

# Autonomous orientation predicts longevity: New findings from the Nun Study

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## Abstract

**Objective:** Work on longevity has found protective social, cognitive, and emotional factors, but to date we have little understanding of the impact of motivational dynamics. Autonomy orientation, or stable patterns of self-regulation, is theorized to be a protective factor for long-term mental and physical health (Ryan & Deci, 2017), and it is therefore a prime candidate for examining how stable psychosocial factors are linked to longevity, or life expectancy.

**Method:** Essays written in the 1930s by participants in the Nun Study were coded for indicators of an autonomy orientation. These were selected in line with an extensive theoretical literature based in self-determination theory (Deci & Ryan, 1985). Essays were coded for the propensity for choice in action, susceptibility to pressure, self-reflection, integration of experiences, and parental support for autonomy. These coded variables were used to predict age of death.

**Results:** Using 176 codable essays provided by now-deceased participants, linear regression analyses revealed that choiceful behavior, self-reflection, and parent autonomy support predicted age of death. Participants who demonstrated these stable and beneficial motivational characteristics lived longer.

**Conclusions:** Personality constructs reflecting a healthy form of self-regulation are associated with long-term health. Implications for health interventions are discussed.

## KEYWORDS

autonomy, longevity, motivation, Nun Study, self-determination theory

## 1 | INTRODUCTION

Across disciplines, researchers have found strong evidence for cognitive, social, emotional, and personality factors predicting *longevity*, or life expectancy; yet, the role of motivation has been ignored. Among other factors, higher intelligence (Gottfredson & Deary, 2004); personality traits such as conscientiousness, openness, and extraversion (e.g., Fry & Debats, 2009); expressing more positive emotions (Danner, Snowdon, & Friesen, 2001); and providing social support (Brown, Nesse, Vinokur, & Smith, 2003) have predicted longevity. There is

reason to believe that individuals' motivational orientation could impact longevity as well, as motivation governs behavior over a life span in ways that can either protect long-term mental and physical health or undermine it (for a review, see Ryan & Deci, 2017; Weinstein & Ryan, 2011). Herein, we explore the characteristics of an autonomous motivational orientation that may be impactful for long-term health, considered in terms of longevity. Data were collected as part of the Nun Study, a longitudinal study of aging in Catholic sisters, which has paired early life essays written by the sisters at the point of entry to the North American School Sisters of Notre Dame (SSND)

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congregation with age of death, collected decades later. Essays were autobiographical and often centered around reasons for becoming a sister, providing us with a unique and rich opportunity to explore whether tendencies characteristic of an autonomous motivational orientation were related to longevity.

## 1.1 | Autonomous motivational orientation, stress, and health

Defined by the theoretical framework of self-determination theory (SDT; Deci & Ryan, 2008a), an *autonomous motivational orientation* is a tendency for one's behavior to be driven by interests, goals, and values, and less so by pressure from others (Deci & Ryan, 1985, 2008b). Autonomously oriented individuals take more interest in the world, and in their own internal experiences and emotions, and they experience a greater sense of choice around their behaviors (Weinstein, Przybylski, & Ryan, 2012). This pattern of behaving benefits mental and physical health across the life span (see reviews in Deci & Ryan, 2008a; Weinstein & Ryan, 2011).

A body of work reveals that a more autonomous orientation is associated with effective coping with stressful situations, and a greater likelihood of demonstrating resilience in the face of adversity (Ryan & Deci, 2017; Weinstein & Hodgins, 2009; Weinstein & Ryan, 2011). Over time, this has cumulative effects on physical health, leading to lower risk for mortality and illness in old age (e.g., Surtees, Wainright, & Knaw, 2006). Those who are higher in autonomy have also been shown to exhibit fewer type A personality patterns (Deci & Ryan, 1985), less rageful behaviors (Knee, Nanayakkara, Victor, Neighbors, & Patrick, 2001), and more psychological growth following stressful events (e.g., Lumb, Beaudry, & Blanchard, 2016), indicating they respond more adaptively to both daily and major life stressors. Further, those who regulate autonomously experience more vitality, a positive arousal state that reflects a high level of functioning, after a stressful encounter (Weinstein & Hodgins, 2009). Moreover, these patterns of resilient responding are evident across the life span (Chang & Yu, 2013). Beyond looking at an autonomous motivational orientation globally, its specific components each have been found to protect health, giving more insight into how it might relate to longevity.

### 1.1.1 | Autonomous motivation for behavior

According to self-determination theory, as individuals are increasingly autonomously oriented, they tend to behave from a sense of *choice*—acting volitionally and fully endorsing behavior—rather than behaving because of *pressure*—being coerced or pushed into behaving by others (Ryan & Deci, 2008a). Researchers have argued experiencing choice (and not pressure) around important life decisions and even on a daily basis is a key reason that autonomously oriented

individuals tend to cope better with stress (Weinstein & Ryan, 2011). For example, research suggests that the experience of choice is related to stressors being seen as challenging rather than overwhelming (De Cuyper & De Witte, 2006), with implications for mortality and health (Seery, 2011). Complementing work shows that a greater sense of pressure is linked to higher salivary cortisol responses (Quested et al., 2011) and high blood pressure (Weinstein, Legate, Kumashiro, & Ryan, 2016).

