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Socioeconomic Status, Psychosocial Factors, and Health in the Second Half of Life

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ABSTRACT

Socioeconomic status (SES) is important for health (e.g., Knopf, Ellert, & Melchert, 1999). It is not well understood, however, whether there is a change in the SES-health association in the second half of life. Moreover, it can be assumed that SES differences do not completely translate into health differences, but that there is substantial between-person variation within SES groups. The interplay between SES and psychosocial factors needs to be taken into consideration, as is suggested by the Reserve Capacity Model (Gallo & Matthews, 2003). There is evidence for the impact of psychological and social resources as well as emotions on health up to old age (Aldwin, Park, & Spiro, 2007), but less attention has been given to the theoretically and practically relevant question whether these associations differ in population subgroups with varying SES. Given this background (see also Chapter 1), the overall aim of this dissertation is to demonstrate the usefulness of combining sociological and psychological perspectives on health in later life. In particular, four research questions are examined:

(1) Does the association between SES and health change in the second half of life?
(2) Do psychological and social resources have differential effects on health according to SES?
(3) Does between-person variation in levels and changes of emotions and health differ by education, a central aspect of SES?
(4) Do dynamic associations between emotions and health differ by education?

To answer these questions, a combination of cross-sectional and longitudinal data from the German Ageing Survey (DEAS), a nationally representative study including middle-aged and older adults (40+ years), was used. Recent state-of-the-art methods were employed for the analyses.

The cross-sectional results point to stability in the SES-health association throughout middle and older adulthood except for an increase in wealth-related absolute inequality in physical and functional health and a decrease in income-related differences in subjective health. Longitudinal analyses indicate continuity up to older adulthood, with some indication of decreasing education-related differences in physical health in very old age (Chapter 2, 4, 5). Further analyses suggest that psychological resources (optimistic self-beliefs) are stronger predictors of functional and subjective health in low than in higher educated participants. Social resources (social support) are positively related to health mainly in (older) people with low income (Chapter 3). There is also evidence for substantial between-person variance in levels and changes of functional health and depressive affect within education groups in older adulthood, with mostly larger variation at lower education levels (Chapter 4). The association between changes in functional health and depressive affect as well as the impact of negative affect on change in physical health are stronger in low-educated individuals. The effect of physical health on positive affect does not seem to vary by education (Chapter 4, 5).

The findings are subsequently integrated and discussed, and implications for research and intervention are provided (Chapter 6). Regarding research, differential effects of psychosocial resources and emotions on health according to SES should be examined more closely, taking into account the multifaceted and dynamic nature of the constructs. To further study potential mechanisms (e.g., health behavior, emotion regulation) as well as their longer-term influence on health, studies collecting data across multiple time scales are needed. Concerning practical implications, societal efforts to reduce social inequality should be complemented by interventions at the level of the individual and his or her private network. The latter should take into account the educational background and financial status of individuals to allow for more targeted interventions for enabling healthy aging.

ZUSAMMENFASSUNG

Die Gesundheit ist ein wichtiger Lebensbereich, vor allem in der zweiten Lebenshälfte (Staudinger & Schindler, 2002). Gesundheit ist auch ein komplexes Phänomen, welches von einer Vielzahl an Faktoren beeinflusst wird und somit am besten interdisziplinär zu verstehen ist. Das Ziel der vorliegenden Dissertation ist es, den Nutzen einer Kombination soziologischer und psychologischer Perspektiven auf die Gesundheit in der zweiten Lebenshälfte aufzuzeigen.

Die soziologische Forschung hat wiederholt gezeigt, dass ein niedriger sozioökonomischer Status (SES) mit einer schlechteren Gesundheit einher geht (Knopf, et al., 1999; Marmot, Ryff, Bumpass, Shipley, & Marks, 1997). Der sozioökonomische Status zeigt dabei im Allgemeinen die Stellung in einer Gesellschaft an, die durch soziale Ungleichheit gekennzeichnet ist (Lampert & Kroll, 2006). SES besteht jedoch aus mehreren Facetten, welche eine zumindest partiell unterschiedliche Bedeutung für die Gesundheit haben. Bildung impliziert dabei Wissen, einschließlich Kenntnissen über das Gesundheitsverhalten, sowie die Fähigkeit, dieses effektiv zu nutzen, um wichtige Lebensbereiche wie die Gesundheit zu beeinflussen. Das Einkommen hingegen spiegelt die (aktuellen) finanziellen Möglichkeiten wider, um Bedürfnisse zu erfüllen und professionelle Hilfe zur Bewältigung von Problemen hinzuziehen zu können (Geyer & Peter, 2000). Darüber hinaus reflektiert das Vermögen als weiterer Indikator der finanziellen Situation in der zweiten Lebenshälfte vermutlich stärker kumulative Prozesse (Robert & House, 1996). Auch die Gesundheit umfasst mehrere Aspekte. Speziell ab dem mittleren Erwachsenenalter sollten zusätzlich zur Anzahl der Krankheiten (körperliche Gesundheit) die funktionale Gesundheit (z.B. Mobilität) und die subjektive Einschätzung des eigenen Gesundheitszustandes berücksichtigt werden (Liang, 1986).

Die Berücksichtigung der Multidimensionalität beider Konstrukte ist auch im Hinblick auf die Frage wichtig, ob sich der Zusammenhang zwischen SES und Gesundheit in der zweiten Lebenshälfte verändert. Hierzu gibt es unterschiedliche Annahmen. Die Nivellierungsthese geht davon aus, dass sich der Einfluss des SES auf die Gesundheit im Alter verringert, wobei biologische Prozesse zu einer Annäherung der Statusgruppen beitragen sollen (Herd, 2006). Die Kontinuitätsthese geht hingegen von geringen Altersunterschieden bzw. Stabilität im Ausmaß sozialer Ungleichheit in der Gesundheit aus, da SES die Lebenschancen und Aktivitäten und somit auch die Gesundheit über die zweite Lebenshälfte hinweg kontinuierlich beeinflusst (O'Rand & Henretta, 1999). Schließlich wird im Rahmen der Kumulationsthese aufgrund einer sozial stratifizierten Anhäufung von Risiko- bzw. Schutzfaktoren über die Lebensspanne ein zunehmend stärkerer Einfluss des SES auf die Gesundheit mit steigendem Alter erwartet (Ross & Wu, 1996). Internationale Studien erbrachten Belege für alle drei möglichen Altersgradienten (z. B. Chandola, Ferrie, Sacker, & Marmot, 2007; Herd, 2006; Yao & Robert, 2008). In Deutschland ist die Entwicklung gesundheitlicher Ungleichheit in der zweiten Lebenshälfte hingegen kaum erforscht (Lampert, Saß, Häfelinger, & Ziese, 2005).

Das Reservekapazitätsmodell nimmt an, dass ein niedrigerer SES nicht nur mit einer schlechteren Gesundheit sondern auch mit weniger psychosozialen Ressourcen einhergeht (Gallo, de los Monteros, & Shivpuri, 2009). Als psychologische Ressourcen werden hierbei vor allem optimistische Selbsteinschätzungen wie hohes Selbstwertgefühl und Kontrollüberzeugungen sowie positive Ergebniserwartungen (optimistische Zukunftsorientierung) angesehen. Diese haben sich aufgrund ihrer Wirkung als Stresspuffer und ihrer zentralen Rolle für das Gesundheitsverhalten als relevant für die Gesundheit erwiesen (Noar & Zimmerman, 2005; Seeman & Seeman, 1983). Die verfügbare bzw. als verfügbar wahrgenommene Unterstützung innerhalb eines sozialen Netzwerks wird ebenfalls

als bedeutsam für die Stressbewältigung und somit als soziale Ressource für die Gesundheit angesehen (Cohen, 2004). Einige Studien haben bereits Belege dafür erbracht, dass psychosoziale Ressourcen den Einfluss von SES auf die Gesundheit (partiell) vermitteln (Matthews, Gallo, & Taylor, 2010). Wenig untersucht ist hingegen die Annahme, dass diese Ressourcen vor allem wichtig für die Gesundheit von Personen mit niedrigem SES sind, was vermutlich teilweise durch deren größere Stressbelastung bedingt ist (Gallo, et al., 2009). Kaum berücksichtigt wurde zudem, dass verschiedene Facetten von SES auch unterschiedliche gesundheitsrelevante „Capabilities“[1] reflektieren (s.o.) und optimistische Selbsteinschätzungen sowie verfügbare soziale Unterstützung somit möglicherweise differentielle kompensatorische Effekte auf die Gesundheit aufweisen (Vitaliano, et al., 2001).

Neben psychosozialen Ressourcen spielen Emotionen eine wichtige Rolle im Reservekapazitätsmodell und empirische Befunde belegen, dass SES nicht nur die Gesundheit sondern auch das emotionale Erleben beeinflusst (Gallo, Bogart, Vranceanu, & Matthews, 2005; Gallo & Matthews, 2003). Diese Zusammenhänge sind jedoch vermutlich nicht komplett deterministisch. Vielmehr kann angenommen werden, dass es substantielle Unterschiede zwischen Personen *innerhalb* von SES-Gruppen gibt. Dabei gibt es bereits erste Hinweise auf eine größere Varianz in Gesundheit und emotionalem Erleben bei niedrigem SES (Ferrer & Palmer, 2004), wobei Variabilität in Veränderungsverläufen nur in einer Studie untersucht wurde (Sacker, Head, Gimeno, & Bartley, 2009). Zudem ist ungeklärt, ob sich ähnliche Resultate speziell für das höhere Erwachsenenalter zeigen.

Überdies kann angenommen werden, dass sich nicht nur die Variation in sondern auch die Ko-Variation beziehungsweise der Zusammenhang zwischen emotionalem Erleben und Gesundheit nach SES unterscheiden. Psychosoziale Ressourcen gelten als hilfreich für die Bewältigung gesundheitlicher Einschränkungen und mildern deren Einfluss auf das

[1] Der Begriff “capabilities” bezeichnet dabei eine Mischung aus Fähigkeiten und Möglichkeiten.

emotionale Erleben (Bisschop, Kriegsman, Beekman, & Deeg, 2004), können jedoch auch den Umgang mit Emotionen und damit ihre Wirkung auf die Gesundheit beeinflussen. Ein höheres Ausmaß an psychosozialen Ressourcen trägt somit möglicherweise zu geringeren Zusammenhängen zwischen negativen Emotionen und Gesundheit bei Individuen mit höherem SES bei (Carvalhais, et al., 2008; Merjonen, et al., 2008; Smith, Langa, Kabeto, & Ubel, 2005). Die aufgeführten Studien betrachteten vorwiegend finanzielle Aspekte des SES und erlauben zudem keine Aussagen zur Wirkrichtung sowie zu möglichen differentiellen Zusammenhängen zwischen positiven Emotionen und Gesundheit in Abhängigkeit von SES.

Vor diesem Hintergrund (siehe auch *Kapitel 1*) werden in der vorliegenden Dissertation vier Fragestellungen untersucht:

(1) Verändert sich der Zusammenhang zwischen SES und Gesundheit in der zweiten Lebenshälfte? Hierbei wird berücksichtigt, inwiefern sich Unterschiede in Abhängigkeit von der SES- und Gesundheitsfacette zeigen.

(2) Haben psychologische und soziale Ressourcen unterschiedliche Effekte auf die Gesundheit in Abhängigkeit von SES? Genauer wird untersucht, ob die Effekte nach SES-Aspekt und Art der Ressource, und zusätzlich in Abhängigkeit vom Alter, variieren.

(3) Gibt es Unterschiede hinsichtlich der Varianz in der Gesundheit und im emotionalem Erleben in Abhängigkeit von Bildung? Dabei wird die interindividuelle Variabilität in den Niveaus und in den Veränderungen betrachtet. Der Fokus liegt auf dem höheren Erwachsenenalter.

(4) Gibt es Unterschiede hinsichtlich dynamischer Zusammenhänge zwischen Emotionen und Gesundheit in Abhängigkeit von Bildung? Hierbei werden unterschiedliche Aspekte emotionalen Erlebens einbezogen und potentiell bidirektionale Emotions-Gesundheits-Beziehungen berücksichtigt.

Zur Beantwortung dieser Fragen werden quer- und längsschnittliche Daten des Deutschen Alterssurveys genutzt (DEAS). Dabei handelt es sich um eine bundesweit repräsentative Befragung von Personen im mittleren und höheren Erwachsenenalter (40 Jahre und älter; Engstler & Motel-Klingebiel, 2010). Die Untersuchung der Forschungsfragen wird in den Kapiteln 2 bis 5 dargestellt.

In *Kapitel 2* wird der Frage nach einer möglichen Veränderung des SES-Gesundheits-Zusammenhangs in der zweiten Lebenshälfte nachgegangen. Es werden Daten der zweiten Erhebungswelle des DEAS genutzt. Relative und absolute Unterschiede in körperlicher, funktionaler und subjektiver Gesundheit in Abhängigkeit von drei SES-Facetten – Bildung, Einkommen und Geldvermögen - werden betrachtet. Im Allgemeinen weisen Individuen mit einem niedrigeren SES eine schlechtere Gesundheit auf als jene mit höherem SES, wobei Bildung konsistenter mit körperlicher Gesundheit assoziiert ist als Einkommen und Vermögen. Der Zusammenhang zwischen SES und Gesundheit erweist sich als überwiegend stabil über die Altersspanne von 40 bis 85 Jahren. Es gibt jedoch Hinweise auf einen Anstieg absoluter vermögensbasierter Ungleichheit in körperlicher und funktionaler Gesundheit. Nur die einkommensbasierten Unterschiede in subjektiver Gesundheit verringern sich im Alter. Die Befunde zeigen, dass der sozioökonomische Status in Deutschland bis ins höhere Erwachsenenalter hinein von Bedeutung für die Gesundheit ist.

Kapitel 3 beschäftigt sich mit der Frage nach differentiellen Effekten psychischer und sozialer Ressourcen auf die Gesundheit in Abhängigkeit von SES. Wiederum werden Daten der zweiten Erhebungswelle des DEAS genutzt. Mithilfe von Mehrgruppen-Strukturgleichungsmodellen wird untersucht, ob die Zusammenhänge zwischen optimistischen Selbsteinschätzungen sowie sozialer Unterstützung und Gesundheit in Gruppen mit unterschiedlicher Bildung bzw. unterschiedlichem Einkommen variieren. Psychische Ressourcen haben einen positiven Effekt auf die Gesundheit in allen SES-

Gruppen und sind stärkere Prädiktoren funktionaler und subjektiver Gesundheit bei niedrig gebildeten als bei höher gebildeten Personen. Der Zusammenhang zwischen sozialen Ressourcen und Gesundheit unterscheidet sich nicht in Abhängigkeit von Bildung, variiert jedoch mit dem Einkommensniveau. Ein höheres Ausmaß an sozialen Ressourcen ist vor allem bei Personen mit niedrigem Einkommen mit besserer Gesundheit assoziiert. Zusätzliche Analysen beziehen Interaktionen mit dem Alter ein. Dabei erweist sich potentiell verfügbare Unterstützung innerhalb eines sozialen Netzwerks als besonders wichtig für die Gesundheit finanziell benachteiligter *älterer* Menschen. Die Resultate legen nahe, dass unterschiedliche SES-Facetten teilweise unterschiedliche Bedeutungen haben und dass der Einfluss psychischer und sozialer Schutzfaktoren auf die Gesundheit deshalb in Abhängigkeit von der SES-Facette variiert.

Die verbleibenden empirischen Kapitel beschäftigen sich mit der Variation in und Ko-Variation zwischen Emotionen und Gesundheit in unterschiedlichen Bildungsgruppen und liefern zudem längsschnittliche Befunde zur Frage nach konvergierenden, stabilen oder divergierenden sozioökonomischen Unterschieden in der Gesundheit. In *Kapitel 4* wird untersucht, ob es Unterschiede hinsichtlich der Varianz in der Gesundheit und im emotionalem Erleben in Abhängigkeit von Bildung gibt. Hierfür werden längsschnittliche Daten des DEAS genutzt, welche 2002 und 2008 erhoben wurden. Da der Fokus auf dem höheren Erwachsenenalter liegt, werden nur Teilnehmer einbezogen, die 2002 65 Jahre alt oder älter waren. Für die Analysen werden latente Veränderungsmodelle (latent change score models; McArdle & Prindle, 2008) als Mehrgruppenmodelle spezifiziert. Die Resultate legen nahe, dass sich bildungsbasierte Unterschiede in funktionaler Gesundheit über die Zeit hinweg nicht signifikant verändern. Darüber hinaus werden substantielle interindividuelle Varianzen innerhalb der Bildungsgruppen gefunden, sowohl in den Niveaus als auch in den Veränderungsraten, mit vorwiegend größerer Variation bei niedrigerer Bildung. So gibt es

ältere Personen, die trotz niedriger Bildung nur geringe Einschränkungen und Verschlechterungen der funktionalen Gesundheit sowie wenig affektive Symptome einer Depression aufweisen, was Interventionspotential aufzeigt.

Kapitel 5 beschäftigt sich mit der Frage, ob sich dynamische Zusammenhänge zwischen emotionalem Erleben und Gesundheit in Abhängigkeit vom Bildungsniveau unterscheiden. Analysen des vorhergehenden Kapitels geben bereits erste Hinweise auf stärkere Zusammenhänge zwischen Veränderungen in funktionaler Gesundheit und depressivem Affekt. Dies wird hier erweitert: Indikatoren für positiven und negativen Affekt werden einbezogen und Multigruppen-Dual Change Score-Modelle (McArdle, 2007) werden für die Analysen genutzt. Daten des DEAS von bis zu drei Wellen, erhoben über einen Zeitraum von 12 Jahren, werden verwendet, und Veränderungsverläufe über eine Altersspanne von 40 bis 87 Jahren werden ermittelt. In diesen Analysen erweisen sich bildungsbasierte Unterschiede in körperlicher Gesundheit als weitgehend stabil, nehmen jedoch ab einem Alter von ca. 80 Jahren etwas ab. Zudem kann ein Effekt körperlicher Gesundheit auf Veränderungen im positiven Affekt aufgezeigt werden, welcher in beiden Bildungsgruppen gleich stark ist. Hingegen gibt es einen differentiellen Effekt negativen Affekts auf Veränderungen in der Gesundheit, welcher bei niedriger im Vergleich zu höherer Bildung stärker ausgeprägt ist. Die jeweils umgekehrte Wirkrichtung (z.B. der potentielle Effekt körperlicher Gesundheit auf negativen Affekt) erwies sich als nicht signifikant. Die Resultate legen nahe, dass es bildungsbasierte Unterschiede im Umgang mit negativen Emotionen gibt, wodurch diese bei Personen mit niedriger Bildung einen stärker gesundheitsschädigenden Einfluss haben.

Die Befunde werden in *Kapitel 6* integriert und diskutiert. Implikationen für Forschung und Praxis werden dargestellt. Zusammenfassend kann gezeigt werden, dass der sozioökonomische Status, insbesondere auch die in früheren Lebensphasen erworbene

Bildung, in Deutschland bis ins höhere Erwachsenenalter hinein von Bedeutung für die Gesundheit ist. Die substantielle Variabilität innerhalb der SES-Gruppen legt jedoch nahe, dass sozioökonomische Unterschiede nicht unbedingt und vollständig in Gesundheitsunterschieden münden. Vielmehr scheint das Zusammenspiel von verschiedenen SES-Facetten auf der einen sowie psychischen und sozialen Ressourcen und (negativen) Emotionen auf der anderen Seite wichtig für die Gesundheit zu sein. Diese Befunde demonstrieren den Nutzen einer interdisziplinären Sichtweise auf die Gesundheit in der zweiten Lebenshälfte, vor allem einer Kombination soziologischer und psychologischer Perspektiven. Die künftige Forschung sollte differentielle Zusammenhänge zwischen psychosozialen Faktoren und Gesundheit in Abhängigkeit von SES verstärkt untersuchen, wobei potentielle Veränderungen in den Konstrukten sowie deren Multidimensionalität beachtet werden müssen. Um die den gefundenen Effekten potentiell zugrundeliegenden Mechanismen (z.B. Gesundheitsverhalten, Emotionsregulation) sowie deren längerfristige Auswirkungen auf die Gesundheit zu untersuchen, sind Studien erforderlich, welche Daten auf verschiedenen Zeitskalen erfassen. Was die praktischen Implikationen betrifft, so sollten gesellschaftliche Bemühungen zur Verringerung sozialer Ungleichheit durch Interventionen auf der Ebene des Individuums und dessen sozialem Netzwerk ergänzt werden. Letztere sollten den Bildungshintergrund und den finanziellen Status der Person berücksichtigen, um gezieltere Interventionen zur Förderung gesunden Alterns zu ermöglichen.

Chapter 1

Introduction

Introduction

Health is an important aspect of life. This is especially true for the second half of life when limitations in health become more prevalent (Staudinger & Schindler, 2002; Whitbourne, 2002). Health is also a complex phenomenon influenced by a broad range of factors and hence can be best understood interdisciplinarily. Research in medical sociology and epidemiology has for some time now demonstrated the importance of socio-structural characteristics, particularly socioeconomic status (SES), for health in midlife (e.g., Marmot, Ryff, Bumpass, Shipley, & Marks, 1997). More recently, the question has been raised whether the SES-health association changes over the adult life-span (Alwin & Wray, 2005). This will be addressed in more detail in the present thesis and in the second part of this chapter, following the introduction to the concepts of SES and health.

Moreover, SES does not only have a major effect on health, but it may also moderate associations between psychosocial factors and health (Gallo, de los Monteros, & Shivpuri, 2009). Health psychology research provides evidence of the impact of psychological and social resources as well as emotions on health up to old age (for an overview see, e.g., Aldwin, Park, & Spiro, 2007). However, less attention has been given to the theoretically and practically relevant question whether these associations differ in population subgroups with varying SES. The present thesis attempts to shed more light on this issue. The third part of this chapter outlines a theoretical framework for the investigation of the potentially moderating influence of SES on the effects of psychological and social resources on health. The fourth section is devoted to emotions and health, focusing on potential differences in variation in and co-variation between emotions and health across SES groups.

Socioeconomic Status and Health

Socioeconomic status denotes position in a society characterized by social inequality (Lampert & Kroll, 2006). The term social inequality is used as these positions are regularly accompanied by advantages and disadvantages in relation to the distribution of highly valued and scarce assets such as knowledge, power, prestige, financial means and material possessions, as well as regarding chances of obtaining these assets (Borgers & Steinkamp, 1994). Most importantly, social inequality has been linked to health inequality, so that individuals with lower SES show worse health, on average, than their higher SES counterparts (Knopf, Ellert, & Melchert, 1999; Mackenbach, Kunst, Cavelaars, Groenhof, & Geurts, 1997; Marmot, et al., 1997).

Theory and results of existing research suggest that *SES* is a multifaceted construct, including at least education, occupation, and income. These facets have been shown to be moderately related and are assumed to have at least partly different meanings for health, particularly in later life, which argues against the common practice of using them interchangeably or using combined indices (Braveman, et al., 2005; Geyer, Hemström, Peter, & Vågerö, 2006; Liberatos, Link, & Kelsey, 1988). Education implies knowledge including, but not limited to, knowledge about health and health behavior, as well as the ability to use this knowledge effectively to influence important aspects of life such as the courses of health. Moreover, (formal) education, particularly school education, is obtained early in life. Hence, with regard to health in later life, education reflects long-time exposure to a broad range of risk factors and resources (Ross & Wu, 1996). Occupation denotes characteristics of the work not limited to hazards and toxins but also including control over the workplace and social recognition. Links between such work characteristics and health are not directly applicable to those not or no longer part of the labor force making occupation-based measures particularly

problematic to use in research that includes older adults (Grundy & Holt, 2001). Income indicates the financial means to fulfill needs and to master demanding situations by being able to buy professional assistance and help (Geyer & Peter, 2000). Particularly in older adulthood, however, income only partially reflects the financial situation. It has thus been recommended to additionally include indicators of wealth like the amount of financial assets, which might also reflect cumulative processes over the life-span (Robert & House, 1996).

It has long been recognized that *health* is a multidimensional construct as well and comprises at least physical, functional and subjective aspects (Liang, 1986). In the second half of life in particular, health cannot be defined solely as the absence of disease. From the age of about 40 years, physical illnesses become more and more frequent (Statistisches Bundesamt, 2009, 2010). The increase in diseases is partly due to age-related physiological changes (Whitbourne, 2002). Moreover, the long latency of some diseases and the enduring exposure to risk factors successively damaging organs contribute to an accumulation of chronic diseases in middle and older adulthood (Tesch-Römer & Wurm, 2009). It is thus important to take into account the number of coexistent chronic diseases, that is, multimorbidity. Partly as a concomitant phenomenon or after effect of chronic diseases, functional limitations and disabilities are increasingly prevalent in later life. Although severe limitations that affect independent living become particularly conspicuous in very old age (Steinhagen-Thiessen & Borchelt, 1999), some limitation in mobility - a central domain of physical functioning - is already present in a substantial number of middle-aged adults (Wurm, Schöllgen, & Tesch-Römer, 2010). Subjective or self-rated health, that is, the individual's evaluation of his or her overall health, is another important health aspect, particularly in later life. Subjective health has been shown to be only moderately related to physical health and to be a better predictor of mortality than objective health indicators (Benyamini, Leventhal, & Leventhal, 1999; Idler & Benyamini, 1997).

The multifaceted nature of SES and health needs to be taken into account in studies on social inequality in health. This is particularly important in examining how the association between SES and health develops in later life, which will be explicated in the following.

Development of the Association Between Socioeconomic Status and Health in the Second Half of Life

Three contradictory theoretical assumptions concerning the influence of SES on health over the adult life-span have been discussed in the literature (O'Rand & Henretta, 1999). Representatives of the *age-as-leveler* hypothesis suggest that the strength of the SES-health relationship decreases in old age relative to middle adulthood. Universal biological frailty is assumed to contribute to converging socioeconomic differences in health in old age (House, Lepkowski, Kinney, & Mero, 1994). Other authors, however, have suggested that social inequality in health is characterized by *continuity*, which is indicated by little age differences or stability in the SES-health relationship (O'Rand & Henretta, 1999). This perspective assumes that SES continuously shapes life chances and activities and thus also health throughout the second half of life. Finally, proponents of the *cumulation* theory (Dannefer, 1987; Ross & Wu, 1996) assume that the influence of SES on health gets stronger with increasing age due to a socially stratified accumulation of resources as well as risks over the life-span leading to a cumulative advantage or disadvantage.

Research has provided empirical evidence for all three potential age gradients mentioned above (e.g., Beckett, 2000; Chandola, Ferrie, Sacker, & Marmot, 2007; Herd, 2006; Kim & Durden, 2007; Yao & Robert, 2008). As has been explicated above, SES and health are by no means homogeneous constructs but are assemblies of a variety of aspects. Hence, the arguments underlying the age-as-leveler, continuity and cumulation hypothesis

may not apply equally to the various facets of SES and health, which might partly account for the differential age gradients found in different studies.

The societal context might explain why the evidence in favor of the age-as-leveler hypothesis is particularly strong in US studies. The American health care system is characterized by socially patterned health insurance coverage up to the age of 65 years, when virtually all citizens receive basic health insurance through Medicare (Herd, 2006). