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Regret Intensity, Diurnal Cortisol Secretion, and Physical Health in Older Individuals: Evidence for Directional Effects and Protective Factors

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Two studies were conducted to examine the associations between life regrets and health-relevant variables among older adults. Study 1 explored whether intense experiences of regret would be associated with a health-relevant biological process (i.e., diurnal cortisol secretion) and acute physical problems ($N = 183$). In Study 2, a group of 103 older adults was followed over a period of 3 months, and changes in cold symptoms and sleep problems were examined. Study 2 incorporated an experimental manipulation, targeted at engaging participants in adaptive social–cognitive processes through writing. The results of Study 1 showed intense life regrets to be associated with a larger volume and a steeper morning rise of cortisol secretion and with higher levels of acute physical symptoms. Study 2 demonstrated that levels of regret intensity generally declined only in the experimental group, whereas certain aspects of regret intensity remained stable in the control group. In addition, the intervention evidenced a beneficial effect on the association between initial regret intensity and increased sleep problems over time.

Keywords: aging, regret, self-regulation, cortisol, physical health

Many older adults have physical health problems (National Center for Health Statistics, 1999). It is therefore important to identify factors that influence older adults' physical health to explore pathways to successful aging. Although some of the physical health problems in old age are related to age-normative biological losses (Baltes, Cornelius, & Nesselroade, 1979), psychological challenges may also compromise physical health. In this regard, research has suggested that intense regret may represent a psychological challenge that is associated with older adults' health problems (Wrosch, Bauer, & Scheier, 2005). In addition, it has been documented that certain social–cognitive processes (e.g., external attributions; Wrosch & Heckhausen, 2002) can be associated with a reduced intensity of regret among older adults. To address these possibilities, this research examined whether intense regret is associated with multiple health-relevant variables (e.g., cortisol secretion and physical problems). Moreover, we investigated whether engaging older adults in social–cognitive processes may relieve their regret experiences and benefit their physical health.

Regret and Physical Health in Old Age

Regret is a common psychological phenomenon, experienced by up to 90% of older adults (Landman, 1987; Wrosch et al., 2005). Life regrets usually involve the experience of counterfactual thoughts (e.g., "What would have happened if . . ."; Kahneman, 1995; Roese, 1997) and specific negative emotions (e.g., feeling angry, desperate, or sentimental; Gilovich, Medvec, & Kahneman, 1998). Such regrets are most frequently associated with major developmental pathway decisions in the work and family domains (e.g., having married the wrong person or not having finished university education; Roese & Summerville, 2005; Wrosch & Heckhausen, 2002).

Of importance, there are individual differences in the extent to which people are angry, desperate, or sentimental about their regretted behaviors (Gilovich et al., 1998). These emotions reflect a person's intensity of regret and have been shown to predict older adults' (but not younger adults') depressive symptomatology (Wrosch et al., 2005), because older adults often lack the opportunities to undo the negative consequences of their regretted behaviors (for research on age effects of regret, see also Lecci, Okun, & Karoly, 1994).

These findings have important implications for examining pathways to healthy aging, as research suggests that challenging events and the associated distress have the potential to modify biological processes in the endocrine and immune systems in a way that increases vulnerability to disease (Kiecolt-Glaser, McGuire, &

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Robles, 2002; Miller, Chen, & Zhou, 2007; Segerstrom & Miller, 2004). Further, stressful experiences have been found to influence clinical illness when people are exposed to a virus (Cohen et al., 1998). In addition, findings from meta-analyses and reviews have converged to suggest that the effects of challenging events on biological and health variables increase with age (Kiecolt-Glaser & Glaser, 2001; Otte et al., 2005; Segerstrom & Miller, 2004). Thus, it may be reasonable to assume that intense regret experiences may be profound enough to influence older adults' physical health.

Consistent with this line of thought, research has reported a link between older adults' regret experiences and their physical health problems (Torges, Stewart, & Miner-Rubino, 2005; Wrosch et al., 2005). However, this finding must remain preliminary because the reported studies examined cross-sectional effects of regret experiences on self-reported physical health. Of importance, associations between psychological distress and physical health are thought to be bidirectional (Schulz, Martire, Beach, & Scheier, 2000; Wrosch, Schulz, & Heckhausen, 2004), and a person's regret experiences may also be influenced by levels of chronic illness. In addition, previous work has documented the effects of negative affectivity on biases in physical health reports (Watson & Pennebaker, 1989). This implies that individuals who generally experience high levels of negative affect may simply view their world more negatively and, therefore, be more likely to label vague symptoms as physical health problems (and may also experience their regrets as more intense).

Moreover, certain characteristics of regrets may also be associated with more intense regret experiences, suggesting that specific aspects of life regrets may have the potential to influence physical health. For example, it has been argued that regretted omissions (as compared with commissions) are particularly troublesome for older individuals (Gilovich & Medvec, 1994). In addition, regrets occurring more recently may be more salient and therefore more intense than distant regrets. By contrast, the benefit of time may allow a person to positively reinterpret a stressful event. On the basis of these considerations, it seems mandatory that research on the effects of life regrets on physical health should assess health-relevant variables that are not based entirely on self-reports (e.g., diurnal cortisol dysregulation), that it provide longitudinal evidence, and that it control for possible confounding variables.

Given the adverse effects of intense regret on older adults' quality of life, it is also important to gain a greater understanding of how older adults can avoid the experience of intense regret and protect their physical health. In this regard, research suggests that adaptive social–cognitive processes can relieve the experience of regret among older adults. For example, reduced levels of regret intensity have been found among older adults who did not blame themselves for their regretted behaviors, who were disengaged from undoing the consequences of their regrets, and who had meaningful future goals available (Wrosch et al., 2005; Wrosch & Heckhausen, 2002). In addition, downward and lateral social comparisons may relieve regret experiences if older people perceive that their own situation is similar to or less problematic than the circumstances of other people (Bauer, Jobin, & Wrosch, 2007; for protective functions of social comparisons, see also Wills, 1981).

Although the reported associations between adaptive social–cognitive processes and reduced levels of regret intensity suggest pathways to healthy aging, methodological problems inherent to this research (e.g., cross-sectional data) preclude drawing conclusions about the direction of effects. An alternative approach to documenting directional effects would be to engage participants in behaviors associated with adaptive social–cognitive functioning. Based on the reviewed research, such behaviors may be related to external attributions (to avoid self-blame; Wrosch & Heckhausen, 2002), social comparisons (to recognize that one's regrets are not worse than other people's regrets; Bauer et al., 2007), or the salience of meaningful future goals (to facilitate goal adjustment; Wrosch et al., 2005).

In this regard, a promising intervention method is associated with engaging participants in writing behaviors. A substantial body of research has documented that writing about personally relevant and stressful events can benefit a person's health (see Broderick, Junghaenel, & Schwartz, 2005; King, 2001; Pennebaker, 1997; Solano, Donati, Pecci, Persichetti, & Colaci, 2003). In addition, research suggests that, in particular, individuals with high levels of emotion regulation skills can benefit from a writing intervention (O'Connor, Allen, & Kaszniak, 2005; Sloan & Epstein, 2005). Thus, a writing intervention that is aimed at engaging older adults in adaptive social–cognitive processes may reduce the intensity of severe life regrets and prevent the negative effects on older adults' physical health.

