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Psychosocial and biological aspects of dispositional optimism at old age

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Chapter 8

General discussion

Introduction

Optimism is traditionally seen as a predictor of better health, but it is possible that mental and physical well-being may influence one's levels of optimism as well. For example, being diagnosed with a severe illness or feeling socially isolated may lower one's level of optimism. Conversely, being in good health, engaging in health promoting behaviors, and perceiving social support probably reinforce one's level of optimism. Furthermore, 'third variables' may mediate and moderate the associations between optimism and health. Until now, most of the scientific work in this field has been devoted to the effects of optimism on physical and mental health status. There has been less focus on whether optimism changes during life and, if so, whether these changes are related to biological, psychological, or lifestyle factors. Also the potential role of third variables in the association between optimism and health has barely been investigated.

The main aim of this thesis was to investigate whether and through what mechanisms dispositional optimism is related to important biological, psychological, and lifestyle correlates. These associations were studied recognizing dispositional optimism as either predictor or outcome of these associations among older people who are especially susceptible to health problems.

Summary of the main findings

In chapter 2 we focused on the question of whether parental longevity is associated with levels of optimism of their offspring. Previous studies had found an association between optimism and longevity within individuals (Chida & Steptoe, 2008; Giltay *et al.*, 2004a; Giltay *et al.*, 2006; Tindle *et al.*, 2009), and family studies had found that parental longevity is related to psychological features of the offspring (Yashin *et al.*, 2010). To investigate this association, we used an inter-generational methodological approach in which we examined the relationship between dispositional optimism of the offspring and parental longevity. We conducted our analyses in two independent samples of community-dwelling subjects who had also provided information on their parents' age or age of death. The results of this study showed a consistent inter-generational relationship between parental longevity and dispositional optimism of their offspring. This finding supports the hypothesis that hereditary factors and (very) early environmental factors that predispose some people to high optimism are linked to those that affect longevity. However, these results are preliminary and future studies should explore underlying mechanisms and potential causality in the association between hereditary factors, dispositional optimism, and lifespan.

In chapter 3, we explored the cross-sectional and longitudinal association between a marker of biological aging - telomere length- and dispositional optimism. Previous studies had shown a relationship between telomere shortening and poor mental well-being during adulthood (Simon *et al.*, 2006; O'Donovan *et al.*, 2009; Panossian *et al.*, 2003; Honig *et al.*, 2006; Tyrka *et al.*, 2009; Epel *et al.*, 2004), but whether this association persisted in late life was less well investigated. The results of our study showed no evidence of an association between telomere length and optimism in older adults. These findings contrast with our hypothesis that lower optimism would be associated with shorter telomeres and telomere shortening over time in older adults. However, precisely the old age of our sample may have hampered the detection of an association due to, for example, the higher instability of telomere length at old age. In older people, the enzyme telomerase shortens and elongates

telomeres more arbitrarily, hindering thereby the finding of associations with fluctuations in telomere length (Martin-Ruiz *et al.*, 2005). Future studies investigating telomere length and affective states and traits should therefore take this into consideration.

In chapter 4 we studied C-reactive protein (CRP) as one of the many markers of chronic low-grade inflammation (in absence of infection) in relation to optimism. We analyzed the association between CRP haplotypes and levels of optimism using a Mendelian randomization design that takes adequately into account unobserved confounding and allows the inference of causality (Lawlor *et al.*, 2008; Smith & Ebrahim, 2004; Bochud & Rousson, 2010). Our results showed no overall association between CRP haplotypes and levels of optimism. However, when we stratified for body mass index (BMI) we found that CRP haplotypes that lead to higher CRP plasma levels were also associated with lower levels of optimism in people with obesity (i.e. with a BMI ≥ 25 kg/m²). These findings suggest that these CRP haplotypes may be causally related to dispositional optimism, being this association probably modulated by BMI. In other words, low-grade inflammation may adversely affect optimism in obese subjects.

In chapter 5, we examined the association between the lifestyle factor physical activity and optimism in a sample of older subjects with a history of myocardial infarction. As both physical inactivity and low optimism are predictors of less favorable outcomes in patients with cardiovascular disease (Davidson *et al.*, 2010; Giltay *et al.*, 2004b; Woodcock *et al.*, 2010), we hypothesized that they would be strongly interrelated in this population. At baseline, lower optimism levels were only weakly associated with less physical activity. Moreover, no longitudinal association was found on the long-term. These results suggest that physical activity does not beneficially affect levels of optimism over time.

In chapter 6 and 7, we investigated the association between optimism and psychosocial correlates. Chapter 6 described the longitudinal relationship between optimism and loneliness. Given that low optimism and loneliness are both predictors of poor health outcomes, it is possible that optimism is also strongly related to loneliness. Furthermore, loneliness may explain the observed association of low optimism with poor health outcomes. The results of our study among older men showed that higher levels of optimism were predictive of less feelings of loneliness after 10 years of follow-up, even after adjustment for the important covariate depressive symptoms. Our findings suggest that subjects with low levels of optimism are more vulnerable to loneliness and might therefore benefit from more clinical attention and interventions aimed to prevent and alleviate loneliness. Thus, future interventions that enhance optimism may help to reduce feelings of loneliness in older people.

In chapter 7 we reported the results from our study on the cross-sectional association between optimism and mental imagery. Mental imagery, the experience of a visual perception in the absence of external stimuli, is strongly related to emotion and is seen as a possible tool in cognitive behavioral therapy. Earlier studies with a limited follow-up period (i.e. two weeks) have suggested that it is possible to increase optimism through interventions aimed to promote positive visualizations of future events (Peters *et al.*, 2010). Our study showed a strong cross-sectional association between higher levels of optimism and positive mental imagery. These findings, though preliminary, suggest that optimists may have specific properties in their use of mental imagery regarding the future and open new perspectives for cognitive behavioral therapy in making a shift from verbal to visual training exercises in order to increase optimism.

Interpretation of our findings

Effects of biological and lifestyle correlates on optimism

As previously discussed, the benefits of an optimistic outlook on health are manifold. This evidence calls for the identification of factors that may contribute to cultivate optimism and ultimately improve our health status. Recent research suggests that a combination of genetic and environmental influences is involved in one's levels of optimism (Gillham & Reivich, 2004; Vaughan, 2000). Genetic studies among twins have shown that though optimism has a genetic component, our levels of optimism are only determined by genes for only approximately 25% (Plomin *et al.*, 1992). From these results we may deduce that other biological as well as environmental factors have a major impact on our levels of optimism. For example, being a victim of physical or emotional abuse or neglect during childhood leads to lower levels of optimism in adulthood (Gillham & Reivich, 2004). In older adults, biological and lifestyle factors that may influence optimism have been less studied.

Previous studies have shown that optimistic persons live longer (Giltay *et al.*, 2004a; Tindle *et al.*, 2009). Longevity is, in turn, closely related to the length of a cellular marker named telomere (Aviv & Bogden, 2010), the region of repetitive DNA sequences at the end of a chromosome that protects it during replication (Blackburn, 2001). Therefore, we hypothesized that telomere length might help to identify persons with higher or lower optimism levels. The results of this study presented in chapter 4 showed that telomere length is not related to levels of optimism, at least not in the old age. Although this null-finding could also result from the advanced age of our sample or from an attrition bias (Halaschek-Wiener *et al.*, 2008; Martin-Ruiz *et al.*, 2005), it seems unlikely that such a specific cellular marker is directly linked to optimism.

Lifestyle factors, such as physical activity, are traditionally seen as important correlates of an optimistic outlook on life. People who are optimistic are indeed prone to engage in healthy behaviours and are thought to be more physically active (Giltay *et al.*, 2007). Therefore, the question that arose was whether physical activity might increase levels of optimism over time. The results of the study presented in chapter 5 showed that physical inactivity was not predictive of future levels of optimism. So, we may conclude that physical activity per se neither causes fluctuations in optimism on the short-term, nor in the long run.

The results of the studies described in the previous paragraphs show that the influence of biological and lifestyle factors on dispositional optimism were either absent or rather small. Maybe it is not the way they behave what makes optimistic persons maintain their positive outlook on life, but rather the way they think about the future. It has been suggested that the use of mental imagery as a cognitive process encourages more optimistic persons in pursuing their goals, wherein mental imagery refers to the ability of visualizing future events in the mind's eye (Holmes & Mathews, 2010). Generating compelling positive mental images of future events may help to interpret these positive future events as more likely to happen and consequently engage in adaptive behaviours that in the end lead to the achievement of the desired goals (Sharot *et al.*, 2007). The results of the study presented in chapter 8 showed indeed that, in the general population, optimistic persons were able to mentally picture more vivid images of positive events of the future and have a greater sense of likelihood of these events to happen in a near future. Although these findings are correlational, they identify a new cognitive marker that may be of interest in future intervention studies aiming to increase optimism.

Effects of optimism on lifespan and psychosocial correlates

An optimistic outlook on the future has been related to a myriad of positive health outcomes. Optimism has even been shown to predict longevity. In a longitudinal study with a follow-up of 8 years, those participants with a positive outlook on life had a lower risk for all-cause or cardiovascular mortality (Tindle *et al.*, 2009). Also in older adults, optimism was predictive of survival after 15 years of follow-up (Giltay *et al.*, 2004b). In line with the results of these studies, the findings of the study presented in chapter 2 of this thesis showed an association between longevity and optimism. Because this study had an inter-generational design and showed that parental longevity was associated to optimism of the offspring, our results also provide further support to the hypothesis of shared heritability of optimism and longevity. It is possible that the phenotypes longevity and dispositional optimism have a common heritable component that may be part of a phenotypical spectrum that is inherited together (Martin *et al.*, 2007; Plomin *et al.*, 1992). However, shared heritability is only one of the multiple potential mechanisms that may play a role in this association.

Several studies support the popular notion that optimistic persons are more likely to be married, or to belong to a close family or circle of friends, thereby perceiving more emotional and social support (Brissette *et al.*, 2002; Jackson *et al.*, 2000; Nurmi *et al.*, 1996). The results of the study presented in chapter 7 also show that optimism is predictive of less feelings of loneliness over 10 years of follow-up. These findings are especially relevant in older adults, as it has been shown that loneliness has negative effects on health and decreases survival in older adults (Hawkley & Cacioppo, 2010). Our results support the idea that an optimistic orientation may provide extra benefit to older people as it prevents feelings of loneliness that are so closely related to poor health outcomes.

The role of a third variable in the association between optimism and health

There are many complex mechanisms that may underlie the association between optimism and health outcomes. It is possible that the association between optimism and good health is mediated or moderated by third variables. We have studied some of these numerous possibilities. We found no support for such a relationship with physical activity. In our study among subjects with a history of myocardial infarction, higher levels of physical activity were not predictive of higher levels of optimism over time. Thus, physical activity is unlikely to enhance optimism and does not mediate the previously found association between optimism and longevity. Other more specific biological characteristics, such as the rate of telomere shortening, do neither affect levels of optimism. Thus, higher levels of optimism seem to be independent of cellular longevity. This conclusion suggests that the observed association between optimism and longevity is not reflected at the cellular level of telomere lengths.

Obesity, by contrast, seemed to play a moderating role in the association between optimism and levels of the inflammatory marker CRP. In our study, we found that optimism was associated with the inflammatory marker CRP, but only in obese or overweight subjects. These finding of lower levels of optimism in obese subjects prone to high CRP levels may explain part of the higher cardiovascular mortality rates found among these persons. From the results presented in chapter 4, we may conclude that obesity is a moderator of the association between optimism and inflammation.

There are many other potential “third variables” that may moderate or underlie the association between optimism and longevity that have not been considered in this thesis. These

potential third factors may have a behavioral or physiological nature. More adaptive coping has been posited as one behavioral mechanism explaining the association of optimism with lower mortality risk. As optimists consider being healthy a desirable goal, they engage in health-promoting lifestyles, such as non-smoking, increased physical activity, moderate alcohol use and consumption of more fruits, vegetables, and whole grains (Giltay *et al.*, 2007; Steptoe *et al.*, 2006; Kelloniemi *et al.*, 2005) and adhere better to medical treatment (DiMatteo *et al.*, 2000). Furthermore, it is also possible that the association between optimism and longevity is mediated by physiological mechanisms. Dispositional optimism may influence health through the regulation of the autonomic nervous system by attenuating the sympathetic nervous system activity and enhancing parasympathetic activity, as evident from the increased heart rate variability and lower blood pressure observed in optimists (Steptoe, 2007). These effects may also derive from the reduced hypothalamic-pituitary-adrenal axis (HPA axis) reactivity to stressors observed in persons with high optimism (Chida & Hamer, 2008). Another possible underlying mechanism that may explain the association between optimism and longevity is the regulation of immune processes. Several studies have shown that optimism may buffer the negative impact of stress on immune responses. For example, during situations of acute stress that are often accompanied by reduced lymphocyte turnover, optimistic persons display increased numbers of cytotoxic T cells, improved natural killer cell (NKC) activity, and larger antigen-stimulated delayed-type hypersensitivity responses (Segerstrom, 2001; Segerstrom & Sephton, 2010). However, the relationship between optimism and immunity is highly complex and dependent on the duration and nature of the stressor or pathogen involved (Cohen *et al.*, 1999). Moreover, little is known about the potential effect of optimism on the interaction between the HPA axis, the autonomic nervous system, and immune responses.

