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DOES VISUAL IMPAIRMENT AFFECT SOCIAL TIES IN LATE LIFE? FINDINGS OF A MULTICENTER PROSPECTIVE COHORT STUDY IN GERMANY

A. HAJEK[1], C. BRETTSCHNEIDER[1], D. LÜHMANN[2], M. EISELE[2], S. MAMONE[3], B. WIESE[3], S. WEYERER[4], J. WERLE[4], M. PENTZEK[5], A. FUCHS[5], J. STEIN[6], T. LUCK[6], H. BICKEL[7], D. WEEG[7], K. HESER[8], F. JESSEN[9,10], W. MAIER[8,10], M. SCHERER[2], S.G. RIEDEL-HELLER[6*], H.-H. KÖNIG[1*], FOR THE AGECODE STUDY GROUP

1. Department of Health Economics and Health Services Research, Hamburg Center for Health Economics, University Medical Center Hamburg-Eppendorf, Germany; 2. Department of Primary Medical Care, Center for Psychosocial Medicine, University Medical Center Hamburg-Eppendorf, Germany; 3. Institute of General Practice, Hannover Medical School, Germany; 4. Central Institute of Mental Health, Medical Faculty Mannheim/Heidelberg University, Germany; 5. Institute of General Practice, Medical Faculty, Heinrich-Heine-University Düsseldorf, Germany; 6. Institute of Social Medicine, Occupational Health and Public Health, University of Leipzig, Germany; 7. Department of Psychiatry, Technical University of Munich, Germany; 8. Department of Psychiatry, University of Bonn, Germany; 9. Department of Psychiatry and Psychotherapy, University of Cologne, Germany; 10. German Center for Neurodegenerative Diseases (DZNE), Germany; * These authors contributed equally to this work. Corresponding author: Dr. André Hajek, University Medical Center, Hamburg-Eppendorf, Department of Health Economics and Health Services Research, Hamburg Center for Health Economics, Telephone +49 40 7410 52877; Fax +49 40 7410 40261, E-mail: a.hajek@uke.de

Abstract: *Objective:* To investigate how visual impairment affects social ties in late life longitudinally. *Design:* Population-based prospective cohort study. *Setting:* Individuals in old age were recruited via general practitioners' offices (at six study centers) in Germany. They were interviewed every 18 months. *Participants:* Individuals aged 75 years and above at baseline. Follow-up wave 2 (36 months after baseline, n=2,443) and wave 4 (72 months after baseline, n=1,618) were used for the analyses presented here. *Measurements:* Social ties were assessed using the 14-item form of the questionnaire for social support (F-SozU K-14). Visual impairment was self-rated on a three level Likert scale (no impairment, mild visual impairment, or severe/profound visual impairment). *Results:* Adjusting for sociodemographic factors, hearing impairment and comorbidity, fixed effects regressions revealed that the onset of mild visual impairment decreased the social support score, in particular the emotional support score. Additionally, the onset of mild hearing impairment decreased the social support score in men. Moreover, increasing age decreased the social support score in the total sample and in both sexes. Loss of spouse and increasing comorbidity did not affect the social support score. *Conclusion:* Our results highlight the importance of visual impairment for social ties in late life. Consequently, appropriate strategies in order to delay visual impairment might help to maintain social ties in old age.

Key words: Visual impairment, social support, older people, longitudinal study.

Introduction

According to the World Health Organization (1) 285 million people are visually impaired worldwide (including 39 million who are totally blind), with 65% of those patients aged 50 and over. Furthermore, visual impairment is associated with a tremendous financial burden (2, 3). Moreover, visual impairment is associated with numerous adverse health-related outcomes including decreased quality of life (4), functional impairment (5-7) or worsened mental health (8, 9) in old age. Visual impairment also has serious effects on health of partners (10). It is assumed that the number of individuals with visual impairment in late life will markedly increase in the next decades due to demographic shifts (11).