### 1.1.2 | Autonomous processing of experiences

A second aspect of an autonomous orientation is processing emotional experiences fully and openly. Specifically, those who are autonomously oriented *self-reflect*, or actively consider their reactions and feelings about emotion-laden experiences (Deci & Ryan, 1985; Turner & Silvia, 2006), and they demonstrate a curiosity or willingness to think more about their own past and present experiences (Hodgins et al., 2010; Weinstein et al., 2012). This way of self-reflecting is also indicative of a mindful orientation, or an open receptivity to experiences as they occur, which has been closely linked to autonomy (Brown & Ryan, 2003). Mindfulness has also been linked to lower stress (e.g., Brown & Ryan, 2003; Weinstein et al., 2012), as indicated by lower salivary cortisol after stressful events (Brown, Weinstein, & Creswell, 2012) and lower autonomic arousal generally (Ditto, Eclache, & Goldman, 2006).

Complementing self-reflective processes, the other aspect of autonomously processing affective experiences is *integration*, or bringing new experiences, both positive and negative, into harmony with one's emotions, sense of self, and values (for a review, see Weinstein, Przybylski, & Ryan, 2013); the result is an increasingly coherent and developing sense of self. An emerging line of research has identified that such integrative processing of experiences promotes successful coping (Roth & Assor, 2012) and results in lower autonomic arousal when individuals are emotionally challenged (Roth et al., 2014; Weinstein & Hodgins, 2009), suggesting they learn from and adapt to stressors.

Importantly, seminal work coding content in personal narratives has found that narratives demonstrating integration and awareness (self-reflection) correlate with wellness (Bauer & McAdams, 2004; Bauer, McAdams, & Sakaeda, 2005). Even more immediate to the current work, coding of identity processes that show integration has been shown to be predictive of the health of older adults 10 years later, as indicated by subjective coding (Pals, 2006). Further, constructs related to autonomous functioning such as self-integration have been coded in narratives of older and younger adults and relate to wellness in both (Bauer et al., 2005; Pasupathi & Mansour, 2006).

### 1.1.3 | Parent autonomy support

Finally, a *precursor* to an autonomous orientation is parent autonomy support, or parents' acceptance and encouragement for self-expression (e.g., Wong, Wiest, & Cusick, 2002). Autonomy support from parents and close others has been shown to reduce ill health, stress reactivity (Quested et al., 2011), and physical health symptoms on a daily basis (Legate, Ryan, & Rogge, 2017); in fact, support that does not promote autonomy has been shown to increase cardiovascular reactivity (Zniva, Pauli, & Schulz, 2017). Given its implications for health, we explored essays for themes of parents as autonomy supportive or not; in this case, parent support was considered by evaluating how sisters described their parents' reaction to the life-altering decision to join the congregation, one that can lead to conflict and withdrawal of support within families (Trzebiatowska, 2008).

## 1.2 | The Nun Study sample

It is important to consider the historical and cultural context from which these essays emerged, as narratives are colored by the culture of their writer (Schuman, Rieger, & Gaidys, 1994; Thorne & McLean, 2003). The sisters in this study entered the SSND order and wrote these autobiographical essays between 1930 and 1942. Their decisions were likely influenced by less access to education and occupational opportunities for girls and women at the time (primarily domestic service, factories, and clerical work, with fewer in professional roles as teachers or nurses; Baughman, Bondi, Layman, McConnell, & Tomkins, 2001) and by economic hardship (these young women came primarily from working-class and rural farming community backgrounds; McNamara, 1996). This was also a period of peak activity for religious orders and their influence in schools, led by Pope Pius XI (the "social-action pope"), who emphasized the importance of Catholics shaping society (O'Donoghue & O'Donoghue, 2004). During this time, young women were often encouraged or persuaded by Catholic teachers or religious leaders to join for their own salvation as well as that of society (Cummings, 2009; Lee & Holland, 1993). Thus, joining a religious congregation was more common for young women at the time than it is today, and it was often seen as a prestigious, and dutiful, contribution to the church from large Catholic families. Sisters in the United States, who typically held professions (teachers, nurses) and were involved in the community, likely had more in common with women in the general population than they did with secluded orders of nuns residing in nunneries. Though the latter show lower psychosocial stress levels than the general population (Timio et al., 1997), the same may not have been true for the population of sisters living and working within the United States; indeed, religious leaders in the United States show substantial

variability of stress levels (Rayburn, Richmond, & Rogers, 1986).