The Present Research

Two studies were conducted to examine the associations between regret intensity and multiple health-relevant variables in old age. In Study 1, we assessed diurnal cortisol rhythms and acute physical symptoms. It was hypothesized that intense regrets would be associated with dysregulated patterns of diurnal cortisol secretion (larger area under the curve [AUC], higher awakening levels, increased early morning rise, or flattened slope of cortisol secretion) and acute physical health problems.

Study 2 followed a group of older adults over a period of 3 months, and cold symptoms and sleep problems were measured as indicators of physical health. In addition, Study 2 incorporated an experimental manipulation. Participants in the experimental group were engaged in a writing intervention that was designed to facilitate adaptive social–cognitive functioning (i.e., writing about external factors responsible for regret, other people's regrets, and meaningful goals). Participants in the control group wrote about their daily nonemotional events. We expected that the writing intervention would result in decreased levels of regret intensity over time. In addition, given that high levels of regret intensity can influence physical health problems, we hypothesized that the intervention might demonstrate a beneficial effect on the association between initial regret intensity and increases in physical health problems. Finally, we explored whether the intervention effects on indicators of physical health could be explained by changes in regret intensity.

In both studies, the analyses were controlled for basic sociodemographic characteristics (age, sex, education level). In addition, we controlled the obtained results in subsequent analyses for chronic illness, negative affectivity, and regret characteristics—that is, type of regret (omission vs. commission) and recency of the regretted event—given that these variables could be associated with the effects of intense regret on health-relevant variables.

Study 1

Method

Participants. This study is based on the Montreal Aging and Health Study, examining a heterogeneous sample of 215 older adults from the large metropolitan area of Montreal (Wrosch, Schulz, Miller, Lupien, & Dunne, 2007). Participants were between 63 and 94 years old ($M = 72.41$, $SD = 5.91$). Forty-eight percent of the sample was male, and 32% had attained an undergraduate university degree or a higher education. The study participants were recruited via newspaper advertisements. After they contacted the laboratory, participants were invited for an initial appointment. Participants who were unable to visit the lab were assessed in their homes. During the initial appointment, they were provided with a baseline questionnaire. They were also instructed to collect saliva samples over the course of 3 nonconsecutive typical days and to respond to a short questionnaire at the end of each of the 3 days. After finishing the study, participants were visited by the research assistant in their homes. All materials were collected, and participants received $50 for participating in the study.

Of the 215 participants, a subset of 183 participants was included in the study because they indicated the experience of regret, documenting a prevalence of life regrets similar to those in previously reported studies (Wrosch et al., 2005). Participants who did not report a regret were excluded from the study because they did not provide data for regret intensity. Participants who were included in the study did not significantly differ from participants who were not included with respect to age, sex, socioeconomic status, and the outcome variables.

Materials. The main study materials consisted of measures of participants' sociodemographic characteristics, life regrets, diurnal cortisol secretion, acute physical symptoms, chronic illness, and negative affectivity.

Sociodemographic characteristics were assessed in the baseline questionnaire and included participants' age, sex, and SES. SES was measured with three variables: (a) highest education level completed (five levels: 0 = *no education*, 4 = *master's degree or PhD*), (b) yearly family income (five levels: 0 = *less than $17,000*, 4 = *more than $85,000*), and (c) perceived SES (participants indicated the rung on a ladder that represented their socioeconomic strata within society; see Adler, Epel, Castellazzo, & Ickovics, 2000). The three SES variables were significantly correlated with each other (rs = .33 to .52; ps $< .01$). To obtain a global measure of SES, we averaged the standardized scores of the three single SES variables ($M = -.01$, $SD = .80$, $\alpha = .70$).

Life regrets were measured in the baseline questionnaire following procedures outlined in previous research (Wrosch et al., 2005; Wrosch & Heckhausen, 2002). Participants were asked to think about their lives and to report their most severe life regret. They were also asked to report whether their regret was related to a behavior they had done (commission) or a behavior they did not do (omission) and to indicate when the behavior occurred that had led to the regret. Twenty-two percent of the participants identified their most severe regret as a commission, 59% of participants reported an omission regret, and 19% did not classify their regret.[1] On average, the regretted behaviors occurred 29.61 years ago ($SD = 19.90$).

To assess regret intensity, we further asked the participants to report the extent to which they experienced each of nine emotions during the past few months when they thought about their regrets. Each emotion was rated on a 5-point Likert-type scale (1 = *very slightly or not at all*, 5 = *extremely*). The nine emotions were selected on the basis of Gilovich and colleagues' (1998) work and included despair-related emotions (desperate, helpless, and sorrow; $M = 1.86$, $SD = .85$, $\alpha = .61$), hot emotions (angry, irritated, and embarrassed; $M = 1.71$, $SD = .88$, $\alpha = .76$), and wistful emotions (nostalgic, sentimental, and contemplative; $M = 2.13$, $SD = .97$, $\alpha = .77$). The three subsets were significantly correlated with each other (rs = .44 to .63, ps $< .01$), and we obtained a broad indicator of regret intensity by averaging the nine emotions ($M = 1.91$, $SD = .75$, $\alpha = .84$).

Diurnal cortisol rhythms were assessed across 3 nonconsecutive typical days. We asked the participants to collect saliva samples as they engaged in their normal daily activities. On each of the 3 days, the participants were instructed to collect five saliva samples at specific times of the day: awakening, 30 min after awakening, 2 p.m., 4 p.m., and before bedtime. Each of the saliva samples was collected using Salivettes (Sarstedt, Nümbrecht, Germany). Participants were asked not to eat or brush their teeth immediately prior to saliva collection to prevent contamination with food or blood. They were provided with a timer that they had to set at 30 min at the time they collected their first saliva sample after awakening. A second sample was collected 30 min after awakening. To ensure compliance concerning the collection of the afternoon and evening samples, participants were called at 2 p.m. and 4 p.m. They were further instructed to collect the last sample of the day by themselves at the time they went to bed. The actual time of the day was recorded by the participants for all of the collected saliva samples, allowing for the calculation of hours after awakening for each sample.

The saliva samples were stored in participants' home refrigerators until they were returned to the lab 2 to 3 days after collection was completed (for stability of salivary cortisol concentrations in these conditions, see Clements & Parker, 1998). After the saliva containers were returned to the lab, they were spun in a centrifuge for 5 min until a clear, low-viscosity supernatant emerged, and they were subsequently frozen at –70 °C until the completion of the study. Cortisol assays were performed in duplicate using a time-resolved fluorescence immunoassay with a cortisol–biotin conjugate as a tracer (Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999). This assay has a sensitivity of 0.43 nmol/L. The intra-assay coefficient of variation was less than 5%.

