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Development and Structural Dynamics of Personal Life Investment in Old Age

Ines Schindler
Dresden University of Technology

Ursula M. Staudinger
International University Bremen

John R. Nesselroade
University of Virginia

The development of personal life investment (PLI) during old age was investigated with longitudinal and cross-sectional data from the Berlin Aging Study (N = 516, ages = 70–103 years). PLI measures motivational energy expended in life domains that require (obligatory PLI) or do not require (optional PLI) investment in old age. The authors used structural modeling to determine developmental trajectories and dynamics of the PLI types. On average, obligatory PLI remained unchanged between 70 and 101 years. Optional PLI declined during the transition to the 4th age (between 80 and 90 years). When change on the intraindividual level was considered, reductions in optional PLI were not related to changes in obligatory PLI, but declining obligatory PLI was associated with declining optional PLI.

Keywords: personal life investment, self-regulatory dynamics, goal striving, third and fourth age, latent difference score models

People regulate their development through striving for goals (P. B. Baltes, Lindenberger, & Staudinger, 1998, 2006; Brandtstädter, 1998; Brandtstädter & Lerner, 1999; Freund & Baltes, 2000; Heckhausen, 1999; Lerner & Busch-Rossnagel, 1981). In old age, dwindling resources limit this goal striving, which led some researchers to assume that older people disengage from life (Cumming & Henry, 1961) or invest less in life (Kuhlen, 1968). Others have stressed that remaining actively engaged in life is essential to successful aging and well-being and have demonstrated that disengagement is not typically observed in older adults (Garfein & Herzog, 1995; Lemon, Bengtson, & Peterson, 1972; Rowe & Kahn, 1997). Today, researchers are in agreement that older individuals continue to hold and actively pursue personal goals, although these goals sometimes need to be adapted in response to age-related losses and constraints (e.g., M. M. Baltes & Carstensen, 2003; P. B. Baltes & Baltes, 1990; Brandtstädter & Greve, 1994; Cross & Markus, 1991; Freund & Baltes, 2000). Some research even points to developmental gains related to goal striving in older age (Riediger, Freund, & Baltes, 2005).

With this study, we wanted to shed more light on the development of self-reported engagement with life during old age. Specifically, our aim was to address two important issues regarding the longitudinal development of goal striving in old and very old age. First, during the last decades, evidence has accumulated that underlines the necessity to differentiate between a third and a fourth age (P. B. Baltes & Smith, 2003; Smith, 2003). Aging during the third age (up to age 80–85 years) is characterized by much resilience in self and personality functioning, although cognitive and physical functioning show some decline (e.g., Staudinger, Marsiske, & Baltes, 1995). The limits of this resilience become evident during the fourth age (after age 85 years), when development takes a considerably more negative turn. The fourth age is characterized by increased dysfunctionality and disability, diminished life quality and subjective well-being, and declines in desirable personality traits (P. B. Baltes & Smith, 2003; Smith, 2003). We expected to find that making the transition between the third and the fourth age is also associated with changes in goal engagement reflecting the general picture of increasing losses and reduced resources during this transition. Second, we were interested in studying the self-regulatory dynamics underlying goal

Ines Schindler, Department of Psychology, Dresden University of Technology, Dresden, Germany; Ursula M. Staudinger, Jacobs Center for Lifelong Learning and Institutional Development, International University Bremen, Bremen, Germany; John R. Nesselroade, Department of Psychology, University of Virginia.

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Correspondence concerning this article should be addressed to Ines Schindler, who is now at the Department of Psychology, University of Utah, 380 S. 1530 E., Room 502, Salt Lake City, UT 84112. E-mail: ines.schindler@psych.utah.edu

engagement during the third and fourth age. Uncovering some of the self-regulatory principles behind goal engagement should contribute to a better understanding of why we observe specific age trends—and also of why some older adults may depart from these general trends. As a result of these two central aims, we used two different perspectives in conducting our analyses: First, we focused on a detailed description of age trends in goal engagement that are characteristic of the entire sample (age perspective). Second, we were interested in intraindividual developmental trends and interindividual differences in those trends and, therefore, focused on how individual participants changed their goal engagement across time in this study (time-in-study perspective).

We used data from the Berlin Aging Study (BASE; P. B. Baltes & Mayer, 1999), which are optimally suited to address the two central issues raised. In contrast to previous studies, we used longitudinal data on the intensity of goal striving not only in old adults but also in very old adults (85–100 years), which allowed us to study the transition between the third and fourth age. We focused on participants' personal life investment (PLI; Staudinger & Fleeson, 1996; Staudinger, Freund, Linden, & Maas, 1999; Staudinger & Schindler, 2006), that is, the amount of motivational energy (action and thought) they reported investing in 10 central life domains (e.g., health, family, leisure). Investment was further differentiated into obligatory—things people must do—and optional—things people can do—PLI (Schindler, 2005; Schindler & Staudinger, 2006). This classification followed the following theoretical rationale: A life domain is considered as obligatory if it involves age-normative challenges or demands that need attention if actual or imminent losses in basic resources for goal striving (e.g., basic levels of physical functioning, basic social network) are to be avoided, compensated, or managed. In contrast, optional PLI domains are those that do not involve demands that push people to invest but rather offer opportunities for expressing personal desires. Moreover, losses in these domains can be accepted without serious negative consequences to the overall level of functioning.

The classification of domains as obligatory or optional is not universal but changes across the life span as well as, to some degree, between cultures and historical times. Considering the typical life circumstances for current cohorts of old and very old Germans, we classified PLI in the domains of health, cognitive fitness, independence, family, life reflection, and death as *obligatory PLI*. Older people are not free to choose whether to care about their health, cognitive functioning, or independence if they want to maintain a basic level of functioning. The family usually is the basic social network and an important resource for older adults (e.g., Lang & Carstensen, 1998), but it requires some investment to keep family bonds intact. Life reflection is a basic tool necessary for life composition (Staudinger, 2001) and for coming to terms with one's live as lived. Together with accepting the terminality of life, this is a central task of old age (e.g., Erikson, Erikson, & Kivnick, 1986).

Investments in the domains of leisure, friends, sexuality, and occupation were categorized as *optional PLI*. Spending time in leisure activities and with friends is what people usually do with their free time. As reproduction is not a goal typically held by older people, engaging in sexual activities is merely an option. Occupation ceases to be obligatory after retirement, which is mandatory in Germany. Nowadays, older Germans do not have to work to earn a living, and neither is there a strong cultural value that pushes them to volunteer.

We previously found evidence for the usefulness and validity of this distinction of two PLI types. Obligatory and optional PLI showed different correlative patterns with self and personality variables in the cross-sectional BASE sample (Schindler & Staudinger, 2006): Obligatory PLI was positively related to extraversion and hoped-for possible selves but also positively related to neuroticism and feared possible selves. In other words, obligatory PLI was associated with indicators of approach as well as avoidance tendencies (Elliot & Thrash, 2002). In contrast, optional PLI was positively related only to indicators of an approach tendency. Moreover, whereas obligatory PLI was unrelated to functional health status, optional PLI was positively related to functional health (Schindler & Staudinger, 2006). These cross-sectional findings speak to the different functionality and development of the two PLI types during old age, which we investigated in detail with longitudinal data in this study.

Two Perspectives of the Study: Age Trends and Self-Regulatory Dynamics Across Time

One of the major goals of developmental psychology is to gain an accurate picture of age-related changes in a variable. At best, the established developmental trend is representative of the population under study. A second developmental focus concerns the analysis of interindividual differences and similarities in intraindividual development and the interrelationships between developmental change in two or more variables (P. B. Baltes & Nesselroade, 1979). In the present research, we studied the development of obligatory and optional PLI from both perspectives; that is, we investigated the development of the two PLI types in people between the ages of 70 and 100 years or older and the intraindividual development of the two types across time in BASE (up to 10 years), including the dynamic interplay between obligatory and optional PLI.

Development of PLI in Old and Very Old Age (Age Perspective)

We previously have shown with cross-sectional data that engagement with life is slightly reduced during old age: Average PLI (obligatory and optional PLI combined) showed small negative age differences between adulthood and very old age (Staudinger & Schindler, 2006). Other researchers found that older people report fewer personal goals compared with young adults (Cross & Markus, 1991; Hooker, 1992; Parks, Klinger, & Perlmutter, 1988). However, reduced engagement is typical only of some life domains. Older adults hold fewer work- or education-related goals and fewer goals associated with financial welfare. In contrast, not only goals related to one's health, physical functioning, or independence but also goals in the realms of leisure, free time, and civic and community issues increase in frequency, importance, or salience with increasing age (Brandtstädter, Renner, & Baltes-Götz, 1989; Cross & Markus, 1991; Dittmann-Kohli, 1995; Heckhausen, 1997; Hooker, 1992; Hooker & Kaus, 1992; Lapierre, Bouffard, & Bastin, 1993; Nurmi, 1992; Staudinger & Schindler, 2006). Additional differences have been found between old and very old age: Health goals were more prominent, whereas leisure

or social relationship goals were less prominent (Frazier, Hooker, Johnson, & Kaus, 2000; Frazier, Johnson, Gonzalez, & Kafka, 2002; Hooker & Siegler, 1993; Smith & Freund, 2002). Overall, these findings suggest constant or higher investment in life domains that we consider obligatory (health, independence) and reduced investment in optional life domains (leisure, work) between old and very old age. Still, the cited findings are largely based on cross-sectional evidence, and developmental trajectories based on cross-sectional and longitudinal data are not necessarily identical (e.g., Salthouse, 2000; Zelinski & Burnight, 1997). Findings can diverge because of cohort, selection, or retest effects (P. B. Baltes, Reese, & Nesselroade, 1977/1988; Schaie, 1965). For this article, we had available data on intraindividual change in participants for up to 10 years between the ages of 70 and 101 years and were also able to compare this longitudinal information with cross-sectional evidence from the larger and more representative initial BASE sample. As the longitudinal BASE sample represents a positive selection among the initial participants (Lindenberger, Singer, & Baltes, 2002), we were particularly concerned about selection effects for PLI, which may have led to attenuated age gradients.

