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Accelerated increase and relative decrease in subjective age and changes in attitudes toward own aging over a 4-year period: results from the Health and Retirement Study

 Ehud Bodner^{1,2} · Liat Ayalon³ · Sharon Avidor⁴ · Yuval Palgi⁵

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Abstract The passage of time may force people to adjust their subjective age in response to changes in their attitudes toward own aging (ATOA). Although positive associations have been found between well-being and both positive ATOA and younger subjective age, the relationships between changes in these measures have not been examined yet. We expected (1) a decrease in positive ATOA to be associated with an accelerated increase in subjective age and (2) an increase in positive ATOA to be associated with a relative decrease in subjective age. Participants were individuals and their spouses, aged 50 and over, recruited by the Health and Retirement Study, who provided responses to a question concerning one's subjective age in 2008 and 2012 ($n = 4174$). A change in subjective age over the two waves was regarded as (1) an accelerated increase if it was greater than 5 years (36.2 % of the sample); (2) a relative decrease (39.1 %), if it was less than

the 3 years; (3) no change if it did not comply with criteria 1 or 2 (24.7 %). A decrease in positive ATOA over the two waves resulted in an accelerated increase in subjective age, and an increase resulted in a relative decrease in subjective age. Older age and more physical impairments and depressive symptoms in 2012 compared with 2008 were associated with an accelerated increase in subjective age. Our findings emphasize the consequences ATOA might have on subjective age experiences, and the need to improve them.

Keywords Attitudes toward own aging · Health and Retirement Study · Older adults · Subjective age

Introduction

Previous studies have pointed to the positive outcomes of both subjective age and attitudes toward own aging (ATOA), which are referred to as cognitive representations and perceptions people have toward their own aging process [see Westerhof and Wurm (2015) for a comprehensive review]. The bulk of the studies on subjective age and self-representations of aging have focused on their long-term effects on health and mortality among older adults (Kotter-Grühn et al. 2009; Levy et al. 2002a, b; Sargent-Cox et al. 2014), but relatively less is known about the association between changes in ATOA and in subjective age during the second half of life, or about their developmental outcomes. This lacuna in the literature calls for further investigation, as both measures are dynamic constructs that change throughout life (Westerhof and Wurm 2015). Therefore, the aim of the present study is to examine the relationship between ATOA and prospective changes in subjective age over time.

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The dynamic nature of subjective age and ATOA

Throughout one's lifetime, both subjective age and ATOA undergo constant change (Westerhof and Wurm 2015). Most adolescents and young adults report feeling older than their chronological age. However, this pattern shifts at around their late twenties, when most individuals report feeling younger, until they maintain a stable relative ratio of their reported subjective age and their chronological age after midlife (when this gap is standardized by dividing it by chronological age; i.e., Rubin and Berntsen 2006). In an 8-year survey, conducted among 451 participants (Uotinen et al. 2006), about half of the participants demonstrated variability in the gap between chronological and subjective age over time (i.e., a decline or an increase in this gap). Moreover, a contemporary 10-year survey found that younger subjective age at baseline was associated with both changes in specific personality traits and with variations in subjective age over time (Stephan et al. 2015). The dynamic nature of subjective age was also demonstrated in an 8-day daily study, which found that subjective age might even change on a daily basis, due to health problems, or stress (Kotter-Grühn et al. 2015). Finally, subjective age has been shown to change in response to a simple experimental manipulation involving feedback regarding hand-grip performance (Stephan et al. 2013).

ATOA also continuously change throughout life. It has been suggested that older adults retain and in some cases even increase their positive ATOA in order to cope with the challenges of old age (Kleinspehn-Ammerlahn et al. 2008). Two recent studies have emphasized the importance of monitoring changes in ATOA over time. An intervention which targeted views on aging in a group that underwent a physical activity program, and compared this intervention to two control groups (all at the age of 65+), found an increased positivity of such views across a 10-month period in the intervention group (Wolff et al. 2014). In addition, a longitudinal study with two birth cohorts followed over 12 years, provided support for the assumption that there is a greater modifiability of aging attitudes among middle-aged compared with young-old individuals (Miche et al. 2014).