We obtained typical diurnal rhythms of cortisol across all 3 days. Cortisol levels (in nanomoles per liter) increased from awakening (Ms = 11.90 to 13.30, SDs = 8.14 to 9.15) to 30 min after awakening (Ms = 15.51 to 17.25, SDs = 10.52 to 10.85) and declined steadily

[1] We note that it is, at times, difficult to categorize a regret, given that most regretted behaviors can be construed as both an omission and a commission. To statistically address the considerable proportion of participants in Study 1 who did not categorize their type of regret, we computed dummy variables comparing participants who reported a certain type of regret against all other participants. In Study 2, we addressed this problem by prompting participants, who indicated that their regret was both an omission and a commission, to decide whether it was an omission or a commission, and much lower rates of noncategorization (3%) were obtained in Study 2.

over the remaining part of the day (2 p.m.: *M*s = 5.31 to 6.00, *SD*s = 3.20 to 3.87; 4 p.m.: *M*s = 4.84 to 5.29, *SD*s = 3.46 to 4.15; bedtime: *M*s = 3.23 to 3.76, *SD*s = 3.37 to 4.78). To obtain measures of participants' daily volume of cortisol secretion, we calculated the AUC of cortisol secretion for each day separately (based on hours after awakening). We excluded all samples that deviated more than 3 standard deviations from the mean cortisol secretion for the time of day. In addition, we calculated AUC only if the participants provided at least four out of five samples for a specific day. This procedure ensured that all scores were based on at least one valid morning sample (when cortisol secretion is usually increased) and two valid day or evening samples (when cortisol secretion is usually reduced). Six participants did not meet these criteria. In cases in which a single saliva sample was missing, we replaced the missing value with the sample mean before calculating AUC. To obtain a stable measure of individual differences in cortisol secretion, we averaged the three single-day AUC measures ($M = 121.32$, $SD = 54.60$, $\alpha = .84$).

To further explore whether differences in cortisol volume were associated with cortisol secretion at a particular time of day, we also calculated indicators of awakening levels, morning rise, and slope of cortisol secretion. Awakening levels of cortisol were obtained by averaging the first measurement of cortisol across days ($M = 12.83$, $SD = 6.77$, rs = .40 to .45, ps $< .01$, $\alpha = .68$). Estimates of early morning increase in cortisol secretion were calculated in regression analyses by predicting the 30-min measures of cortisol by participants' awakening levels of cortisol and saving the residuals. Single-day measures of early morning cortisol increase were averaged across days ($M = 0.13$, $SD = 6.97$, rs = .31 to .41, ps $< .01$, $\alpha = .66$). To estimate slope, we conducted a linear regression model for each participant for each of the 3 days separately, where his or her log-transformed cortisol values were regressed on hours since waking. We did not include the 30-min peak measure into the regression models to obtain a measure of slope that is not biased by increases in early morning cortisol secretion. Single-day measures of cortisol slope were significantly correlated (rs = .23 to .25, ps $< .01$), and we averaged the single-day measures to obtain a reliable index of cortisol slope ($M = -.04$, $SD = .02$, $\alpha = .47$).

Acute physical symptoms were also assessed across the 3 typical days. We asked the participants to report at the end of each of the 3 days whether or not they had experienced 12 physical health symptoms during the day (e.g., chest, back, or joint pain; headaches; shortness of breath). This list of symptoms was derived from the PRIME MD patient questionnaire screener (Spitzer et al., 1994). We computed a count variable, representing the total number of physical health problems experienced across the 3 days ($M = 2.53$, $SD = 3.07$, $\alpha = .85$).

Levels of chronic illness were measured in the baseline questionnaire by asking the participants to report whether they were affected by 17 different health problems. The health problems included, for example, the presence of coronary heart disease or heart attack, cancer, high blood pressure, stroke, osteoarthritis or rheumatoid arthritis, chronic lung disease, diabetes, serious liver problems, or problems with blood circulation. A count variable was computed to obtain an indicator of participants' level of chronic illness ($M = 2.46$, $SD = 1.66$). Ten percent of the respondents reported no chronic health problems, whereas 20% mentioned one problem, 45% reported two or three problems, and 24% mentioned having four or more chronic health problems.

Negative affectivity was assessed in the baseline questionnaire by administering a 10-item measure of negative affect experienced during the past year (e.g., distressed, upset, or nervous), which has been shown to exhibit traitlike stability in previous research (PANAS; $M = 1.93$, $SD = 0.69$, $\alpha = .88$; Watson, Clark, & Tellegen, 1988).

Results

We expected intense regret to be associated with dysregulated patterns of cortisol secretion. To test this hypothesis, we conducted four separate regression analyses. In a first analysis, we predicted participants' AUC of cortisol secretion because this construct represents a widely used measure of a person's overall volume of cortisol secretion. We included age, sex, and socioeconomic characteristics in addition to regret intensity as predictor variables into the regression equation. Further, we conducted three additional analyses, predicting awakening levels, early morning increase, and slope of cortisol secretion as dependent variables. Given that effects on overall volume of cortisol secretion may vary at different times of the day, these analyses were intended to qualify an effect of regret intensity on the overall volume of cortisol secretion.[2]

Table 1 shows the results of the regression analyses for predicting the four indicators of participants' cortisol rhythms. The findings demonstrate a significant association between regret intensity and the AUC of cortisol secretion, $F(1, 172) = 8.04$, $p < .01$. Participants who experienced more intense regret secreted a larger volume of cortisol secretion than participants who experienced less intense regret. Of the sociodemographic variables, only sex was significantly associated with volume of cortisol secretion, $F(1, 172) = 4.55$, $p < .05$. Women secreted a larger volume of cortisol than men. Further, the analyses of the different aspects of the diurnal cortisol rhythm demonstrated that regret intensity was associated with a steeper early morning increase of cortisol secretion, $F(1, 172) = 5.43$, $p < .05$. However, regret intensity did not predict awakening levels or slope of cortisol secretion. Of the covariates, only age was associated with slope of cortisol secretion in the multivariate analyses, $F(1, 172) = 11.93$, $p < .01$, suggesting that older participants exhibited a more flattened slope than younger participants.[3]

[2] Across both studies, participants who had missing data for regret intensity and physical health outcomes were excluded from the analyses. In Study 1, 6 participants did not provide sufficient saliva samples to estimate AUC of cortisol secretion, and 3 participants had missing data on the main measures of regret intensity, sleep problems, or cold symptoms in Study 2. We replaced missing data related to sociodemographic characteristics, chronic illness, and negative affectivity with the sample mean. In Study 2, 2 participants did not report data with respect to negative affectivity.

[3] The analyses also showed that regret intensity did not significantly predict different slopes of cortisol secretion, neither if the 30-min measure was included in the calculation of slope nor the slope from the 30-min measure to the bedtime measure (excluding the cortisol awakening levels). In this regard, we acknowledge that different aspects of cortisol rhythm could also be analyzed by using piecewise growth curve models. When procedures outlined by Hernandez-Lloreda, Colmenares, and Martinez-Arias (2004) were applied, piecewise models showed that regret intensity predicted the early morning slope, $B = 2.17$, $SE = 0.94$, $t = 2.31$, $p = .02$, but was not significantly associated with cortisol slope for the remainder of the day.

