Review Article

Associations of Awareness of Age-Related Change With Emotional and Physical Well-being: A Systematic Review and Meta-analysis

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Abstract

Background and Objectives: This systematic review aimed to synthesize and quantify the associations of awareness of age-related change (AARC) with emotional well-being, physical well-being, and cognitive functioning.
Research Design and Methods: We conducted a systematic review with a correlational random effects meta-analysis. We included quantitative studies, published from January 1, 2009 to October 3, 2018, exploring associations between AARC and one or more of the following outcomes: emotional well-being, physical well-being, and cognitive functioning. We assessed heterogeneity (I^2) and publication bias.
Results: We included 12 studies in the review, 9 exploring the association between AARC and emotional well-being and 11 exploring the association between AARC and physical well-being. No study explored the association between AARC and cognitive functioning. Six articles were included in the meta-analysis. We found a moderate association between a higher level of AARC gains and better emotional well-being ($r = .33$; 95% CI 0.18, 0.47; $p < .001$; $I^2 = 76.01$) and between a higher level of AARC losses and poorer emotional ($r = -.31$; 95% CI –0.38, –0.24; $p < .001$; $I^2 = 0.00$) and physical well-being ($r = -.38$; 95% CI –0.51, –0.24; $p < .001$; $I^2 = 83.48$). We found a negligible association between AARC gains and physical well-being ($r = .08$; 95% CI 0.02, 0.14; $p < .122$; $I^2 = 0.00$). Studies were of medium to high methodological quality.
Discussion and Implications: There is some indication that AARC gains and losses can play a role in emotional well-being and that AARC losses are associated with physical well-being. However, the number of included studies is limited and there was some indication of heterogeneity.
PROSPERO Registration: CRD42018111472.

Keywords: Aging, Awareness, Cognition, Health, Meta-analysis, Review

The proportion of older individuals in the world is increasing (United Nations, 2017) and as a consequence, the number of people that experience poor emotional and physical well-being and poor cognitive health, including dementia, is also increasing (United Nations, 2017). Poor emotional and physical well-being and dementia place a high economic burden on healthcare services (Morrison, 2008; Prince et al., 2015). As a result, increasing emphasis

is being placed on research into prevention of poor emotional and physical well-being, cognitive impairment, and dementia (World Health Organization, 2015). There is great individual variability in levels of emotional and physical well-being, and of cognitive functioning, among older people (e.g., Deary et al., 2009; Gow, Pattie, Whiteman, Whalley, & Deary, 2007; Jagger et al., 2009). A better understanding of those factors that account for individual variability may be useful in suggesting ways of preventing poor emotional well-being, physical well-being, and cognitive decline with aging.

Empirical evidence has shown that positive subjective aging (SA), the way in which individuals experience aging, is associated with better health and well-being (Westerhof et al., 2014). Previous studies, for example, have found associations between positive SA and better physical and cognitive functioning (Levy, Slade, Kunkel, & Kasl, 2002; Robertson, King-Kallimanis, & Kenny, 2016; Robertson, Savva, King-Kallimanis, & Kenny, 2015), lower risk of medical problems such as cardiovascular events, falls, and hospitalizations (Levy, Slade, Chung, & Gill, 2015; Levy, Zonderman, Slade, & Ferrucci, 2009; Moser, Spagnoli, & Santos-Eggimann, 2011), higher longevity (Levy et al., 2002; Moser et al., 2011), and lower levels of Alzheimer's-like neuropathology (Levy et al., 2016). SA covers a range of concepts attempting to understand the ways in which individuals experience the aging process (Westerhof et al., 2014). Examples of such concepts are self-perception of aging (Kleinspehn-Ammerlahn, Kotter-Grühn, & Smith, 2008; Kotter-Grühn, Kleinspehn-Ammerlahn, Gerstorf, & Smith, 2009), subjective age, age identity (Kotter-Grühn & Hess, 2012), attitudes toward aging (Bennett & Eckman, 1973), and age stereotypes (Levy, 2003, 2009).

A more recently-introduced SA concept is awareness of age-related change (AARC; Diehl & Wahl, 2010). AARC refers to "a person's state of awareness that his or her behavior, level of performance, or way of experiencing life has changed as a consequence of having grown older" (Diehl & Wahl, 2010, p. 342). The term was introduced in 2010 by an international working group to overcome some of the limitations of previous SA concepts. In contrast to other SA concepts, AARC acknowledges that individuals' SA experience may vary across different life and behavioral domains (e.g., health and physical functioning, cognitive functioning, interpersonal relationships, socio-cognitive and socio-emotional functioning, and lifestyle/engagement). It is also the first construct recognizing that people can experience both positive and negative age-related changes, called AARC gains and AARC losses, respectively. An example of AARC gains in the cognitive functioning domain is "I have become wiser," while an example of AARC losses in the same domain is "I am slower in my thinking." An example of AARC gains in the health and physical functioning domain is "I pay more attention to my health" while an example of AARC losses in the health and physical functioning domain is "I have less energy." Interestingly,

AARC gains and AARC losses may occur simultaneously even in the same behavioral or life domain.

Different to other SA concepts (e.g., attitudes toward aging and age stereotypes) that act at a pre-conscious level, AARC has been conceptualized as a form of conscious self-knowledge. This makes the AARC concept potentially useful to identify individuals who, because they experience high awareness of negative age-related change, may be highly motivated to engage in health-promoting interventions.