Furthermore, we were interested in the exact shape of the developmental trajectories of obligatory and optional PLI. As previously stated, one may benefit from not thinking about aging as continuously ongoing loss and decline but rather from considering the distinction between the third and fourth ages (e.g., P. B. Baltes, 1997; P. B. Baltes & Smith, 2003; Smith, 2003) that illustrates that old age is not just one life phase. During the transition to the fourth age, people experience a rapid depletion of physical and cognitive resources. Given that "resources are actual or potential means for achieving one's goals" (Freund & Riediger, 2001, p. 373), this depletion of resources seriously limits goal striving and requires adaptation to this change in the developmental context. Even though it seems that people start shifting their goal orientation from growth to maintenance and regulation of loss already during the third age (Ebner, 2005; Freund & Ebner, 2005; see also Staudinger et al., 1995), the necessity of protecting the remaining resources and adapting to loss becomes even more pressing during the fourth age. The resulting investments are part of what we consider to be obligatory PLI: People strive to maintain their physical and cognitive functioning and independence as far as possible but also have to accept the physical changes happening to them and prepare for impending death. In contrast to the third age, these obligatory investments can be expected to take up so much of the limited resources during the fourth age that the remaining resources only allow for reduced optional PLI. Therefore, changes in optional PLI during old age may not be linear but rather show a pattern of stability up to age 80; decline between 80 and 90 years, when the vast majority of people make the transition to the fourth age; and stability on a reduced level beginning at age 90. Specifically, until age 80, older adults should possess enough resources to maintain their obligatory and optional PLI levels. The serious loss of functional resources marking the transition to the fourth age is expected to demand a stronger focus on obligatory PLI at the expense of optional PLI. Thus, optional PLI is expected to decline during the transition to the fourth age. For two reasons, however, it seems unlikely that this declining trend of optional PLI continues during the 9th and 10th decades of life. First, some older people should reach a level of optional PLI that cannot be further reduced and thus stop changing (floor effect). Second, survival becomes increasingly selective the closer people get to 100 years. The population of nonagenarians and centenarians should thus comprise a larger proportion of people who did not experience substantial age-related losses (Rott, d'Heureuse, Kliegel, Schönemann, & Becker, 2001), that is, people who did not experience the "typical" transition to the fourth age (after all, individuals differ in whether and when they encounter serious losses in very old age; see P. B. Baltes & Smith, 2003). If a sample age 90 and older comprises, on the one hand, people who have reached the floor of possible optional PLI scores and, on the other hand, people who are extremely resilient and thus will show only very little change in optional PLI until their death (or shortly before their death), the overall result is predicted to be stability in optional PLI, albeit on a lower level compared with that during the 7th decade of life. Indeed, this hypothesized change pattern has been found for other self and personality constructs in BASE (e.g., extraversion, positive affect, aging satisfaction; J. Smith, personal communication, March 2, 2004; see also Smith, Borchelt, Maier, & Jopp, 2002).

On the basis of these considerations and previous findings, we hypothesized that, when considering the average trend in the entire sample, obligatory PLI remains unchanged in those between 70 and older than 100 years. In BASE, it should be difficult to observe increases in obligatory PLI because of a ceiling effect: Participants' investments in domains like health are already very high during their 70s and, thus, there can hardly be significant increases in these areas during their 80s. Optional PLI was expected to decline in old age. Specifically, we predicted stable optional PLI up to age 80 years, declining investment between 80 and 90 years, and again stable optional PLI beginning at age 90.

Intraindividual Change and Self-Regulatory Dynamics Between Obligatory and Optional PLI (Time-in-Study Perspective)

In studying intraindividual change up to 10 years in the BASE sample, we expected average change in level of investment to be much smaller than the observed amount of change across the entire age range of more than 30 years that is covered by the cross-sectional sample. Even with regard to memory functioning, which shows strong decrements with increasing age, Zelinski and Burnight (1997) advised a time interval of about 6 years to assure statistically reliable longitudinal decline. We thus hypothesized on average no change in obligatory PLI and very little decline or no change in optional PLI across 10 years in BASE. Still, we expected to find interindividual differences in developmental trajectories across time: Some people should change their PLI in spite of no average change. Because our central aim in using the time-in-study perspective was to investigate the dynamic interplay between obligatory and optional PLI, the demonstration of significant interindividual variability in intraindividual change was a required first step.

Regarding the dynamic interplay between developmental trends of obligatory and optional PLI, we assumed that obligatory PLI takes primacy over optional PLI: Parts of a person's obligatory PLI serve to protect the physical, cognitive, and motivational resources that enable optional PLI (see M. M. Baltes, Maas, Wilms, Borchelt, & Little, 1999; Horgas, Wilms, & Baltes, 1998; Pushkar, Arbuckle, Maag, Conway, & Chaikelson, 1997, for similar arguments related to basic and expanded levels of competence or

obligatory and discretionary/optional activities in old age). Thus, obligations have to be met before one can invest in optional pursuits; optional PLI at the expense of obligatory PLI may lead to neglecting resource protection and premature resource depletion. When facing the resource losses typical of the fourth age, we expected older people to cut back optional PLI without changing obligatory PLI. In contrast, reductions in obligatory PLI should be an exception: Only when both physical and psychological resource losses become severe (a situation that should be encountered by only few older adults facing the most adverse aging processes), older people may also decrease their obligatory PLI. This differential timing of resource losses affecting the two PLI types should be reflected in their dynamic interplay: We predicted that people may reduce optional PLI without changing obligatory PLI. However, once dwindling resources require participants to cut back on obligatory PLI, we expected that optional PLI would be reduced.

Method

The BASE (for details, see P. B. Baltes & Mayer, 1999; P. B. Baltes & Smith, 1997; Smith & Delius, 2003; Smith, Maas, et al., 2002) is a multidisciplinary study of old and very old people. The present analyses were conducted with cross-sectional and longitudinal PLI data from BASE that were collected during four measurement occasions between 1990 and 2000.

Sample and Measurement Schedule

The BASE sample at the first measurement occasion (T1 sample) was designed to be representative of the older population of the western districts of Berlin. It is a heterogeneous age-by-sex–stratified sample of community-dwelling and institutionalized individuals that was randomly drawn from the city registration office. The sample was divided into six age groups (70–74, 75–79, 80–84, 85–89, 90–94, and 95–103 years). Each age group comprised 43 women and 43 men, resulting in a sample of 516 participants. The first occasion consisted of a 14-session in-depth assessment, mostly conducted at the participant's place of residence. Data collection at T1 took place between 1990 and 1993. Survivors of the T1 sample were included in longitudinal follow-ups if they were willing and able to participate. Characteristics of the BASE sample across time and time intervals between measurement occasions are given in Table 1. As would be expected, the stratified age distribution at T1 was not maintained in the longitudinal sample. A much larger proportion of participants over age 90 at T1 dropped out of the study compared with the proportion of younger participants who dropped out (Smith & Delius, 2003; Smith, Maas, et al., 2002). Similarly, the percentage of women increased across time in the longitudinal study. Table 1 further shows that the time intervals between measurement occasions varied between and within participants.

Measurement of Personal Life Investment

The Personal Life Investment Schedule (Staudinger & Fleeson, 1996; Staudinger et al., 1999) was developed for the Berlin Aging Study and hence fitted the necessities of data collection in a sample of old and very old people. We measured PLI in 10 life domains with 10 single items using a 5-point Likert scale. These ratings measure the amount of motivational energy invested in terms of action and thought in the domains of health, cognitive fitness (cognition), hobbies and interests (leisure), friends and acquaintances (friends), sexuality, well-being of family members (family), occupation or occupation-like activities (occupation), independence, thinking about one's life (life reflection), and one's death and dying (death). At all measurement occasions, PLI data were collected by trained research assistants in face-to-face interviews during one of the psychology sessions (T1: Session 8 of 14; T2 and T3: Session 3 of 6; T4: Session 3 of 4). Obligatory PLI was computed as mean PLI in the domains of health, cognition, family, independence, life reflection, and death (Cronbach's $\alpha_{T1} = .67$, $\alpha_{T2} = .59$, $\alpha_{T3} = .65$, $\alpha_{T4} = .60$). Optional PLI was computed as mean PLI in the domains of leisure, friends, sexuality, and occupation ($\alpha_{T1} = .48$, $\alpha_{T2} = .46$, $\alpha_{T3} = .58$, $\alpha_{T4} = .53$).[1] Subsequently, PLI scores were transformed to a new metric reflecting the individual's position on the scale as a percentage of the maximum possible (POMP) score (Cohen, Cohen, Aiken, & West, 1999), that is, the highest score that can theoretically be attained on this scale. The resulting scores can range between 0 and 100.

Before performing analyses, we checked the PLI data for outliers. Univariate outliers were assigned the smallest or largest value that did not produce an outlier (Tabachnick & Fidell, 1996). Where adjustments had to be made, the same range constrictions were applied to all measurement occasions to ensure comparability of the data. The resulting scores for obligatory PLI ranged between 29.8 and 95.8, and the scores for optional PLI ranged between 9.8 and 91.7. Higher scores indicate higher investment.