Scholars have recently acknowledged the need to better understand the relationship between different self-representations of the aging process and subjective age (Diehl et al. 2014; Westerhof and Wurm 2015). The importance of understanding the individual's awareness of age-related changes has also been emphasized (i.e., the experience of age-related change in terms of gains and losses in five behavioral domains, see Diehl and Wahl 2010), whereas others have studied the paths leading from subjective age and ATOA to various health and well-being developmental outcomes (e.g., Brothers et al. 2015). Therefore, the aim of

the present study is to examine if changes in ATOA are related to different trajectories of one's subjective age over time. Rather than relying on single measurements of ATOA and subjective age, we aim to examine the prediction of changes in subjective age by changes in ATOA between these two different subjective aging constructs over a period of 4 years. Specifically, we investigate the association between changes in ATOA and three trajectories of change in subjective age, which we defined as *balanced* (consistent with the passage of time), *accelerated increase* (feeling older relative to the passage of time), and *relative decrease* (feeling oneself younger relative to the passage of time).

Similarities and differences between Subjective age and ATOA

As people grow old, they tend to pay attention to biological, social, and psychological changes that follow their development (i.e., Levy 2003). This can be interpreted as "subjective aging," a cognitive representation that people have about their aging process (Westerhof and Wurm 2015). Two concepts included in this term are subjective age and ATOA (Diehl et al. 2014). Subjective age is defined as one's self-evaluation of how old one perceives oneself to be (Barak and Stern 1986; Montepare 2009) and can be seen as an active self-schema and an integral part of our social and self-identities (Kastenbaum et al. 1972). According to Montepare (2009), a person can deviate from his/her chronological age in response to experiences which are situationally and socially associated with a certain normative age (e.g., retiring from work). Therefore, it is based on a comparison between specific experiences and normative conceptions of aging. Although Kastenbaum et al. (1972) regarded subjective age as a multidimensional construct composed of several aspects (e.g., look age, felt age, do age, and interest age), felt age is the most frequently used measure in psychological aging research (Brothers et al. 2015). Felt age is indeed an important marker that can predict developmental outcomes, in the fields of health and well-being. Younger felt age has been associated with better physical functioning (Montepare 2009) and decreased mortality risk (Kotter-Grühn et al. 2009), as well as lower mental distress and higher well-being (Choi et al. 2014; Keyes and Westerhof 2012). Nevertheless, it is a unidimensional measure of age identity, and it does not regard specific personal conceptions of aging experiences (Diehl et al. 2014).

Peoples' attitudes toward their own aging are defined as general attitudes, which include both societal and personal attitudes, with which older adults approach their aging process. These attitudes, as reflected by the ATOA scale (ATOA; Lawton 1975) are measured by a global assessment

of affective, cognitive, and evaluative components (Diehl et al. 2014). Like felt age, ATOA are associated with many developmental outcomes, including health and well-being (Bryant et al. 2012; Levy 2003; Moser et al. 2011; for a recent comprehensive meta-analysis of 11 longitudinal datasets, see Westerhof et al. 2014). Many studies have demonstrated that the maintenance of positive ATOA throughout life is associated with better health (Levy et al. 2002a, b; Westerhof et al. 2014), better physical functioning (Sargent-Cox et al. 2014), better health behaviors (Westerhof et al. 2014), and better longevity (Levy et al. 2002a, b; Kotter-Grühn et al. 2009; Westerhof et al. 2014), as well as with successful aging, younger subjective age, and improved self-regulation processes (e.g., Baltes and Smith 2003; Krueger and Heckhausen 1993; Sneed and Whitbourne 2005). Although there is some conceptual overlap between these two constructs, they also differ from one another. ATOA measure affective and cognitive components of how an individual perceives the aging process, while felt age captures a global estimation of the feeling of one's age (Brothers et al. 2015). Furthermore, because ATOA shape how one perceives one's own aging process, and since they become increasingly self-relevant starting in the adult years (Diehl et al. 2014), it stands to reason that ATOA would also be predictive of personal perceptions of felt age.

Thus, based on the small-to-medium correlations previously revealed between ATOA and subjective age (Brothers et al. 2015; Kotter-Grühn and Hess 2012), and on the above-mentioned similarities in these two theoretical constructs, we view them as associated yet divergent from one another. Because ATOA refer to general as well as personal perceptions of aging, and because subjective age (including felt age) has been theorized to be anchored, at least in part, in age-related expectations and experiences (Montepare 2009) we assumed that changes in ATOA would predict *changes* in subjective age (measured as felt age). However, because ATOA can be related to factors which may be less relevant to changes in subjective age (e.g., the aging of close relatives) it is less likely that various trajectories of changes in subjective age would be predictive of changes in ATOA. Specifically, it was hypothesized that changes in ATOA over a period of 4 years would be associated with changes in subjective age during the same time period. Furthermore, we hypothesized that a decrease in positive ATOA between 2008 and 2012 would be associated with an increase in subjective age during the same time period.