Table 1
Summary of Multiple Regression Analyses for Variables Predicting Indicators of Cortisol Secretion

	Area under the curve			Awakening levels			Morning rise			Cortisol slope		
Predictors	R^2	β	*r*	R^2	β	*r*	R^2	β	*r*	R^2	β	*r*
Main effects	.07**			.01			.03			.09**		
Age	.00	.05	.03	.00	−.04	−.05	.00	−.04	−.06	.06**	.25**	.24**
Sex[a]	.02*	−.16*	−.16*	.00	−.06	−.06	.00	.00	.01	.01	−.13	−.15*
SES	.00	.01	.04	.00	.01	.02	.00	−.03	−.02	.01	.09	.10
Regret intensity	.04*	.21**	.20**	.01	.08	.08	.03*	.18*	.18*	.01	.09	.06

Note. SES = socioeconomic status.
[a] Higher values represent female as compared with male participants.
* $p \leq .05$. ** $p \leq .01$.

We also examined whether regret intensity would be associated with levels of acute physical symptoms. To this end, we conducted a regression analysis in which participants' levels of acute physical symptoms were predicted by the same independent variables used in the previously reported analyses. The results are reported in Table 2 and demonstrate a significant effect of regret intensity on levels of acute physical symptoms, $F(1, 172) = 10.93$, $p < .01$. Participants who experienced more intense regret reported higher levels of acute physical symptoms than participants who experienced lower levels of regret intensity. Of the sociodemographic variables, sex, $F(1, 172) = 4.80$, $p < .05$, and SES, $F(1, 172) = 11.49$, $p < .01$, were significantly associated with levels of acute physical symptoms. This suggests women and lower SES participants reported higher levels of acute physical symptoms than did men and higher SES participants.[4]

We also considered the possibility that the associations between regret intensity and cortisol secretion as well as the presence of acute physical symptoms may be correlated. Therefore, we repeated the original analyses and in addition included the indicators of diurnal cortisol dysregulation into the analysis for predicting acute physical symptoms (and vice versa). In these analyses, all effects of regret intensity remained significant, indicating that regret intensity shared unique portions of variance with diurnal cortisol dysregulation and acute physical symptoms. In fact, the zero-order associations between the indicators of cortisol dysregulation and levels of acute physical symptoms were not significant (*r*s < .08, *p*s > .05).

Table 2
Summary of Multiple Regression Analysis for Variables Predicting Acute Physical Symptoms

	Acute physical symptoms		
Predictors	R^2	β	*r*
Main effects	.15**		
Age	.00	.02	−.01
Sex[a]	.02*	.16*	.21**
SES	.06**	−.24**	−.26**
Regret intensity	.05**	.23**	.23**

Note. SES = socioeconomic status.
[a] Higher values represent female as compared with male participants.
* $p \leq .05$. ** $p \leq .01$.

Finally, we repeated the main analyses by in addition controlling in separate analyses for chronic illness, negative affectivity, and characteristics of the regrets—type of regret (omission vs. commission) and recency of regret—to explore whether these variables may explain the effects of intense regrets on health-relevant outcomes.[5] Chronic illness, negative affectivity, and type of regret did not explain the associations between regret intensity and indicators of diurnal cortisol dysregulation and physical health symptoms.[6] In addition, recency of regret did not explain the association between regret intensity and levels of acute physical health symptoms. However, incorporating recency of regret into the regression models statistically reduced the association between regret intensity and early morning increase of cortisol secretion, $F(1, 171) = 2.93$, $\beta = .13$, $R^2 = .02$, $p = .09$. In fact, more recent regrets were experienced as more intense than distant regrets ($r = .34$, $p < .01$), and recency of regret was associated with a larger AUC of cortisol secretion, $F(1, 171) = 7.90$, $\beta = .23$, $R^2 = .04$, $p < .01$, and showed a trend effect in predicting a steeper early morning increase of cortisol secretion, $F(1, 171) = 3.37$, $\beta = .15$, $R^2 = .02$, $p = .07$.

Discussion

Study 1 examined whether intense regret can be associated with older adults' diurnal cortisol secretion and acute physical health

[4] We also explored the association between the three subsets of regret-related emotions and the outcome variables. Despair-related emotions and wistful emotions were significantly correlated with acute physical symptoms and volume and morning rise of cortisol secretion (all *r*s > .14, all *p*s < .05). However, the correlations between hot regret emotions and the outcome variables were only marginally significant (*r*s > .12, *p*s < .10).

[5] Thirty-eight participants of Study 1 provided invalid data with respect to recency of the regret. Reasons for these missing data were based on a mistake related to checking the box "years" in the questionnaires instead of writing down the exact number of years, as well as difficulty with identifying the exact time for some regrets (e.g., "never having a good romantic relationship"). In Study 2, 3 participants had missing data for type of regret and 13 participants had missing data with respect to recency of regret. We replaced the missing data with the sample means.

[6] Cortisol secretion could also be influenced by the use of medication (e.g., antidepressants, β-blockers, or anti-inflammatory drugs). To address this possibility, we also controlled the analyses for the presence and number of drugs that may influence cortisol. The reported effects of regret intensity on participants' cortisol secretion remained significant after these variables were taken into account.

problems. The results strongly support this hypothesis. As compared with participants who experienced less intense regret, older adults who experienced more intense regret also exhibited patterns of diurnal cortisol dysregulation and reported higher levels of acute physical health problems. More specifically, intense regrets were associated with a larger daily volume and a steeper early morning increase of cortisol secretion. By contrast, regret intensity was not associated with awakening levels of cortisol secretion or variation in slope of cortisol.

This pattern of results is consistent with the assumption that regret experiences have the potential to influence increased levels of cortisol secretion shortly after people wake up and start their day. In addition, given that there were no differences in cortisol slopes associated with regret intensity (see Footnote 3), we suggest that regret-related differences in cortisol secretion remained stable over the remaining part of the day. These results are consistent with previous studies showing that intense regret can be troublesome in old age and is associated with distress and self-reported physical health problems (Wrosch et al., 2005). In addition, the findings extend previous research by demonstrating that intense regret can also predict diurnal cortisol dysregulation, a biological process that is thought to be a "gateway" in the association between challenges and physical health problems (Kiecolt-Glaser et al., 2002; Miller et al., 2007; Segerstrom & Miller, 2004).

We note that our findings indicated that the associations of regret intensity with diurnal cortisol secretion and acute physical symptoms were not correlated with each other. Thus, it may be that the observed dysregulated patterns of cortisol secretion represent early manifestations of developing physical health problems and therefore cortisol did not mediate the association between regret and physical health in cross-sectional analyses. Alternatively, it should be considered that we did not find an association between cortisol and physical symptoms because a blunted early morning cortisol response may also increase vulnerability to disease. In fact, challenges may result, over time, in cortisol levels that are bound to below normal levels and thereby may affect a person's physical health (Miller et al., 2007). Given that subsequent waves of this study are being conducted, we propose to examine in our future work the circumstances under which elevated versus blunted cortisol response may influence physical health over time.

Finally, the study's results showed that the associations between regret intensity and health-relevant variables were largely independent of possible confounding variables, such as sociodemographic characteristics, levels of chronic health conditions, negative affectivity, and medication use. However, we note that more recent regrets (as compared with distant regrets) were associated with higher levels of regret intensity and cortisol dysregulation, thereby suggesting that certain regret characteristics may play an important role in the adverse consequences of intense regret on health-relevant outcomes.

