Being slower, feeling older? Experimentally induced cognitive aging experiences have limited impact on subjective age

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Abstract Initial experimental research has shown that subjective age may change in response to induced aging experiences, but replication and extension are needed. The present study investigates if age-related cognitive gain or loss experiences evoke decreases/increases in subjective age. A multidimensional subjective age measure was used to explore domain-specific internalization effects. 78 individuals aged 59–70 years were randomly assigned to two experimental conditions and a control group. Participants took a cognitive attention test and received gain-oriented feedback on their accuracy or loss-oriented feedback on their processing speed. A mixed factors analysis of covariance was used to examine changes in feel age, look age, do age, and interest age. After being primed with age-related losses, participants reported older do ages as compared to before the experimental priming. Priming age-related gains had only a marginally significant effect on do age. All other subjective age dimensions remained unaffected by the experimental priming. Although previous research has shown that subjective age can be manipulated experimentally, findings from the present study underscore that a comprehensive and cross-domain improvement of subjective age may require personally relevant and repeated experiences of age-related gains.

Keywords Age stereotypes · Contamination hypothesis · Labeling hypothesis · Subjective age

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Introduction

Subjective age is a central component of the aging self (Diehl et al. 2014) and it is associated with a range of successful aging indicators, such as health, cognitive functioning, and subjective well-being (Barrett 2003; Stephan et al. 2014; Teuscher 2009; Westerhof et al. 2003). Longitudinal evidence points to the predictive role of feeling younger than one's chronological age for psychosocial and physical functioning in later life (Westerhof et al. 2014). The strong empirical evidence for the developmental consequences of subjective age warrants a systematic examination of the plasticity and within-person variability of subjective age (Kotter-Grühn et al. 2015a, b). The present study aims to replicate and extend previous experimental findings on the plasticity of subjective age by comparing the effects of a gain and loss manipulation of aging experiences in the domain of cognitive functioning. As a novelty compared to existing experimental studies, we use a multidimensional subjective age measure to examine the plasticity of subjective age in different life domains (e.g., everyday activities, physical appearance).

Theoretical foundations for the experimental manipulation of subjective age

A limited number of experimental studies have shown that the age a person feels can be changed when aging experiences are induced. Manipulation strategies that yielded an older subjective age include the experience of visual disfluency or generation gaps (Eibach et al. 2010) and taking or simply expecting to take a memory test (Hughes et al. 2013). To our knowledge, only one study succeeded in making participants feel younger, namely by providing positive social comparison feedback after a handgrip task

(Stephan et al. 2013). The observed effects can be explained with the contamination hypothesis (Rothermund 2005; Rothermund and Brandtstädter 2003), sometimes also referred to as labeling hypothesis (Kotter-Grühn and Hess 2012). According to the contamination hypothesis, older adults assimilate their self-view to negative age stereotypes, particularly when becoming aware of belonging to the group of older adults. Consequently, negative age stereotypes may induce older subjective ages when being presented in an individualized way, that is, when participants are made to believe that negative age stereotypes are self-descriptive.

Another experimental approach to change subjective age has been to confront older adults with generalized views of older people. Findings of these studies are somewhat mixed. Whereas in one study the presentation of negative age stereotypes (conveyed through an aging quiz) resulted in younger subjective ages relative to the conditions with positive or neutral age stereotypes (Weiss and Lang 2012), the findings of another study point into the opposite direction; that is, the priming with negative age stereotypes as portrayed in photographs and text of older women resulted in older subjective ages (Kotter-Grühn and Hess 2012). Contrary to the expectations of the authors, participants in this study also had older subjective ages after being primed with positive age stereotypes.

The emerging picture is that it seems to be easier to make individuals feel older, rather than inducing younger subjective ages (Kotter-Grühn 2015; Kotter-Grühn et al. 2015a). The most promising strategy to induce younger subjective ages seems to be the presentation of positive performance feedback (Kotter-Grühn et al. 2015a). The manipulation strategy in our study therefore involves the priming of positive or negative aging experiences through performance feedback in the domain of cognitive functioning. In addition, we argue that the consideration of subjective age as multidimensional construct is needed to advance our knowledge about the plasticity of subjective age.

Multidimensionality of the subjective age construct

In the early seventies, Kastenbaum et al. (1972) introduced *personal age* as a multidimensional construct consisting of feel age (how old a person feels), look age (how old a person looks), do age (how involved a person is in doing “things” favored by members of a certain age group), and interest age (how similar a person’s interests are to members of a certain age group). These multiple aspects of subjective age reflected in the four-item scale have not been mirrored by subjective aging research over the past decades. In particular, most experimental studies aiming to

manipulate subjective age have used feel age as the primary indicator of a person’s subjective aging perception (Eibach et al. 2010; Hughes et al. 2013; Stephan et al. 2013), and, to our knowledge, only one study discriminated between different subjective age domains (i.e., feel age, look age, and desired age, but not do age and interest age; Kotter-Grühn and Hess 2012). However, asking participants how old they feel is only a limited portrayal of subjective perceptions of aging. Like other authors have done before (Kotter-Grühn et al. 2015a), we claim that more research on subjective age domains other than feel age is needed to better understand the distinctions between subjective age domains and to test how the effects of experimental manipulations may differ for different facets of subjective age. Studies on the plasticity of a wider range of subjective aging indicators are especially needed in order to inform intervention research that aims at a long-term and comprehensive improvement of subjective aging.

This goal, however, may be difficult to achieve without further evidence about the modifiability of different facets of subjective aging. For example, a physical activity intervention conducted by Wolff et al. (2014) changed only one facet of general attitudes toward older adults. In particular, the ‘views-on-aging’ component included in one of the intervention groups yielded positive effects on the integrity subscale, which reflects how older adults are perceived in terms of satisfaction and confidence. Further justification for the need of using multiple subjective age dimensions comes from correlational research, which has shown that different dimensions of subjective age are uniquely linked to different identity constructs, such as body esteem (Montepare 1996). Therefore, we strive to examine the susceptibility of subjective age by considering a more fine-grained subjective age differentiation. To this end, the decision was made to include all four subjective age dimensions proposed by Kastenbaum et al. (1972).

Based on the finding that age stereotypes seem to have greater effects on behavior and functioning if the outcome domain corresponds to the stereotype content (Levy and Leifheit-Limson 2009), we argue that a similar stereotype-matching effect might play a role in internalization processes. This argument is further supported by cross-sectional research. Kornadt and Rothermund (2012) found domain specificity of the internalization of age stereotypes into current self-views. Consequently, we expected domain-specific priming effects of cognitive aging experiences. That is, we expected effects on subjective age domains that relate to cognitive performance, namely ‘do age’ and ‘interest age.’ Although ‘do age’ and ‘interest age’ do not exclusively pertain to the cognitive domain, these items cover aspects of subjective aging that are related to cognitive functions, such as the ability to perform well on cognitive tests as well as intellectual interests.

Potential of cognitive aging experiences for the manipulation of subjective age

Also of importance for our study, only little experimental research has been conducted in the field of cognitive functioning (Hughes et al. 2013) although cognitive functioning is associated with subjective age (Stephan et al. 2014) and highly important for individuals' self-views (Dark-Freudeman et al. 2006; Kessler et al. 2012; Lawton et al. 1999). Moreover, cognitive aging is characterized by the coexistence of gains and losses. For example, on speed/accuracy trade-off tasks older adults perform slower but also more accurately (Brebion et al. 1997), characteristics that are reflected in the gains and losses that aging individuals expect for their own cognitive development in later life (Heckhausen et al. 1989). Manipulating age attributions in the cognitive domain thus provided the opportunity to construct two comparable experimental conditions that prime widely accepted age-related gains (accuracy) or losses (speed)—a crucial requirement to compare the effects of negative and positive age-related changes.

Evidence from a meta-analysis suggests that negative age stereotypes have a three times larger effect on behavioral outcomes (e.g., memory) as compared to positive age stereotypes (Meisner 2012). This evidence related to negative age stereotypes suggests that providing adults with information that reinforces their negative expectations with regard to aging should result in stronger effects on subjective age as compared to information that reinforces positive aging experiences. However, given that previous experimental research has mostly used loss-oriented manipulation strategies and compared effects to a control group, it is yet unclear whether the relatively stronger influence of negative compared to positive aging experiences also pertains to the manipulation of subjective age.

Research aims

As an extension of previous experimental research, the goal of the present study was threefold: First, we employed a more fine-grained, multidimensional subjective age measure in order to test for differential and domain-specific effects. Second, in contrast to previous studies, which mostly primed age-related physical changes, our manipulation strategy was anchored in the domain of cognitive functioning. Third, instead of using only a negative (respectively positive) prime, we developed two parallel conditions inducing either age-related gains or losses which allowed a comparison of effects. Based on the contamination hypothesis, we expected that induced aging experiences would be internalized into age-related self-views. That is, age-related losses should translate into older subjective ages and age-related gains were expected to

result in younger subjective ages. This effect was expected to be stronger for induced age-related losses than for gains (Meisner 2012). Due to a lack of multidimensional subjective age measures in previous studies, our aim was to explore if previously observed effects on feel age would extend to other subjective age domains. Overall, we expected effects to be most pronounced for 'do age' and 'interest age,' given that these subjective age items are most closely related to the domain of cognitive functioning.

Method

Participants

Participants were recruited from various sources, such as a University register of interested study participants and senior education institutions. Upon commencement of the study, participants were told that the aim of the research project was to investigate personal goals and cognitive fitness in middle and old age. 78 participants were randomly assigned to the three experimental groups (age-related gains, age-related losses, and control) with $n = 26$ in each group. Given this sample size, the power to detect an effect comparable to other studies (cf., Stephan et al. 2013, obtained an effect size of $f = .37$) in a mixed factors analysis of variance was $1 - \beta = .99$.

Participants (59.0 % women) were aged 59–70 years ($M = 64.6$ years, $SD = 3.1$ years). We purposefully selected a young-old age group for our study, because this is the age when cognitive loss experiences start to emerge and cognitive worries become stronger, while overall cognitive functioning is still maintained. Furthermore, young-old adults might be more susceptible to reinforcements of negative age stereotypes than old-old adults, due to habituation effects, which make negative age stereotypes less threatening to old-old adults (Eich et al. 2014). Participants had above-average monthly household incomes ($M = 3089$ €; $SD = 1683$ €) and above-average education (64.1 % with a university or university of applied science degree). Self-ratings of health were 'good' on average ($M = 3.8$; $SD = .7$) on a scale from 1 (*very poor*) to 5 (*very good*).

The three experimental groups did not differ on a set of demographic variables, health domains, and psychological constructs (i.e., age, income, education, marital status, physical functioning, number of physical conditions, self-rated health, life satisfaction, self-esteem, time taken for the d2 Test, number of errors made, and subjective ages before the experimental manipulation); all p 's $> .05$. Hence, it can be concluded that the random assignment of participants to the experimental groups was successful.

Experimental manipulation

Participants completed an adapted version of the d2 Test of Attention (Brickenkamp and Zillmer 1998). The d2 Test is a visual cancellation test consisting of the letters d and p with one to four dashes arranged individually or in pairs of two above and/or below each letter. Participants are asked to cross out each d that is accompanied by two dashes as quickly and accurately as possible. As one of the experimental conditions relied on feedback about the amount of time taken for the test, we slightly adapted the test format and measured the total time taken to process a set of 180 characters instead of presenting several series of characters with a predetermined processing time of 20 s each.

In the *gains condition*, feedback was given on their accuracy. They were presented a bar graph depicting the actual percentage of correct answers (which was conveyed as being similar to the alleged average of their own age group) along with fictional mean scores for three age decades below that of the participant's age. The graphs were standardized so that the mean accuracy score for each age decade departed by 10 % from the next oldest age decade, yielding a picture of steady increase in accuracy with age. The feedback was presented along with a statement on the participant's performance: "In this kind of tasks accuracy increases with age. This was also true for you. As you can see in the graph, your percentage of correct answers was higher than the average of younger age groups." Here the intention was to prime age-related gain experiences and to induce a younger subjective age. Participants in the *losses condition* received feedback on the time taken for the test. Similarly to gains condition, participants' actual performance time was presented as average in relation to their own age group and a bar graph with processing time increasing by 10 % over each of the three age decades below that of the participant's age was presented to convey age-related losses in processing speed. Along with this graph, the following verbal feedback was provided: "The amount of time taken for such tasks increases with age. This was also true for you. As you can see in the graph, you performed slower than the average of younger age groups." No feedback was given in the *control group*.