The present study

As previously noted, subjective age is susceptible to change due to social and health events throughout life. The evaluation of the shifting gaps between chronological age

and subjective age over time can tell whether one is subjectively aging faster or slower as compared with the passage of time. Moreover, the measurement of changes occurring in subjective age can differentiate between those who might report feeling younger than their chronological age at baseline, but are subjectively aging fast (i.e., may report to have aged by more than the 4 years that passed since the first measurement), and those who might report feeling older than their chronological age at baseline, but are still subjectively aging more slowly (i.e., may report feeling younger than the passage of 4 years when measured at wave 2).

Hence, we examined an accelerated increase vs. a relative decrease in subjective age. In line with a previous examination of changes in age perceptions (Ayalon et al. 2015), an *accelerated* increase in subjective age over the 4-year period of the study was defined as an increase in subjective age that was greater than 5 years. A *relative decrease* in subjective age was defined as a difference in subjective age between 2012 and 2008 that was lower than 3 years. A change in subjective age in the range of 3 to 5 years over the 4-year period of the study, represented a *balanced* subjective age consistent with the passage of time. We also controlled for ATOA in 2008, background variables (e.g., age, gender, education), and changes in health and mental health variables (e.g., physical morbidity, physical functioning, and depressive symptoms) given their known associations with cognitive representations of aging and subjective age (i.e., Choi et al. 2014; Keyes and Westerhof 2012). It was hypothesized that an increase in positive ATOA between 2008 and 2012 would predict a relative decrease in subjective age, whereas a decrease in positive ATOA during this time period would result in an accelerated increase in subjective age.

Methods and procedure

Data

Data were collected by the Health and Retirement Study (HRS). This survey is a US nationally representative survey of individuals over the age of 50 and their spouses of any age, conducted every other year. Data were collected using face-to-face or phone interviewing, mainly gathering information about income, work, assets, health, and disability. In 2006, a self-administered psychosocial questionnaire was added to the HRS, and was delivered to half of the sample (a random half of the sample received the questionnaire every 4 years). The psychosocial questionnaire completed by the sample evaluates, among other things, subjective age and ATOA.

Participants

The current study represents a longitudinal panel of those who completed two waves of the psychosocial questionnaire (in 2008 and 2012). In 2008, 7500 individuals completed the psychosocial questionnaire. Among them, 6479 completed and returned the questionnaire, and an additional 97 completed it by phone with an interviewer. We excluded 78 individuals who completed the psychosocial questionnaire, although they were not assigned to complete it, and 846 individuals who did not return the questionnaire. In 2012, 5235 individuals completed the questionnaire and 302 had someone else complete it for them, and were thus, excluded. For 82 individuals, the person assigned to receive the psychosocial questionnaire did not answer it.

The present study concerns those individuals, 50 years and older in 2008, who completed the two waves of the psychosocial questionnaire and provided a response to the question about their subjective age perception ($n = 4174$). Compared with those who were eligible to complete the psychosocial questionnaire in 2008 and did not respond, those who responded to the question about subjective age in 2008 and in 2012 were younger ($M = 70.4[11.5]$ vs. $M = 67.6[9.3]$, $t[df] = 12.1[7654]$, $p < .001$), more educated ($M = 11.9[3.5]$ vs. $M = 12.9[2.9]$, $t[df] = -12.9[7643]$, $p < .001$), with a lower number of medical conditions ($M = 2.2[1.4]$ vs. $M = 1.9[2.9]$, $t[df] = 7.8[7653]$, $p = .02$), better physical functioning ($M = 3.1 [2.9]$ vs. $M = 2.2[2.5]$, $t[df] = 13.4[7654]$, $p < .001$), and fewer depressive symptoms ($M = 1.7[2.2]$ vs. $M = 1.2[1.8]$, $t[df] = 10.6[7506]$, $p < .001$). In addition, the percentage of women was higher for those who responded to the question about subjective age in 2008 and in 2012, compared with those who were eligible to complete the psychosocial questionnaire in 2008 and did not respond (60.7 vs. 58.3 %, $\chi^2[df] = 4.7[1]$, $p = .03$).

Measures

Subjective age

Subjective age was measured by asking participants how old they felt (Kastenbaum et al. 1972). Those who provided extreme responses (age <15 years or age >120 years; less than one percent of the sample) were not included. We calculated a difference score by subtracting the subjective age provided in 2008 from the subjective age provided in 2012. A difference score that was between 3 and 5 years was coded as 0 = changes in subjective age are consistent with the passage of time. A score difference lower than 3 years was coded as 1 = relative decrease in subjective age,

whereas a score difference greater than 5 years was coded as 2 = accelerated increase in subjective age.

Attitudes toward own aging (ATOA)

The Philadelphia Geriatric Center Morale Scale (Lawton 1975) includes five questions (e.g., “things keep getting worse as I get older”), rated on a six-point scale, ranging between 1 (strongly disagree) and 6 (strongly agree). The total mean score, after reverse-coding appropriate items, ranged between 1 and 6, and was calculated to indicate an overall level of ATOA, with a higher score indicating more positive attitudes. The alpha coefficient for the reliability of the scale for waves 1 and 2 was .74 and .73, respectively.

Demographic information

This information was based on self-report as part of the core interview, including age, gender, and years of education.

Number of medical conditions

As part of the core interview, respondents reported if they were diagnosed by a physician as suffering from one to seven possible conditions: high blood pressure, arthritis, diabetes, heart condition, cancer, lung disease, and stroke. The score ranged between 0 (no medical conditions) and 7 (all medical conditions). We calculated a difference score by subtracting the overall number of medical conditions reported in 2008 from the overall number of medical conditions reported in 2012.

Physical functioning

As part of the core interview, respondents reported if they are capable of performing 10 physical activities like lifting weights, walking several blocks, jogging one mile, etc. Range was between 0 (no physical activities) and 10 (all physical activities), so that a higher score reflected greater impairment (Wallace et al. 2004). We calculated a difference score by subtracting the overall number of physical activities reported in 2008 from the overall number of physical activities reported in 2012.

Depressive symptoms

An eight-item version of the Center for Epidemiologic Studies Depression (CES-D) (Geisser et al. 1997) was used as part of the core interview to assess depressive symptoms over the past week, (yes/no). We calculated a total score after reverse-coding appropriate items. The score ranged between 0 and 8, and a higher score indicated greater

depressive symptoms. Cronbach's alpha was .79 in 2008 and .81 in 2012. We calculated a difference score by subtracting the score of depressive symptoms reported in 2008 from the score of depressive symptoms reported in 2012.

Data analysis

To assess differences in relation to the three groups (subjective age consistent with the passage of time, accelerated increase, and relative decrease), we first computed descriptive statistics, including Chi-square analyses to examine differences between categorical variables and MANOVAs to identify differences between continuous variables. Then we conducted a multinomial regression analysis, in which group membership (the three subjective age groups) served as the outcome variable, with subjective age consistent with the passage of time serving as the reference category. In the first model, changes in ATOA between 2012 and 2008 were entered as predictors. In the second model, socio-demographic variables (e.g., age, gender, and education) ATOA in 2008 and functioning, health and mental health variables (e.g., changes in medical conditions, physical functioning and depressive symptoms between 2012 and 2008) were entered as control variables. Since the study examines changes in subjective age and in attitudes toward aging over time, covariates included changes, instead of baseline measures (e.g., in health variables).

Results

The findings presented include the characteristics of the sample and the results of the multinomial analysis. For 24.7 % of the sample, changes in subjective age were consistent with changes in the passage of time over the 4-year period. A total of 39.1 % had a relative decrease in subjective age, whereas 36.2 % had an accelerated increase. There were significant differences between the three groups with regard to age, gender, and level of education. In addition, the degree of change between the two waves in functional impairment, depressive symptoms, and ATOA also differed across the three groups. These findings appear in Table 1.

More specifically, Bonferroni post hoc tests of the three groups, demonstrated that in comparison to the two groups, the group with accelerated increase of subjective age demonstrated an older chronological age ($p < .01$) and, and had lower levels of education ($p = .01$), in comparison to the group whose changes with subjective age were consistent with passage of time. Moreover, the post hoc tests showed that the group with relative decrease of subjective

age had a lower subjective age in 2008 than the group with accelerated increase of subjective age ($p < .001$) and a higher subjective age than the group whose changes with subjective age were consistent with passage of time ($p < .05$), and in 2012, this group had a lower subjective age than the other two groups ($p < .001$). The group with a relative decrease of subjective age also had a higher difference between chronological age and subjective age in 2012, compared with the two other groups ($p < .001$), a lower degree of change in their physical impairments, and fewer depressive symptoms in the second wave, as compared with the group with accelerated increase of subjective age ($ps < .001$). In addition, this group did not exhibit the decrease in the positivity level of ATOA in the second wave which was demonstrated by the other two groups ($ps < .001$). Nevertheless, their baseline level of ATOA in 2008 was lower than that of the group with accelerated increase of subjective age ($ps < .001$). Chi-square analysis for independent samples also revealed that the group with relative decrease of subjective age consisted of more women [$\chi^2(2) = 8.41, p = .02$].

As shown in Table 2 several variables were moderately or highly correlated. Age and subjective age in 2008 were highly positively correlated ($r = .55, p < .001$), and subjective age in 2008 was highly negatively correlated with the difference between chronological and subjective age in 2008 ($r = -.74, p < .001$). It should also be noted that subjective age in 2008 was only moderately negatively correlated with ATOA in 2008 ($r = -.37, p < .001$) and that the difference between subjective age in 2008 and 2012 was only weakly negatively correlated with difference in ATOA between 2008 and 2012 ($r = -.11, p < .001$). This shows that both measures of subjective age and ATOA, as well as the changes in these measures do not overlap. Finally, differences in ATOA were highly negatively correlated with ATOA in 2008 ($r = -.46, p < .001$).

Table 3 presents the results of the multinomial analysis. In the unadjusted multinomial regression (model 1), an increase in positive ATOA from 2008 to 2012 was associated with a relative decrease in subjective age (odds of 1.32 to be included in the relative decrease in subjective age group compared with the group in which subjective age was consistent with the passage of time). A decrease in positive ATOA from 2008 to 2012 was related to an accelerated increase in subjective age (odds of .29 to be included in the group that had a change in the accelerated increase in subjective age group compared with the group in which subjective age was consistent with the passage of time). These findings remained significant and almost similar after controlling for ATOA in 2008, socioeconomic variables and functioning, health and mental health variables (model 2). In addition, older age and women were

Table 1 Sample characteristics as a function of changes in subjective age

	Overall sample (4174)	Changes in subjective age consistent with passage of time (1033; 24.7 %)	Relative decrease of subjective age (1632; 39.1 %)	Accelerated increase of subjective age (1509, 36.2 %)	$F (df)/\chi^2 (df)$	p
Age in 2008	67.97 (8.82)	67.04 (7.84)	67.78 (8.81)	68.80 (8.80)	12.89 (4174, 2)	<.001
Subjective age in 2008	57.11 (12.99)	58.92 (12.31)	60.25 (13.09)	52.47 (11.99)	166.10 (4171, 2)	<.001
Subjective age in 2012	61.53 (13.49)	63.48 (12.14)	55.25 (12.73)	67.00 (12.34)	366.07 (4171, 2)	<.001
Difference between chronological age and subjective age in 2008	10.86 (10.96)	8.12 (8.50)	7.54 (11.16)	16.33 (10.04)	344.38 (4171, 2)	<.001
Difference between chronological age and subjective age in 2012	10.53 (10.96)	7.66 (8.27)	16.62 (11.01)	5.91 (9.80)	510.79 (4171, 2)	<.001
Attitudes toward aging in 2008	4.12 (1.10)	4.13 (1.04)	4.02 (1.16)	4.21 (1.07)	11.30 (4171)	<.001
Women	2520 (60.4 %)	606 (58.7 %)	1030 (63.1 %)	884 (58.6 %)	8.4 (2)	.02
Education	12.89 (2.94)	13.17 (2.84)	12.76 (3.06)	12.82 (2.86)	6.61 (4167, 2)	<.01
Difference in number of medical conditions (-5 to 4)	.28 (.74)	.29 (.75)	.25 (.71)	.31 (.76)	2.76 (4170, 2)	.06
Difference in number of physical impairments (-8 to 9)	.43 (1.95)	.37 (1.87)	.24 (1.92)	.68 (2.02)	20.77 (4171, 2)	<.001
Difference in number of depressive symptoms (-7 to 7)	.03 (1.61)	.01 (1.57)	-.14 (1.63)	.24 (1.60)	23.04 (4057, 2)	<.001
Difference in attitudes toward aging (-4.38 to 4.00)	-.19 (1.01)	-.21 (.94)	.04 (.98)	-.43 (1.04)	87.77 (4157, 2)	<.001

Changes in subjective age are consistent with the passage of time = subjective age increased by 3–5 years over the 4-year period; Relative decrease = a difference in subjective age between 2012 and 2008 was lower than 3 years over the 4-year period; Accelerated increase = subjective age increased by more than 5 years over the 4-year period

more likely to experience a relative decrease in subjective age. Furthermore, an increase in functional impairment and in depressive symptoms in 2012 compared with 2008 was associated with greater odds of being included in the accelerated increase in subjective age group compared with the group in which subjective age was consistent with the passage of time.¹

Discussion

The present study examined the relationships between changes in ATOA and subjective age over a 4-year period, using a categorical division of changes in subjective age vs.

the passage of time. The premise of this study is that it is possible to identify three clusters of individuals. The first cluster included those who changed their subjective age in line with the passage of time. In the present study, these individuals reported an increase of 3–5 years in their subjective age, which is consistent with the 4 years that have elapsed between the two waves of data collection. The second cluster demonstrates an accelerated increase in subjective age, even though only 4 years have passed between administrations. This group has shown an increase of more than 5 years in its subjective age. Finally, the third cluster included those who have shown a relative decrease in subjective age, and reported a change in subjective age of less than 3 years, despite the fact that 4 years have passed (the change could even be lower than zero, for those who felt older in 2008 than in 2012). By referencing absolute changes in subjective age ratings to the number of years passed between the two measurement occasions, we suggest a new approach to the operationalization of changes in subjective age. The findings of this study support the suggested operationalization. In line with the two hypotheses, while controlling for important confounding variables (such as sociodemographic variables, as well as change in physical and mental health) the study found that

¹ In order to examine if these results are reconstructed with subjective age as a continuous measure, we also conducted a sensitivity analysis. In this analysis, we controlled for subjective age (as computed by the difference between subjective and chronological age divided by chronological age in 2008), for gender and for years of education, as well as for medical conditions, physical functioning, and depressive symptoms in 2008. In this analysis, we used ATOA in 2008 as a predictor variable, and used the same 2008 discrepancy computation for subjective age in 2012, which was entered to the model as a predicted variable. Results remained consistent, and ATOA in 2008 predicted the continuous measure of subjective age in 2012, $R^2 = .28$, $B = .44$, $t = 4.72$, $\beta = .47$, $p < .0001$.

Table 2 Intercorrelations among the study variables

	1	2	3	4	5	6	7	8	9	10	11
1. Age in 2008	–									–	–
2. Difference between chronological and subjective age in 2008	.15***	–									
3. Subjective age in 2008	.55***	–.74***	–								
4. Attitudes toward own aging in 2008	–.10***	.35***	–.37***	–							
5. Gender ^a	.07***	–.01	.06***	.01	–						
6. Education	–.09***	.10***	–.15***	.20***	.06***	–					
7. Difference in number of medical conditions (–5 to 4)	–.03	–.01	–.01	–.00	.02	–.01	–				
8. Difference in number of physical impairments (–8 to 9)	.12	.04*	.05**	.01	.01	–.01	.11***	–			
9. Difference in number of depressive symptoms (–7 to 7)	.08***	.06	–.00	.06	.01	–.02	.04**	.15***	–		
10. Difference in attitudes toward own aging (–4.38 to 4.00)	–.10***	–.11***	.03	–.46***	–.03	–.03	–.05**	–.14***	–.20***	–	
11. Difference between subjective age in 2008 and 2012	.08***	.31***	–.21***	.04*	.01	–.04**	.01	.07***	.07***	–.11***	–

N = 4174

* $p \leq .05$; ** $p < .01$; *** $p < .001$

^a Coded 0 = man, 1 = woman

Table 3 Multinomial regression analyses, predicting accelerated and relative decrease in subjective age relative to subjective age being consistent with the passage of time (reference category)

	Relative decrease OR (95 % CI)		Accelerated increase OR (95 % CI)	
	Model 1	Model 2	Model 1	Model 2
Age in 2008		1.02*** (1.00–1.03)		.99 (.99–1.00)
Difference between chronological and subjective age in 2008		0.99 (.98–1.00)		1.11*** (1.10–1.12)
Positive attitudes toward aging in 2008		1.11* (1.01–1.22)		.71*** (.64–.79)
Gender ^a		.82* (.70–.97)		1.06 (.89–1.27)
Education		.96** (.93–.99)		.95** (.92–.98)
Difference in number of medical conditions (–5 to 4)		.93 (.83–1.04)		.99 (.88–1.12)
Difference in number of functional impairments (–8 to 9)		.97 (.93–1.01)		1.05 (1.00–1.09)
Difference in number of depressive symptoms (–7 to 7)		.98 (.94–1.03)		1.06* (1.00–1.12)
Difference in positive attitudes toward aging (–4.38 to 4.00)	1.32** (1.20–1.45)	1.34*** (1.24–1.51)	.71** (.67–.81)	.72*** (.65–.80)

^a Coded 0 = man, 1 = woman; Changes in subjective age are consistent with the passage of time = subjective age increased by 3–5 years over the 4-year period; Relative decrease = a difference in subjective age between 2012 and 2008 was lower than 3 years over the 4-year period; Accelerated increase = subjective age increased by more than five years over the 4-year period. Two multinomial regression analyses were conducted: (a) model 1: only difference in positive perceptions of aging were entered into the model; (b) model 2: age, gender, education, difference in number of medical conditions, difference in number of physical impairments, and difference in number of depressive symptoms were also entered into the model as control variables. Differences scores are calculated as the difference between 2012 and 2008

OR Odds Ratio, CI Confidence Interval

* $p < .05$, ** $p < .01$; *** $p < .001$ Model 1: $-2ll = 784.41$; Model 2: $-2ll = 7885.85$

an improvement in positive ATOA between the two waves was associated with a relative decrease in subjective age, whereas a worsening of ATOA was associated with an accelerated increase in subjective age. Moreover, several differences emerged when we compared the different groups by their respective change scores. Compared with the accelerated increase of subjective age group, the group with a relative decrease of subjective age demonstrated better functioning and better mental health. This group showed a lower increase in physical impairments, as well as a decrease in depressive symptoms, compared with the increase in these symptoms during this 4-year time period, in the group with relative increase of subjective age. The relative decrease of subjective age group demonstrated less positive ATOA at baseline, as compared with the group with accelerated increase.

It is important to note that on the second measurement, apart from a quarter of the participants who experienced a balanced change in their subjective age, most individuals (75.3 %) reported a subjective age that did not linearly take into consideration the actual passage of chronological time (4 years). Moreover, the percentage of those who demonstrated a relative decrease in subjective age was similar to those who demonstrated an accelerated increase. This distribution not only supports previous findings showing a gap in the second half of life between the objective and the subjective perception of age (i.e., Rubin and Berntsen 2006), but also reflects the non-linear perception of time along the passage of years (Ayalon et al. 2015).

Our findings provide the first examination for the need put forth by several scholars, to better understand the relationship between various self-representations of the aging process (Diehl et al. 2014; Westerhof and Wurm 2015). Our findings show that although ATOA measure both affective and cognitive components, whereas subjective age (as measured by felt age) only captures a global estimation of the perception of one's age, these two self-representations are connected and are simultaneously changing over time. Moreover, our findings provide additional support for the need to increase awareness to age-related change when examining the theoretical constructs of subjective age and ATOA (Brothers et al. 2015; Diehl and Wahl 2010).

Our findings raise further questions to be discussed. One important question concerns the temporal order of these two variables. The current study was not designed to answer this question, as its goal was to examine the relationship between changes in ATOA and accelerated increase or relative decrease in subjective age. Future studies using a cross-lagged model which investigates the reciprocal relationships between perceptions of aging and subjective age at T1 and T2, may provide an answer to the question of temporal order.

Another question deserving an answer that was not addressed by this study is about the causal mechanism which explains the trajectories by which ATOA and subjective age are linked? We can suggest some speculations for the association between these two measures, which are based on the dual-process model (Wentura and Brandstädter 2003) and on the Identity Process Theory (IPT; Whitbourne et al. 2002).

The dual-process model of development argues that the adjustment to the aging self is based on the interplay between assimilative processes, aimed at preventing or compensating for functional deficits, and on losses and accommodative processes, that enhance the adjustment to these deficits and losses (e.g., Brandstädter and Rothermund 2002; Brandstädter et al. 1999). Following this model, it can be argued that positive ATOA might buffer against negative attributions of health problems and losses, which are part of the aging process, and thereby contribute to preserving a young subjective age. According to previous studies, older adults who received a high score in accommodative flexibility demonstrated a more positive perception of their aging process which allowed them to integrate into their sense of subjective age new positive meanings and to mitigate the effect of negative perceptions of aging (Wentura and Brandstädter 2003). For example, a 50-year-old person who turns sixty, has positive ATOA and feels a decrease in the energy to perform daily physical activity, can attribute the decrease to non-age-related factors (e.g., temporary tiredness or burnout). Such a person would not assimilate negative perceptions of aging to his/her sense of subjective age in order to explain this lack of energy (e.g., perceiving himself/herself as more fragile), would not attribute this problem to age, and might even enrich his/her sense of subjective age, by emphasizing the fact that he/she had kept this habit of daily physical activity for the last 10 years. Therefore, this person would be able to keep a younger sense of subjective age.

According to the Identity Process Theory (IPT), older adults have to adapt to future decreases in their physical functioning, as their body's ability to deal with everyday functioning becomes an important aspect of their lives (Whitbourne et al. 2002). In order to avoid the negative awareness to losses in their physical functioning that have to do with age, older adults tend to interpret such losses in a way that maintains their positive sense of identity (Whitbourne, and Collins 1998). These assimilative processes are mostly based on older people's tendency to attribute the decrease in their physical functioning to health problems, which are more reversible and less unidirectional than aging processes (Whitbourne et al. 2002). In contrast, identity accommodation leads to the attribution of physical functioning to age; a less adaptive attribution, in which minor events of physical difficulties are understood as a

sign that a complete loss of physical independence is approaching. Therefore, the attribution of physical difficulties either to health problems that can be experienced at any age (assimilation), or to aging processes signifying a new aging identity (accommodation) may mediate the relationship between ATOA and subjective age. Future studies should examine the role of specific assimilative and accommodative mechanisms in the above-mentioned relationship.

Although not the focus of the current study, it is worthwhile to interpret the relationships found between the controlled variables and subjective age. Based on Nydegger's (1986) description of timetables, specialized timetables refer to the social contexts that have a potential effect on one's timetables, and include chronological age, socioeconomic status or gender, among other background variables. In contrast, personal timetables include experiences which are specific to the individual (e.g., subjective and objective functioning and health). In line with this timetable perspective (Nydegger 1986), the current findings show that both specialized timetables (i.e., chronological age, gender, and education) as well as personal timetables (i.e., an increase in physical impairments and in depressive symptoms) are related to changes in the individual's subjective age. With regard to specialized timetables, it was found that being older, and being a woman were related to a relative decrease in subjective age, whereas lower levels of education were associated with both an accelerated and a relative decrease in subjective age. The present findings extend previous findings (Choi et al. 2014; Kaufman and Elder 2002) by demonstrating that older adults perceive their advancing age as increasing more slowly. In contrast to men, women are perceived as aging earlier (Barrett and von Rohr 2008; Kogan 1979) and are more likely to suffer from negative age stereotypes (Clarke and Griffin 2008). It is possible that the relative decrease in subjective age among women reflects a defense against these negative age stereotypes. As to education, our finding demonstrate that education cannot differentiate properly between those who are conceived as having an accelerated increase or a relative decrease in subjective age (see Barak and Stern 1986; Rubin and Berntsen 2006 for other inconsistent findings regarding the role of education as a predictor of subjective age).

As for personal timetables, an increase in functional impairment and in depressive symptoms predicted an accelerated increase in subjective age. More specifically, those who demonstrated an increase in the number of physical impairments and depressive symptoms over the two waves were more likely to be among the age accelerators. The association between increased functional impairment and older subjective age is consistent with past research which has shown that older adults in the age group

of 70–79 with more physical impairments were more likely to feel older and less likely to feel younger (Choi et al. 2014), with another study that found physical functioning to be associated with a lower subjective age (Infurna et al. 2010), and with the fact that physical decline is an expected occurrence in old age (Hairi et al. 2010). The association between increased depressive symptoms and an accelerated increase in subjective age is also in line with contemporary findings showing that younger subjective age predicted lower psychological distress in general (including depressive symptoms) in a sample of 1073 community-dwelling older adults (Shrira et al. 2014). They are also in accordance with another study (Keyes and Westerhof 2012) which found that feeling younger predicted a lower risk for major depressive disorder, by analyzing data of 3032 participants from the Midlife in the United States.

Despite its strengths and innovation, our study suffers from several limitations. As this study is based on two waves of data collection, additional waves of data collection are needed in order to conduct a longitudinal analysis of the changes that occurred in subjective age and in order to assess the temporal order of subjective age and ATOA. Secondly, the sample covered a broad age range of people aged 50 or older. As the difference between subjective age and chronological age becomes larger with increasing age this could have affected the results. Nevertheless, we added a sensitivity analysis (see footnote 1) which reconstructed the results, controlled for chronological age in our analysis, and also found that the interaction between age and ATOA was not associated with changes in subjective age [OR 1.00 (.99–1.00), $p = .915$]. Therefore, we believe that we have accounted for this limitation. Third, future analyses should include other variables, such as subjective distance to death and well-being (Palgi et al. 2014; Shrira et al. 2014; Uotinen et al. 2003) that could also potentially predict changes in subjective age. Fourth, in the HRS, interviews are conducted with couples who live in the same household. Hence, a potential dependency in their answers could decrease the variability in the measures collected. Finally, other dimensions of subjective age (i.e., “look age,” “mental age,” “physical age,” and “ideal age”) should also be considered in models based on its relationship to ATOA (see Kastenbaum et al. 1972; Uotinen et al. 2003).

Nonetheless, in light of the growing evidence regarding the association between younger subjective age, better physical functioning (Montepare 2009), decreased mortality risk (Kotter-Gröhn et al. 2009), lower mental distress, and higher well-being (Choi et al. 2014; Keyes and Westerhof 2012), the findings of the current study carry both theoretical and practical benefits. From a theoretical point of view, our findings demonstrate the important association between preserving positive ATOA in old age and subjective age, and show that this association is

maintained, even after considering sociodemographic and health variables. From a practical point of view, it might be beneficial to design interventions for improving ATOA.

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Compliance with ethical standards

Conflict of interest None.

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