Study 2

Study 2 was conducted to examine associations between regret intensity and indicators of physical health in a longitudinal design. In Study 2, we assessed cold symptoms and sleep problems as indicators of physical health, because these health problems have been shown to be associated with psychological stressors in previous research (Cohen et al., 1998; Wrosch, Miller, Scheier, & Brun de Pontet, 2007). Study 2 also incorporated an experimental manipulation, targeted at engaging older adults in adaptive social–cognitive processes through writing. We expected that the intervention would reduce the intensity of regret over time. In addition, we hypothesized that the intervention would alleviate the adverse effect of high levels of initial regret intensity on indicators of physical health. Finally, we explored whether intervention effects on changes in physical health would be mediated by changes in regret intensity.

Method

Participants and procedures. This study included a heterogeneous sample of older adults recruited from the region of Montreal who reported having a life regret. Initially, 116 participants were enrolled in the study, and the final sample included 103 participants. Thirteen participants did not complete the study because of difficulty in identifying a regret and incomplete or delayed responses to the assignments. Participants were between 60 and 87 years old ($M = 71.77$, $SD = 7.50$). Thirty-five percent of the sample was male, and 51% had attained an undergraduate university degree or a higher education.

Participants were recruited via advertisements posted in local newspapers, community centers, and retirement homes, as well as by setting up a recruitment table at community and shopping centers. They were invited to the laboratory for an initial appointment, during which they were instructed to complete the first questionnaire (Time 1; T1). Participants who were unable to visit the lab were assessed in their homes. Three months later ($M = 3.19$, $SD = 0.37$), participants were contacted again (Time 2; T2) and responded to another questionnaire. They received $20 for their participation in the study.

Experimental manipulation. Participants were randomly assigned to either the experimental group ($N = 52$) or the control group ($N = 51$) and completed a writing intervention on 3 consecutive days. Each day, they were asked to open an envelope, which included instructions and examples of topics they should address in their writings. They were further instructed to write for 20 min each day, for 3 consecutive days, between 12h00 and 14h00. They had to record the date and the time at which they began–finished writing to ensure compliance. After completing the writing interventions, participants were instructed to read what they had written, only once, at bedtime on the 3rd day.

On the 1st day, individuals in the experimental group were instructed to engage in social comparison processes by writing about the regrets of their age peers and of people they know personally. On the 2nd day, the intervention intended to elicit external attributions for participants' regretted behaviors by instructing participants to write about the external factors that were beyond their control and that were responsible for their regretted behavior. Finally, on the 3rd day, participants in the experimental group were asked to write about their current and future goals. They were asked to describe how these goals are important to them, how they contribute positively to their life, how they make their life interesting and enjoyable, and how they benefit other people in their life or community. The different writing topics for the experimental group were chosen based on previous research and theories, suggesting that external attributions, social comparisons, and meaningful future goals may serve a protective function among people who experience intense life regrets (Bauer et al., 2007; Wrosch et al., 2005; Wrosch & Heckhausen, 2002).

Participants in the control group were told the study was intended to examine the effects of life regrets on types of daily activities. On the 1st day, they were instructed to describe in detail events or activities they had performed during the day since they woke up in the morning. On the 2nd day, they were asked to describe in detail events or activities they intended to do during the remainder of the day or on a typical evening of the week. Finally, on the 3rd day, participants were asked to describe in detail the most recent social event they had attended. Participants were instructed not to address their emotions, feelings, or opinions regarding what they wrote about, and to keep their description as neutral and objective as possible.

Materials. The main materials in Study 2 included measures of sociodemographic characteristics, life regrets, cold symptoms, perceived sleep problems, chronic health problems, and negative affectivity.

Sociodemographic characteristics were assessed at T1 and included participants' age, sex, and education level. Education level was measured by asking the participants to indicate their highest level of education completed (five levels: 1 = *primary school*, 5 = *master's or doctorate*; $M = 3.37$, $SD = 1.12$).

We measured life regrets by asking participants, at T1, to report their most severe life regret. Thirty-three percent of the participants identified their most severe regret as a commission, 64% reported an omission, and only 3% of participants did not categorize their regret. On average, the regretted behaviors occurred 38.47 years ago ($SD = 17.51$).

We further measured intensity of regret by asking the participants in the baseline questionnaire to report the extent to which they experienced each of six emotions during the past few months when they thought about their reported regret. Participants were asked again at T2 to report the extent to which they experienced the same emotions when they thought about their regret during the past month. Each emotion was rated on a 5-point Likert-type scale (1 = *not at all*, 5 = *extremely*). The six emotions reflected despair-related emotions (desperate, helpless, and sorrow; $\alpha_{T1} = .71$, $\alpha_{T2} = .81$), and hot emotions (angry, irritated, and embarrassed; $\alpha_{T1} = .74$, $\alpha_{T2} = .76$). In contrast to Study 1, Study 2 did not include a measure of wistful emotions. At both measurement points, the two subsets of regret-related emotions were significantly correlated with each other (rs = .74 to .77, ps $< .01$), and we also obtained a broad indicator of regret intensity by averaging the six emotions at each measurement point separately ($M_{T1} = 2.09$, $SD_{T1} = 0.95$, $\alpha_{T1} = .85$; $M_{T2} = 1.84$, $SD_{T2} = 0.82$, $\alpha_{T2} = .87$). The measures of regret intensity were significantly correlated with each other over time ($r = .56$, $p < .01$). To obtain a measure of change in regret intensity, we predicted, in a regression analysis, the T2 indicator of regret intensity from the T1 indicator of regret intensity, and we saved the standardized residuals for analysis.

Cold symptoms were measured at T1 and T2 by assessing eight symptoms that had previously been used in other research (Hamrick, Cohen, & Rodriguez, 2002). Participants were asked to indicate on 5-point Likert-type scales (0 = *none*, 4 = *very severe*) whether they had experienced or been treated for the following symptoms during the *past couple of weeks*: (a) nasal congestion, (b) runny nose, (c) sneezing, (d) cough, (e) feeling under the weather, (f) scratchy–sore throat, (g) fever, and (h) headaches. We computed mean scores of the eight items separately at T1 ($M = 1.51$, $SD = 0.57$, $\alpha = .83$) and T2 ($M = 1.63$, $SD = 0.68$, $\alpha = .85$). The measures of cold symptoms assessed at T1 and T2 were significantly correlated with each other ($r = .60$, $p < .01$). We note that other researchers used a cold index, wherein a cold was indicated if participants reported at least two of the symptoms at the severe level (Hamrick et al., 2002). Contrary to this approach, we used continuous variables of cold symptoms in our analyses because we were interested in predicting fine-grained levels of change in cold symptoms. In addition, the incidence of a cold would have been low in our sample if using the suggested index (10 participants at baseline and 12 participants at T2). A measure of change in cold symptoms was obtained by predicting, in a regression analysis, the T2 indicator of cold symptoms from the T1 indicator of cold symptoms, saving the standardized residuals for analysis.