Since visual impairment in late life might affect mobility or social engagement (e.g. in a club), it is conceivable that visual impairment has an impact on social ties in late life. Eventually, the loss of social ties might result in loneliness and social exclusion. It is well known that decreased social ties are associated with numerous health variables such as decreased health-related quality of life (12), cognitive impairment (13) or mortality (14).

Associations between visual impairment and decreased social ties in late life have mostly been found cross-sectionally (15-18). Thus far, only one study (19) examined the effect of visual impairment on social support in old age by using longitudinal data: By using a prospective age-homogenous, community-dwelling cohort, Jacobs et al. found that, cross-sectionally, visually impaired individuals showed increased loneliness. However, visual impairment at baseline (age 70) did not significantly predict subsequent loneliness (7 years later). Yet, this study used visual impairment at baseline to predict subsequent social ties. Therefore, this study could not account for changes in the baseline characteristics. Consequently, it is unknown how changes in visual impairment affect social ties in late life. We hypothesize that the onset of visual impairment in late life increases the tendency to avoid social relations, which ultimately might result in an increased risk of social isolation and loneliness.

In this manuscript, we aimed at examining how changes in visual impairment affect social ties in late life by using a panel data method (fixed effects (FE) regressions). This knowledge is important to obtain insights into the causal relationship between visual impairment and social ties in old age. In turn, developing interventional strategies (20) to postpone visual impairment in old age might be a fruitful approach in order to maintain social

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ties in late life.

Methods

Sample

Data from the German Study on Ageing, Cognition and Dementia in Primary Care Patients (AgeCoDe) were used. It is a multicenter prospective cohort study. General practitioners' offices recruited the individuals in six study centers (Leipzig, Hamburg, Dusseldorf, Mannheim, Bonn and Munich) in Germany in 2003/2004 (baseline, n=3,327). Since then, individuals as well as their proxies were interviewed by trained staff every 1.5 years. Individuals were included if they met the following inclusion-criteria at baseline: (a) aged 75 years and over, (b) lack of dementia and (c) at least one contact with the general practitioner during the last 12 months. Individuals were excluded if they met at least one of the following criteria at baseline: insufficient knowledge of the German language, consultations only via home visits, residence in a nursing home, severe illness the general practitioner would deem fatal within 3 months, deafness, blindness, lack of ability to provide informed consent and being an irregular patient of the participating practice. Luck et al. (21) provided more details regarding the sampling frame. Main reasons for lack of follow-up data (follow-up wave 1-2) were refused participation and death. Since our outcome variable was assessed in follow-up wave 2 and 4, only follow-up wave 2 (36 months after baseline, n=2,443) and wave 4 (72 months after baseline, n=1,618) were used for the analyses presented here. Main reasons for lack of follow-up data (follow-up wave 2-4) were refused participation (n=310) and death (n=347).

Compared to individuals with complete data, individuals dropped out between follow-up wave 2 and 4 were initially older, had a lower social support and a higher comorbidity score. Moreover, they were more severely impaired according to hearing and visual impairment. However, the status was not significantly associated with family and living situation (results are not shown, but are available upon request from the authors).

The study has been approved by the local ethics boards of all participating centers and written informed consent was obtained from all individuals. The research followed the tenets of the Declaration of Helsinki.

Social support

To quantify social support the 14-item short form of the questionnaire for social support (F-SozU K-14) by Fydrich et al. (22, 23) was used from follow-up wave 2 onwards. It can be considered as a reliable (Cronbach's a = 0.94, 1-week test–retest reliability r = 0.96) and valid scale. To account for possible cognitive impairment in old age individuals, the items were dichotomized (no; yes). Examples are: "I know several people with whom I like to do things", "I have some friends/relatives with whom I can be quite playful" or "There are people who accept me the way I am without reservations". The social support score was calculated by taking the sum of the 14 items (higher scores indicating increased levels of social support). The score was used as a metric.

Additionally, the three subscales of the F-SozU K-14 questionnaire were used: emotional support, practical support, and social integration. These subscales reflect different types of social support. In the 'additional models' section, the three subscales were examined independently. The sum scores were created by using the aforementioned procedure.

Independent variables

The grade of visual impairment was assessed by using a self-reported scale (with optical aid if necessary) with "no impairment" (Ref.), "mild visual impairment" and "severe/profound visual impairment". Hearing impairment (Ref.: no impairment, mild hearing loss, and severe/profound hearing loss) was assessed analogously.

Comorbidity was also included. For this purpose, the general practitioner assessed the presence/absence of 28 chronic conditions: Diabetes, hypertension, cardiac arrhythmia, coronary heart disease, myocardial infarction, hyperlipidemia, hypercholesteremia, chronic heart failure, peripheral arterial disease, Parkinson's disease, epilepsy, depression, alcohol abuse, stenosis, transient ischaemic attack, stroke, hyperthyroidism, hypothyroidism, renal insufficiency, chronic liver disease, traumatic brain injury, back pain, arthrosis, obesity, gout, varicose veins, chronic obstructive pulmonary disease, asthma and gastritis. The chronic illnesses were rated by the general practitioner from 1 (mild) to 4 (severe) if the condition was present. We created a weighted sum score by summing the severity ratings for chronic conditions as present. Therefore, the severity of the chronic conditions was taken into consideration.

As for sociodemographic variables, age, gender and education were used. Education was measured by using the CASMIN (24) classification with primary, secondary and tertiary education. Moreover, family status was used with "married" as reference category and "others" including "single", "widowed" and "divorced". Furthermore, living situation was used with "living alone in private household" as reference category and "others" including "living with spouse/partner", "living with other relatives", "living in nursing home", "assisted living", "living in retirement home" and "other". It is worth mentioning that education and living situation were solely used for descriptive purposes.

Statistical analysis

Time-constant unobserved heterogeneity is a main challenge in regression analysis. Under the assumption that time-constant unobserved factors (such as personality, genetic disposition, optimism) are systematically correlated with the predictors, pooled ordinary least squares (OLS) regressions provide inconsistent estimates. The same is true for random effects (RE) regressions (25). Contrarily, linear FE regressions provide

Table 1
Sample characteristics at follow-up wave 2 (n=2,443) and follow-up wave 4 (n=1,618)

Variables	Follow-up wave 2	Follow-up wave 4	p-value (chi²-tests or t-tests whenever appropriate)
Age: Mean (standard deviation, 95% confidence interval)	82.6 (±3.4, 82.5-82.7)	85.4 (±3.2, 85.2-85.6)	<.001
Gender: number (%)			not significant
Female	1,612 (66.0)	1,083 (66.9)	
Male	831 (34.0)	535 (33.1)	
Education: number (%)			not significant
Primary	1,487 (60.9)	942 (58.2)	
Secondary	674 (27.6)	481 (29.7)	
Tertiary	282 (11.5)	195 (12.1)	
Family status: number (%)			<.001
Married	938 (38.5)	533 (33.0)	
Others	1,500 (61.5)	1,084 (67.0)	
Living alone in own household: number (%)			<.001
No	1,207 (49.4)	808 (50.0)	
Yes	1,236 (50.6)	809 (50.0)	
Visual impairment: number (%)			<.001
No visual impairment	1,925 (79.0)	1,160 (71.7)	
Mild visual impairment	375 (15.4)	320 (19.8)	
Severe/profound visual impairment	138 (5.6)	137 (8.5)	
Hearing impairment: number (%)			<.001
No hearing impairment	1,491 (61.2)	872 (53.9)	
Mild hearing loss	876 (35.9)	666 (41.2)	
Severe/profound hearing loss	71 (2.9)	79 (4.9)	
Morbidity (weighted count score): Mean (standard deviation, 95% confidence interval)	4.5 (±3.9, 4.3-4.7)	4.5 (±3.8, 4.3-4.7)	not significant
Social support: Mean (standard deviation, 95% confidence interval)	12.3 (±2.5, 12.2-12.4)	11.9 (±2.7, 11.8-12.0)	p<.001

consistent estimates under the aforementioned assumption (under the assumption of strict exogeneity). The FE-estimator is also called 'within-estimator' because only within-variations over time are taken into account.

Generally, panel regression models can be written as (26):

$Y_{it} = \alpha_i + \beta X_{it} + \gamma_i W_i + \lambda_t + \varepsilon_{it}$, i=1, …, N: units (persons); t=1,…, T: time

W_i are constant observed characteristics of individual units, whereas λ_t are factors changing over time (constant across individuals). While time-dependent predictors are denoted as X_{it}, the time-dependent outcome measure is denoted as Y_{it}. Furthermore, the time-dependent idiosyncratic errors are denoted as ε_{it}. FE regression analysis uses within-transformed data to estimate the aforementioned equation from variation in observed predictors and dependent variable (within individuals over time):

$Y_{it} - \overline{Y}_i = \beta(X_{it} - \overline{X}_i) + \lambda_t - \overline{\lambda} + (\varepsilon_{it} - \overline{\varepsilon}_i)$

By differencing the data, the effect of time-constant unobserved factors – observed W_i and unobserved α_i – was removed. Thus, the changes in the dependent variable (Y_{it}-Y_i) only depend on changes in time-dependent predictors (X_{it}) and time-dependent idiosyncratic errors ε_{it}.

Moreover, it is worth noting that we computed cluster-robust standard errors to take serial correlation and heteroscedasticity into consideration (27). The level of significance was set to 5%. All statistical analyses were performed using Stata 14 (Stata Corp., College Station, Texas). As social support was included in all six study centers only in follow-up waves 2 and 4 (3 years later), only these waves were used in our regression analysis. The analysis were performed for the total sample and separately for both sexes.

Results

Sample characteristics

Mean age at follow-up wave 2 was 82.6 years (±3.4), ranging from 77 to 101 years (see Table 1). The majority was female (66.0%). Moreover, most of the individuals had

Table 2
Longitudinal predictors of social support. Results of fixed effects regressions (Follow-Up Waves 2 and 4)

	(1) Social support score - Total sample	(2) Social support score - Women	(3) Social support score - Men
Increasing age	-0.160***	-0.162***	-0.160***
	(0.0194)	(0.0251)	(0.0291)
Loss of spouse (Ref.: Married)	-0.0416	0.0329	-0.209
	(0.207)	(0.244)	(0.386)
Onset of mild visual impairment (Ref.: No visual impairment)	-0.377**	-0.345+	-0.440+
	(0.144)	(0.181)	(0.233)
Onset of severe/profound visual impairment	-0.0279	-0.164	0.353
	(0.269)	(0.347)	(0.370)
Onset of mild hearing loss (Ref.: No hearing impairment)	-0.143	0.0253	-0.439*
	(0.123)	(0.163)	(0.181)
Onset of severe/profound hearing loss	-0.394	-0.00897	-1.022+
	(0.378)	(0.483)	(0.581)
Increasing comorbidity (Weighted score)	-0.00421	-0.00502	0.00165
	(0.0198)	(0.0259)	(0.0282)
Constant	25.70***	25.67***	25.97***
	(1.572)	(2.025)	(2.413)
Observations	3,851	3,038	2,296
R^2	0.067	0.057	0.103
Number of Individuals	2,389	2,064	1,808

Comments: Beta-Coefficients were reported; Cluster-robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05, + p<0.10; Observations with missing values were dropped (listwise deletion).

primary education (60.9%), were not married (single, widowed or divorced; 61.5%) and 50.6% were living alone in private household. Mean comorbidity score was 4.5 (±3.9) and mean social support score was 12.3 (±2.5). The majority had no impairment in vision (79.0%) and hearing (61.2%).

