other aspects of daily life. Although bereaved individuals can already experience PGD symptoms shortly after their loss, PGD can be diagnosed when symptoms persist for over a month at 12 months post-loss (six months after the loss for children and adolescents) (Lundorff et al., 2017). PGD affects 7-10% of bereaved individuals (Szuhany et al., 2021).

Studies suggests that grief is a dynamic process (Avis et al., 2021; Bonanno & Kaltman, 2001). This emphasises the importance of assessing PGD in daily life (Reis, 2012). A useful way to assess symptomatology and mental states in daily life is through the experience sampling methodology (ESM), otherwise known as ecological momentary assessment (EMA) (Myin-Germeys et al., 2018). With ESM, participants are asked to fill out a short questionnaire multiple times a day for a certain amount of time where they are asked about how they are feeling, what they are experiencing that day and in what context (e.g. where they are and with whom). ESM seems to be a successful tool for recording symptoms and understanding internal

experiences and environmental factors, as it can provide insights into the behavioural and emotional patterns of the bereaved and the role of context, contact and daily activities (Myin-Germeys et al., 2018). Research by Lenferink, Van Eersel, et al. (2022) suggested that ESM can also be useful in the context of PGD, which assessed PGD symptoms more accurately in comparison with retrospective recording of symptoms and includes contextual determinants of PGD in daily life as well. This may provide a more comprehensive and accurate picture of PGD in individuals' natural environment and in daily life (Mintz et al., 2023).

The procedure of self-reporting mental states daily with ESM makes it a form of self-monitoring, which is a process that involves recording certain behaviours, thoughts or emotions systematically. Several researchers have indicated the potential for therapeutic use of self-monitoring through ESM. Research by Van Os et al. (2017) suggests that the self-monitoring functions of ESM can empower individuals to a) take command of their coping or recovery process; b) raise individuals' awareness of their mental state and requirements for improvement; and c) help individuals to understand and accept their circumstances and emotions. Furthermore, research by Morris et al. (2010) found that self-monitoring seems to be associated with increased emotional self-awareness (ESA), which is said to help individuals a) put their emotional distress into context; b) regulate their reactions to stressful events; and c) beneficially influence positive mood and coping strategies. Congruently, their study found a positive influence on mood and coping strategies associated with self-monitoring. Research from Kauer et al. (2012) also found increased ESA after self-monitoring, which in turn decreased symptoms of depression in their sample. They posited that increased ESA associated with self-monitoring may also be beneficial for other disorders, which could apply to PGD as well. In a study by Lenferink, Van Eersel, et al. (2022), moment-to-moment data from ESM yielded lower levels of PGD symptoms when compared to retrospective data in bereaved individuals. Other research also suggests that using ESM may avoid overrepresenting symptoms as opposed to reporting symptoms retrospectively (Myin-Germeys et al., 2009; Scollon et al., 2003). Avoiding overreporting symptoms with ESM may cause individuals to look more accurately and positively on their grieving process, which can be important for treatment efficacy and patient outcome (Ben-Zeev & Young, 2010).

Satisfaction with treatment processes seems to be associated with symptomatology (McElvaney & Timulak, 2013). In research, satisfaction is often assessed using the Reactions to Research Participation Questionnaire (RRPQ), which measures satisfaction with research participation (Newman et al., 2001). A study by Nilsson et al. (2007) found that in a sample of patients receiving Cognitive Behavioural Therapy or Psychodynamic Therapy, higher

satisfaction with the therapy was associated with lower symptomatology and improved coping strategies (particularly in relation to feelings) and emotional stability. Research by Wenzel et al. (2008) also found that a positive attitude towards treatment was associated with lower symptoms for borderline personality disorder. As self-monitoring mental health is an independent and self-administered process, individual's attitudes towards and satisfaction with the self-monitoring process may be related to the efficacy of self-monitoring as well (Charlier, 2020). Research by Parks-Leduc et al. (2014) suggests that self-monitoring and its potential influence on symptoms are regulated both by motivation and satisfaction regarding self-monitoring and self-monitoring skill, which is one's capacity to change behaviour in order to improve. A positive disposition towards self-monitoring and a desire for change seem to be associated with the success of self-monitoring in reducing symptoms according to a literature review by Korotitsch and Nelson-Gray (1999). Although these findings provide a starting point, there is insufficient empirical evidence concerning self-monitoring satisfaction's association with symptomatology. The influence of self-monitoring satisfaction on symptoms has also not been explored in the context of PGD.

To that end, this study aimed to investigate how self-monitoring satisfaction is related to PGD levels in bereaved individuals. It was expected that individuals who reported higher levels of satisfaction with the self-monitoring process would experience lower PGD levels after self-monitoring than individuals who reported lower levels of satisfaction, while controlling for PGD levels before self-monitoring.

Methods

Participants and procedures

This study is part of the Grief in Daily Life (Grief-ID) project, which focuses on examining and treating PGD symptoms in daily life. The present study concerns a secondary analysis of data collected by Lenferink, Van Eersel, et al. (2022). Participants in this study were adults fluent in Dutch or German who suffered the loss of a significant other (i.e., partner, family member or friend) at least three months prior to participating in the study. The participants needed to own a smartphone to be able to participate. Exclusion criteria were suicidal ideations or (previously) being diagnosed with a psychotic disorder. Participants were recruited through advertisements posted on social media platforms for networks of the researchers. In addition, websites for bereaved individuals were used to post materials for recruitment. People participating in the study had a chance to win a €50 voucher. Ethical

approval was granted by the ethics committee of the University of Twente under request number 211101.

Participants first received an information letter and were then asked to read and sign an informed consent form. After this, trained Master students in Psychology conducted interviews via telephone at Time point 1 (T1), that lasted 47 minutes on average. In these telephone interviews, information regarding background, loss-related characteristics, PGD symptoms and exclusion criteria was collected. After T1 was finished, participants started the ESM-phase with the help of instructional materials and, where needed, technical support from the research team. The ESM data was collected using the Avicenna (Ethica) app for two weeks and five times per day. After completing the ESM-phase, telephone interviews were conducted with the participants again at Time point 2 (T2). For the telephone interviews at T2, PGD levels were assessed again as well as the level of satisfaction with the self-monitoring process (ESM). For this study, only data from T1 and T2 measures were examined.

Measures

Traumatic Grief Inventory - Clinician Administered (TGI-CA)

The TGI-CA was administered at T1 and T2, which is a version of the self-report test *Traumatic Grief Inventory – Self Report Plus* (TGI-SR+), adapted to be administered through interviews (Lenferink et al., 2023). The measure comprises 22 items meant to test for PGD symptoms. Originally, the TGI-CA measures symptoms 'over the past month'. Because the ESM period is two weeks, the TGI-CA was adapted for this study to measure symptoms 'over the past two weeks'. An example is "In the past two weeks, did you have difficulty accepting the loss of your loved one?". These questions were rated from 1 (*never*) to 5 (*always*). In this study, total scores were created for TGI-CA data at both T1 and T2 by summing the scores for all items. The cut-off score for probable caseness for PGD when using the TGI-CA is the same as for the TGI-SR+, which is a total score of ≥71, as only the manner of administering is altered (Lenferink, Eisma, et al., 2022). The psychometric properties of the TGI-CA are sound (Lenferink, Franzen, et al., 2022) and a Cronbach's alpha of 0.88 at both T1 and T2 was observed for this particular sample.

Reactions to Research Participation Questionnaire (RRPQ)

At T2, the RRPQ was administered. This questionnaire is designed to assess satisfaction with research participation (Newman et al., 2001). For this study, the items were adapted to test for participants' satisfaction with the ESM part of the study that was used as a form of self-

monitoring, similar to a previous study's approach (Waterman et al., 2019). For example, "Did you personally find research participation meaningful?" was changed to "Did you personally find participation in the daily diary measures meaningful?". These questions were rated from 1 (*strongly disagree*) to 5 (*strongly agree*). There were two subscales: Personal Benefits (relating to positive experiences with the ESM-phase) and Emotional Reactions (relating to emotional issues evoked by participating in the ESM-phase), both consisting of four items. For this research, only the Personal Benefits items were used, as these items specifically measure satisfaction with the self-monitoring. The scores on the four items in the Personal Benefits factor were summed to create a total score for 'self-monitoring satisfaction'. Both the original and adapted version of the RRPQ have sufficiently sound psychometric properties (Kassam-Adams & Newman, 2002; Scotti et al., 2012; Waterman et al., 2019). A Cronbach's alpha of 0.85 for the Personal Benefits items was observed for the present sample.

Data analysis

For data analysis, the RStudio statistical analysis software version 4.3.0 was used (see Appendix A). Before conducting analyses, subjects with incomplete data were removed from the matrix. The assumptions of linearity, independence, homoscedasticity and normality of residuals were tested.

Following data preparation, a linear regression model was fitted with PGD levels at T2 as the dependent variable and self-monitoring satisfaction as the independent variable. After this, a multiple linear regression model was created. This model introduced number of observations (frequency of entries during the ESM self-monitoring process) as a control variable to the previous analysis, to account for the degree of participation in self-monitoring. Lastly, another multiple linear regression model was created. This model included the same variables with the addition of PGD levels at T1 as a second control variable. An alpha level of 0.05 was used as a measure of significance. Explained variance coefficients were produced as well. Although lower R-squared values can sometimes be acceptable, a value of >0.6 is generally considered acceptable and <0.6 is considered weak (Ozili, 2022). The models' output was visualised in plots.

Results

Assumption testing

The assumption of linearity was tested using a scatterplot, which revealed linearity, meaning that the assumption of linearity was met (see Appendix B Figure 1). the assumption

of independence was met when tested using the Durbin-Watson test, as it indicated no significant autocorrelation ($DW = 1.66$, $p = 0.064$). The Breusch-Pagan test ($BP = 18.08$, $p < 0.001$) showed that the assumption of homoscedasticity was violated. Additionally, the fitted values were plotted against the residual values in a graph to see whether homoscedasticity could be observed (see Appendix A Figure 2). The plot revealed patterned scatter and a Lowess Line that was not horizontal and centred around zero, indicating heteroscedasticity. To address this, the model was adjusted to handle the violation by using robust standard errors that account for heteroscedasticity in the residuals. This adjustment ensures the validity of statistical inference despite the violation by accounting for the previously unaddressed variability in the errors. The Shapiro-Wilk test was used to test the assumption of normality of residuals, which was violated ($W = 0.94$, $p = 0.003$). This issue was addressed by identifying and removing outliers using Cook's distance. After removing outliers, the Shapiro-Wilk test was conducted again, which indicated that the assumption of normality of residuals was not violated after this adjustment ($W = 0.99$, $p = 0.695$).

Sample characteristics

Out of the total of 69 participants, there were 18 (26.09%) males and 51 (73.91%) females in the sample with a mean age of 41.51. Thirty-seven participants (53.62%) were born in Germany, 30 (43.48%) were born in the Netherlands and two participants (2.90%) were born elsewhere. Forty-one participants (59.42%) had a college or university level of education and 28 (40.58) had a level of education lower than college or university. Fifty-six losses (81.16%) were due to natural causes, five (7.25%) were due to suicide, one (1.45%) to a homicide and seven losses (10.15%) were caused by something else.

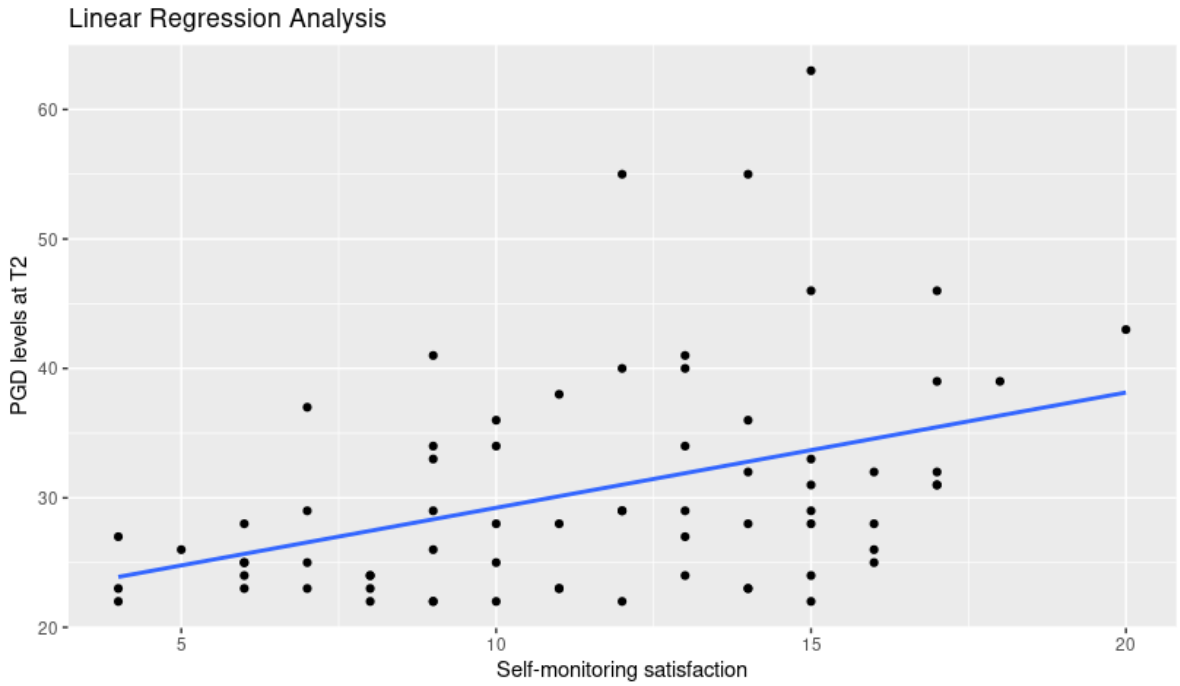
PGD levels at T1 had a mean value of 35.86 ($SD = 10.47$, range = 22-76). For PGD levels at T2, the mean was 30.57 ($SD = 8.67$, range = 22-63). Lastly, self-monitoring satisfaction (RRPQ total scores) had a mean score of 11.49 ($SD = 3.92$, range = 4-20). There was one participant with PGD levels above the probable caseness cut-off score of 71 at T1, and none at T2.

Linear regression analyses

The results from the linear regression model with self-monitoring satisfaction predicting PGD levels at T2 indicated a significant positive relationship ($b = 0.89$, $t(67) = 3.60$, $p < 0.001$). However, the amount of explained variance was weak ($R^2 = .16$, $R^2_{adjusted} = .15$, $F(1, 67) = 12.97$, $p < 0.001$). The scatterplot visually represents the found relationship (see Figure 1).

Figure 1

Visualised association between self-monitoring satisfaction and PGD levels



Note. PGD = Prolonged Grief Disorder; T2 = Time point 2 (after self-monitoring)

The results from the multiple linear regression model with number of observations as a control variable are displayed in Table 1. The results indicated a significant positive relationship between self-monitoring satisfaction and PGD levels at T2 (b = 1.00, $t(66)$ = 4.01, p < .001). Number of observations did not significantly predict PGD levels at T2 (b = -0.12, $t(66)$ = -1.88, p = 0.064). The explained variance coefficients for this multiple linear regression model were weak (R^2 = 0.21, $R^2_{adjusted}$ = 0.18, $F(2, 66)$ = 8.50, p < .001).

Table 1

Regression coefficients for associations between self-monitoring satisfaction, number of observations and PGD levels.

Predictor	Estimate	Robust Std. Error	$t(66)$	p-value
(Intercept)	23.79	2.60	6.85	< .001
Self-monitoring satisfaction	1.00	0.20	4.01	< .001
Number of observations	-0.12	0.05	-1.88	0.064

Note. PGD = Prolonged Grief Disorder

The results of the multiple linear regression model with both number of observations and PGD levels at T1 as control variables are displayed in Table 2. Self-monitoring satisfaction no longer predicted PGD levels at T2 when controlling for PGD levels at T1 (b = 0.26, t(65) = 1.56, p = 0.124). The relationship between number of observations and PGD levels at T2 remained non-significant (b = -0.05, t(65) = -1.29, p = 0.201). PGD levels at T1 significantly predicted PGD levels at T2 (b = 0.65, t(65) = 10.90, p < .001). The amount of explained variance increased to an acceptable 71% when including PGD levels at T1 as a predictor of PGD levels at T2 (R^2 = 0.72, $R^2_{adjusted}$ = 0.71, F(3, 65) = 55.35, p < .001).

Table 2

Regression coefficients for associations between self-monitoring satisfaction, number of observations, PGD levels at T1 and PGD levels at T2.

Predictor	Estimate	Robust Std. Error	t(65)	p-value
(Intercept)	6.16	2.46	2.34	0.023
Self-monitoring satisfaction	0.26	0.16	1.56	0.124
Number of observations	-0.05	0.04	-1.29	0.201
PGD levels at T1	0.65	0.06	10.90	< .001

Note. PGD = Prolonged Grief Disorder; T1 = Time point 1 (before self-monitoring)

Discussion

This study aimed to investigate the relationship between self-monitoring satisfaction and PGD levels among bereaved individuals. It was hypothesised that higher self-monitoring satisfaction would relate to lower PGD levels after self-monitoring when controlling for initial PGD levels (i.e. before self-monitoring). Results showed that self-monitoring satisfaction was positively associated with PGD levels, but when the initial PGD levels were controlled for, this association was not significant anymore. In addition, self-monitoring satisfaction by itself explained a small amount of variance in PGD levels. Number of observations was not related to PGD levels after self-monitoring. Conversely, analysis showed that initial PGD levels seemed to be strongly associated with PGD levels after the self-monitoring process and explained an acceptable amount of variance.

The first association that was examined was between self-monitoring satisfaction and PGD levels independently. Results of this analysis showed that higher self-monitoring

satisfaction was associated with higher PGD levels. This deviates from findings by Nilsson et al. (2007) concerning Cognitive Behavioural Therapy and Psychodynamic Therapy and Wenzel et al. (2008) for borderline personality disorder, which found that higher satisfaction with treatment was associated with lower symptomatology. Previous research on self-monitoring satisfaction's relationship with symptomatology is limited, especially in the context of PGD. However, Lenferink, Van Eersel, et al. (2022) also found that higher PGD levels were associated with higher reported personal benefits from ESM (i.e. self-monitoring satisfaction). They reasoned that individuals with higher PGD levels may benefit more from self-monitoring than individuals with lower PGD levels and therefore report a higher degree of self-monitoring satisfaction. The literature review by Korotitsch & Nelson-Gray (1999) made a similar argument. It referenced two studies by Lipinski et al. (1975) and Komaki and Dore-Boyce (1978), which found that individuals who volunteered for treatment or requested help had higher motivation for change and perceived personal benefits as those who did not volunteer or ask for treatment. This was associated with higher efficacy of self-monitoring in their sample. Notably, the studies assessed motivation with one question in a questionnaire, which may decrease the reliability of this assessment. Moreover, the methods for self-monitoring were mostly centred around group discussions and have limited similarities with self-monitoring through ESM. Several studies indicated that higher initial symptomatology is related to an increase in motivation, intention and perceived need to seek treatment (Edlund et al., 2006; Mojtabai et al., 2010; Rickwood & Braithwaite, 1994). Combining these findings shows that individuals with higher levels of initial symptoms may have higher motivation and perceived need for self-monitoring. Thus, they may report more personal benefits i.e. higher self-monitoring satisfaction. Therefore, it is possible that higher initial PGD levels lead to higher self-monitoring satisfaction, as opposed to higher self-monitoring satisfaction leading to higher PGD levels after self-monitoring.

The influence of number of observations during self-monitoring was examined as well. Whereas research by Morris et al. (2010) found participation in self-monitoring to be associated with decreased symptomatology, a higher number of observations was not related to PGD levels in the sample of the present study. This means that more self-monitoring was not associated with higher or lower PGD levels. Kauer et al. (2012) found self-monitoring to be associated with larger decreases in depression symptoms in comparison to a control group that did not self-monitor. Although individuals who dropped out or had minimal engagement in self-monitoring were included in the present sample as well, no such association was found in this study. The association between self-monitoring satisfaction and PGD levels remained after

controlling for number of observations. This means that the degree to which participants engaged in self-monitoring did not seem to change self-monitoring satisfaction's relationship with PGD levels.

Finally, initial PGD levels were controlled for. Results showed that the association between self-monitoring satisfaction and PGD levels disappeared when initial PGD levels were accounted for. This contradicts research by Charlier (2020) and Parks-Leduc et al. (2014), which identified satisfaction with self-monitoring as being related to the efficacy of self-monitoring. Initial PGD levels were found to be strongly associated with PGD levels after self-monitoring and explained an acceptable amount of variance, while self-monitoring satisfaction and number of observations did not. This means that initial PGD levels may substantially determine subsequent PGD levels and be a better predictor of PGD levels than self-monitoring satisfaction and number of observations. This strong association and self-monitoring satisfaction no longer predicting PGD levels after self-monitoring suggests that self-monitoring satisfaction is not related to PGD levels by enhancing the efficacy of self-monitoring. This further corroborates the possibility that higher initial symptoms being associated with higher reported satisfaction with self-monitoring could potentially explain these findings (Lenferink, Van Eersel, et al., 2022).

Limitations and future directions

One limitation of this study is the relatively small sample size, which might decrease the validity of the results. Furthermore, only one participant exceeded the cut-off score for probable caseness of PGD at T1 and zero at T2. This limited representation of individuals with diagnosable levels of PGD may decrease generalisability of the findings across clinical populations. Another limitation is that the self-monitoring phase only lasted for two weeks. The medium used for self-monitoring in this study was ESM, for which 2 weeks is the conventional timespan. However, studies that used other types of self-monitoring suggested that longer periods of self-monitoring may be more beneficial. For instance, Morris et al. (2010) found the lowest levels of anxiety in week three and four of self-monitoring. Notably, this study used certain therapeutic exercises in addition to self-monitoring, which may have influenced symptoms as well. Kauer et al. (2012) suggested 2-4 weeks to be an optimal timespan for self-monitoring and found a steady decrease in depression symptoms per week, suggesting that more weeks of self-monitoring would be associated with a larger decrease in symptoms. Thus, if participants in the present study had self-monitored for a longer period of time, the findings may have been different. Furthermore, participants who dropped out of the study may have

influenced the data. For example: a) individuals who were dissatisfied with the self-monitoring; b) individuals with high PGD levels for whom the study was too burdensome; and c) individuals with low PGD levels who did not feel continued participation was necessary may have dropped out, removing (potentially) deviating data. Moreover, most losses were due to natural causes, and happened multiple years prior to participating in the study, which means the findings may not be generalisable to individuals who have suffered recent or traumatic losses.

Higher initial symptomatology resulting in more satisfaction with self-monitoring due to higher motivation and perceived need was considered as a possible explanation for the findings in this study (Korotitsch & Nelson-Gray, 1999; Mojtabai et al., 2010). As the present study and previous research cannot confirm this, this relationship should be explored further in the future. In addition, future study may want to explore whether a longer period of self-monitoring relates to changes in PGD symptomatology.

Conclusion

This research investigated the relationship between self-monitoring satisfaction and PGD levels in bereaved individuals. The findings from this study contribute to the understanding of self-monitoring satisfaction and PGD, which is a relatively unresearched relationship. Contrary to the hypothesis, higher self-monitoring satisfaction was associated with higher instead of lower PGD levels after self-monitoring. More self-monitoring was not related to PGD levels and the relationship between self-monitoring satisfaction and PGD levels disappeared when initial PGD levels were controlled for. Initial PGD levels were a strong predictor of subsequent PGD levels, indicating relative stability of PGD symptoms across the self-monitoring period. These findings suggest that self-monitoring satisfaction is not related to PGD levels by an influence on the efficacy of self-monitoring. It is possible that individuals with higher PGD levels indicate higher self-monitoring satisfaction because they are more motivated and perceive a greater need for self-monitoring. This relationship should be investigated further in future research.

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Appendix A

R script

```
#read files
dataset <- read_sav("ESM1_T1_T2_Wide.sav")
dataset2 <- read_sav("Data_number of observations.sav")

#merge data
merged_data <- dataset %>% left_join(dataset2, by = "QualtricsID")

#remove na
merged_data <- merged_data %>% drop_na(T2_RRPQ_1)

#remove incomplete
merged_data <- merged_data[-c(13), ]

#total score TGI T1
merged_data <- merged_data %>% mutate(total_T1_TGI = 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)

#total score TGI T2
merged_data <- merged_data %>% mutate(total_T2_TGI = 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)
```

```
#total score RRPQ
merged_data <- merged_data %>% mutate(total_T2_RRPQ = T2_RRPQ_1 + T2_RRPQ_2 +
T2_RRPQ_3 + T2_RRPQ_4)

#linear model
model2 <- lm(total_T2_TGI ~ total_T2_RRPQ + total_T1_TGI + NcompleteAPP2
,data=merged_data)
summary(model2)

#plot
fitted_values <- fitted(model2)
residuals <- resid(model2)

# Create the plot
plot(fitted_values, residuals, xlab = "Fitted Values", ylab = "Residuals", main = "Residuals vs
Fitted Values")
abline(h = 0, col = "red")

# add a lowess line to check for any patterns
lines(lowess(fitted_values, residuals), col = "blue")

#linearity
plot(merged_data$total_T2_RRPQ, resid(model2), xlab = "Self-monitoring satisfaction", ylab
= "Residuals")
abline(h = 0, col = "red")  # Add a horizontal line at y = 0

# Independence of Errors
dwtest(model2)  # Durbin-Watson test

# Homoscedasticity
bptest(model2)  # Breusch-Pagan test

# Obtain heteroscedasticity-robust standard errors
robust_se <- sqrt(diag(vcovHC(model2)))

# Combine coefficient estimates and robust standard errors
coefficients_summary <- cbind(coef(model2), robust_se)
```

```
# Print the combined summary
print(coefficients_summary, digits = 4)

# Conduct hypothesis tests using robust standard errors
coeftest(model2, vcov. = vcovHC(model))

# Normality of Residuals
shapiro.test(resid(model2))  # Shapiro-Wilk test

#calculate cooks distance
cooksd <- cooks.distance(model2)

# Plot Cook's distance to visually inspect potential outliers
plot(cooksd, type = "h", main = "Cook's Distance", ylab = "Cook's distance")
abline(h = 4/length(cooksd), col = "red")  # Common threshold for identifying outliers

# Identify the influential points
influential_points <- as.numeric(names(cooksd)[(cooksd > (4/length(cooksd)))])

# Remove influential points from the dataset
dataset_clean <- merged_data[-influential_points, ]

# Fit the linear model again without the outliers
model_clean <- lm(total_T2_TGI ~ total_T2_RRPQ + total_T1_TGI, data = dataset_clean)

# Summary of the new model without outliers
summary(model_clean)

# Normality of Residuals
shapiro.test(resid(model_clean))  # Shapiro-Wilk test

dataset_clean %>% count(T1_cause)

#descriptive stats

# Calculating descriptive statistics for PGD levels at T1
mean_T1_TGI <- mean(dataset_clean$total_T1_TGI, na.rm = TRUE)
sd_T1_TGI <- sd(dataset_clean$total_T1_TGI, na.rm = TRUE)
range_T1_TGI <- range(dataset_clean$total_T1_TGI, na.rm = TRUE)
```

```
# Calculating descriptive statistics for PGD levels at T2
mean_T2_TGI <- mean(dataset_clean$total_T2_TGI, na.rm = TRUE)
sd_T2_TGI <- sd(dataset_clean$total_T2_TGI, na.rm = TRUE)
range_T2_TGI <- range(dataset_clean$total_T2_TGI, na.rm = TRUE)

# Calculating descriptive statistics for RRPQ at T2
mean_T2_RRPQ <- mean(dataset_clean$total_T2_RRPQ, na.rm = TRUE)
sd_T2_RRPQ <- sd(dataset_clean$total_T2_RRPQ, na.rm = TRUE)
range_T2_RRPQ <- range(dataset_clean$total_T2_RRPQ, na.rm = TRUE)

# Print the results
cat("Descriptive Statistics for PGD levels at T1:\n")
cat("Mean:", mean_T1_TGI, "\n")
cat("Standard Deviation:", sd_T1_TGI, "\n")
cat("Range:", range_T1_TGI, "\n\n")

cat("Descriptive Statistics for PGD levels at T2:\n")
cat("Mean:", mean_T2_TGI, "\n")
cat("Standard Deviation:", sd_T2_TGI, "\n")
cat("Range:", range_T2_TGI, "\n\n")

cat("Descriptive Statistics for RRPQ at T2:\n")
cat("Mean:", mean_T2_RRPQ, "\n")
cat("Standard Deviation:", sd_T2_RRPQ, "\n")
cat("Range:", range_T2_RRPQ, "\n")

#cronbach's alpha TGI T1
itemsTGI <- dataset_clean[, 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")]

# Calculate Cronbach's alpha
alpha_result <- alpha(itemsTGI)
```

```
# Print the results
print(alpha_result)

#cronbach's alpha TGI T2
itemsTGI2 <- dataset_clean[, 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")]

# Calculate Cronbach's alpha
alpha2_result <- alpha(itemsTGI2)

# Print the results
print(alpha2_result)

#cronbach's alpha RRPQ
itemsRRPQ <- dataset_clean[, c("T2_RRPQ_1", "T2_RRPQ_2", "T2_RRPQ_3",
"T2_RRPQ_4")]

# Calculate Cronbach's alpha
alpha_result <- alpha(itemsRRPQ)

# Print the results
print(alpha_result)

#linear models
modelRRPQ <- lm(total_T2_TGI ~ total_T2_RRPQ,data=dataset_clean)
summary(modelRRPQ)

modelN <- lm(total_T2_TGI ~ total_T2_RRPQ + NcompleteAPP2 ,data=dataset_clean)
summary(modelN)

model <- lm(total_T2_TGI ~ total_T2_RRPQ + NcompleteAPP2 + total_T1_TGI
,data=dataset_clean)
summary(model)
```

```
# Calculate robust standard errors
robust_se <- vcovHC(modelN, type = "HC1")

# Display the coefficients with robust standard errors
coeftest(modelN, robust_se)

# Display the coefficients with robust standard errors
robust_se <- sqrt(diag(vcovHC(model, type = "HC1")))

coefficients <- coef(model)
results <- cbind(coefficients, robust_se)
rownames(results) <- c("Intercept", "total_T2_RRPQ", "NcompleteAPP2", "total_T1_TGI")
colnames(results) <- c("Estimate", "Robust SE")
print(results)

#plot
ggplot(dataset_clean, aes(x = total_T2_RRPQ, y = total_T2_TGI)) + geom_point() +
geom_smooth(method = "lm", se = FALSE) + labs(x = "Self-monitoring satisfaction", y =
"PGD levels at T2", title = "Linear Regression Analysis")
```

Appendix B

Figure 1

Scatterplot for testing assumption of linearity.

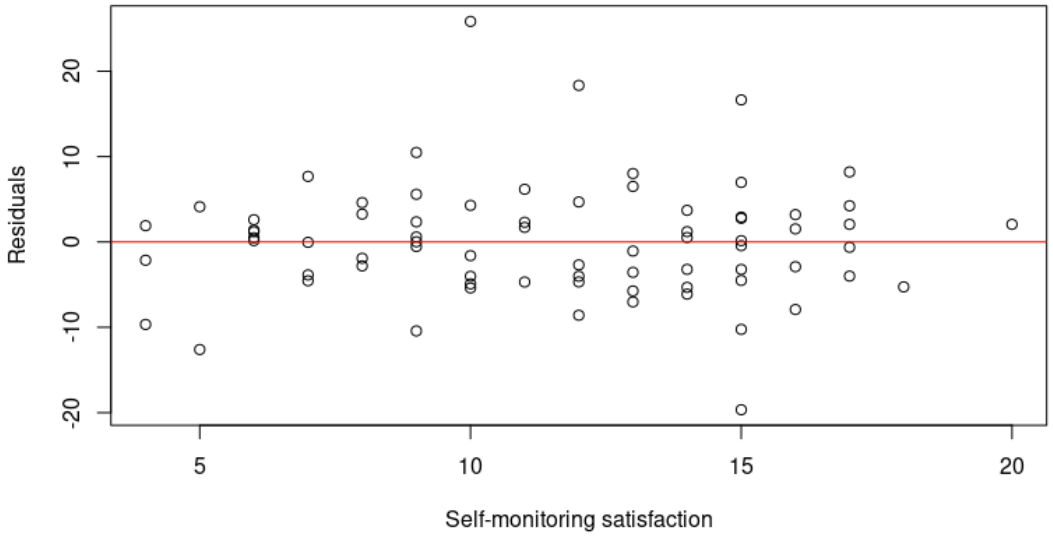

Figure 2

Plot fitted values x residual values