Table 1. Characteristics of cohorts used in the studies presented in this thesis

	Arnhem Elderly Study	Alpha Omega Study	Cretan Elderly Study	Leiden Longevity Study	ROM reference group	Zutphen Elderly Study
Number of participants	426	769*	123	1252	242	416*
Age (years); mean $\pm$ SD	74.3 $\pm$ 5.7	69.2 $\pm$ 5.7	84.1 $\pm$ 4.2	66.1 $\pm$ 6.4	43.0 $\pm$ 12.7	74.8 $\pm$ 4.6
Male sex (%)	48%	77%	100%	48%	64%	100%
Comorbidity	Population-based sample	Post-MI patients	Population-based sample	Population-based sample	Population-based sample	Population-based sample
Optimism instrument	SSWO	LOT-R	4Q	LOT-R	LOT-R	4Q
Chapters in this thesis	4	2,5	3	2,4	7	3, 4, 6

SSWO: Scale of Subjective Well-being of Older People; LOT-R: Life Orientation Test-Revised; MI: myocardial infarction; ROM: Routine Outcome Monitoring; 4Q: 4-item optimism questionnaire.

* Given the different exclusion criteria used across the studies presented in this thesis, this table presents only the highest sample size used.

Methodological considerations

Albeit the use of different instruments used to assess optimism, we found consistent results across different samples of older people (see Table 1). To ensure comparability, we homogenized all variables across samples and we included only participants without missing values for the main variables and covariates. Nevertheless, we also would like to highlight the following issues which may limit the interpretation of our results. First, the focus on older populations may have resulted in an attrition bias due to selective survival of the healthiest subjects. Second, some of the samples were only composed of men; which hampers the generalization of our results to women. Third, the use of self-report (though well validated) questionnaires for variables such as physical activity in these older people may have resulted in an underestimation of the effects due to a recall bias. Finally, most of our studies were of observational nature, restricting the identification of confounders and the inference of causality.

Implications for general and clinical practice

Optimism is related to positive health outcomes, commitment to self-care, social functioning, and a better adherence to medical treatment (Carver *et al.*, 2010; DiMatteo *et al.*, 2002). Although it is insufficiently clear whether the relationship between optimism and good health is causal, the importance of identifying persons at risk for poorer prognosis can hardly be overemphasized in clinical practice. The assessment of optimism may help to recognize older people at risk for somatic and psychological health problems. From the studies presented in this thesis, it seems that low levels of optimism are associated with a shorter lifespan, a higher risk of inflammation in obese persons, and more feelings of loneliness. Moreover, our work supports a strong relationship between optimism and positive mental imagery. As these results are correlational, future intervention studies could investigate whether levels of optimism are modifiable on the long term by means of a cognitive therapy based on mental imagery. If so, people with lower levels of optimism could be offered interventions to strengthen personal resilience and enhancing optimistic dispositions that might help them to recover from setbacks or diseases. Furthermore, mobilizing their social resources may be helpful to avoid problems related to loneliness.

Future directions of research

Lately, interest is shifting beyond stress, disease and psychopathologic factors towards the exploration of resilience and other factors that promote health and thriving. Optimism is one of these factors that are related to a greater resilience and help people to cope with adversities. Moreover, optimism is easily assessed with self-report questionnaires that can be included in large epidemiological studies. It is also necessary to collect optimism data at frequent intervals over lengthy follow-up periods to address questions about its fluctuations across lifespan and its link to health outcomes in more detail. In this way, the cumulative exposure, possible fluctuations, and outcome of optimism may be studied in relation to disease and health states.

In future studies, the overlap of optimism with other constructs, such as positive affect, low neuroticism, or extraversion, should also be addressed. Studies have often used these psychological concepts as synonyms of optimism, but they are not equivalent. Future studies should therefore differentiate optimism from these overlapping psychological con-

structs. Furthermore, to demonstrate a causal relationship between optimism and health, randomized trials investigating whether a (psychotherapeutic) intervention aimed at boosting optimism in patients can make a meaningful difference in long-term health are needed. In our work we found preliminary evidence for an association between optimism and positive mental imagery, which is the ability to visualize positive future events. Mental imagery has been successfully used in cognitive behavioral therapy and it is possible that including positive mental visualizations of the future may increase levels of optimism. However, it is yet to be investigated whether changes in optimism achieved through mental imagery interventions are enduring.

Conclusion

Throughout the studies presented in this thesis, our findings fit the hypothesis that optimism predicts enhanced mental well-being and longevity, but also that levels of optimism within a certain person are rather stable over time and resistant to change. However, this stability of optimism does not necessarily imply that no fluctuations in optimism are possible. Certain positive or negative life events are likely to provoke small changes in optimism. But it is possible that dispositional optimism is a stable personality trait that cannot be learned or wherein only little changes are possible. Thus, as things stand, it remains unclear whether adopting a more positive outlook on life can enhance your likelihood of survival. Thoughtfully designed future clinical and epidemiologic studies are required to explore the potential benefits of boosting optimism. But it certainly would not hurt – and it might put a smile on your face– to see the glass half full.

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