Multivariate outliers were identified as people who showed a highly unusual pattern across the 10 PLI items at one occasion or highly unusual developmental trajectories of obligatory or optional PLI (Mahalanobis distance at $p < .001$; Tabachnick & Fidell, 1996). Screening for multivariate outliers was performed after adjustment of univariate outliers. On the basis of these analyses and closer inspection of the outlying cases, 5 participants were excluded from the sample as multivariate outliers, 2 because of unusual and implausible PLI patterns, and 3 because of extreme developmental trajectories.

With longitudinal data, we also needed to address the question whether the scales measure the same latent construct across all measurement occasions. Both the two-factor (obligatory and optional) structure of PLI and the measurement invariance (metric factorial invariance; see Horn, McArdle, & Mason, 1983) of the two-factor model have been demonstrated (Schindler, 2005). Thus, the intercorrelation pattern of the 10 PLI items did not change across time in BASE, which is a prerequisite for conducting longitudinal comparisons of the two PLI types.

Sample Selectivity

From the beginning, problems of sampling bias have received special attention in BASE. Selection analyses have shown that the T1 sample can be considered fairly representative of the West Berlin older population

[1] Before one draws conclusions on the reliability and factorial structure of PLI, a note of caution is at issue. Both the demonstration of internal consistency and the demonstration of factorial invariance rest on the assumption that participants possess latent dispositions toward obligatory and optional PLI that influence responses to the 10 PLI items. The PLI items would hence be considered as *effects indicators* (Bollen & Lennox, 1991; MacCallum & Browne, 1993). This assumption does not match with the theoretical conceptualization of obligatory and optional PLI. The PLI types are indicative of the amount of effort that is currently invested in obligatory and optional life domains rather than personal dispositions. The PLI items are thus *causal indicators* (Bollen & Lennox, 1991; MacCallum & Browne, 1993); that is, high investment in leisure, friends, sexuality, and work is what "causes" high optional PLI rather than the other way around. This also means that someone who invests much in the health domain cannot be expected to also invest much in the family domain. Therefore, neither Cronbach's alpha nor confirmatory factor analysis is theoretically adequate for testing the reliability of the PLI types. Internal consistencies of the PLI types were included only to inform the reader about the degree of overlap between the PLI items. From a methodological standpoint, it was also important to us that the correlative pattern of the PLI items did not change across time or age, which is a prerequisite for conducting longitudinal comparisons of the PLI types. However, from a theoretical standpoint, the results should not be interpreted as speaking to whether the constructs of obligatory and optional PLI were reliably measured.

Table 1
Sample Characteristics, Measurement Schedule, and Basic Descriptives of Personal Life Investment (PLI) for the Berlin Aging Study Sample Across Time

Characteristic	Cross-sectional sample T1	Longitudinal sample			
		T1	T2	T3	T4
N	511	206	206	130	81
Data collection period	1990–1993	1990–1993	1995–1996	1997–1998	2000
Time interval (years)					
Since T1: *M* (*SD*)			3.8 (0.7)	5.6 (0.8)	9.0 (0.8)
Since previous occasion: *M* (*SD*)			3.8 (0.7)	1.8 (0.3)	3.4 (0.2)
Age group (%)					
70–<80	33.5	58.3	37.9	31.5	6.2
80–<90	33.3	32.5	45.1	54.6	75.3
90–100+	33.3	9.2	17.0	13.8	18.5
Age (years): *M* (*SD*)	84.9 (8.7)	79.7 (6.8)	83.5 (6.9)	83.8 (6.0)	85.7 (4.4)
Women (%)	49.5	49.5	49.5	53.8	59.3
Obligatory PLI: *M* (*SD*)	60.3 (16.1)	60.0 (15.4)	60.4 (14.2)	61.8 (14.8)	61.8 (14.4)
Optional PLI: *M* (*SD*)	42.5 (17.2)	46.1 (16.7)	44.1 (15.2)	44.7 (17.3)	48.4 (16.5)

Note. Five participants represented multivariate outliers on the PLI variables and were excluded from the present analyses. Descriptive statistics are given for the reduced sample. T = time.

(P. B. Baltes & Smith, 1997; Lindenberger et al., 1999). When comparing the longitudinal sample ($N = 206$) with the cross-sectional T1 sample, evidence for nonrandom sample attrition was found (Lindenberger et al., 2002): Participants in the longitudinal study were younger, showed higher levels of cognitive functioning, and were in better functional health.

Selection analyses for obligatory and optional PLI, overall, yielded no selection effects in the longitudinal sample (Schindler, 2005). However, when selection was estimated separately for different age groups (70–<80, 80–<90, 90–100+ years), participants older than 90 years in the longitudinal sample were found to be selected for higher optional PLI (small effect). It is important to note that this selection was not associated with mortality (i.e., attributable to very old people with low optional PLI dying); it was experimental selection (i.e., attributable to people with low optional PLI not participating in the study, although they were alive at that time). This sampling bias may have implications for the interpretation of the present findings and is considered in the Discussion section.

Statistical Models

Several analytic approaches could be used to accomplish the simultaneous modeling of intraindividual change and interindividual differences in intraindividual change, even in the presence of incomplete data and with varied timing and spacing of observations (see, e.g., Collins & Sayer, 2001; Little, Schnabel, & Baumert, 2000; Raudenbush, 2001). For this study, we adopted univariate and bivariate latent difference score models (LDS models; for details see Hamagami, McArdle, & Cohen, 2000; McArdle, 2001; McArdle & Hamagami, 2001; McArdle & Nesselroade, 2003), which can be considered as part of a larger class of models that are variously labeled latent growth models, hierarchical models, or multilevel models. In contrast to other growth models, LDS models include parameters that directly estimate *change* in a variable between two assessments, which opens up additional possibilities for modeling effects involving the rate of change (cf. Hamagami et al., 2000; McArdle & Hamagami, 2001). This inclusion of latent difference or latent change scores also explains why they are referred to as LDS models or change-score models.

Figures 1 and 2 depict the LDS models that were used in this study. The univariate model in Figure 1 estimates a time-based trajectory for the entire sample that is described by the means of an initial level L (μ_L), a linear slope S (μ_S), and a quadratic slope QS (μ_{QS}). The trajectories of individual participants are represented as deviations from the group trajectory (σ^2_L, σ^2_S, σ^2_{QS}). The LDS model further accommodates incomplete data and accounts for varying distances between measurement occasions. We did not need to have data from every participant at each measurement occasion nor did we need the measurement occasions to be equidistant. Instead, we identified a set of time points at which each participant could have been measured (here, an initial assessment PLI[0] and five subsequent assessments within 2-year intervals: PLI[1] after 1–2 years up to PLI[5] after 9–10 years) and rearranged the observed data according to this new time scale.[2] Because none of the BASE participants were observed on six occasions separated by 2-year time intervals, this procedure led to a substantial amount of (hypothetically) incomplete data. However, current structural equation modeling software (the present analyses were conducted with Mplus Version 2.02; Muthén & Muthén, 1998) can handle incomplete data using all available observations to compute full-information maximum-likelihood parameter estimates, without either imputing or dropping data. Thus, only the observed data for each participant were used to fit the model, whereas "missing" observations were treated as latent variables (as illustrated by the circles inside squares in Figures 1 and 2).[3]

The LDS models used to study change across age are basically identical to the model in Figure 1. The only difference was that the number of 2-year time intervals was increased from 6 to 16 (age increased from 70–71 to

[2] Although the reduction of time points to 2-year instead of 1-year intervals was beneficial for the analyses (fewer instances of incomplete data), it also had one drawback. Because the minimal time interval between T2 and T3 was 1 year for some participants, reduction to 2-year intervals led to some participants being observed twice during one time interval, which made it impossible to distinguish between the two observations. To ensure that each measurement was assigned to a different 2-year interval, we made adjustments for the 45 participants for whom the problem occurred: Time intervals were slightly enhanced or reduced to move them to the preceding or subsequent time interval. Overall, the differences between the original and new time intervals between measurement occasions were small, ranging from 0.01 to 0.40 years ($M = 0.12$ years). Two-year age intervals were determined on the basis of new time intervals.

[3] PLI(0) was observed for every participant and PLI(1) was never observed. Therefore, the observations are not drawn as circles inside squares.

100–101).[4] Further, parameters in the age models were specified such that μ_L does not give the initial level at T1 but the estimated mean PLI at 70–71 years and that μ_S and μ_{QS} represent the average change per 10 years of age.

Although the information gained from models across time in study and age may seem similar at first sight, the two time perspectives can help address different research questions. Age models are suited for determining the exact developmental trajectory across the entire observed age span, but they can also have a drawback: Simulations have shown that the power to detect significant interindividual variability in slopes and covariances between slopes is considerably limited when the reliability of measures is not very high (above .85), and there are fewer than eight measurement occasions in samples of about 100 to 200 participants (Hertzog, Lindenberger, Ghisletta, & von Oertzen, 2004). When, in addition, only three or four repeated measurements are stretched out across an age span of more than 30 years, LDS models are not well suited for assessment of interindividual differences in intraindividual change (see Ghisletta & Lindenberger, 2003). When one is interested in studying interindividual differences in intraindividual change or correlated change in two variables in the above-described circumstances, one may benefit from considering LDS models across time in study. Stretching the repeated observations across 10 instead of 30 years can ease demonstrating significant interindividual variability in intraindividual change. However, those models are again not well suited for studying nonlinear change across age (although age can be included as a covariate of the level and slopes), such as decline during the 8th decade of life but stability before and after this decade. Therefore, both analytic perspectives (age, time in study) were used in this study to arrive at a detailed understanding of the development of obligatory and optional PLI.

In investigating the developmental dynamics between obligatory and optional PLI, we wanted to focus on dynamics at the intraindividual level rather than only at the group level (see Ghisletta & Lindenberger, 2003, for an example of the latter approach). Thus, in line with previously stated expectations, we used a bivariate LDS model across time in study to address whether optional PLI can be changed without changing obligatory PLI but not vice versa. The model is depicted in Figure 2, which shows a combination of two univariate LDS models. When studying the dynamics of change, one is well advised to consider that observed change can reflect change within the individual variables, correlated change of the variables, and dynamic interrelations, such that one variable influences the other variable across time, and to use a method that can capture all of these aspects (Ferrer & McArdle, 2003). However, not all data sets are optimally suited to accomplish this differentiation between correlated change and additional causal impacts across time points. A crucial question is whether the timing and spacing of measurement occasions can capture the changing states of the variables of interest (Hertzog & Nesselroade, 2003). Because the self-regulatory dynamics between obligatory and optional PLI were assumed to operate across short time spans (weeks or months rather than years), the time intervals in BASE are not suited to the study of these particular causal influences: Estimation of lagged effects (e.g., change in obligatory PLI at Time t affects change in optional PLI at Time t + 1) may be a fruitless endeavor. In this study, the interval between a putative cause and its putative effect was much shorter than the interval between the repeated assessments, and we chose to estimate contemporaneous rather than lagged effects (cf. Hertzog & Nesselroade, 2003). This strategy is illustrated in Figure 2.

Results

We first investigated the development of the two PLI types in participants between the ages of 70 and 101 years to study the transition between the third and fourth age, and we subsequently turned to the development across time-in-study (10 years) and the developmental dynamics between obligatory and optional PLI. We determined the best-fitting univariate and bivariate LDS models by estimating a set of nested models. A common strategy is to start with a sensible baseline model and then step by step increase the complexity of the estimated model and test for improvement in model fit (e.g., Ghisletta & McArdle, 2001). We always started with a model assuming no change across age or time (no change score [NCS] model; Figure 1) and then included additional parameters. The set of estimated LDS models differs between the age and time perspective.

Development of Obligatory and Optional PLI Across Age

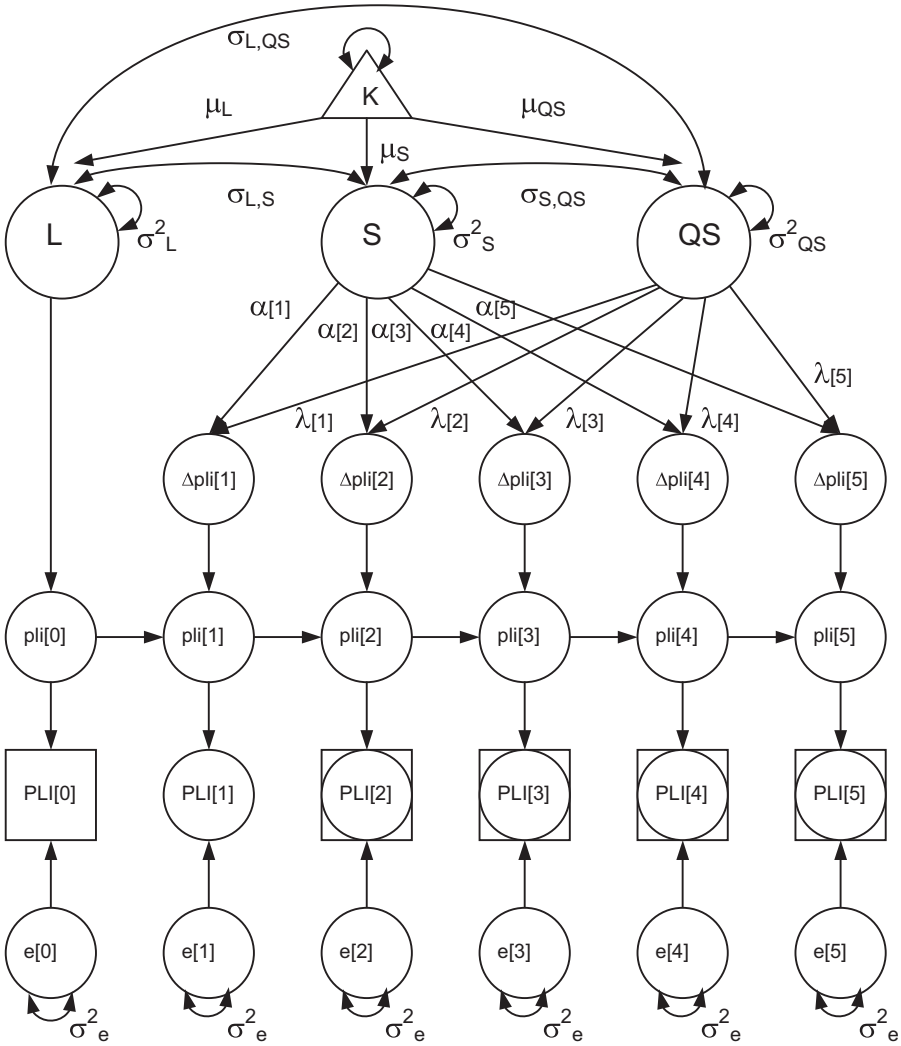
To arrive at an accurate picture of age-related changes in the two PLI types, we first estimated age trajectories on the basis of complete longitudinal information ($N = 206$; 619 PLI measurements). Because selection effects may have influenced the observed longitudinal age gradients, we further estimated age gradients on the basis of cross-sectional BASE data for comparison purposes. Cross-sectional age gradients were determined with the T1 data of the longitudinal BASE sample (T2 sample, $N = 206$; 206 PLI measurements) and of the entire cross-sectional T1 sample ($N = 511$; 511 PLI measurements).

Three LDS models were fitted to the obligatory and optional PLI data: a no-change model ($\alpha = 0$), a constant (linear) change model ($\alpha = 0.2$), and a model depicting the hypothesized trajectory of change only during the 8th decade of life and stability before and after this decade ($\alpha[1] - \alpha[6] = 0$, $\alpha[7] - \alpha[11] = 0.2$; $\alpha[12] - \alpha[16] = 0$).[5] The fit statistics of the three models are presented in Table 2. The standard output from structural equation models with incomplete data is the overall sum of individual misfits to the expected variance–covariance matrix and mean vector (–2 log-likelihood [–2LL]). This value does not provide much information when considered individually but can be used for model comparisons: The difference between the –2LL values of two nested models is chi-square distributed with degrees of freedom equal to the difference between the number of estimated parameters. In addition, we considered the Akaike information criterion (AIC) and Bayesian information criterion (BIC) for model comparisons.

As can been seen in Table 2, the NCS model provided the best fit to the obligatory PLI data. In line with our expectations, participants differed in their characteristic level of obligatory PLI, but no age-related change was evident: Neither a constant-change score (CCS) model nor the stability–change–stability (SCCS) model showed a better fit compared with the NCS model. Having to reject the CCS model also indicates that we detected no significant variability in change across age. That is, in addition to no change in the average developmental trend of the sample, there were no individuals who increased or reduced their obligatory PLI as they aged. People merely differed in their characteristic obligatory PLI levels. The average level of obligatory PLI, irrespective of participants' age, was estimated as $\mu_{Lob} = 60.6$. The estimated

[4] Only 1 participant lived to the age of 102–103 and subsequently to the age of 104–105. Because the estimated trajectory at these ages would be based on only one person, we constricted the modeled age range to 70–101 years.

[5] We also fitted quadratic change models. Those did not improve the model fit compared with linear change models, so we excluded them from the presentation.



No change score (NCS) model $pli[t]_i = pli[0]_i = L_i$

$\alpha[1] - \alpha[5] = 0$, $\lambda[1] - \lambda[5] = 0$

Constant change score (CCS) model $pli[t]_i = pli[t-1]_i + 0.20 \times S_i$

$\alpha[1] - \alpha[5] = 0.20$, $\lambda[1] - \lambda[5] = 0$

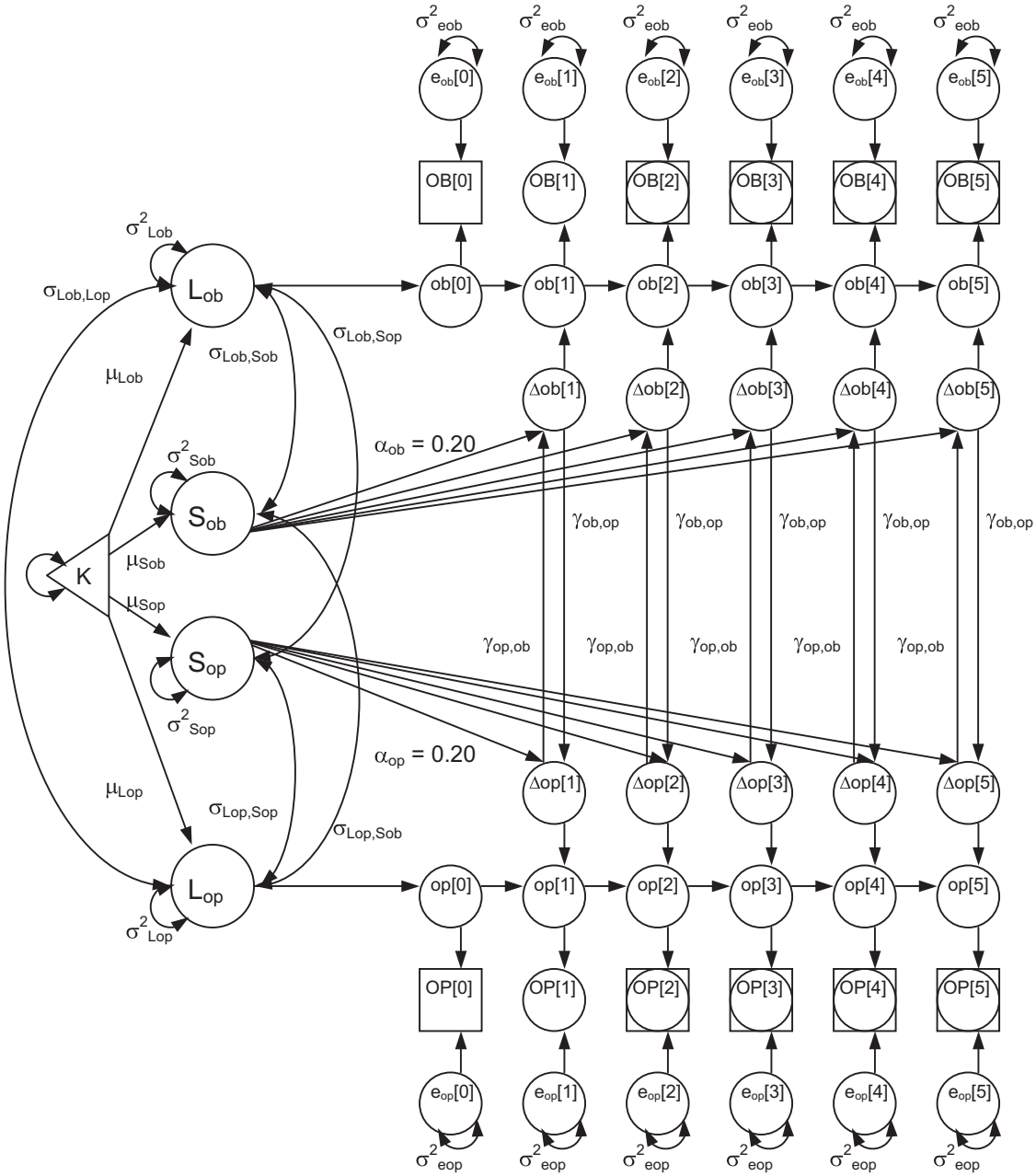
Quadratic change score (QCS) model $pli[t]_i = pli[t-1]_i + 0.20 \times S_i + \lambda[t] \times QS_i$

$\alpha[1] - \alpha[5] = 0.20$, $\lambda[1] = 0.04$, $\lambda[2] = 0.12$, $\lambda[3] = 0.20$, $\lambda[4] = 0.28$, $\lambda[5] = 0.36$

Figure 1. Univariate latent difference score model across time-in-study. Unlabeled paths are fixed at 1. "Observed" PLI data (circles inside squares) are decomposed into a latent true score, pli[t], and an independent error or unique score, *e*[t]. The error scores are assumed to have a mean of zero and a nonzero variance (σ^2_e), which is constrained to be equal across all time points. Beginning at the second observation, latent difference scores Δpli[t] represent the rate of change in PLI across each 2-year interval. PLI at Time [t] is the sum of PLI at time [t – 1] plus the change in PLI at time [t]. These changes were computed on the basis of two slopes, S and QS, where the mean of S gives the total amount of linear change in PLI and the mean of QS gives the total amount of quadratic change in PLI across 10 years in BASE. These slopes can be allowed to correlate with each other and with the level L (σ_{LS}, $\sigma_{L, QS}$, $\sigma_{S, QS}$). K = constant score (1); L = initial level; S = linear slope; QS = quadratic slope; PLI = personal life investment.

standard deviation of obligatory PLI levels was $\sigma_{Lob} = 11.3$, and the standard deviation of the residuals was $\sigma_{eob} = 9.6$.

With optional PLI, both the CCS and SCCS model fitted better than the NCS model (Table 2). As hypothesized, the SCCS model also showed a better fit than the CCS model: With the same number of estimated parameters, it yielded a smaller misfit, and the AIC and BIC criteria were smaller (indicating better fit). The estimated average trajectory of optional PLI started at a level of



Bivariate constant change score (BCCS) model with contemporaneous associations between PLI types

$$ob[t]_i = ob[t\text{-}1]_i + 0.20 \times S_{ob,i} + \gamma_{op,ob} \times \Delta op[t]_i$$

$$op[t]_i = op[t\text{-}1]_i + 0.20 \times S_{op,i} + \gamma_{ob,op} \times \Delta ob[t]_i$$

Figure 2. Bivariate latent difference score (LDS) model across time-in-study. Unlabeled paths are fixed at 1. The two univariate LDS models for obligatory and optional PLI are linked by allowing the levels to correlate with each other and with the slopes. In contrast to the bivariate LDS models introduced by McArdle and Hamagami (e.g., Hamagami et al., 2000; McArdle, 2001; McArdle & Hamagami, 2001), the slopes are not allowed to correlate, and lagged effects of obligatory PLI at Time t on change in optional PLI at Time t + 1 and vice versa are not included. Instead, the covariance between the slopes is split into the effect of change in obligatory PLI at Time t on change in optional PLI at Time t ($\gamma_{ob,\ op}$) and the effect of change in optional PLI at Time t on change in obligatory PLI at Time t ($\gamma_{op,\ ob}$) to determine the direction of influence between simultaneous changes in the two variables (cf. Schooler & Mulatu, 2001; Schooler, Mulatu, & Oates, 1999). The γ paths are thereby constrained to be equal across all time intervals. PLI = personal life investment; OB = obligatory PLI; OP = optional PLI.

Table 2
Fit Statistics for LDS Models Across Age (70–101 Years)

Model	−2LL	N Par.	Δ-2LL	ΔN Par.	*p*	AIC	BIC
			Obligatory PLI				
1. NCS	4,867.8	3				4,873.8	4,883.8
2. CCS[a]	4,865.1	5	vs. 1: 2.7	2	.26	4,875.1	4,891.8
3. SCCS[a]	4,867.3	5	vs. 1: 0.5	2	.78	4,877.3	4,8940.0
			Optional PLI				
1. NCS	5,021.3	3				5,027.3	5,037.3
2. CCS[a]	5,012.9	5	vs. 1: 8.4	2	.02	5,022.9	5,039.5
3. SCCS[a]	5,008.2	5	vs. 1: 13.1	2	.00	5,018.2	5,034.8

Note. LDS = latent difference score; −2LL = −2 log-likelihood; N Par. = number of parameters; *p* indicates the significance of the difference between two nested models; AIC = Akaike information criterion; BIC = Bayesian information criterion; PLI = personal life investment; NCS = no-change score; CCS = constant-change score; SCCS = stability 70s, constant change 80s, stability 90s.
[a] The covariance between level and slope was set to zero.

46.6 (σ_{Lop} = 11.1; σ_{eop} = 10.7) during the participants' 70s, declined by 4.3 POMP units (σ_{Sop} = 10.6) during their 80s, and stabilized at 42.3 during their 90s. Although the decline of 4.3 units was small, it significantly differed from zero (95% confidence interval [CI] = −8.2, −0.4). It should also be noted that the slope between 80 and 90 years varied: People differed in the amount of change during that decade. The estimated average longitudinal age trends for obligatory and optional PLI are illustrated in Figure 3.

Because selection, cohort, or retest effects may have influenced our findings, we further tested for convergence between longitudinal and cross-sectional trajectories. We compared the level and slope parameters that had been obtained with the longitudinal data, first, to the cross-sectional age gradients of the longitudinal sample and, second, to the cross-sectional age gradients of the total T1 sample. To accomplish that, we had to set the variances of level and slope to zero; that is, we could estimate only an average trajectory. We compared unconstrained models that freely estimated the level and slope parameters on the basis of cross-sectional information and constrained models in which the parameters were set equal to the obtained results from the longitudinal data.

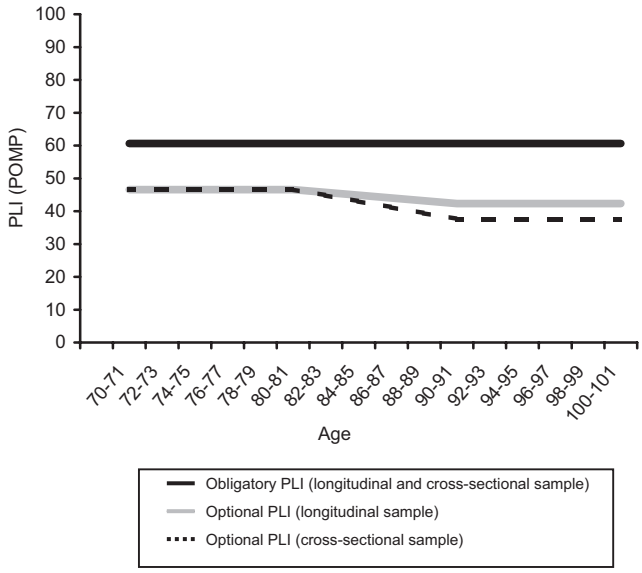


Figure 3. Estimated age gradients of obligatory and optional personal life investment (PLI). POMP = percentage of the maximum possible.

Let us first consider the cross-sectional trajectory in the longitudinal sample (N = 206). When we constrained the average level of obligatory PLI to 60.6, this did not lead to a significant loss of fit, $\chi^2(1) = 0.3$, *ns*. Similarly, when we set the level of optional PLI to 46.6, the fit of the SCCS model did not change, $\chi^2(1) = 0.4$, *ns*. Further, model fit did not change when we put an additional constraint on the slope (–4.3), $\chi^2(1) = 0.3$, *ns*. Thus, the longitudinal and cross-sectional data of the longitudinal sample yielded identical results.

When we tested for convergence between the longitudinal age trajectories and the cross-sectional trajectories in the total T1 sample (N = 511), the picture changed somewhat. Although the level of obligatory PLI could again be constrained to 60.6 without losing fit, $\chi^2(1) = 0.2$, *ns*, we found differences for optional PLI. The level during the 70s could be constrained to 46.6 without losing fit, $\chi^2(1) = 0.0$, *ns*, but the linear decline during the 80s differed when comparing the longitudinal and cross-sectional data, $\chi^2(1) = 16.1$, $p < .001$: The decline in optional PLI was estimated as 9.0 POMP units instead of 4.3 POMP units (as illustrated in Figure 3). Although the findings converged regarding the level of optional PLI during the 70s, the decline in optional PLI with the beginning of the fourth age was greater in the cross-sectional BASE sample. This divergence in findings may be due to the reported sampling bias among the oldest participants (90 years and older)—a possibility that we further consider in the Discussion section.

Development of Obligatory and Optional PLI Across Time-In-Study and Developmental Dynamics

As a first step in studying the developmental dynamics between obligatory and optional PLI, we estimated LDS models across

Table 3
Fit Statistics for LDS Models Across Time in Study (10 Years)

Model	−2LL	N Par.	Δ-2LL	ΔN Par.	*p*	AIC	BIC
			Obligatory PLI				
1. NCS	4,884.2	3				4,890.2	4,900.2
2. CCS	4,875.5	6	vs. 1: 8.7	3	.03	4,887.5	4,907.5
3. QCS[a]	4,875.5	7	vs. 2: 0.0	1	1.00	4,889.5	4,912.8
			Optional PLI				
1. NCS	5,036.0	3				5,042.0	5,051.9
2. CCS	5,025.2	6	vs. 1: 10.8	3	.01	5,037.2	5,057.1
3. QCS[a]	5,018.4	7	vs. 2: 6.8	1	.01	5,032.4	5,055.7

Note. LDS = latent difference score; −2LL = −2 log-likelihood; N Par. = number of parameters; *p* indicates the significance of the difference between two nested models; AIC = Akaike information criterion; BIC = Bayesian information criterion; PLI = personal life investment; NCS = no-change score; CCS = constant-change score; QCS = quadratic-change score.
[a] The variance of the quadratic slope (QS) and all possible covariances including QS were set to zero. Releasing the constraint on σ^2_{QS} did not further improve model fit for optional PLI, $\chi^2(1) = 0.3$, *ns.*

time-in-study (up to 10 years) separately for both PLI types. Our focus in using the time-in-study perspective was on interindividual differences in intraindividual trajectories rather than age trends. Therefore, we first needed to assure significant interindividual variability in change across time for both PLI types (within the age perspective this variability was only uncovered for optional PLI). We used NCS, CCS, and quadratic-change (QCS) models. The estimated level and slope parameters thereby give the average level of PLI at T1 and the amount of change across 10 years, regardless of participants' age at T1.

We found that the CCS model best fitted the obligatory PLI data (Table 3): It provided a significantly better fit compared with the NCS model and also produced a lower AIC value. However, the BIC value increased slightly with the CCS model. Given that BIC favors models with fewer parameters than AIC—that is, it involves a larger penalty for each additional parameter (e.g., Sclove, 1987)—this result is not surprising. Still, it indicates that the difference between the NCS and CCS model was significant but not large. Addition of a quadratic slope (QCS model) did not further improve model fit. The best-fitting CCS model yielded the parameter estimates of 60.0 for average obligatory PLI at T1 ($\sigma_{Lob} = 12.5$), 1.5 for the slope mean ($\sigma_{Sob} = 9.7$), a correlation of $\rho_{L,\,S} = -.43$ between the level and slope, and the standard deviation of the residuals was $\sigma_{eob} = 8.9$. Note that the slope mean did not significantly differ from zero (95% CI = –1.2, 4.3). In line with our hypothesis, obligatory PLI again showed no change in average level across time. Nevertheless, we found variability in slopes; that is, some participants did not change, some reduced, and some increased their obligatory PLI. As expected, the time-in-study perspective, but not the age perspective, helped to uncover that the average trajectory of obligatory PLI is not representative of every individual participant. This finding is illustrated in Figure 4, in which the estimated trajectories of 10 participants are depicted in addition to the average trajectory of obligatory PLI. These 10 participants were selected so as to represent the entire range of developmental trends; that is, some trajectories with very steep slopes were included in addition to trajectories that are very close to the average trajectory.

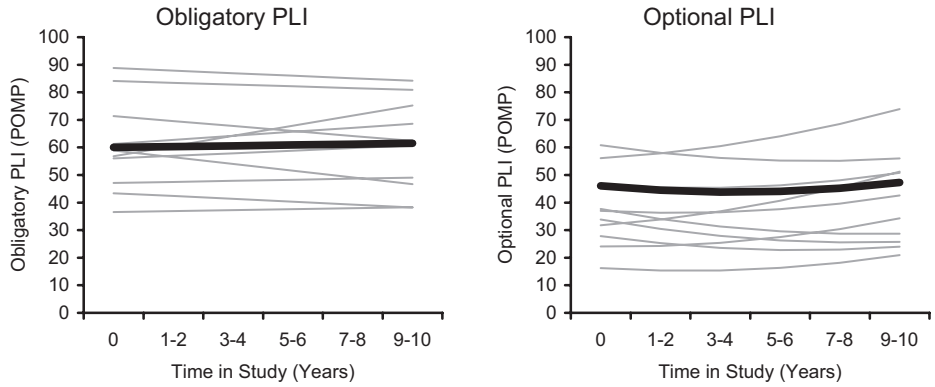


Figure 4. Estimated trajectories of obligatory and optional personal life investment (PLI) across time-in-study. Estimated trajectories for 10 participants (gray) are shown in addition to the average trajectory (black). POMP = percentage of the maximum possible.

Table 4
Parameter Estimates of the Best-Fitting Bivariate LDS Model Across Time-In-Study (10 Years)

Parameter	Estimate	Standardized estimate	95% confidence interval
Obligatory PLI			
Level			
μ_{Lob}	60.04		58.03, 62.05
σ^2_{Lob}	150.20		109.02, 191.39
Linear slope			
μ_{Sob}	1.35		−1.41, 4.12
σ^2_{Sob}	107.85		27.23, 188.47
Covariance level, slope $\sigma_{Lob,Sob}$	−46.36	−.36	−91.09, −1.64
Residual variance σ^2_{eob}	78.04		64.59, 91.48
Optional PLI			
Level			
μ_{Lop}	46.13		43.79, 48.48
σ^2_{Lop}	203.06		147.81, 258.30
Linear slope			
μ_{Sop}	−11.60		−19.27, −3.93
σ^2_{Sop}	135.15		6.38, 263.92
Quadratic slope μ_{QSop}	11.78		3.46, 20.09
Covariance level, slope $\sigma_{Lop,Sop}$	−116.48	−.70	−181.98, −50.98
Residual variance σ^2_{eop}	93.74		77.34, 110.15
Association between obligatory and optional PLI			
Covariance level, level $\sigma_{Lob,Lop}$	58.47	.34	32.92, 84.01
Path change obligatory to change optional $\gamma_{ob,op}$	0.96	.65	0.30, 1.63

Note. LDS = latent difference score; PLI = personal life investment; Lob = level of obligatory PLI; Lop = level of optional PLI; Sob = linear slope of obligatory PLI; Sop = linear slope of optional PLI; eob = error of obligatory PLI; eop = error of optional PLI.

The best-fitting model for optional PLI was more complex than the one for obligatory PLI. Both adding a linear slope and adding a quadratic slope improved the model fit (Table 3). Note, however, that the quadratic slope has no variance; that is, each participant's trajectory is modeled with the identical quadratic slope parameter, and only the linear slope varies between participants. With the QCS model, average optional PLI at T1 was estimated as 46.1 (σ_{Lop} = 13.4), the average linear slope as –10.1 (σ_{Sop} = 13.2), and the average quadratic slope as 11.4 (σ_{QSop} = 0). The correlation between the level and linear slope was $\rho_{L,S}$ = –.43, and the standard deviation of the residuals was σ_{eob} = 9.9. Although both the linear (95% CI = –17.5, –2.8) and the quadratic (95% CI = 2.9, 19.8) slope are significantly different from zero, together they produce an average trajectory of optional PLI that shows no meaningful change (as illustrated in Figure 4). This finding may still be considered as in line with the hypothesized pattern of little decline or no average level change in optional PLI. The 10 individual trajectories in Figure 4 further show that people usually did not have a truly quadratic change pattern (decline followed by increase) but that the quadratic slope rather serves to model accelerating or decelerating increase or decline. As with obligatory PLI, stable, declining, and also increasing individual trajectories have been observed. Although optional PLI has been found to decline when participants are between the ages of 80 and 90 years and although many participants showed decelerating declining trajectories across time in BASE, there are also some people who increased their optional PLI in old age.

Dynamics Between Change in Obligatory and Optional PLI

After having ensured that intraindividual trajectories across time vary between participants (in spite of no average level change), it was possible to answer the question of how changes in obligatory and optional PLI relate to each other. We used the best-fitting LDS models for obligatory and optional PLI and combined them as depicted in Figure 2.[6] We had predicted that dwindling resources would first affect optional PLI and only later start to also affect obligatory PLI. Therefore, we should be able to observe change in optional PLI without change taking place in obligatory PLI, but changes in obligatory PLI should be accompanied by changes in optional PLI. This means that the path from change in optional PLI to change in obligatory PLI ($\gamma_{op,\ ob}$) would be zero or at least significantly smaller compared with the reverse path ($\gamma_{ob,\ op}$).

For the analyses of developmental dynamics (again, the analyses were performed on 619 PLI measurements provided by the 206 participants in the longitudinal sample), we first included both PLI types in one model but allowed for no associations of any kind between obligatory and optional PLI. We then tested which cor-

[6] To avoid unnecessary complexity, we did not include the quadratic slope of optional PLI in Figure 2, although it was included in the analyses. Because this slope has no variance, it cannot be related to any of the other parameters but just has the function of adding a constant quadratic trend to the individual optional PLI trajectories.

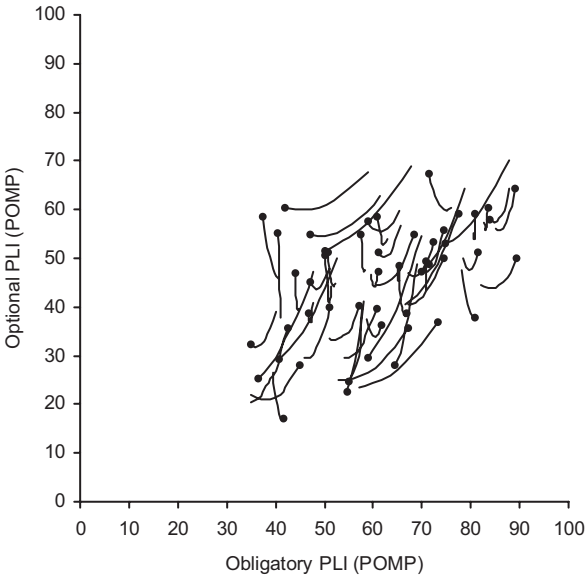


Figure 5. Developmental dynamics of obligatory and optional personal life investment (PLI). Estimated trajectories for 50 participants are plotted. Dots indicate the starting point of each trajectory at Time 1, and the curves illustrate the joint development of the two PLI types across 10 years in study. POMP = percentage of the maximum possible.

relations should be included in the model. Allowing the levels of obligatory and optional PLI to be correlated brought about a significant improvement in model fit, $\chi^2(1) = 25.6$, $p < .001$, $\rho_{Lob,Lop} = .25$. Including an additional correlation between the linear slopes of obligatory and optional PLI again yielded a better fit, $\chi^2(1) = 17.9$, $p < .001$, $\rho_{Sob,Sop} = .68$, but adding correlations between obligatory PLI level and optional PLI slope and optional PLI level and obligatory PLI slope did not further improve model fit, $\chi^2(2) = 0.7$, *ns*. After having established that changes in obligatory and optional PLI are correlated, we proceeded to test our hypothesis. We set the correlation between the slopes to zero (the correlation between the levels was retained) and instead included the two γ paths in the model to determine whether change in obligatory PLI had a dominant impact on change in optional PLI. We then tested whether it is possible to constrain one of the two paths to zero without losing fit. The model fitted worse once the path from change in obligatory PLI to change in optional PLI ($\gamma_{ob,\ op}$) was set to zero, $\chi^2(1) = 5.4$, $p < .05$. In contrast, setting the path from change in optional PLI to change in obligatory PLI ($\gamma_{op,\ ob}$) to zero did not alter the model fit, $\chi^2(1) = 0.3$, *ns*. As hypothesized, change in obligatory PLI was linked to change in optional PLI (standardized $\gamma_{ob,\ op} = .65$), but change in optional PLI had no consequences for change in obligatory PLI. The parameter estimates for this final best-fitting model are reported in Table 4. The finding is further illustrated in Figure 5, in which the developmental trajectories of 50 participants (estimated based on the best-fitting bivariate LDS model) are shown. Again, we chose these participants so as to represent the various shapes of trajectories in the sample, the frequent as well as the less frequent ones. The dots mark the beginning of the trajectories at T1, and the lines depict the estimated joint development of obligatory and optional PLI across 10 years in BASE. There are many almost vertical trajectories, showing that change in optional PLI was not necessarily accompanied by change in obligatory PLI. In contrast, there are no almost horizontal lines, which shows that change in obligatory PLI without change in optional PLI did not occur. Rather, change in obligatory PLI was usually accompanied by change in optional PLI (i.e., both PLI types declined or increased together).

Discussion

Our two major aims were to establish developmental trajectories of obligatory and optional PLI during the transition between the third and the fourth ages and to study the dynamic interplay between changes in obligatory and optional PLI to uncover some functional relations underlying the observed developmental trends. For these analyses, we used two analytic time perspectives—development across age and development across time in study—and found that each perspective was optimally suited to answer the question at hand.

Age Trends of Obligatory and Optional PLI

The obtained results matched our hypothesized developmental trajectories: On average, obligatory PLI did not change in participants who were between 70 and 101 years old, whereas optional PLI declined. As expected, the decline in optional PLI was not linear. Optional PLI was stable in participants up to age 80, showed some decline in participants between 80 and 90 years old, and stabilized again on a lower level beginning when participants reached age 90. With regard to optional PLI, aging thus cannot be characterized as continuously ongoing loss and decline; rather, the experience of the fourth age appears to be related to reduced investment. Not every resource loss or constraint that is encountered during old age leads to changes in optional PLI. Only severe resource losses that typically mark the beginning of the fourth age (cf. P. B. Baltes & Smith, 2003; Smith, 2003) seriously limit investments in some life domains and require adaptations in goal-striving intensity. Because the developmental context of older people does not stimulate optional PLI and because optional activities in addition require a fairly high level of competence (cf. M. M. Baltes et al., 1999), optional investments are the first to be reduced when resources become seriously constrained. Goals in optional domains may have become completely unattainable and, thus, need to be given up, or they may compete with goals in obligatory domains over limited resources. As older people need to invest in obligatory domains, they can only cut back optional PLI. Note that it is the LDS models used across age that allowed revelation of this specific age trend of optional PLI. This finding could not have been made with an LDS model across time in study with age as a covariate of the level and slope because this model does not allow for nonlinear associations between age and the level and slope.

In our analyses, we also addressed the issue of selection effects via testing the convergence of age gradients that were based on the longitudinal and cross-sectional data. Obligatory PLI was found to be stable on a level of about 61 POMP units in all analyses; that is, the longitudinal and cross-sectional information converged. With optional PLI, only the analyses with the longitudinal and cross-sectional data of the longitudinal sample ($N = 206$) converged. The estimated trajectory that was based on the entire cross-

sectional T1 data ($N = 511$) differed from the findings with the longitudinal sample: The decline in optional PLI in participants between 80 and 90 years old was 9 POMP units, which is about 5 units more than the estimated decline in the longitudinal sample. Consequently, the estimated level of optional PLI in participants between 90 and 101 years was also lower (38 instead of 42). Given these differences in results, which age gradient can be considered the more accurate estimate of change in optional PLI on the population level? On the basis of the experimental selection effect for optional PLI that was found in participants age 90 and older (see Method section; Schindler, 2005), the cross-sectional findings from the entire T1 sample may be more representative of the actual development of optional PLI. The oldest participants in the longitudinal sample were selected for higher optional PLI, which may have led to an overestimation of the optional PLI level in this age group. As the longitudinal and cross-sectional findings from the longitudinal sample converged, other explanations for the divergence between cross-sectional and longitudinal trajectories (e.g., retest and cohort effects; cf. P. B. Baltes et al., 1977/1988; Schaie, 1965) seem less likely but cannot be ruled out.

In sum, as they age, older people continue to do what needs to be done and to meet their developmental obligations but simultaneously reduce their optional investments when losses in physiological and psychological functioning become severe, as is usually the case during the transition to the fourth age (P. B. Baltes & Smith, 2003; Smith, 2003). There is less of a choice in pursuing obligatory goals and, thus, when resources become scare, optional goals are the first ones to be dropped. The experience of the fourth age may also aggravate the competition between obligatory and optional investments. Whereas optional activities may often synergistically contribute to the pursuit of obligatory goals during the third age (e.g., when engaging in gardening as a leisure activity also helps to remain physically fit), the fourth age requires a stronger focus on self-preservation (obligatory PLI), which includes giving up optional goals that may now conflict with obligatory goals (e.g., when someone tries to continue gardening by all means although having been warned by the doctor about negative health consequences that will most likely result from this activity).

However, we should also keep in mind that the average reduction in optional PLI is not very large: Even if we consider the cross-sectional estimate of 9 POMP units to be adequate, this is a decline of about half a standard deviation in optional PLI across 31 years. Given the stability of obligatory PLI and the small reduction of optional PLI up to 101 years, old and even very old age clearly cannot be considered a time of disengagement or lack of investment. Rather, even the oldest individuals reported to be quite actively engaged in life. These findings are in line with theoretical accounts of late-life development (e.g., M. M. Baltes & Carstensen, 2003; P. B. Baltes & Baltes, 1990; Brandtstädter & Greve, 1994; Freund & Baltes, 2000): People selectively focus their remaining resources on the attainment of important goals and give up less important goals, but they do not cease to strive for goals. With this study, we have demonstrated that this general pattern is most clearly observed with indicators of global life investment during the transition to the fourth age. Although higher selectivity and loss-based changes and accommodations in the personal goal hierarchy are evident already during the third age (e.g., P. B. Baltes & Baltes, 1990; Brandtstädter & Greve, 1994; Freund & Baltes, 2000; Schulz & Heckhausen, 1996), it is the fourth age that is associated with changes in global indicators of goal striving across domains. For those who are interested in studying age-related changes in *global* indicators of self-regulation, it may thus be most fruitful to target people between the ages of 80 and 90 years in their studies.

Development Across Time in Study and Dynamics Between Obligatory and Optional PLI

When intraindividual change was studied across 10 years in BASE, both obligatory and optional PLI were found to be rather stable, regardless of participants' age. Specifically, there was no average change in level of obligatory PLI, and optional PLI showed a very small initial decline followed by a very small increase—a trajectory that points to stability rather than to change. These findings were again largely in line with our hypothesized trajectories of no change in obligatory PLI and no change or very little decline in optional PLI. We further found the expected variability in intraindividual PLI trajectories; that is, there were stable, declining, and increasing individual trends. An established average trend should not let us forget that individual trajectories may show substantial departures from this trend. To predict change in PLI, one may have to consider an individual's specific constellation of resources and developmental contexts in addition to the age of that person. Here, the LDS models across time in study proved to be optimally suited to showing that interindividual variability in change patterns was present. This variability was not detected for obligatory PLI across age. The stretching of a maximum of four observations across 31 years in the age models reduced the sensitivity for detection of significant variability in change across age.

One may still ask the question of whether the quadratic change in optional PLI is problematic insofar as it departs from the hypothesized trajectory and also from the previously established age gradient of optional PLI. For two reasons, we believe this not to be the case. First, most of the individual trajectories are in line with the age gradient: People showed stable trajectories or decelerating decline (i.e., an initial decline that leveled off), but truly quadratic change was rarely observed. Second, the average quadratic trend in the longitudinal sample may be a result of the older participants dying earlier and thus not providing data after 7–8 or 9–10 years in study. With the declining trajectories of older participants and the stable trajectories of younger participants starting together but with only the stable trajectories actually extending across 10 years in study, the resulting average trajectory is quadratic, although this trend is not typical of any individual.

In our analyses across time in study, our primary concern was to show that the two PLI types are not independent of each other. Both share one pool of resources that can be invested in obligatory and optional pursuits. These resources are increasingly invested in maintaining levels of functioning and counteracting loss during old age (Ebner, 2005; Freund & Ebner, 2005; Staudinger et al., 1995). We have assumed that this shift in goal orientation is typical of obligatory life domains. Recent evidence supports this assumption: Older adults, as compared with younger adults, focused on maintenance and prevention of loss in domains like physical and cognitive functioning and health but not in optional domains like leisure or friends and acquaintances (Ebner, 2005). Given that one function of obligatory PLI is to protect necessary resources for

obligatory and optional goal striving, obligatory PLI holds primacy over optional PLI (people first have to meet their obligations before they can make optional investments). Therefore, we had predicted that change in obligatory PLI would be associated with change in optional PLI but not the other way around. Given significant interindividual variability in change for both PLI types, we were able to use a bivariate LDS model across time to study the hypothesized dynamics at the intraindividual level. The findings confirmed our prediction: Older people reduced their optional PLI without changing their obligatory PLI, but changes in obligatory PLI were accompanied by changes in optional PLI. When resources become limited, people thus seem to first reduce optional PLI while maintaining obligatory PLI and to reduce both obligatory and optional PLI only when resource losses are severe. This situation should typically be encountered by people who experience reductions in their basic level of competence (i.e., those who cannot care for themselves anymore). A basic level of competence is a prerequisite for most kinds of activity (M. M. Baltes et al., 1999); therefore, losing this basic level of competence affects goal striving irrespective of domain and, thus, leads to reductions in both types of PLI.

We have considered the transition to the fourth age and the associated losses in physical and cognitive functioning as primary reasons that account for interindividual differences in the joint development of obligatory and optional PLI. People making this transition should face the necessity of adapting their goals to their changed developmental context and, thus, show the greatest decline in optional PLI. However, this should not affect their obligatory PLI, which needs to be maintained to protect the remaining resources and cope with the challenges of the fourth age. Some support for this assumption was found in Schindler's (2005) dissertation: Participants who initially reported high levels of satisfaction and were in good functional health (which is indicative of being in the third age) showed greater declines in optional PLI across time (when making the transition to the fourth age) compared with participants who had reported low levels of satisfaction and were in poor health already at the beginning of the study (which is indicative of being in the fourth age).

However, there are certainly additional factors that may give rise to interindividual differences in PLI changes—especially in those people who showed developmental patterns that would not be expected on the basis of developmental trends in the entire sample (e.g., declining obligatory and optional PLI, increasing optional PLI). For instance, extraversion, neuroticism, and internal control beliefs have been related to the two PLI types, and some of these associations have been found to differ depending on functional health status (cross-sectionally; Schindler & Staudinger, 2006). Specifically, neuroticism was unrelated to optional PLI in participants in good and fair health but was positively related to optional PLI in participants in poor health. These changes in the functional relations of PLI during old age may also suggest that personality variables are predictive of differential change in PLI. For instance, people high in neuroticism may not report declining but rather stable or increasing optional PLI when facing serious health constraints during the fourth age. This level of investment, however, may not indicate that they are enjoying optional activities but rather that they have started ruminating about optional activities that are not feasible anymore and have problems disengaging from these activities. Similarly, depressed affect may cause some older adults to lose interest in life and may be the reason that they reduce obligatory and optional PLI, even in the absence of age-related physical impairments that would demand such a reduction. It should be fruitful to investigate these and related issues in future studies on goal engagement during old age.

Limitations and Outlook

We would like to acknowledge some theoretical and methodological limitations of the present study. The assessment of PLI had to be rather brief because of time constraints in BASE. Domain-specific PLI was measured with one item per domain, and investment in terms of acting and thinking was combined into one overall rating. We therefore cannot rule out the possibility that measuring only action-related investment would have shown more age-related change. Goal striving clearly demands both thinking and acting, but it seems plausible that, as one ages, the ratio of action to thought changes in favor of thoughts. Whether both kinds of investment are equally adaptive remains an open question in this context. For instance, we cannot rule out that the stability of obligatory PLI results from very old people worrying about their health and death instead of showing "positive" ways of engaging in obligatory domains. It would be desirable to test in future studies whether investments in terms of thinking and acting show different age gradients.

It should further be noted that the present classification of life domains as obligatory and optional is not necessarily generalizable across historical times and cultures. In societies without retirement, for instance, the work domain would remain obligatory even in old age. The best way to handle this classification in future research would be to directly ask participants what they perceive to be required as compared with possible/desired investments. Because we made this distinction after data collection was completed, this approach was not feasible with the present data but should lead to interesting future findings. Given that life domains or goals are accurately classified, we would expect that our observations regarding the impact of resource loss on obligatory and optional PLI prove to describe a global self-regulatory mechanism. Thus, we assume that under conditions of reduced resources, such as after breaking one's leg or in times of extreme emotional strain, this differential impact on the pattern of obligatory and optional investments can be observed also in young adulthood.

Our analyses also neglected the possible role of cohort and retest effects that may affect the observed age gradients (individually or in combination). Given that these effects theoretically do not seem very likely for such broad indicators of goal-striving intensity as obligatory and optional PLI and that the longitudinal rather than cohort-sequential design of BASE makes it difficult to isolate these effects (P. B. Baltes et al., 1977/1988; Schaie, 1965), our reluctance to do so appears permissible.

The LDS models further rest on several simplifying assumptions that may not always be tenable or even testable. Most important, all individual trajectories are assumed to belong to the same overall group curve (e.g., Ghisletta & McArdle, 2001); that is, all individuals may be described by the same general change function, although variability in change is permitted. This assumption is of special interest with the LDS models across age, in which the collective 30-year age gradients were computed from individual age gradients of up to 10 years. Thus, the reported trajectories are

at best representative of the population of survivors at a given age or time but may not provide a good estimate of how an individual person is likely to develop between the ages of 70 and 100+ years. Selection effects that were evident in participants who were age 90 and older further limit these generalizations. Despite these limitations, it seems safe to conclude that optional PLI, on the population level, becomes reduced during the fourth age.

Finally, the time intervals in BASE were too long to capture the self-regulatory dynamic between obligatory and optional PLI, which we assumed to operate across much shorter time spans (weeks or months). We introduced a bivariate LDS model that allowed determining the direction of influence between simultaneous changes in the two PLI types as one way to handle this challenge. Applying this model in other situations in which the timing of observations does not match the timing of the phenomenon under study should prove interesting. In addition, it would be interesting to replicate the present findings while considering cross-lagged associations between changes in obligatory and optional PLI. For this purpose, short-term longitudinal studies would be needed.

In conclusion, our findings highlight research on individual differences but in a way that is often too little recognized—individual differences in change patterns. Classical research design and analysis did not recognize much merit to looking beyond average change (Nesselroade, 2002). Our data not only refute this notion but also illustrate the richness of individual differences in changes and how this richness can be examined.

We would also like to note that the distinction between obligatory and optional PLI helped us to identify two PLI types with different developmental trajectories during old and very old age. Considering that the developmental context during old age poses some demands and challenges to which older people must respond further allowed us to uncover some of the dynamics of goal striving in old age. Optional investments can be cut back without many consequences for goal striving in other domains. However, once reductions in obligatory investment become necessary, other (optional) domains can be expected to be affected as well. It should be interesting to consider this distinction between the "musts" and "cans" of aging in future studies of self-regulation.

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