Also important is that previous studies have relied on the Nun Study sample to study health and longevity. Most research with this sample has focused on dementia, longevity, and the link between these two (e.g., Tyas, Snowdon, Desrosiers, Riley, & Markesbery, 2007). Work on dementia finds that factors like brain infarcts (Snowdon et al., 1997), low educational attainment (Mortimer, Snowdon, & Markesbery, 2003), and low linguistic ability in early life (Riley, Snowdon, Desrosiers, & Markesbury, 2005) and in later life (Kemper, Greiner, Marquis, Prenovost, & Mitzner, 2001) are predictors. Research on longevity using this sample has found that self-rated functioning and self-rated global health (Greiner, Snowdon, & Greiner, 1996), as well as low linguistic ability in early life (Snowdon, Griener, Kemper, Nanayakara, & Mortimer, 1999), predicted all-cause mortality. Most immediate to the present research, Danner and colleagues (2001) linked the presence of positive emotions in the sisters' narratives to their longevity, using mortality data available at the time from 42% of the sample.

## 1.3 | Present research

The present research draws on autobiographical essays written at a pivotal moment in these young women's lives to examine the relation between an autonomous orientation and longevity. These accounts were drafted when participants had made the impactful life decision to join a religious congregation and thus provide rich insights into the motivational orientations of these young women at a formative life stage. Informed by the literature in self-determination theory, essays were coded for these characteristics of an autonomous motivational orientation and linked to age of mortality. If such a link were present, it may be that these motivational characteristics already known to protect short-term health might extend to greater longevity.

Focusing on core constructs indicative of an autonomous motivation orientation, hypotheses were as follows:

*Hypothesis 1:* Experiencing more choice and less pressure for joining the congregation would relate to greater longevity. As essays centered around reasons for joining the congregation, both types of motivation were expected to be highly salient.

*Hypothesis 2:* Demonstrating a tendency for self-reflection and the ability to more fully integrate hardships (exhibiting learning and growth from these experiences) would be linked to greater longevity.

*Hypothesis 3:* Describing parents as being autonomy supportive would be linked to greater longevity.

## 2 | METHOD

### 2.1 | Participants

Data from 678 women who were members of the North American School Sisters of Notre Dame (SSND) congregation who participated in the Nun Study were analyzed for the present study. The Nun Study cohort was followed closely from 1991 until the present with the aim of evaluating the cognitive, functional, and neuropathologic correlates of aging (see more in Danner et al., 2001; Snowdon et al., 1996). Informed consent for release of SSND records, study evaluations, and brain autopsy was obtained from all individual participants at the time of enrollment and periodically throughout follow-up. Procedures were approved by the institutional review boards of the University of Kentucky and the University of Minnesota. Archived essays were included for 180 individuals from the Baltimore (79 women) and Milwaukee (101 women) SSND regions (though the women originated from the midwestern, eastern, and southern United States). The North American SSND requested that each incoming sister provide an autobiography. Of the full sample, a total of 180 essays from the Baltimore and Milwaukee regions met the criteria of being handwritten so they could be authenticated as unaltered, and written by native English speakers. Of the 180 women who wrote these essays, ages ranged from 18 to 32 years ( $M = 22$  years). Data on age of death were available for 176 individuals, as four were still alive at time of analysis and were therefore excluded from our analyses.

### 2.2 | Procedures for coding constructs

As a first step, the article's authors, researchers well versed in self-determination theory, examined a subset of essays to ensure that essays were suitable to code for content indicative of an autonomous motivational orientation. Indicators of autonomous motivation, processing of experience, and themes of parental autonomy support emerged, and coders decided on ratings for each before coding commenced.

Coding of the essays comprised two phases. In a first phase, the two raters consulted with a third, who was well trained in the theoretical approach employed in this project. Fifty-four essays were coded in this way, with discussions to resolve discrepancies between the three coders. Having achieved satisfying inter-rater reliability at this early stage, two raters continued to evaluate essays, at this point making separate evaluations, but using a round-robin procedure with overlaps in coding to allow continued checks of reliability that reflect agreement throughout the coding process. Major discrepancies were resolved through discussion. This approach resulted in scores from two raters for just over 50% of the essays (98 essays); the remaining essays were evaluated by one rater.

### 2.3 | Coded constructs (predictors)

#### 2.3.1 | Choice

Choice was operationalized as expressing a willful decision to enter the congregation. Essays were coded 0 if there was no choiceful behavior in them, 1 if there was indication of choiceful behavior (i.e., participants expressed that they willfully entered the congregation), and 2 if they showed persistent or enthusiastic choiceful behavior around entering the congregation. A coding of 2 was further defined if choice was a recurrent theme in the essay, or if they expressed persistence in choosing to enter the congregation despite obstacles in making the choice. Inter-rater reliability between coders for this construct was acceptable. To ensure ongoing agreement on these complex topics, disagreements were resolved through ongoing discussions after, approximately, each set of eight participants, and discussions were mediated by a third, independent researcher. As a result, reliability improved for codings derived during the training session, from  $\kappa = .79$ , to very high after the training period,  $\kappa = .96$ . See Table 1 for excerpts from essays illustrating how this construct (choice) and other constructs were coded.