Sleep problems were measured at T1 and T2 by administering an item from the Brief Pittsburgh Sleep Quality Index (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). Participants were asked to report how they would rate their overall sleep quality during the past month on a 4-point Likert-type scale (1 = *very good*, 4 = *very bad*). The measures of perceived sleep problems ($M_{T1} = 1.89$, $SD_{T1} = 0.86$; $M_{T2} = 1.86$, $SD_{T2} = 0.79$) were significantly correlated across measurement points ($r = .76$, $p < .01$). To obtain a measure of change in sleep problems, we predicted, in a regression analysis, the levels of sleep problems assessed at T2 from the T1 indicator of sleep problems, and we saved the standardized residuals for analysis.

To measure levels of chronic health problems, we administered a five-item symptom checklist at T1 and asked the participants to indicate whether they had experienced any of the symptoms during the past 12 months. The symptoms included (a) arthritis, rheumatism, or other bone joint diseases; (b) urinary or bladder problems; (c) high blood pressure or hypertension; (d) diabetes or high blood sugar; and (e) chronic sleeping problems. Chronic sleeping problems were incorporated into our measure of chronic health problems to address the possibility that the hypothesized effects on changes in sleep problems could not be explained by underlying chronic sleeping problems (that may be based on factors other than regret or the manipulation). We computed a count variable, representing the total number of chronic health problems ($M = 1.45$, $SD = 1.17$). Of the participants, 23% reported having no chronic health problems, 32% reported having one problem, 30% reported having two problems, and 15% reported having three or more problems.

Finally, negative affectivity was assessed at T1 by administering the same instrument as used in Study 1 (the PANAS). We measured the mean levels of 10 negative emotions experienced during the past year ($M = 1.99$, $SD = 0.82$, $\alpha = .93$).

Results

We expected that the experimental intervention would evidence beneficial effects on older adults' regret experiences, thereby alleviating the adverse effects of intense regret on changes in physical health problems. Before testing these hypotheses, we examined whether the random assignment of participants to the experimental and control groups was successful and not associated with baseline levels of predictor or outcome variables. Zero-order correlations demonstrated that the group variable was not signifi-

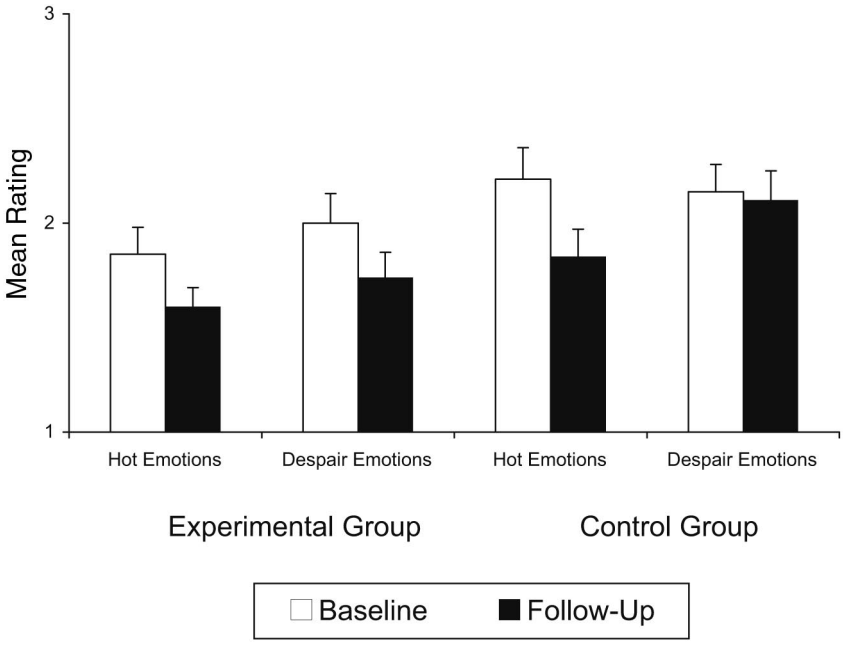

Figure 1. Mean levels of regret intensity (hot and despair-related affect) in the experimental group and in the control group across time. Error bars represent standard errors of the means.

cantly associated with baseline levels of any of the predictor or outcomes variables (all rs $< .18$, all ps $> .05$).

In addition, we analyzed the content of participants' writings to obtain an indicator of their compliance with the instructions. We coded, for each day separately, whether participants complied fully, partially, or not at all with the instructions. In the experimental group, only 1.9% of participants did not comply with the instructions on more than 1 day (control group = 9.8%). In addition, 65.4% of participants in the experimental group fully complied with the instructions on all 3 days (control group = 74.5%), and 32.7% of participants in the experimental group partially complied with the instructions (control group = 15.7%).

To test our main hypotheses, we examined whether the manipulation predicted reduced levels of regret intensity in the experimental group by conducting a 4 (regret-specific emotions) $\times$ 2 (group) analysis of variance (ANOVA), incorporating the within-subject factors time and type of regret emotions. We also included age, sex, and education level as covariates into the analysis.[7] The results of the analysis revealed a significant main effect for time, $F(1, 92) = 4.77$, $p < .05$, $\eta^2 = .05$. Participants reported lower levels of regret intensity at T2 ($M = 1.83$, $SD = 0.81$) as compared with T1 ($M = 2.05$, $SD = 0.91$). In addition, the analysis revealed a significant three-way interaction between group, time, and type, $F(1, 92) = 4.56$, $p < .05$, $\eta^2 = .05$.

We plotted the significant three-way interaction in Figure 1. The shape of the interaction effect indicated that regret-specific emotions generally declined in the experimental group across time, whereas only some aspects of regret intensity (hot emotions) declined across time in the control group. Follow-up t tests confirmed that participants in the experimental group experienced declines in both hot emotions and despair-related emotions, ts$(47) > 2.10$, ps $< .05$. By contrast, participants in the control group showed declines only in hot emotions, $t(48) = 2.90$, $p < .01$, not in despair-related emotions, ts$(48) = 0.27$, $p > .10$. In addition, supplementary analyses (using regression techniques as described later) showed that the intervention effect on changes in regret intensity was not moderated by participants' initial levels of regret. There were no significant interactions between manipulation group and initial regret intensity on changes in hot or despair-related regret emotions over time.

In addition, we examined whether the intervention affected participants' health problems by conducting two 2 (health problems) $\times$ 2 (group) ANOVAs, incorporating the within-subject factor time, for predicting participants' sleep problems and cold symptoms separately. Age, sex, and education level were included in the analyses as covariates. The results of the analyses did not show significant effects for group, time, or the interaction between group and time.

Next, we tested whether the intervention would alleviate the adverse effect of high levels of initial regret intensity on indicators of physical health. Given that regret intensity represented a continuous construct, we conducted two separate regression analyses, in which we predicted changes in participants' cold symptoms and sleep problems (using residuals) as dependent variables. In the first step of these analyses, age, sex, and education level were included in the regression equation as covariates in addition to manipulation

[7] Given the heterogeneous nature of our sample, the inclusion of covariates may reduce noise in the outcome variables and thereby allow the manipulation effect to stand out more clearly (Christenfeld, Sloan, Carroll, & Greenland, 2004). In addition, we note that 3 participants had missing data for one subset of regret emotions, but not for the other subset. We excluded those participants from the analysis.