Measures

Subjective age domains

Subjective age was measured in four domains: *feel age* ("Most of the time I feel as if I am ... years old."), *look age* ("Most of the time I look as if I am ... years old."), *do age* ("Most of the time my activities are most like those of a ... year-old."), and *interest age* ("Most of the time my

interests are comparable to those of a ... year-old.") (Kastenbaum et al. 1972). The order of the subjective age items was kept consistent across measurement occasions and across participants. A proportional discrepancy score (Rubin and Berntsen 2006) was calculated for each facet of subjective age. A negative proportional discrepancy score represents the percentage of years that a person feels younger compared to his or her chronological age. A positive proportional discrepancy score indicates a relatively older subjective age. Subjective age domains were assessed before and after the experimental manipulation. Because intraindividual variation in emotional, mental, or physical status (e.g., stress, health complaints) may influence momentary subjective age ratings on a given day (Kotter-Grühn et al. 2015b), we asked for a more general evaluation of subjective age domains at pretest (e.g., "Most of the time I feel as if I am ... years old"). At posttest, however, we wanted to capture exactly these situational influences. Hence, we decided to use a slightly different wording at posttest (e.g., "At the moment I feel as if I am ... years old"). A similar procedure has been successfully used in another experimental study, which also employed a within-person approach (Stephan et al. 2013).

Covariates

The physical functioning subscale of the SF-36 (Bullinger and Kirchberger 1998), time taken for the d2 Test, and the number of errors made were entered as control variables in all analyses.

Test performance ratings

Participants were asked to compare their performance on the d2 Test to that of younger, same-aged, and older individuals on a 5-point scale (1 = *much worse*, 5 = *much better*). These comparative test performance ratings served as an indicator of perceived past and expected future age-related changes of cognitive functioning, which was expected to change in response to the experimental manipulations. Hence, in order to test if the experimental feedback successfully induced perceptions of age-related gains or losses in cognitive functioning, we conducted a 3 (Condition: gains vs. losses vs. control) $\times$ 3 (Comparison group: older vs. same age vs. younger) mixed factors analysis of variance as a manipulation check.

Procedure

Participants were mailed a questionnaire including demographic variables, our set of covariates, as well as a pretest measure of subjective age, which they completed on average 2.9 days before their individual lab appointment.

During the interview, participants took the d2 Test, received the respective feedback, and were asked to evaluate their test performance. Afterwards, subjective age domains and some additional questionnaires not relevant to this study as well as a second speed/accuracy trade-off task (i.e., Stroop Test; Bäumlér 1985) were administered. Finally, participants were asked for the presumed goal of the study, debriefed, and received a compensation of €10.

Results

Preliminary analyses

Means and standard deviations for the key constructs of this study are presented in Table 1. Table 2 depicts the bivariate correlations among the four subjective age domains before and after the experimental manipulations. Correlations among subjective age domains were somewhat higher after as compared to before the experimental manipulation. Overall, however, the largest correlations were found for the repeated measures of each subjective age item ($r = .58 - .80$).

Manipulation check

A significant condition (gains vs. losses vs. control) $\times$ comparison group (older vs. same age vs. younger) interaction emerged for comparative test performance ratings, $F(4, 148) = 6.00$, $p < .001$, $\eta_p^2 = .14$, which is depicted in Fig. 1. A test of the simple main effect of comparison group yielded significant differences between the three comparative ratings within each experimental condition. Furthermore, a test of the simple effect of condition revealed that comparative test performance ratings with younger individuals were more negative in the losses condition ($M = 2.4$) than in the control group ($M = 2.8$) and in the gains condition ($M = 3.0$). Comparative ratings with older individuals differed between the gains and the losses conditions. Individuals in the gains condition rated their own performance to be more similar to older age groups ($M = 4.0$) than did individuals in the losses condition ($M = 4.3$). Comparative ratings with the same-aged peers were similar between groups. Taken together, these comparative ratings indicate that cognitive aging experiences and aging expectations were successfully manipulated: Participants in the losses condition had the impression of a comparatively higher extent of cognitive decline over the past years, whereas the answers of

participants in the gains condition indicate expectations of a lower extent of cognitive decline over the years ahead.