#### 2.3.2 | Pressure

Pressure was operationalized in terms of being compelled, forced, or coerced into entering the congregation by others. For example, such influences might come from teachers, parents, or other influential religious figures in one's life (a priest). Pressure was coded 0 when absent, 1 when present but subtle (i.e., when text suggested a pressuring influence but pressure was not explicitly expressed), and 2 when present and explicit. Decisions made by the two coders for this construct were highly related during and after training ( $\kappa = .82-1.00$ ).

#### 2.3.3 | Self-reflection

Self-reflection was operationalized in terms of demonstrating having thought about one's own psychological experiences and emotions, also reflected in showing insight and awareness about experiences. Essays were coded 0 when absent, 1 when present but subtle (e.g., when this was apparent in one or two meaningful sentences), and 2 when self-reflection was a strong and consistent theme across text in an essay ( $\kappa_{\text{training}} = .91$ ,  $\kappa_{\text{post training}} = .97$ ).

#### 2.3.4 | Integration of hardships

Integration of hardships was operationalized in terms of learning and growth from challenges and difficulties in one's life. Such growth from hardships, in particular, is a powerful indicator of psychosocial adjustment (McAdams, Reynolds,

TABLE 1 Example essay excerpts of how constructs were coded

Codes	
1	2
Choice	<p>“The ardent desire to live for Christ Crucified could not be resisted. More thoroughly than ever convinced that the world was never to know me I departed it with joy on {month} {date}, {year} when I received the Bonnet in {congregation} Monastery Convent Chapel.”</p>
Pressure	<p>“At the end of my second year at highschool, I was persuaded to join three other girls who were going to the Aspiranture in {city}.”</p>
Self-reflection	<p>“I heard this statement from my aunt. ‘Those who always say they are going to be Sisters are the very ones who get married.’ From the day I listened to my aunt’s speech I seldom again ever said I would be a Sister.”</p>
Integrating experience	<p>“This first break from home was hard, very hard. I was an only child and I know my mother felt my leaving keenly, but the beautiful spirit in which she made the sacrifice, helped to lessen the pain of parting.”</p>
Parent autonomy support	<p>(1) “My Mother cannot be reconciled to my Vocation, and the knowledge of the suffering which I have caused her, has been the one unhappy obstacle, to an otherwise perfectly happy year.”</p>
	<p>“Just when I received the desire to become a sister I do not know, for as long as I can remember, even as a child, I always expressed the desire to my parents. . . . When I finished high school I was not able to enter due to my father’s unemployment. . . . During this time I had not only helped my parents, but also saved enough to embrace my heart’s fondest desire. In the meantime my father had received steady employment, so I felt free to enter as I had the consent of my parents and approval of my confessor, Father {last name}.”</p> <p>“The Sisters urged me to return with her, but I was as still in doubt. I prayed to the blessed Virgin to help me and to show me the way, for I had great confidence in her. The blessed Virgin did help me and led me here. How? I do not know, but in a week’s time I was ready to enter with the new class.”</p> <p>“Our visits with him each Thanksgiving and summer made a deep impression and turned my mind to the great question of ‘what doth it profit?’ His growth in physical health and spiritual peace made me reflect and it is to his example of courage and perseverance that I gratefully attribute my own following of Christ’s call. Of course the annual retreats at school, especially those of my last college years, prepared the way but his ready sacrifice of all that was near and dear gave me something concrete to ponder over and imitate.”</p> <p>“The doctor confirmed my mother’s fears—it was scarlet fever. The doctor fought for four months what he termed would be a ‘losing battle,’ but faith and prayers triumphed and I was spared. . . . [T]hen Mother said, ‘If you think you will like that life; be happy with the choice, I will not stand in your way. Perhaps God spared you to me years ago—so that I could give you back to Him.’ Joy and sorrow filled my heart—joy at the consent of my dearest one on earth and sorrow at the thought of leaving so tender a mother.”</p> <p>(1) “Though this was a sudden shock to my parents, they consented cheerfully, allowing me to finish highschool at {institution}.”</p>

Lewis, Patten, & Bowman, 2001). Essays were coded 0 when absent, 1 when present but subtle (e.g., when expressed through one or two meaningful sentences), and 2 when learning and growth were profound ( $\kappa_s = .89-.99$ ).

### 2.3.5 | Parent autonomy support

Parent autonomy support was operationalized in terms of parents' being perceived as for, against, or neutral in terms of the decision to enter the congregation. Essays were coded 0 when parents were explicitly against the decision, 1 when neutral (or absent), and 2 when explicitly supportive. In some cases, participants reported their parents struggled with the decision (for economic or personal reasons), but over time they embraced and supported the decision; parents' willingness to support was coded 2 even if initial conflict was present, given the willingness to be open and responsive is characteristic of being autonomy supportive (Ryan & Deci, 2017;  $\kappa_s = .95-.93$ ).

## 2.4 | Outcome and control variables from the longitudinal data set

### 2.4.1 | Outcome variable

#### Age of death

Data were available for 176 out of 180 participants, as four were still living at the time of analyses; age of death ranged from 78 to 107 years ( $M = 89.36$ ,  $SD = 5.63$ ). Descriptive analyses showed that age of death was normally distributed across the sample (skewness = .34, kurtosis =  $-.27$ ).

### 2.4.2 | Control variables

#### Parent age of death

Data were available for both fathers' and mothers' age of death in 156 and 160 cases, respectively. Parents' age of death ranged from 22 to 110 years (fathers'  $M = 71.42$ ,  $SD = 15.52$ ; mothers'  $M = 73.46$ ,  $SD = 15.95$ ).

#### Education

As a measure of educational achievement, the number of years in school was recorded at the time of entry into the Nun Study (age 75 or older) and ranged from 8 to 18 years ( $M = 16.50$ ,  $SD = 2.31$ ).

#### Age when writing essays

Women ranged in age from 18 to 32 years when writing the autobiographical essays coded in this article ( $M = 21.84$  years,  $SD = 2.67$ ).

#### Positive emotions

Positive emotion sentences were coded for all essays and data published in Danner et al. (2001), and the coding

procedures that derived this variable are further described in the article. The authors also coded negative and neutral emotion words, but found these did not relate to age of death; as such, we only control for positive emotions in our analyses.<sup>1</sup>

## 3 | RESULTS

### 3.1 | Preliminary correlations

Zero-order correlations between our predictor, outcome, and control variables of interest are presented in Table 2. Findings showed no relations between sisters' parents' age of death and sisters' own age of death, mother  $r(156) = -.03$ ,  $p = .73$ , father  $r(152) = .06$ ,  $p = .46$ , and parents' age of death did not relate to any of our coded constructs ( $r_s < .12$ ,  $p_s > .14$ ). Additional correlations examined relations of our constructs of interest (coded scores and age of death) with education levels, operationalized as the number of years of education, given that more educated individuals may have a higher quality of life (and longer life span). Pearson correlation analyses showed no relations with years of education for all but the parent support construct, in which case more education related to more parent support,  $r(180) = .24$ ,  $p = .001$ . In addition, those who received more parental autonomy support were younger at age of writing,  $r(180) = -.25$ ,  $p = .001$ . Finally, relations were present with coding of positive emotions, with  $r_s$  ranging from .21–.62 (except for perceived pressure, which did not relate  $p = .51$ ). All other relations were  $r_s < .09$ ,  $p_s > .24$ .

### 3.2 | Analytic strategy

In previous work, the percent of those who had died by the time data analysis took place was used as the primary outcome (Danner et al., 2001), but in this case, age of death was available for all but four participants. Given that the primary benefit of using a hazard model over regression analyses is that it allows for estimates in instances where much of the sample is still alive, the more parsimonious approach was employed, excluding the small minority of participants who were still alive in this case. Data were analyzed, first, using linear regression analyses not adjusting for controls, and second, adjusting for (a) years of education, (b) age at writing, and (c) positive emotions coding, because these potential confounds correlated with our coding in the preliminary analysis.

### 3.3 | Primary Analyses

Multiple regression analyses were used to predict age of death from our motivational constructs as reflected in the essays.

**TABLE 2** Correlations between primary study constructs of interest and constructs examined as potential covariates

	1	2	3	4	5	6	7	8	9	10
<b>Major study constructs</b>										
1. Age of death										
2. Choice	.27**									
3. Pressure	-.05	-.05								
4. Self-reflection	.19*	.40**	.16*							
5. Integration	.12	.33**	.16*	.62**						
6. Parent support	.19*	.06	.13	.10	.08					
<b>Covariates</b>										
7. Father's age of death	.06	.07	.03	-.12	-.07	.11				
8. Mother's age of death	-.03	.06	-.05	.01	-.00	-.07	.08			
9. Years of education	.06	-.04	.02	.04	.00	.24**	-.06	-.09		
10. Age at writing	.15*	.10	.04	.04	.14	-.25**	.09	.09	-.23**	
11. Positive emotions	.10	.37**	.05	.53**	.64**	.21**	.16*	.10	.04	-.03

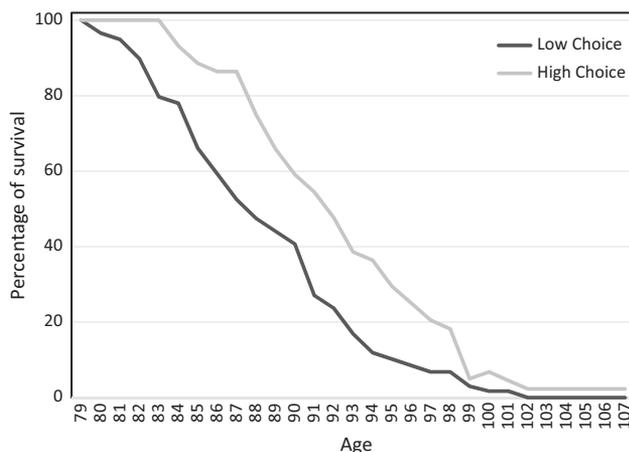
Note. \* $p < .05$ . \*\* $p < .01$ .

### 3.3.1 | Hypothesis 1: Motivation would link to longevity

Findings showed those who expressed *choice* around joining the SSND lived longer, on average 2.04 years longer for every unit coded,  $b = 2.04$ , 95% CI [0.94, 3.14],  $\beta = .27$ ,  $t(174) = 3.67$ ,  $p < .001$ , though there was no relation with perceived *pressure*,  $b = -0.75$ ; 95% CI [-3.03, 1.53],  $\beta = -.05$ ,  $t(174) = -0.65$ ,  $p = .52$ . For illustrative purposes, Figure 1 shows the percentage alive for high and low choice (above and below the median) at each age.

### 3.3.2 | Hypothesis 2: Fuller processing would link to longevity

Examining autonomous emotional processing, those who demonstrated more *self-reflection* lived longer,  $b = 1.47$  (years per unit coded), 95% CI [0.33, 2.61],  $\beta = .19$ ,  $t$



**FIGURE 1** Percentage of survival to age (defined in  $x$ -axis) as a function of high (+1SD) and low (-1SD) choice as coded in essays

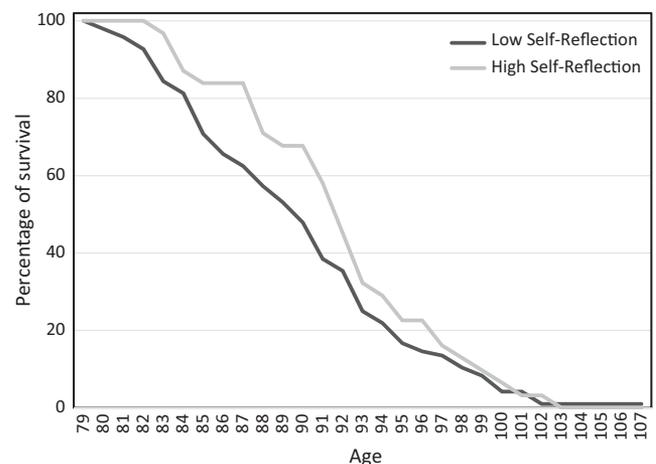
(174) = 2.55,  $p = .01$  (see Figure 2). On the other hand, there was no relation between *integration* and longevity,  $b = 0.95$ , 95% CI [-0.22, 2.16],  $\beta = .12$ ,  $t(174) = 1.61$ ,  $p = .11$ .

### 3.3.3 | Hypothesis 3: Parental autonomy support would link to longevity

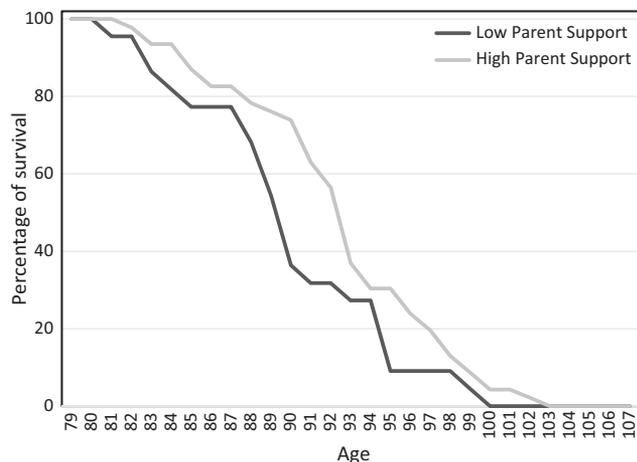
Perceived support from parents was related to a longer life span, with the average unit of coding linking to an additional 1.90 years, 95% CI for  $b$  [0.40, 3.40],  $\beta = .19$ ,  $t(174) = 2.49$ ,  $p = .01$  (Figure 3 illustrates this relation).

### 3.4 | Supplementary analyses

Given our variables of interest were related to years of education, age at writing essays, and positive emotions, an additional series of analyses was conducted regressing age of death onto



**FIGURE 2** Percentage of survival to age (defined in  $x$ -axis) as a function of high (+1SD) and low (-1SD) self-reflection as coded in essays



**FIGURE 3** Percentage of survival to age (defined in *x*-axis) as a function of high (+1SD) and low (−1SD) parent autonomy support as coded in essays

these constructs as well as our own. The analyses showed a weaker, but still significant, effect of choice,  $b = 1.93$ , 95% CI [0.73, 3.12],  $\beta = .25$ ,  $t(171) = 3.19$ ,  $p = .002$ , self-reflection,  $b = 1.37$ , 95% CI [0.04, 2.70],  $\beta = .18$ ,  $t(171) = 2.03$ ,  $p = .04$ , and parental support,  $b = 2.08$ , 95% CI [0.49, 3.68],  $\beta = .20$ ,  $t(171) = 2.58$ ,  $p = .01$ , on age of death.

Additionally, given previous research has identified differences between the two SSND regions (more in Danner et al., 2001), further tests examined whether relations of interest would be moderated by location. To achieve this, a series of hierarchical linear regressions tested moderation for each of our constructs of interest by SSND region. Effects (or absence of effects) did not vary as a function of location for choice,  $t(172) = 0.97$ ,  $p = .33$ , pressure,  $t(172) = -0.82$ ,  $p = .41$ , self-reflection,  $t(172) = 0.12$ ,  $p = .90$ , self-integration,  $t(172) = -0.57$ ,  $p = .57$ , or perceived parent support,  $t(172) = 1.59$ ,  $p = .11$ .

## 4 | DISCUSSION

Our findings expand the existing literature on psychological determinants of physical health by suggesting that one's motivational orientation may be associated with long-term health benefits to the extent of impacting longevity. This study showed three major findings in line with this view: Sisters who demonstrated choicefulness in their behavior, who showed the propensity for self-reflection, and who perceived parents as being autonomy supportive lived longer.

Findings build on previous research showing lower cardiovascular reactivity and salivary cortisol as a function of these three indicators of an autonomous motivational orientation (e.g., Bartholomew, Ntoumanis, Cuevas, & Lonsdale, 2014; Ditto et al., 2006; Hodgins et al., 2010; Weinstein et al., 2016), and they suggest these indicators may have cumulative effects across the life span. These benefits may

be explained by a psychological resilience that buffers against bigger life stressors (Weinstein & Ryan, 2011), or by lower physiological and stress reactivity on a daily basis that have cumulative effects on disease prevalence and recovery in late life (Legate et al., 2017; Surtees et al., 2006). While this study cannot address these potential mechanisms, future work building on these findings would greatly inform how motivation seems to impact health in later life. Behavioral mechanisms may also explain links of present study constructs with health. For example, those who are reflective or experience choice and autonomy support may be more likely to disclose difficult experiences in appropriate ways (Weinstein & Hodgins, 2009), leading to a multitude of health benefits (e.g., Pennebaker, 1993). In addition, those who are more autonomously oriented or supported (all three of our predictive indicators) may be more resilient because they perceive stressful situations as less threatening or overwhelming; but it is equally plausible that autonomous individuals may perceive a stressful situation as threatening but cope in more adaptive ways (Ntoumanis, Edmunds, & Duda, 2009).

In addition, our findings complement existing research suggesting psychological factors can play a role in longevity or mortality. For example, previous work has suggested a link between childhood attachment and mortality (Smith, Williamson, Walsh, & McCartney, 2016), and it might be that autonomy-supportive parenting predicts longevity through promoting a secure attachment (Whipple, Bernier, & Mageau, 2011). Further, while previous research identified that positive emotions link to longevity (Danner et al., 2011), this study suggests that the way that emotions, whether positive or negative, are approached and understood—namely, in a thoughtful and reflective manner—is also important for longevity.

These findings can also be considered in light of Marcia's (1966) Identity Status Paradigm, which further defines identity processes in terms of exploration, that is, the weighing of identity alternatives before choosing a certain direction, and commitment, the extent to which one is then committed to the chosen identity. Though we did not address these identity-relevant constructs in the present article, previous research has suggested that autonomy-supportive parenting increases identity commitment and positive forms of exploration (Luyckx, Goossens, Soenens, & Byers, 2006), revealing that identity processes like exploration and commitment may perhaps be related to long-term health. Indeed, additional work has coded for commitment themes in written narratives and found these relate to generative and pro-social lives (McAdams, Diamond, De St. Aubin, & Mansfield, 1997), a fascinating link given the pro-social nature of religious vocations (Daga & Madnawat, 2016).

Importantly, we explored a narrative approach, which builds on previous work that seeks to define, and understand the impacts of, personal stories. For example, seminal work

by Bauer and colleagues (2005) found that narratives showing integration and learning (using a coding procedure similar to ours for integration and self-reflection) relate to higher well-being. Similar approaches were taken by King and Smith (2004) and Pals (2006), the latter linking processes similar to our self-reflection and integration constructs to participants' subjective perceptions of physical health years later. These approaches, which are examined in Pasupathi, Mansour, and Brubaker (2007) and further reviewed in Adler, Lodi-Smith, Philippe, and Houle (2016), provide options for rich and varied codings of narrative data, and they offer a broad base of understanding of constructs reflected in personal narratives.

We also explore an interesting and nuanced topic, that of choicefulness in entering into a way of life that is perceived by some to have more restrictions or less freedom (see discussion of such perceptions in relation to Catholic religious figures in McNamara, 1996). In fact, the writings of participants in this study illustrated that feeling a sense of choice is important even when choosing a path that may hold certain restrictions. This distinction—between the concept of autonomy and that of freedom—highlights that people can volitionally enter into roles in which they are asked to sacrifice certain freedoms (Ryan & Deci, 2006) or benefit from choice even in restricted environments (Van der Kaap-Deeder et al., 2017). Notably, the strict lifestyle this sample observed (e.g., women who do not smoke, who abstain from sexual activity) may limit the generalizability of these findings to the general population. For example, work comparing this sample to age-matched women in the general population found that the sisters tended to have lower mortality rates, especially in mortality from smoking-related diseases (Butler & Snowdon, 1996). It will therefore be important for future research to test whether motivation orientation and associated constructs, such as choicefulness, predict longevity in other more representative samples.

Finally, the present findings can be viewed in light of existing research on introjected (guilty and pressured) and identified (coming from a place of valuing and interest) motivation for religion, more broadly. An existing literature suggests that Catholics are particularly vulnerable to pressure and guilt as compared to other Christian religions; notably, pressure was not linked to well-being in some past research (Sheldon, 2006), whereas in other studies the experience has, albeit small, links with anxiety, depression, and somatization (Ryan, Rigby, & King, 1993). Informing this nascent literature examining religious motivation, the current findings also failed to find an effect of pressure to join the congregation on longevity. While there was no relation with pressure, choice linked to a longer life span. This finding—that having an autonomous form of religious motivation is beneficial to one's well-being—is conceptually replicated in samples of Belgian Christians (Neyrinck, Vansteenkiste, Lens, Duriez,

& Hutsebaut, 2006), Israeli Jews (Assor, 2012), and American Christians (Ryan et al., 1993).

The study has some notable limitations. Most importantly, findings relied on coding of one written essay, which might not be well-representative of overall experiences or stable tendencies of the sisters. In addition, this research did not investigate why an autonomous orientation would predict longevity, which represents a critical direction of future research. Potential mechanisms could include common genetic determinants of motivation and health, as have been shown in relation to intelligence (Davies et al., 2011), physiological reactions to psychological stress (Savolainen, Eriksson, Kajantie, Pesonen, & Rääkkönen, 2015), and behavioral health habits (Martin, Friedman, & Schwartz, 2007). Finally, the current set of findings should be seen as exploratory in nature as they were not preregistered; future studies should replicate motivational links with longevity before conclusions can be confidently drawn.

Further, our sample consisted of “old adults”; that is, there were no recorded deaths before the age of 79 years, and all Nun Study participants were a minimum of age 75 when the study was begun. Although many psychosocial predictors of functioning relate to physical health similarly in young and old adults (e.g., self-esteem, Pruessner et al., 2005; Big Five personality traits, Costa & McCrae, 1980), certain causes of death at midlife and early old age, such as malignant neoplasms (Heron, 2012), ischemic heart disease and stroke (Lloyd-Jones et al., 2009), injury (Krug, Sharma, & Lozano, 2000), and infections (Chaturvedi, Satoskar, Khare, & Kalgutkar, 2011) may have been less apparent in those individuals we evaluated, who all lived to an old age. Indeed, it may have been that this quality of the sample may have lent more sensitivity to analyses relying on subtle psychosocial indicators of resilience. In this case, our coding may have more immediately predicted variability due to long-term cardiovascular and autoimmune health due to resilient coping styles (Ong & Bergeman, 2004). It is therefore imperative that future work explore whether motivational constructs continue to predict life expectancy across different age ranges.

Yet the findings that choiceful motivation, self-reflection, and parent autonomy support have links with longevity decades later demonstrate the importance of these factors in shaping long-term health. Importantly, these results held when controlling for the presence of positive emotions, as emotional expression as conveyed in narratives plays a critical role in resilience and long-term health (Danner et al., 2001). Interestingly, previous analyses based on the coded content of narratives indicate that more important than either positive or negative emotions is the capacity to experience them concurrently (Adler & Hershfield, 2012), which points to the possibility that a healthy psychological approach to one's emotions and self-relevant experiences is more important

than the emotions themselves. Here, we begin to examine motivation orientation as a style of relating to the self, and to important experiences.

Our findings suggest that modifying one's motivation orientation to be more autonomous might reduce risk for poor health in older age. Motivational characteristics are likely modifiable at different developmental stages (Guay, Boggiano, & Vallerand 2001), as may also be the case for the hypothesized constructs that comprise orientation leading to greater health and longevity (e.g., capacity for self-reflection; Ryan & Deci, 2017). Given this, it suggests fruitful avenues for intervening at different developmental stages to promote a more autonomous motivational orientation, especially by encouraging choiceful decision making, providing opportunities for self-reflection, and intervening with parents to enhance their provision of autonomy support. It is thus critical that work continue to investigate these and other motivational factors that may offer more clues on extending longevity.

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## CONFLICT OF INTERESTS

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## ENDNOTE

<sup>1</sup> When the Danner et al. (2001) analyses were conducted, 104 participants (58%) were still alive. As such, the 2001 analyses used Cox proportional hazards regression (Allison, 1995) to estimate relative risk of death as a function of positive emotions expressed in the essays.

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