At follow-up wave 4 (3 years later), the proportion of unmarried individuals increased to 67.0%. Furthermore, the social support score decreased to 11.9 (±2.7). Moreover, the proportion of individuals with visual and hearing impairment increased markedly. Besides, it is worth noting that bivariate changes in comorbidity score were unrelated to changes in visual impairment (r=.03, p=.23) and social support score (r=.02, p=.70).

Regression analysis

Main models

FE regressions (see Table 2) showed that the onset of mild visual impairment decreased the social support score (β=-.38) significantly in the total sample, but not when women (p=.06) and men (p=.07) were analyzed separately. Furthermore, the onset of mild hearing impairment decreased the social support score in men (β=-.44). Moreover, increasing age decreased the social support score in the total sample (β=-.16) and in both sexes (women: β=-.16; men: β=-.16). Loss of spouse (transitions from 'married' to 'divorced' or 'widowed') and increasing comorbidity did not affect the social support score in a significant way.

Additional models

Additionally, we redid everything with dimensions of social support (practical support, emotional support or social integration, respectively) as outcome measure (see Table 3). Thereby, the onset of mild visual impairment affected emotional support score in the total sample (β=-.26) and in both sexes (women: β=-.26; men: β=-.26) significantly, whereas it did not affect the other outcome variables. The onset of mild hearing impairment only affected social integration score in men (β=-.20) significantly. While increasing age affected all outcome measures in the total sample and in both sexes, loss of spouse and increasing comorbidity did not affect these outcome measures.

Table 3
Longitudinal predictors of emotional support, instrumental support and social integration. Results of fixed effects regressions (Follow-Up Waves 2 and 4)

	(1) Emotional support - All	(2) Emotional support - Women	(3) Emotional support - Men	(4) Instrumental support - All	(5) Instrumental support - Women	(6) Instrumental support - Men	(7) Social integration - All	(8) Social integration - Women	(9) Social integration - Men
Increasing age	-0.0572***	-0.0584***	-0.0540**	-0.0301***	-0.0273**	-0.0364***	-0.0793***	-0.0834***	-0.0738***
	(0.0123)	(0.0163)	(0.0173)	(0.00674)	(0.00859)	(0.0107)	(0.00826)	(0.0105)	(0.0131)
Loss of spouse (Ref.: Married)	0.0281	0.0242	0.0395	-0.0214	0.0124	-0.0915	-0.0272	-0.00291	-0.0943
	(0.135)	(0.164)	(0.234)	(0.0738)	(0.0877)	(0.132)	(0.0840)	(0.103)	(0.151)
Onset of mild visual impairment (Ref.: No visual impairment)	-0.258**	-0.255*	-0.262*	-0.0981+	-0.114+	-0.0639	-0.0794	-0.0284	-0.188+
	(0.0882)	(0.114)	(0.129)	(0.0520)	(0.0669)	(0.0771)	(0.0600)	(0.0743)	(0.0993)
Onset of severe/profound visual impairment	-0.0515	-0.113	0.110	-0.0153	-0.0603	0.0973	0.0291	-0.00593	0.138
Onset of mild visual impairment	(0.191)	(0.247)	(0.251)	(0.0964)	(0.123)	(0.136)	(0.0989)	(0.123)	(0.154)
Onset of mild hearing loss (Ref.: No hearing impairment)	-0.0749	0.00347	-0.203+	-0.0185	0.00854	-0.0631	-0.0662	0.0103	-0.204*
	(0.0790)	(0.106)	(0.111)	(0.0476)	(0.0605)	(0.0786)	(0.0574)	(0.0770)	(0.0826)
Onset of severe/profound hearing loss	-0.182	-0.0328	-0.414	-0.163	-0.173	-0.185	-0.0455	0.166	-0.385+
	(0.222)	(0.289)	(0.332)	(0.125)	(0.161)	(0.202)	(0.143)	(0.185)	(0.215)
Increasing comorbidity (Weighted score)	-0.00312	0.00577	-0.0204	-0.00375	-0.00660	0.00289	-0.00164	-0.00628	0.00969
	(0.0123)	(0.0162)	(0.0159)	(0.00671)	(0.00813)	(0.0121)	(0.00750)	(0.00938)	(0.0124)
Constant	11.97***	11.96***	11.90***	6.231***	5.973***	6.785***	8.996***	9.300***	8.615***
	(0.999)	(1.318)	(1.429)	(0.552)	(0.702)	(0.884)	(0.668)	(0.847)	(1.078)
Observations	3,867	3,051	2,304	3,858	3,041	2,302	3,868	3,051	2,303
R^2	0.029	0.025	0.053	0.025	0.022	0.038	0.077	0.074	0.106
Number of Individuals	2,395	2,071	1,812	2,392	2,066	1,811	2,397	2,073	1,810

Comments: Beta-Coefficients were reported; Cluster-robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05, + p<0.10; Observations with missing values were dropped (listwise deletion).

Discussion

Main findings

This study aimed at investigating the effect of visual impairment on social ties in late life longitudinally. Longitudinal regressions revealed that the onset of mild visual impairment decreased the social support score, especially the emotional support score. Additionally, the onset of mild hearing impairment decreased the social support score in men. Moreover, increasing age decreased the social support score in the total sample and in both sexes. Loss of spouse and increasing comorbidity did not affect the social support score.

Previous research

Based on time-dependent predictors, our study extends cross-sectional studies and a previous study (19) that used visual impairment at baseline to predict subsequent loneliness in old age. Associations between visual impairment and social ties in old age have been shown in numerous cross-sectional studies (15-18). Additionally, Jacobs et al. (19) used a prospective age-homogenous, community-dwelling cohort (at baseline: aged 70 years, at follow-up: 77 years). Jacobs et al. found that individuals with visual impairment showed increased loneliness cross-sectionally, whereas visual impairment at baseline was not significantly associated with subsequent loneliness.

While the onset of mild visual impairment reduced the social support score in our study significantly, the onset of severe visual impairment did not affect social support significantly. This can be mainly explained by statistical power, i. e. only few individuals changed visual impairment status from ‘no visual impairment’ to ‘severe/profound visual impairment’ between follow-up wave 2 and follow-up wave 4. Analogously, the non-significant effect of mild visual impairment in gender-specific regressions can be explained by low statistical power.

In sum, our data corroborate the hypothesis that changes in visual impairment are associated with changes in social ties and

therefore extends previous knowledge about a cross-sectional association of these factors. This finding can be explained by the fact that the onset of visual impairment might increase the tendency to avoid social ties in old age. Reasons for this might be that the visual impairments affect social engagement in a club or in a party. Moreover, visual impairment might affect mobility which in turn may affect social ties. Eventually this may end up in social isolation.

Besides, it is worth noting that some cross-sectional studies reported significant associations between hearing difficulties and social isolation (28, 29), but others reported none (30, 31). Moreover, in longitudinal studies associations between baseline poor hearing and subsequent loneliness for specific subgroups of older persons were observed, for instance in men (32). Associations between the baseline level of hearing impairment and social functioning were also found by Strawbridge et al. (33) and by Wallhagen et al. (34). Analogously, our findings extend these previous studies about an association between hearing impairment and social ties.

Strengths and limitations

This is the first study aimed at examining the effect of visual impairment on social ties in late life by using panel data method. Consequently, our study investigated the effect of changes in visual impairment on social support and thus extends previous knowledge about an association of these factors. By using FE regressions, consistent estimates can be derived (under the assumption of strict exogeneity), even if unobserved time-constant factors are correlated with the predictors. Moreover, since individuals in old age were recruited via general practitioners' offices and nearly every individual in this age-bracket has regular general practitioner visits, our sample can be seen as an almost representative study of elderly individuals in Germany.

Furthermore, the psychometric properties of our outcome measure should be highlighted. Nonetheless, our findings with regard to the dimensions of social support should be interpreted carefully since a short-form questionnaire was used to quantify social support (practical support, emotional support or social integration, respectively).

Additionally, studies exist showing that there are differences between clinical measures of visual impairment and self-reported visual impairment (35). Nevertheless, self-reported visual impairment might be adequate to capture the role of visual impairment in daily life. Even though self-reported measures are an important, complementary measure to quantify the well-being of patients, future studies with objectively measured visual impairment are required. Such objective measures have the advantage of eliminating the evaluation bias. Moreover, future studies should investigate the effect of specific eye-diseases on social ties in old age. Besides, it is worth noting that only self-reported hearing impairment was assessed in the AgeCoDe study. Furthermore, our estimates might be biased downwards due to panel attrition (endogenous selection bias). Additionally, our social support score might be biased due to social desirability (36). However, if social desirability is constant within individuals over time, it does not bias the FE-estimates (even if it is unobserved).

Conclusion

Our findings stress the importance of visual impairment for social ties in late life. As a result, it seems to be meaningful to develop targeted interventions for specific populations (20) to delay visual impairment in late life since three quarters of vision loss is avoidable and many eye care interventions are cost effective (37). For instance, vision aids and support in the community (38) should be given a high priority for individuals with age-related macular degeneration. Additionally, individuals in old age should be encouraged to regular eye-testing (39). Moreover, the problem of uncorrected refractive error is significant in older people (40) and needs to be taken into consideration.

This in turn might contribute to the maintenance of social ties which in turn can help to maintain functional status (41-43). For example, social ties are associated with self-care behaviors (medication behavior and exercise) (44) which in turn can affect functional status. Otherwise, functional status might also affect social ties. Additionally, psychosocial interventions (e.g. self-management and disease management) (45, 46) for visually impaired older adults might be a promising approach to maintain social ties. For example, this might include goal-directed problem-solving strategies in order to elicit positive affect which in turn can affect social ties.

It is expected that the number of individuals with visual impairment in old age will increase considerably in the next decades due to demographic shifts. Consequently, policy-makers and practitioners should be aware of these challenges in the next decades.

Ethics statement

The ethics committees of the participating centers approved the study (reference numbers: 050/02 (University of Bonn), 2079 (Faculty of Medicine, University of Düsseldorf), 2817/2007 (Hamburg Medical Association), 309/2007 (Faculty of Medicine, University of Leipzig), 2007-253E-MA (Medical Ethics Commission II, University of Heidelberg at the University Medical Center of Mannheim), 713/02 (Faculty of Medicine, Technical University of Munich)). The study was conducted according to the principles expressed in the Declaration of Helsinki. All participants gave written informed consent prior to study entry.

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Members of the AgeCoDe Study Group: Principal Investigators: Wolfgang Maier, Martin Scherer*. Heinz-Harald Abholz, Cadja Bachmann, Horst Bickel, Wolfgang Blank, Hendrik van den Bussche, Sandra Eifflaender-Gorfer, Marion Eisele, Annette Ernst, Angela Fuchs, Kathrin Heser, Frank Jessen, Hanna Kaduszkiewicz, Teresa Kaufeler, Mirjam Köhler, Hans-Helmut König, Alexander Koppara, Carolin Lange, Hanna Leicht, Tobias Luck, Melanie Luppa, Manfred Mayer, Edelgard Mösch, Julia Olbrich, Michael Pentzek, Jana Prokein, Anna Schumacher, Steffi Riedel-Heller, Janine Stein, Susanne Steinmann, Franziska Tebarth, Michael Wagner, Klaus Weckbecker, Dagmar Weeg, Jochen Werle, Siegfried Weyerer, Birgitt Wiese, Steffen Wolfsgruber, Thomas Zimmermann. *Hendrik van den Bussche (2002-2011). We want to thank both all participating patients and their general practitioners for their good collaboration.

Conflict of Interest: The authors declare that they have no conflict of interest.

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