Assessing AARC in a more standardized way has been made possible with the introduction of a questionnaire specifically designed to investigate AARC (Wahl, Konieczny, & Diehl, 2013). There are now four published versions of the questionnaire with differing lengths across two languages. In English, there is a 50-item questionnaire (Brothers, Gabrian, Wahl, & Diehl, 2019), a shorter 20-item version (Neupert & Bellingtier, 2017), and a further ultra-short version (AARC-10 SF; Kaspar, Gabrian, Brothers, Wahl, & Diehl, 2019). The 50-item questionnaire resulted from the refinement of two original forms of the questionnaire consisting of 189 and 100 items, respectively (Brothers, 2016). The 20-item and 10-item versions are made up of selected items from the AARC 50-item version. In German, an initial version consisted of 50 items, which were translated and included in the 189-item version, and this 50-item version was subsequently refined to provide a 32-item version (Wahl et al., 2013).

There has been some research investigating AARC gains and AARC losses and their associations with emotional well-being (Dutt, Gabrian, & Wahl, 2016a; Miche et al., 2014; Neupert & Bellingtier, 2017) and functional health (Brothers, Miche, Wahl, & Diehl, 2017; Kaspar et al., 2019). It is therefore an appropriate time to conduct a meta-analysis to summarize findings on the associations of AARC gains and AARC losses with emotional and physical well-being and cognitive functioning, to provide a foundation for future AARC research. Since AARC gains and AARC losses have been conceptualized as two distinct sub-components of the same AARC construct, contrary to other SA concepts, it is possible to separately study AARC gains and AARC losses and to investigate their unique associations with health outcomes. This increased knowledge may be useful in understanding whether the way in which people experience aging explains some of the individual differences in health and well-being over time.

The aim of this systematic review is to synthesize and quantify the associations of AARC with emotional and physical well-being and cognitive functioning reported in studies using quantitative study designs and including only cognitively healthy adult participants (aged 18 years and older). In addition, we aimed to understand study characteristics, the populations in which associations of AARC with emotional and physical well-being and cognitive functioning have been investigated, and the strengths and limitations of the available studies exploring such associations.

Methods

We conducted a comprehensive systematic review in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) Statement (Moher, Liberati, Tetzlaff, & Altman, 2009) and following an a priori protocol. The protocol is registered with PROSPERO (registration number CRD42018111472).

Systematic Search Strategy

The search strategy was developed in consultation with expert librarians and used free-text terms (Supplementary Table 1). The following search terms were used: "awareness of age related change" or "awareness of age-related change"; AARC*; "views on aging" or "views on ageing." We searched the following health care databases and trial registers: Medline, EMBASE, PsycINFO, CINAHL, AgeLine, AMED, and Web of Science (Core collection) from January 1, 2009 to October 3, 2018. We searched for gray literature through PROSPERO, Scopus, and OpenGrey from January 1, 2009 to October 3, 2018. The start date for the searches was set as 2009 because the AARC concept was introduced in 2010. We also searched OpenThesis, British Library EThOS, and PROQUEST with no time limits.

Inclusion Criteria for the Review

We included articles if they: (a) reported quantitative data, including clinical trials, quasi-experimental studies with comparison groups, and cross-sectional and longitudinal observational studies; (b) explored the concept of AARC as defined by Diehl and Wahl (2010) and assessed AARC with one of the following measures: AARC-189, AARC-100, AARC-50 (Brothers et al., 2019), AARC-20 (Brothers et al., 2017; Neupert & Bellingtier, 2017), AARC-10 SF (Kaspar et al., 2019), AARC-32 (Wahl et al., 2013) or diaries (Miche et al., 2014) asking individuals to report their SA experiences in relation to the five behavioral domains described by Diehl and Wahl (2010); (c) investigated associations between AARC and one of the following outcomes: emotional well-being, physical well-being, or cognitive functioning; (d) used any self-rated, informant-rated and/or objective assessments of emotional and/or physical well-being or cognitive functioning; (e) were published from 2009 onwards; (f) were written in English or German; and (g) included only cognitively healthy adult participants (aged 18 years and older) or reported data for cognitively healthy participants separately.

Procedure

All citations identified in the searches were independently assessed for eligibility by two reviewers (S. Sabatini and B. Silarova), and any obviously ineligible titles were removed. At title level, all articles on SA were retained, because it was not possible to determine from titles whether studies focused on AARC or on another SA concept, given that in the SA literature authors often use different terms to refer to the same concept. The same reviewers (S. Sabatini and B. Silarova) then independently assessed the abstracts of the remaining articles. Any that clearly did not meet inclusion criteria were excluded. At abstract level, reviewers retained all articles that included a measure of AARC irrespective of whether outcome measures assessing emotional and/or physical well-being and/or cognitive functioning were listed in the abstract. This was to avoid excluding articles that assessed the association of AARC with emotional and/or physical well-being and/or cognitive functioning but did not report exploration of these associations in the abstract. The full-text version of all potentially eligible studies was assessed for suitability by two reviewers (S. Sabatini and B. Silarova). At every step, discrepancies between the first and second reviewers were resolved through discussion and the involvement of a third reviewer (R. Collins). Once full texts were identified, potential additional articles meeting inclusion criteria were sought through forward and backward searching of references of included articles.

We used a data extraction proforma to extract data from the articles included in the review. We extracted data covering study information (author, title, journal, year of publication, country of origin, funding sources, and language), study characteristics (study aims, design, inclusion/exclusion criteria, sample size, study period, recruitment, response rate, and follow-up times), participants' characteristics (age, gender, level of education, ethnicity, and health status), measure of AARC used, outcome measures, and results.

Where relevant data were unavailable, the authors of the study were contacted to request missing information. Additional information was sought for four articles. All authors replied and provided baseline bivariate correlations between AARC gains and AARC losses and physical well-being for these four articles included in the systematic review of which two were included in the meta-analysis. One author provided data for the association between AARC gains and AARC losses and emotional well-being, and the article was also included in the meta-analysis.