Table 3
Summary of Multiple Regression Analyses for Variables Predicting Cold Symptoms and Sleep Problems

Predictors	Changes in cold symptoms			Changes in sleep problems		
	R^2	β	*r*	R^2	β	*r*
Main effects	.13*			.03		
Age	.01	.12	.11	.01	−.09	−.08
Sex[a]	.00	.05	.02	.01	−.10	−.11
Education level	.02	.15	.09	.00	−.06	−.04
Group[b]	.02	.15	.16	.00	−.06	−.06
Regret intensity (Time 1)	.09**	.30**	.27**	.00	.06	.08
Interaction						
Regret Intensity × Group	.00	.07		.04*	.20*	

[a] Higher values represent female as compared with male participants. [b]Higher values represent the control group as compared with the experimental group.
* $p \leq .05$. ** $p \leq .01$.

group and regret intensity. In the second step, we tested the interaction term between regret intensity and manipulation group for significance. Predictor variables were centered prior to conducting the analyses.

The results of the analyses are reported in Table 3. Sociodemographic variables did not significantly predict any of the physical health outcomes. However, the main effect of baseline regret intensity was significantly associated with changes in cold symptoms, $F(1, 94) = 9.72$, $p < .01$, but did not predict changes in participants' sleep problems. The more intensely participants experienced their regret at baseline, the more cold symptoms they developed over time. In addition, we obtained a significant interaction effect between manipulation group and baseline levels of regret intensity for predicting changes in sleep problems, $F(1, 93) = 4.14$, $p < .05$, but not for predicting changes in cold symptoms.[8]

To illustrate the significant interaction effect, we plotted in Figure 2 the association between regret intensity and changes in sleep problems separately for the experimental and the control groups, using common regression techniques (Aiken & West, 1991). The obtained pattern of results demonstrates that the association between initial regret intensity and increased levels of sleep problems was significantly reduced in the experimental group ($\beta = -.13$, $p > .10$) as compared with the control group ($\beta = .28$, $p = .06$).[9] In support of our hypotheses, particularly high levels of sleep problems were found among participants who experienced high levels of regret intensity at baseline and did not engage in the experimental writing intervention (control group). By contrast, participants in the experimental group who experienced high levels of regret intensity at the beginning of the study even slightly decreased their levels of sleep problems over time. These findings demonstrate a beneficial effect of the writing intervention on the association between initial regret intensity and changes in sleep problems.

To further examine whether changes in regret intensity could explain the beneficial effect of the writing intervention on the association between baseline levels of regret intensity and changes in sleep problems, we repeated the originally reported regression analysis by, in addition, incorporating changes in regret intensity (and the two-way interactions with manipulation group and baseline regret intensity; see Yzerbyt, Muller, & Judd, 2003) as covariates. In this analysis, the formerly significant interaction effect was rendered nonsignificant, $F(1, 90) = 2.34$, $R^2 = .02$, $p > .10$. These findings indicate that the significant moderator effect could, in part, be explained by individual differences in changes in regret-specific emotions over time.

We also reversed the analyses and examined in separate regression analyses whether baseline levels of cold symptoms and sleep problems would be associated with changes in regret intensity over time. This set of analyses was conducted to provide further evidence in support of directional effects of regret intensity on indicators of physical health. The results showed that baseline levels of sleep problems and cold symptoms did not significantly predict changes in regret intensity, Fs$(1, 98) < 0.10$, ps $> .10$, R^2s $< .01$. In addition, these associations did not change after controlling for manipulation group, sociodemographic characteristics, negative affectivity, and chronic illness. Thus, baseline levels of physical health problems were not associated with changes in regret intensity over time.

Similar to the analyses conducted in Study 1, we finally explored in supplementary analyses whether chronic illness, negative affectivity, and certain characteristics of the reported life regrets would statistically explain the obtained effects. We repeated the originally reported analyses by, in addition, controlling in separate analyses for chronic illness, negative affectivity, type of regret (omission vs. commission) and recency of regret. The intervention

[8] We note that zero-order correlations also showed that regret intensity at baseline was associated with higher baseline levels of cold symptoms ($r = .26$, $p < .01$) and sleep problems ($r = .40$, $p < .01$). In addition, we explored associations between the two subsets of regret emotions and health variables. Both hot and despair-related emotions were significantly correlated with changes in cold symptoms (rs $> .25$, ps $< .01$). However, the interaction effect between manipulation group and regret intensity on changes in sleep problems was significant only for hot regret emotions, not for despair-related emotions.

[9] Although the slope in the control group was only marginally significant, we note that this slope would be significant ($b = 0.32$, $p < .05$), if we account for baseline levels of negative affectivity, which have been shown to bias reports of physical health in previous research.

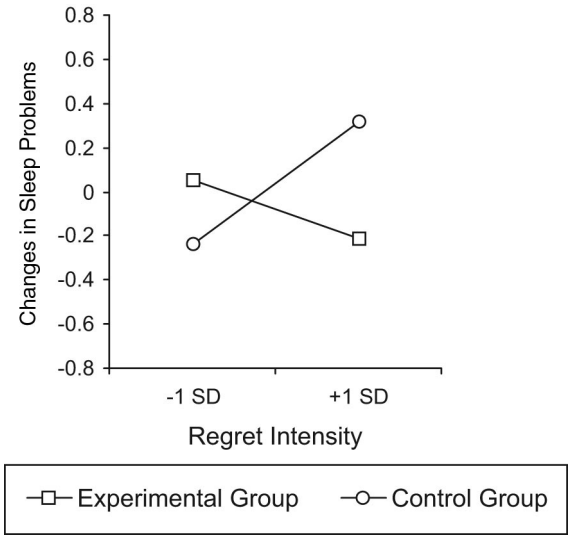

Figure 2. Effects of regret intensity on changes in sleep problems for participants who engaged in a writing intervention designed to facilitate adaptive social–cognitive functioning (experimental group) and who wrote about their daily nonemotional events (control group).

effect on changes in regret intensity and the effects of baseline levels of regret intensity on changes in indicators of physical health remained significant if these variables were incorporated as additional covariates in the analyses.

Discussion

Study 2 was conducted to examine the effectiveness of an experimental writing intervention for alleviating older adults' regret experience and protecting them against the adverse consequences on their physical health. In support of our hypotheses, the analyses documented a beneficial effect of the intervention on changes in older adults' intensity of regret. Whereas participants in the experimental group showed a significant decrease in despair-related regret emotions over time, no changes in despair-related emotions were obtained in the control group. However, with respect to hot regret emotions, a decrease was obtained for both the experimental and the control groups. It may be that the report of their most severe regret in the baseline questionnaire, and the cognitive processes that may have been naturally activated subsequently, were sufficient to relieve some of the negative regret emotions of the participants in the control group.

Although the intervention did not evidence a significant main effect on changes in physical health problems, the results of Study 2 demonstrated a significant interaction effect between initial regret intensity and manipulation group on changes in sleep problems. The shape of the interaction effect supported the hypothesis that the writing intervention can alleviate the effect of intense regret on increases in sleep problems over time. Furthermore, this interaction effect was more closely associated with hot regret emotions than with despair-related regret emotions, suggesting that regret-related experiences that involve high arousal (e.g., anger, irritation, or embarrassment) have a greater potential to disturb an older person's sleep.

The results did not support the hypothesis of a significant interaction effect of manipulation group and baseline regret intensity on changes in cold symptoms. However, the findings demonstrated a main effect of regret intensity on increases in participants' cold symptoms over time. The more intensely participants experienced their regret at baseline, the larger was their increase in cold symptoms. By contrast, baseline cold symptoms did not predict changes in regret intensity over time. Although these results provide further evidence in support of the directional effects of intense regret on physical health problems, they do not support the hypothesis that the intervention influenced the effect of baseline regret intensity on changes in cold symptoms. In spite of the random assignment, there may be group differences related to other variables that could have influenced the results. For example, it should be considered that the expression of different health problems could depend on different factors. In particular, the development of a cold requires the exposure of a person to a virus, and it may be that group differences in social exposure, for example, made it more difficult to demonstrate significant interaction effects for changes in cold symptoms.

In line with the results of Study 1, the findings were largely independent of potentially confounding factors, such as sociodemographic characteristics, chronic health problems, negative affectivity, and characteristics of the regret. However, the interaction effect of manipulation group and regret intensity on increased sleep problems was rendered nonsignificant if changes in regret intensity were statistically controlled for. This result indicated that the beneficial effect of the experimental manipulation on the association between initial levels of regret intensity and changes in sleep problems was associated with the intervention effect on reduced levels of regret intensity.

Together, the results of Study 2 demonstrated that intense regret can be associated with increases in physical health problems, and engaging older adults in social–cognitive processes through a writing intervention may reduce the experience of intense regret. In addition, the intervention significantly reduced the effect of initial regret intensity on increases in sleep problems over time.

General Discussion

This research was conducted to examine the associations between intense life regrets and health-relevant variables in old age. We conducted two studies to examine whether intense regret can predict not only older adults' self-reported health but also a health-relevant biological process (diurnal cortisol secretion) and changes in health problems over time. In addition, we examined whether engaging older adults in adaptive social–cognitive processes through a writing intervention may alleviate the experience of intense regret and protect their physical health.

The reported findings from both studies support our hypotheses. Study 1 confirmed that older adults who experienced intense life regrets secreted a larger volume of diurnal cortisol secretion, which was largely attributable to a steeper early morning increase of cortisol secretion. In addition, intense regret was associated with higher levels of acute physical health problems in Study 1. The results of Study 2 further demonstrated that regret intensity can predict increased levels of cold symptoms over time. By contrast, the health problems assessed in Study 2 did not predict changes in regret intensity over time. The obtained effects were largely un-

related to individual differences in sociodemographic variables, chronic illness, negative affectivity, regret characteristics, and medication use (only Study 1). Therefore, we conclude that the experience of intense regret represents a psychological challenge that can negatively influence older adults' physical health.

Furthermore, Study 2 examined whether a writing intervention that was designed to facilitate adaptive social–cognitive processes might reduce intense regret and benefit older adults' physical health. Consistent with our hypotheses, the writing intervention was associated with a general decrease in regret-specific emotions in the experimental group (only some aspects of regret intensity decreased in the control group). Moreover, the writing intervention demonstrated a beneficial effect on the association between initial regret intensity and increases in sleep problems. Finally, given that the reported findings also suggest that changes in regret intensity may underlie the beneficial effect of the intervention on changes in sleep problems, we conclude that this intervention has the potential to reduce the likelihood of experiencing intense regret and thereby protect older adults' physical health.

Limitations and Future Research

Although the reported results generally supported our hypotheses, some limitations of the reported studies should be addressed in future work. First, we note that the studies did not examine the effects of regret experiences on the development of more severe physical health problems. In addition, Study 1 did not predict different types of disease. These research questions should be examined in future studies, considering that the obtained effects on cortisol dysregulation may be early manifestations of prospective health problems and may be differentially associated with different health problems.

Second, the interpretation of findings concerning the writing intervention is limited because our study did not disentangle the mechanisms by which writing produced these beneficial effects (which may be related to external attributions, social comparisons, or meaningful goals). In addition, Study 2 did not include a control group of participants who were not engaged in writing. Despite these limitations, to the best of our knowledge, Study 2 represents the first experimental manipulation targeted at preventing adverse health effects of life regrets, and we were mainly interested in documenting a global and beneficial effect of the writing intervention. Given these promising findings, we suggest that future research should expand the reported approach by systematically disentangling the effects of writing on the adaptive management of life regrets in the older individuals.

Third, we note that some of our health measures were based on self-reports and that the indicator of sleep problems was a single-item measure. Thus, there may be problems with the reliability of single-item measures and biased health reports. However, given that the prediction of the single-item measure of sleep problems supported our hypotheses, we feel it is rather unlikely that this measure is unreliable. In addition, some of the issues associated with self-reported health were addressed by documenting effects on changes in physical health, because change measures can partial out potential biases associated with self-reports. Moreover, the reported findings predicting self-reported health were independent of individual differences in negative affectivity, a factor that has been shown to produce biases in physical health reports in previous research (Watson & Pennebaker, 1989). Given these considerations, we feel confident in the reliability and validity of our health measures. However, future research should replicate the obtained findings by predicting more objective physical health measures (e.g., morbidity and mortality or clinically relevant biomarkers).

Fourth, the argument could be made that individual differences in regret intensity are a mere reflection of participants' depressive symptomatology. Alternatively, specific emotional experiences may contribute to depression, and depression may be conceptualized as a mediator in the association between regret and physical health (Wrosch et al., 2005). Although we did not previously report on these associations, our studies included measures of depressive symptomatology: the Center for Epidemiological Studies—Depression scale in Study 1 and the Beck Depression Inventory in Study 2. Additionally conducted analyses showed that depressive symptoms did not explain the associations between regret intensity and indicators of cortisol dysregulation and acute physical symptoms in Study 1, and depression did not explain the reported effects of regret intensity on change of sleep problems in Study 2. However, the effect of regret intensity on participants' cold symptoms was rendered nonsignificant if depressive symptomatology was taken into account. Although this pattern of results indicates that regret and depression are empirically distinct constructs, future research should also investigate the circumstances under which depressive symptomatology can play a meaningful role in the association between older adults' regret intensity and their physical health.

Finally, there may be other variables that play an important role in the associations between social–cognitive factors, regret, and physical health in the older individuals. We already mentioned that variables associated with social exposure may influence the development of health problems that require the exposure to a virus. In addition, health-compromising behaviors may play a role in the associations between distress and the development of health problems (e.g., not exercising, smoking). Moreover, it would be useful to study personality variables that are related to the occurrence of intense regret in the first place. Such variables may be associated with people's general tendencies involved in regulating their development, such as maladaptive coping tendencies or pessimism (Carver, Scheier, & Weintraub, 1989; Scheier & Carver, 1985). To address these possibilities, future research should assess additional variables in large-scale longitudinal studies. We feel that such an approach would have the potential to uncover the factors associated with the experience and management of life regrets and to further illuminate pathways to healthy aging.

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