Effects of the experimental manipulation on subjective age domains

A 3 (Condition: gains vs. losses vs. control) $\times$ 2 (Occasion: pretest vs. posttest) mixed factors analysis of covariance was used to test the effects of experimental manipulation separately on each subjective age domain. Condition $\times$ Occasion interactions were nonsignificant for feel age, $F(2, 67) = .67$, look age, $F(2, 66) = 1.09$, and interest age, $F(2, 66) = .38$, with all p 's $> .05$. For do age, the Condition $\times$ Occasion interaction reached significance, $F(2, 70) = 5.31$, $p < .05$, $\eta_p^2 = .12$. T-tests for dependent groups (cf. Fig. 2) revealed an average increase between pre- and post-manipulation in do age by 4.2 percentage points in the losses condition, $t(25) = 1.95$, $p < .05$, $d = .38$, which corresponds to an average absolute increase of 2.7 years ($SD = 6.9$ years) in respondents' do ages. A statistical trend toward a decrease of 3.3 percentage points emerged in the gains condition, $t(24) = 1.62$, $p = .06$, $d = .32$, which corresponds to an average absolute decrease of 2.2 years ($SD = 6.6$ years) in respondents' do ages. According to Cohen (1988), the effect sizes for these changes in do age were in the medium or typical range. No pre- to post-manipulation differences were observed in the control group, $t(25) = .84$, $p = .21$.

Taken together, inducing age-related cognitive losses resulted in older do ages and inducing age-related cognitive gains tended to increase the youthfulness bias for do age. This pattern of results suggests that negative feedback has a stronger impact on do age than positive feedback. To test this assumption, we combined the positive condition with the control group and contrasted it to the losses condition. Again, a significant Condition $\times$ Occasion interaction effect emerged only for do age, $F(1, 71) = 7.30$, $p < .01$, $\eta_p^2 = .09$.

Finally, in a full 3 (Condition: gains vs. losses vs. control) $\times$ 2 (Occasion: pretest vs. posttest) $\times$ 4 (Domain: feel age, look age, do age, interest age) mixed factors analysis of covariance model, the three-way interaction of Condition $\times$ Occasion $\times$ Domain did not reach statistical significance, $F(6, 189) = 1.31$, $p = .25$. Therefore, the significant effect of the losses condition on do age, although theoretically derived and expected, needs to be interpreted with caution.

Finally, testing for gender differences in the effects of the experimental manipulation on all subjective age domains revealed no differences between men and women.

Table 1 Descriptive statistics of key constructs

	Experimental condition		
	Age-related losses <i>M (SD)</i> or %	Age-related gains <i>M (SD)</i> or %	Control group <i>M (SD)</i> or %
Age (years)	64.0 (3.0)	65.1 (2.7)	64.7 (3.5)
Gender (% female)	57.7	57.7	61.5
d2 Test			
Time taken (in seconds)	152 (60)	146 (33)	144 (41)
Number of errors	2.5 (1.9)	4.1 (5.0)	4.0 (3.8)
Physical functioning (SF-36)	82.3 (24.7)	85.5 (14.0)	85.4 (17.1)
Feel age T1	−13.7 (12.5)	−15.8 (12.0)	−11.2 (8.8)
Feel age T2	−11.6 (10.2)	−10.9 (8.7)	−9.1 (9.0)
Look age T1	−8.4 (7.7)	−6.7 (7.8)	−5.9 (6.2)
Look age T2	−7.3 (6.3)	−5.4 (7.2)	−6.2 (5.8)
Do age T1	−13.4 (11.8)	−11.9 (11.4)	−14.6 (11.4)
Do age T2	−9.2 (9.8)	−14.6 (13.1)	−13.2 (9.4)
Interest age T1	−18.3 (13.4)	−18.4 (10.0)	−17.4 (12.0)
Interest age T2	−14.9 (12.5)	−16.4 (10.8)	−15.9 (12.4)

Table 2 Bivariate correlations among subjective age domains and with covariates

	(2)	(3)	(4)	(5)	(6)	(7)	(8)	d2 time	d2 errors	PF
(1) Feel age T1	.46***	.50***	.51***	.62***	.42***	.56***	.46***	.11	.12	−.18
(2) Look age T1		.24*	.35**	.55***	.80***	.27*	.36**	−.08	.09	.06
(3) Do age T1			.55***	.44***	.30**	.58***	.54***	.32**	.05	−.20
(4) Interest age T1				.49***	.25*	.52***	.68***	−.11	.14	.25*
(5) Feel age T2					.59***	.57***	.60***	.00	.28*	.08
(6) Look age T2						.32**	.37**	.08	.15	.04
(7) Do age T2							.56***	.17	.17	.01
(8) Interest age T2								.18	.22	.07

PF = Physical functioning subscale of the SF-36

* < .05, ** < .01, *** < .001

Fig. 1 Estimated marginal means of comparative test performance ratings within each experimental group

Fig. 2 Change in the four subjective age domains before and after the experimental manipulation. *Note* Plots depict estimated marginal means of percentage discrepancy scores between chronological age and subjective age domains. A negative discrepancy scores reflects a

more youthful subjective age than chronological age. Estimated marginal means were controlled for physical functioning (SF-36) and cognitive functioning (d2 Test performance)

Discussion

This study provides one of the first simultaneous tests of the effects of experimentally induced positive and negative cognitive aging experiences on a multidimensional subjective age measure using a repeated measures design. Experienced decrements in processing speed resulted in older do ages after as compared to before the experimental priming, whereas age-related gains had only a marginally significant effect on do age.

We believe that important insights into the distinctions between subjective age domains can be gained from this study. Whereas previous research found that feel age can be experimentally manipulated (Eibach et al. 2010; Stephan et al. 2013), in the present study intraindividual variability was found only for do age. Asking participants to rate four subjective age items might emphasize subtle differences between these items and potentially prompts participants to use distinct reference points for each item. We argue that the experimental effect on do age can be

explained with domain-specific priming effects (Kornadt and Rothermund 2012; Levy and Leifheit-Limson 2009). Whereas the global feel age rating has greater flexibility to capture a broad range of ‘proximal’ (e.g., health-related events) and ‘distal’ reference points (e.g., age norms) (Montepare 2009, p. 43), do age might capture more momentary and performance-related aspects of subjective aging. Of the four subjective age domains, do age may be regarded as having the closest connection with cognitive performance, at least in terms of fluid intelligence. That is, do age comprises subjective perceptions of capabilities, vitality, and fitness, which (among other things) are important for the ability to perform well on an attention test. Therefore, cognitive aging experiences might have been internalized in a domain-specific way into do ages only. By contrast, the observed null effects on look age and interest age might suggest that cognitive performance, at least in relation to fluid intelligence, is irrelevant for physical appearance (look age) and personal interests (interest age). Nevertheless, it is important to note that the domain-specific priming effects observed in the four separate ANCOVA models were not confirmed in the full 3 (Condition: gains vs. losses vs. control) $\times$ 2 (Occasion: pretest vs. posttest) $\times$ 4 (Domain: feel age, look age, do age, interest age) ANCOVA model, which further restricts the evidence for a differential internalization of the experimental feedback. In sum, we regard our pattern of finding as a useful insight for future investigations exploring the domain specificity of subjective age. It is, for example, open to future research, if domain-specific priming effects can be reproduced in a between-person design.

Going further, our findings corroborate existing research that compares the relative influence of positive and negative age stereotypes (Meisner 2012). The relatively stronger influence of negative aging experiences can be explained by the high prevalence of negative age stereotypes in Western societies as well as their considerable persuasive power, which might be difficult to counteract through positive aging experiences. Hence, negative age stereotypes might reinforce individuals’ negative expectations with regard to aging and are thus of greater personal salience. More generally, it seems that unfavorable stereotypes are acquired more easily and are more difficult to overcome than favorable stereotypes (Baumeister et al. 2001). However, alternative explanations might be possible. In particular, there are theoretical grounds for the assumption that positive age-related feedback can result in both younger and older subjective ages depending on the interpretation of the feedback. On the one hand, maintaining or even improving one’s cognitive abilities may be

regarded as a marker of youthfulness, thus resulting in younger subjective ages. On the other hand, feeling younger is often regarded as a denial of aging or a self-protective strategy (Kotter-Grühn et al. 2015a). Thus, when age-related gains are made salient, there might be less need to deny one’s own aging, as expressed in feeling older. The comparatively large variance of do ages at T2 in the gains condition point toward such an alternative explanation. Another potential explanation for the lack of effects of age-related gains might be the presence of floor effects: because most individuals already feel younger, there is only little potential to further increase this youthfulness bias (Kotter-Grühn et al. 2015a).

In sum, our findings suggest that caution is warranted when it comes to the goal of “improving” subjective age. Given the high degree of continuity and stability of the self-concept (Brandtstädter and Greve 1994), long-lasting changes of a person’s subjective aging perception might require personally relevant and repeated experiences of age-related gains or a greater extent of such age-related changes in order to have the potential to override the manifold aging experiences in everyday lives (Miche et al. 2014). Thus, when it comes to improving subjective aging perceptions and reducing the influence of negative age stereotypes by systematic intervention approaches, we conclude that a relatively modest feedback strategy anchored in the fluid intelligence sphere may not be a sufficient tool. Instead, it may be better to rely on domains that do not show age-related decline, such as positive emotional experiences, generativity-related processes, and wisdom or life experience. At the same time, as discussed earlier, a younger subjective age may not be the only (and not even the best) indicator of a positive subjective aging perception. The intention to make older adults feel younger, although based on a vast body of research pointing to the negative developmental consequences of subjective aging, does indeed bear the risk of perpetuating negative age stereotypes (Kotter-Grühn 2015). Therefore, we see a need to include an even broader range of conceptual approaches to the subjective experience of aging in future experimental research.

Limitations and future research

When interpreting the findings of this study, it is important to keep in mind that context-specific, potentially more dynamic subjective age ratings at posttest (“at the moment”) were compared to average baseline and potentially more stable subjective age ratings at pretest (“most of the time”). Although this procedure mirrors previous research (Stephan et al. 2013), participants might have used

different reference points to anchor their subjective age ratings at posttest compared to pretest. Future research might therefore yield different results, if a consistent wording is used between measurement occasions. Additionally, a promising extension for future research would be to augment Kastenbaum's subjective age dimensions by developing a 'mental age' item (e.g., "With regard to my cognitive abilities I feel as if I am ... years old"). Such a mental age rating could then be used in a more unequivocal way of testing domain-specific internalization effects with regard to cognitive functioning.

In the selected age group of young–old adults, cognitive functioning represents a highly valued and carefully monitored personal attribute during this life phase. Cognitive aging experiences might have less strong effects in middle-aged as well as old–old adults. For middle-aged adults, noticeable age-related cognitive decline is less realistic than for young–old adults, whereas for old–old adults it might be less threatening to the self-concept because of greater acceptance for cognitive decline they might have already faced (Eich et al. 2014; Heckhausen et al. 1989). It is therefore open to future research if cognitive aging experiences have similar effects in other age groups.

Altogether, the results of our study in conjunction with previous experimental research indicate that, when age stereotypes are presented in a personalized manner, i.e., when older adults are made to believe that age stereotypes are descriptive of themselves, particularly negative age stereotypes are being internalized into age-related self-views. We argue that the observed internalization effect is in line with the contamination hypothesis (Rothermund and Brandtstädter 2003), because the personalized presentation of age stereotypes (as opposed to a more general confrontation with age stereotypes) provides little opportunity to distance oneself from the stereotypical trait, for example through social downward comparisons. However, it cannot be clearly determined if the effect in our study resulted from (a) the presentation of age stereotypes using fictional mean scores, (b) the personalized feedback, or (c) a combination of both.

Besides such consideration regarding the internalization of age stereotypes into self-views and the limited plasticity of subjective age, the domain-specific susceptibility of subjective age domains to induced cognitive aging experiences highlights subtle differences between subjective age domains. Future research on the plasticity of subjective aging phenomena should therefore employ a broader range of subjective aging measures and should prefer multidimensional over unidimensional constructs.

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