All data were extracted by the first reviewer (S. Sabatini). The second reviewer (B. Silarova) checked 30% of the extracted information. Disagreements between the reviewers were resolved through discussion. We calculated the percent agreement as a measure of inter-rater reliability. The methodological quality of included articles was assessed by the first author (S. Sabatini) using the Critical Appraisal Skills Programme (CASP) checklist for cohort studies (Critical Appraisal Skills Programme, 2018). Each item was scored as low, medium, or high and each article received an overall quality score ranging from low to high. Some articles received an overall quality score of medium to high as they included an equal number of items scored as medium and high.

Statistical Analysis

We conducted a random effects meta-analysis of cross-sectional findings following the procedure outlined by Borenstein, Hedges, Higgins, and Rothstein (2005), as the included studies employed different methods of assessing AARC and emotional and physical well-being, and included heterogeneous samples of middle-aged and older individuals. The random effects model estimates the magnitude of heterogeneity and incorporates this into the overall estimated effect (DerSimonian & Laird, 1986). Where multiple studies used data from the same cohort and reported findings based on the same emotional and/or physical well-being and AARC measures, we planned to include in the meta-analysis the articles reporting the largest sample size and longest follow-up duration. We used a standardized correlational direction and where necessary the direction was changed to facilitate cross-study comparisons. Estimated effect sizes ≤.09 were considered negligible, .10–.29 small, .30–.49 moderate, and ≥.50 large (Cohen, 1988). Between-study heterogeneity for each measure of emotional and physical well-being was assessed using an index of inconsistency (I^2; Higgins, Thompson, Deeks, & Altman, 2003). This statistic calculates a percentage of heterogeneity resulting from study differences that is not due to chance. Larger values indicate larger heterogeneity.

All computations were based on Fisher's *z* transformations and were conducted using the Comprehensive Meta-Analysis 2 (Borenstein et al., 2005) software package which calculated average *z* scores and *p* values, weighted effect *r* values, and 95% confidence intervals (CIs) for the collective effect sizes. One of the included studies (Kaspar et al., 2019) presented correlations between one measure of AARC and multiple measures of emotional and physical well-being. The software package was therefore instructed to average the multiple within-study correlations to correct for violations of independence. For all the remaining studies, only one correlation was reported per analysis. To visualize the amount of variation between the studies and an estimate of the overall effect size (Lewis & Clarke, 2001), we created forest plots using Forest Plot Viewer (Boyles, Harris, Rooney, & Thayer, 2011).

To address the risk of possible publication bias, where studies with nonsignificant findings are less likely to be published than those with significant findings, funnel plots and Egger's regression intercepts were calculated using Comprehensive Meta-Analysis 2. Funnel plots were used to visualize possible publication bias (Borenstein, Hedges, Higgins, & Rothstein, 2009) while Egger's test provides information about the degree of possible publication bias.

In total, we conducted four analyses. The first and second analyses investigated the association of emotional well-being with AARC gains and AARC losses, respectively. The third and fourth analyses investigated the association of physical well-being with AARC gains and AARC losses, respectively.

Results

After removing duplicates, we screened 814 titles, 125 abstracts, and 27 full-text articles. We excluded 17 articles at full-text screening as they either examined other SA constructs (*n* = 15), did not explore relevant outcomes (*n* = 1), or were theses where data had been published in an included journal article (*n* = 1). Ten full-text articles met the inclusion criteria for the systematic review. Inter-rater agreement at title, abstract, and full-text level was 94%, 90%, and 96%, respectively. Through forward and backward chasing of references, 2 more articles were identified, resulting in 12 articles being included in the review (Figure 1). Five studies (Brothers et al., 2017, 2019; Dutt et al., 2016a; Dutt, Gabrian, & Wahl, 2016b; Dutt & Wahl, 2019) were excluded from the meta-analysis as they reported data from the same cohort of included studies and reported findings based on the same outcome measures. One study (Miche et al., 2014) was excluded from the meta-analysis as it reported associations between emotional and physical well-being and overall AARC, instead of AARC gains and AARC losses. We included in the meta-analysis articles that explored emotional and/or physical well-being as main outcomes and/or as covariates. Six articles were included in the meta-analysis. Authors of the studies provided correlational data on the association
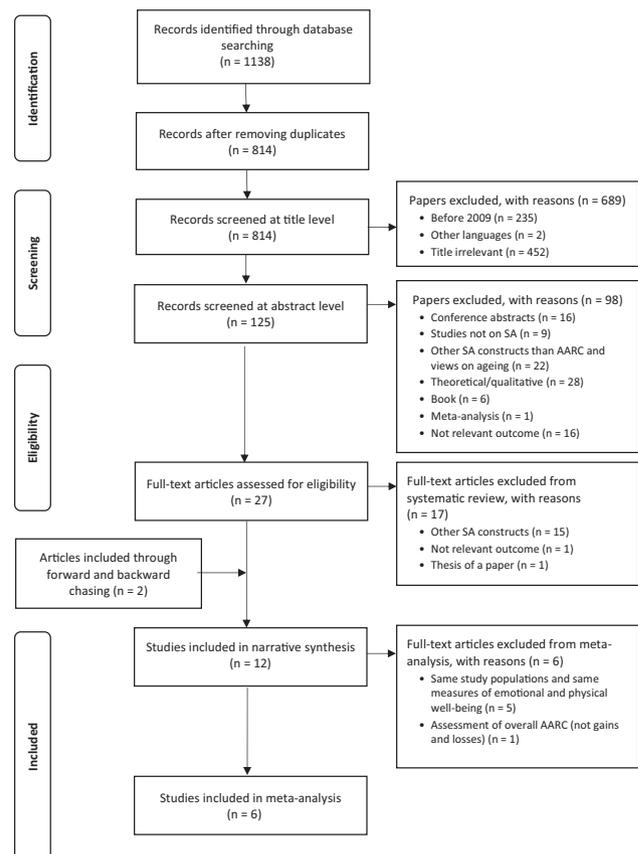

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2009 flow diagram.

between AARC and emotional well-being for one article and correlational data on the association between AARC and physical well-being for two articles.

Characteristics and Populations of Studies Included in the Systematic Review

A summary of the study characteristics, participants, AARC measures, and quality assessment is shown in Table 1 (further information is available from the corresponding author on request). Among the 12 articles included in the systematic review, 8 articles were cross-sectional and 4 were longitudinal. Two studies (Miche et al., 2014; Neupert & Bellingtier, 2017) took diary-based approaches, and for the present review, these were conceptualized as cross-sectional studies. One of these (Neupert & Bellingtier, 2017) included micro-longitudinal work (a 9-day study) exploring variability in the association between AARC and emotional well-being. We did not identify any clinical trials or quasi-experimental studies with comparison groups. Most participants were white females with above average levels of education and self-reported health. Six articles included German participants only, three included U.S. residents only, and three included both U.S. and German participants. Sample sizes ranged between 71 and 819. AARC, emotional well-being, and physical health were assessed using different measures across the included studies (Table 1).

Among the 12 articles included in the systematic review, 3 were judged as being of medium methodological quality, 5 were judged as being of medium-to-high methodological quality, and 4 were judged as being of high methodological quality. No study was of low methodological quality (details of the CASP are available in Table 1). Where articles were downgraded to medium and medium–high ratings, this was due to limited generalizability of study findings resulting from the specific composition of the sample.

The association between AARC and emotional well-being
In this review, we considered the term emotional well-being as an overarching concept (Lara et al., 2013) including concepts such as positive and negative affect (e.g., Bradburn, 1969), psychological well-being (e.g., Ryff & Keyes, 1995), life satisfaction, quality of life (e.g., Andrews & McKennell, 1980; Bryant & Veroff, 1982), and mental health (e.g., depression; Antaramian, Scott Huebner, Hills, & Valois, 2010).

Nine articles (Brothers, Gabrian, Wahl, & Diehl, 2016; Brothers et al., 2017; Dutt et al., 2016a; Dutt & Wahl, 2019; Dutt, Wahl, & Rupprecht, 2018; Kaspar et al., 2019; Miche et al., 2014; Neupert & Bellingtier, 2017; Wahl et al., 2013) explored the association between AARC and emotional well-being; five of these were included in the meta-analysis (Brothers et al., 2016; Dutt et al., 2018; Kaspar et al., 2019; Neupert & Bellingtier, 2017; Wahl et al., 2013). Among the five articles included in the meta-analysis, three (Brothers et al., 2016; Dutt et al., 2018; Kaspar et al., 2019) were combined as they were conducted with the same cohort but

explored associations of AARC with different measures of emotional well-being.

Below we describe first the associations between AARC gains and emotional well-being and then the associations between AARC losses and emotional well-being.

Overall, AARC gains were associated with better emotional well-being (r = .33; 95% CI 0.18, 0.47; p < .001; I^2 = 76.01, see Figure 2a). However, the strength of the association varied depending on the measure of emotional well-being and the cohort used in the study. For example, AARC gains were significantly associated with some indicators of emotional well-being such as satisfaction with life (Brothers et al., 2017; Wahl et al., 2013) and psychological well-being (Brothers et al., 2016) while the results for other indicators such as depressive symptoms (Dutt et al., 2016a, 2018; Dutt & Wahl, 2019; Kaspar et al., 2019) were mixed. The study that found a significant association between AARC gains and depressive symptoms involved analysis of data from a sample of participants aged 80 or older (Kaspar et al., 2019), while the studies (Dutt et al., 2016a, 2018; Dutt & Wahl, 2019) that did not find a significant association between AARC gains and depressive symptoms were conducted with a sample of participants aged between 40 and 96 years. In addition, a study (Miche et al., 2014) that explored the concept of AARC through the use of daily diaries found that positive aging experiences in the cognitive domain were associated with positive affect. The funnel plot (Supplementary Figure 1) suggests some indication of publication bias and therefore the effect sizes of included studies may be slightly inflated. However, Egger's test indicates that the publication bias was not statistically significant (b = 7.27; 95% CI −35.30, 49.84; p < .138).

All nine articles (Brothers et al., 2016, 2017; Dutt et al., 2016a, 2018; Dutt & Wahl, 2019; Kaspar et al., 2019; Miche et al., 2014; Neupert & Bellingtier, 2017; Wahl et al., 2013) that explored the association between AARC losses and emotional well-being found an association between higher levels of AARC losses and lower levels of emotional well-being. Of the nine articles exploring the association between AARC losses and emotional well-being, five were included in the meta-analysis (Brothers et al., 2016; Dutt et al., 2018; Kaspar et al., 2019; Neupert & Bellingtier, 2017; Wahl et al., 2013). AARC losses were found to be associated with lower emotional well-being (r = −.31; 95% CI −0.38, −0.24; p < .001; I^2 = 0.00; see Figure 2b). Findings from a micro-longitudinal study exploring variability in the association between AARC and emotional well-being indicated that individuals who reported daily increases in AARC losses also experienced concomitant increases in negative affect (Neupert & Bellingtier, 2017). There was no evidence of heterogeneity, suggesting that the estimated effect size between AARC losses and emotional well-being was reliable; there was also no indication of publication bias (Figure 2b) and Egger's test was not statistically significant (b = −2.67; 95% CI −12.86, 7.51; p < .093).

Table 1. Characteristics of Studies Included in the Review

	Study characteristics			Population characteristics			Exposure: AARC measure	Measures Outcome	Study quality (CASP)
Author	Study cohort	Study design	N in analysis	Age, M (SD), range in years	Women (%)			
Brothers et al. (2016)	Cohort of adults from the United States and Germany aged 40–98 (Diehl and Wahl as principal investigators)	Longitudinal (2.5 years)	Baseline N = 819; 2.5-year follow-up N = 537	64.13 (12.85), 40–98	63.3	AARC-50	(1) *Emotional well-being:* SPWB-SF (Ryff & Keyes, 1995). (2) *Physical well-being:* Self-rated health through a single-item question (Sargent-Cox, Anstey, & Luszcz, 2012).	Medium
Brothers et al. (2017)		Cross-sectional analysis	N = 819	64.13 (12.85), 40–98	63.3	AARC-189	(1) *Physical well-being:* SF-36v2 (Ware et al., 2007). (2) *Emotional well-being:* SWLS (Glaesmer, Grande, Braehler, & Roth, 2011).	Medium–High
Kaspar et al. (2019)		Cross-sectional analysis	N = 819	64.13 (12.85), 40–98	60	AARC-50; AARC-10 SF	(1) *Physical well-being:* (a) SF-36v2 (Ware et al., 2007). (b) Subjective health through a single-item question. (2) *Emotional well-being:* (a) SWLS (Diener, Emmons, Larsen, & Griffin, 1985). (b) SPWB-SF (Ryff & Keyes, 1995). (c) CES-D-R10 (Baron, Davies, & Lund, 2017).	High
Brothers et al. (2019)	Cohort of adults from the United States and Germany aged 40–98 (Diehl and Wahl as principal investigators)	Cross-sectional analysis	N = 424	69.53 (12.52), 42.15–98.49	52.4	AARC-50	(1) *Physical well-being:* self-rated health through a single-item question.	High
Dutt et al. (2016a)	Cohort of adults from the United States and Germany aged 40–98 (Diehl and Wahl as principal investigators)	Longitudinal (2.5 years)	Baseline N = 423; 2.5-year follow-up N = 356	Baseline 62.94 (11.84), 40–98	Baseline 64	AARC-50	(1) *Emotional well-being:* CES-D (Radloff, 1977). (2) *Physical well-being:* SF-36-German version (Bullinger, 1995).	Medium–High
Dutt et al. (2016b)		Cross-sectional	N = 356	64.04 (11.38), 42–100	65	AARC-50	(1) *Physical well-being:* SF-36-German version (Bullinger, 1995).	High
Neupert and Bellingtier (2017)	Mindfulness and Anticipatory Coping Everyday study (United States)	Micro-longitudinal (9 days)	N = 116	64.71 (4.98), 60–90	61	AARC 20-item version	(1) *Emotional well-being:* PNAS (Watson, Clark, & Tellegen, 1988).	Medium

Table 1. Continued

	Study characteristics			Population characteristics					Measures		
Author	Study cohort	Study design	N in analysis	Age, M (SD), range in years	Women (%)			Exposure: AARC measure	Outcome		Study quality (CASP)
Wahl et al. (2013)	Cohort from the project "awareness of age-related change: a cross-cultural collaboration"	Cross-sectional	N = 265	64 (11), 40–87	69			AARC 32-item version	(1) *Emotional well-being*: SWLS-German version (Diener et al., 1985). (2) Physical well-being: subjective health through a single-item question.		High
Dutt and Wahl (2019)	Cohort of adults from the United States and Germany aged 40–98 (Diehl and Wahl as principal investigators)	Longitudinal (4.61 years)	Baseline N = 423; 4.61-year follow-up N = 299	Baseline 62.94 (11.84), 40–98	64			AARC-50	(1) *Emotional well-being*: CES-D (Radloff, 1977). (2) *Physical well-being*: Sf-36-German version (Bullinger, 1995).		Medium–High
Dutt et al. (2018)	Cohort of adults from the United States and Germany aged 40–98 (Diehl and Wahl as principal investigators)	Longitudinal (4.61 years)	Baseline N = 423; 2.5-year follow-up N = 356; 4.61-year follow-up N = 299	Baseline aged 40–98 (M = 62.94, SD = 11.84 years)	64			AARC-50 losses subscale	(1) *Emotional well-being*: CES-D (Radloff, 1977). (2) *Physical well-being*: SF-36-German version (Bullinger, 1995).		Medium–High
English et al. (2019)	Mindfulness and Anticipatory Coping Everyday study (United States)	Cross-sectional	N = 296	64.67 (4.36)	50			AARC-20	(1) *Physical well-being*: Chronic condition checklist (Ryff & Keyes, 1995).		Medium
Miche et al. (2014)	BEWOHNT study (Germany)	Cross-sectioal analysis (14 days)	N = 225	70–89	Not stated			Diary-based reports of SAEs in the five domains of behavior and functioning suggested by Diehl and Wahl (2010).	(1) *Physical well-being*: SF-LLFDI (Denkinger, Weyerhäuser, Nikolaus, & Coll-Planas, 2009). (2) PNAS (Watson et al., 1988).		Medium

Note: AARC = awareness of age-related change; CASP = Critical Appraisal Skills Programme; CES-D = The Center for Epidemiologic Studies Depression Scale; CES-D-R10 = The Center for Epidemiologic Studies Depression Scale Revised 10-item short form; PNAS = Positive and Negative Affect Scale; SAE = Subjective Aging Experiences; SF-36V2 = Short-Form 36 Health and Well-being Questionnaire, version 2; SF-LLFDI = Function Component of the abbreviated Late Life Function and Disability Instrument; SPWB-SF = Scales of Psychological Well-Being; SWLS = Satisfaction With Life Scale.
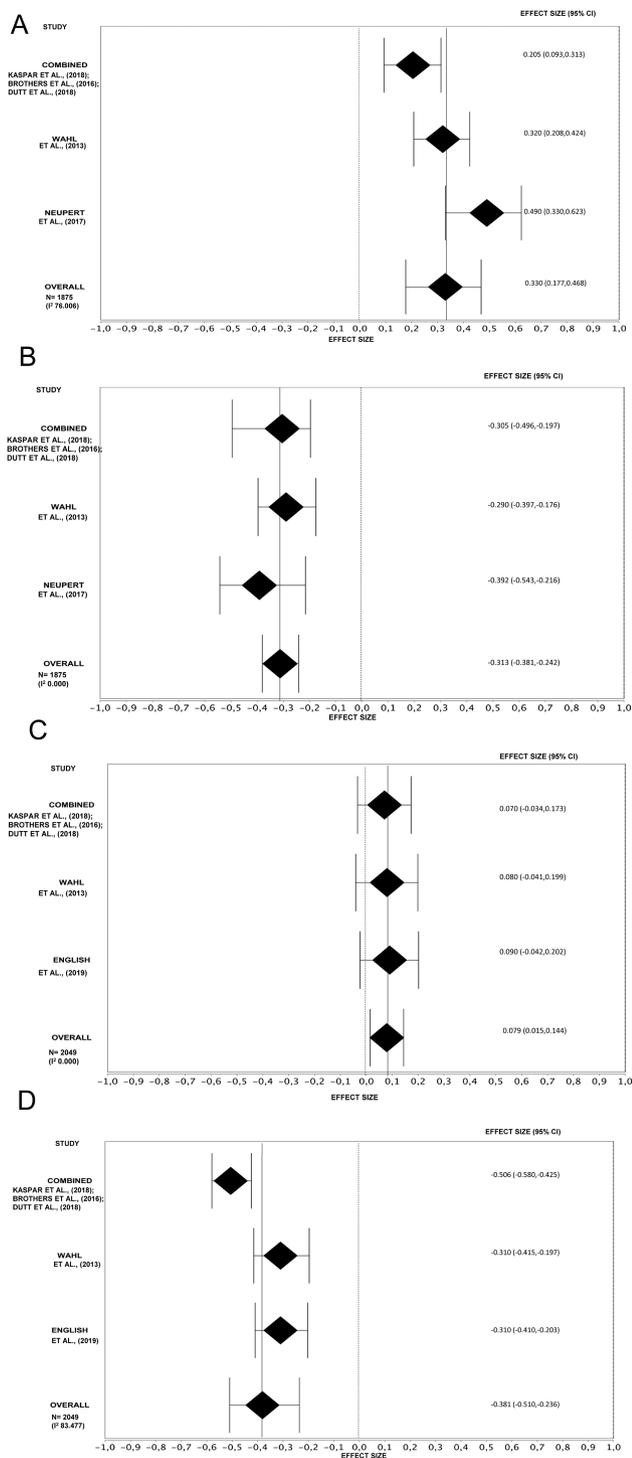
Figure 2. Forest plot of the associations between awareness of age-related change (AARC) (gains and losses) and measures of emotional and physical well-being. (a) Forest plot of the associations between AARC gains and measures of emotional well-being. (b) Forest plot of the associations between AARC losses and measures of emotional well-being. (c) Forest plot of the associations between AARC gains and measures of physical well-being. (d) Forest plot of the associations between AARC losses and measures of physical well-being. Combined = effect sizes of Kaspar et al. (2019), Brothers et al. (2016), and Dutt et al. (2018) were combined; Overall = overall effect size of the five studies included in the meta-analysis.

The association between AARC and physical well-being

In this review, we considered the term physical well-being as an overarching concept including several constructs that provide information about the physical well-being of participants such as perceived-health, presence of chronic illnesses, and ability to carry out instrumental activities of daily living (Huber et al., 2016).

Eleven articles (Brothers et al., 2016, 2017, 2019; Dutt et al., 2016a, 2016b, 2018; Dutt & Wahl, 2019; English, Bellingtier, & Neupert, 2019; Kaspar et al., 2019; Miche et al., 2014; Wahl et al., 2013) explored the association between AARC and physical well-being. Out of these 11 articles, 5 were included in the meta-analysis (Brothers et al., 2016; Dutt et al., 2018; English et al., 2019; Kaspar et al., 2019; Wahl et al., 2013). Among the five articles included in the meta-analysis, three (Brothers et al., 2016; Dutt et al., 2018; Kaspar et al., 2019) were combined as they were conducted with the same cohort but explored associations of AARC with different measures of physical well-being. Below we describe first the associations between AARC gains and physical well-being, and then the associations between AARC losses and physical well-being.

AARC gains were not significantly associated with physical well-being ($r = .08$; 95% CI 0.02, 0.14; $p < .122$; $I^2 = 0.00$; see Figure 2c). While the majority of the included studies did not find an association between AARC gains and physical well-being (Brothers et al., 2016, 2017; Dutt et al., 2016a, 2016b, 2018; Dutt & Wahl, 2019; English et al., 2019; Kaspar et al., 2019; Wahl et al., 2013), one study did find an association (Brothers et al., 2019). There was no evidence of heterogeneity, suggesting that the estimated effect size between AARC gains and physical well-being was reliable. Funnel plots (Supplementary Figure 1) suggested some evidence of publication bias; however, Egger's test indicated that this was not statistically significant ($b = 1.53$; 95% CI –21.88, 24.93; $p < .280$).

All 11 articles found an association between higher levels of AARC losses and poorer physical health. The meta-analysis indicated that AARC losses were associated with lower physical well-being ($r = -.38$; 95% CI –0.51, –0.24; $p < .001$; $I^2 = 83.48$; see Figure 2d). There was a large degree of heterogeneity, suggesting that the estimated effect size may not be reliable. Funnel plots (Supplementary Figure 1) indicated no publication bias and Egger's test was not statistically significant ($b = 30.74$; 95% CI –128.18, 189.65; $p < .123$).

The association between AARC and cognitive functioning
We found no studies that explored the association between AARC and cognitive functioning.

Discussion

This is the first systematic review and meta-analysis to explore the evidence on AARC gains and losses, and their associations with emotional and physical well-being and

cognitive functioning, among cognitively healthy adults. Findings suggest that overall, there are moderate associations between higher levels of AARC gains and better emotional well-being, but different indicators of emotional well-being may have different associations with AARC gains. There is some evidence that higher levels of AARC losses are associated with lower emotional well-being. Results for AARC and physical well-being are equivocal. While there is a negligible association between AARC gains and physical well-being, there is a moderate association between higher levels of AARC losses and poorer physical well-being. No study explored the association between AARC and cognitive functioning.

The moderate association between AARC gains and some indicators of emotional well-being, such as satisfaction with life and psychological well-being, suggests that higher levels of AARC gains may be important for a general positive emotional state. The association between AARC gains and emotional well-being is in line with the broader literature on SA (Bryant et al., 2012). Similarly, the empirical literature on other concepts of SA indicates that there is an association between more positive SA and better emotional well-being, including lower depressive symptoms (Kavirajan et al., 2011; Stephan, Sutin, Caudroit, & Terracciano, 2016). However, our systematic review indicates that the results for AARC gains and depressive symptoms are mixed, and this may be explained by the differing age profiles of participants in the relevant studies. Our results suggest that AARC gains may be a protective factor against depressive symptoms only for individuals aged 80 and older (Kaspar et al., 2019), and may not play a preventive role against depressive symptoms among younger individuals (Dutt et al., 2016a, 2018; Dutt & Wahl, 2019). As the experience of AARC losses increases with age (e.g., Dutt et al., 2018) and AARC losses are associated with depressive symptoms (Dutt et al., 2016a), it may be that the presence of AARC gains in those age groups that are likely to experience high levels of AARC losses buffers the negative effect of AARC losses, resulting in lower levels of depressive symptoms. However, it may also be possible that while AARC plays a role in overall emotional well-being, other aspects of SA such as felt age and attitudes toward own aging may play a more important role in specific mental health conditions, including depressive symptoms (Kwak, Ingersoll-Dayton, & Burgard, 2014; Stephan et al., 2016).

The moderate association between AARC losses and emotional well-being suggests that higher levels of AARC losses are associated with lower levels of emotional well-being. These findings are also in line with the literature on SA which indicates that negative SA predicts the onset and persistence of depression (Freeman et al., 2016; Wurm & Benyamini, 2014). High levels of AARC losses may increase reflection on mortality (Greenberg, Pyszczynski, & Solomon, 1986) and awareness of limited time to live (Brothers et al., 2016) which may facilitate depressive ideation. Empirical literature that explores the way in which individuals perceive their future (Carstensen,

1993) suggests that the emotional well-being of individuals with high levels of AARC losses may be improved by interventions promoting ego-integrity and engagement in fulfilling relations (Westerhof, Bohlmeijer, & McAdams, 2015). Moreover, as the empirical literature shows how several constructs (e.g., mindful attitude) impact on the association between AARC losses and mental health outcomes (Dutt et al., 2018; Dutt & Wahl, 2019), positive emotional well-being could be promoted through mindfulness-based interventions that teach individuals to accept age-related changes and be compassionate toward themselves (Collins & Kishita, 2018; Phillips & Ferguson, 2013; Xu, 2018).

Overall, the association between AARC gains and physical well-being was negligible. This is not consistent with the broader literature on SA which shows that more positive SA is associated with better physical health (Bryant et al., 2012; Kavirajan et al., 2011). The inconsistency found between AARC gains and other SA constructs with regard to physical well-being may be due to AARC being the first concept that separates measurement of gains and losses. This makes it possible to assess the coexistence of AARC gains and losses, whereas other SA concepts are bimodal. It may therefore be that individuals with higher levels of AARC gains do not report better physical health because of the coexistence of high levels of AARC losses. The interplay between AARC gains and AARC losses may be an area of interest for future research.

The negligible association between AARC gains and physical well-being may suggest that when promoting good physical health in older individuals, enhancing experiences of AARC gains may be less useful than targeting AARC losses. However, this interpretation must remain cautious due to the small proportion of individuals with low physical health included in the available studies exploring the association between AARC and physical health. Moreover, associations between AARC gains and physical well-being may emerge over longer time periods than those observed in the included studies.

From the review, only one study found an association between AARC gains and physical well-being (Brothers et al., 2019) and this may be due to the specific sample of participants or to cultural differences. Indeed this study was conducted with a sample of U.S. residents while the remaining studies that investigated the association between AARC gains and self-rated health were conducted either in German samples (Dutt et al., 2016a, 2016b, 2018; Dutt & Wahl, 2019; Wahl et al., 2013) or in combined German and U.S. samples (Brothers et al., 2016, 2017; Kaspar et al., 2019). The different finding of Brothers et al. (2019) may be due to cultural differences, as U.S. individuals have a more optimistic response pattern on AARC questionnaires compared to German individuals (Brothers et al., 2016). Country-specific differences exist also for other SA concepts and their associations with health outcomes (e.g. Westerhof & Barrett, 2005).

The moderate association between higher levels of AARC losses and lower levels of self-rated health is also

in line with the SA literature (Levy, 2003; Robertson et al., 2015) and this association may be due to lower engagement in health-related behaviors by individuals with less positive SA (Levy & Myers, 2004). Individuals with high levels of AARC losses may perceive their age-related changes as physically limiting and as a consequence they may be more likely to reduce engagement in certain health-related behaviors (e.g., physical activity, social relations and hobbies) rather than adapting their behavior according to age-related changes (Dutt et al., 2016b). Individuals with high AARC losses may therefore benefit from interventions helping them to cope with negative changes and identify new goals to compensate for age-related changes (Baltes, 1997; Brandtstädter & Rothermund, 2002).

Only two studies (English et al., 2019; Miche et al., 2014) included in the systematic review reported significant associations between AARC and more objective indicators of physical well-being, such as functional health and the presence of chronic health conditions. In contrast, the remaining studies assessed self-rated health as an indicator of physical well-being. The use of measures of self-rated health as indicators of objective health has been questioned, as existing empirical evidence shows that self-rated health remains stable despite declines in physical and functional health (Jylhä, Guralnik, Balfour, & Fried, 2001). Future research could further explore whether the association between AARC losses and physical well-being remains moderate when using more objective indicators of physical well-being. Research on the association between AARC and objective indicators of physical well-being, such as the presence of chronic conditions, may suggest ways of promoting physical health in older age.

None of the studies included in the systematic review and meta-analysis reported associations between AARC and indicators of cognitive functioning. As subjective cognitive decline is considered to be an indicator of future cognitive decline (Jessen et al., 2014), it may be that individuals' AARC in relation to their cognitive abilities reflects actual cognitive changes. Future research could therefore investigate whether AARC gains and losses are associated with objective measures of cognitive functioning. This would provide knowledge on whether individuals' AARC related to cognition is informative in relation to subtle cognitive changes, and hence whether AARC could be used as an indicator of possible cognitive decline.

Lack of investigation of the association between AARC and cognitive functioning was unexpected. Indeed, other SA concepts, such as attitudes toward own aging and age stereotypes, have been explored in relation to cognitive functioning, and support the predictive role of positive SA in relation to better cognitive functioning (Levy et al., 2002; Opdebeeck, Yates, Kudlicka, & Martyr, 2019; Robertson et al. 2015, 2016) and lower risk of Alzheimer's-like neuropathology (Levy et al., 2016). Studying whether AARC gains and losses predict future cognitive abilities may suggest ways of promoting maintenance of cognitive health in older people.

The interpretation of the results of this systematic review and meta-analysis has to be considered in light of its limitations. For example, among studies included in the systematic review, only two assessed physical well-being with objective instruments. The presence of recall bias in subjective measures is well documented, making it difficult to interpret results related to subjective evaluations of physical health and other domains (Althubaiti, 2016). However, the majority of studies used valid and reliable measures of AARC and emotional well-being. Next, the generalizability of study results is limited as the included studies explored the associations between AARC and emotional well-being and/or physical well-being in four cohorts including mainly white participants, with a majority of women, residing either in the United States or in Germany, with above average education and self-reported health. This highlights a gap in knowledge as levels of AARC are unknown for those individuals who are less educated, have poor physical health status, and reside outside Germany or the United States, and whose ethnicity is not white.

In addition, only four studies explored the longitudinal associations of AARC with emotional well-being and/or physical well-being. Longitudinal studies followed participants for between 2.5 and 4.5 years. Even though 2.5 and 4.5 years may be long enough to detect changes in levels of AARC (gains and losses) in older and very old participants, associations of AARC with emotional well-being and physical well-being in younger participants may need to be explored in studies with longer follow-up periods. Among the SA literature, studies with longer follow-ups found that positive SA predicts both better physical health and emotional health (e.g., 23-year follow-up; Levy et al., 2002; Stephan, Caudroit, & Chalabaev, 2011); hence the association between AARC gains and physical health may need to be explored with longer longitudinal studies.

A further limitation of the meta-analysis is the inclusion of only cross-sectional associations of AARC with emotional and/or physical well-being, making it difficult to establish the direction of associations. However, this was the most appropriate approach as only two (Brothers et al., 2016; Dutt et al., 2018) of the six studies included in the meta-analysis were longitudinal. Another limitation of the meta-analysis lies in the between-study heterogeneity for the associations between AARC gains and emotional well-being and between AARC losses and physical well-being. This indicates that the studies included in the meta-analysis found different effects for the association between AARC gains and emotional well-being and between AARC losses and physical well-being; hence the estimated effects for these associations should be interpreted with caution. Further research in this area could help to determine the actual effect that physical and emotional well-being exerts on AARC. The high heterogeneity observed in the meta-analysis for the associations between AARC gains and emotional well-being and AARC losses and physical

well-being may be explained by the use of diverse measures to assess emotional and physical well-being. For the association between AARC gains and emotional well-being, there was evidence of possible publication bias even though this was not statistically significant. Therefore, it might be that the observed effects for the association between AARC gains and emotional well-being are slightly inflated.

Among the key strengths of this systematic review and meta-analysis is the comprehensive search that covered a wide number of databases including peer-reviewed journal articles and gray literature. Searching gray literature allowed us to seek out ongoing work on AARC that has not yet been published in peer-reviewed journals, and facilitated identification of one of the articles included in the review. Searching gray literature was of particular importance as the concept of AARC is relatively new (Diehl & Wahl, 2010) and interest in the topic of AARC is increasing. During article screening, reviewers screened all abstracts relevant to SA and all full-text versions of quantitative studies on AARC independently of the outcomes mentioned in the abstract, thus increasing the likelihood of identifying all relevant articles, including those assessing emotional and/or physical well-being as covariates.

Conclusion

The moderate effect sizes we found for the associations of AARC gains and AARC losses with emotional well-being, and of AARC losses with physical well-being, indicate that AARC gains and losses can play a role in emotional well-being and that AARC losses are associated with physical well-being. However, these results are limited due to the specific characteristics of the participants included in the available studies, indicating a need for future research to include more diverse samples outside the United States and Germany. We identified several gaps in the literature: the association of AARC gains and losses with cognitive functioning has not been explored; there have been only a few longitudinal studies exploring the role of AARC in relation to emotional and physical well-being, and these may not be of sufficient length; there have been no trials of interventions based on AARC; and AARC has mainly been explored in association with self-reported measures of well-being rather than objective indicators. Further exploration of the AARC concept may be useful in suggesting ways of promoting good emotional and physical well-being, and preventing poor emotional and physical well-being, in older age.

Supplementary Material

Supplementary data are available at *The Gerontologist* online.

Acknowledgment

Funding

Conflicts of Interest

None reported.

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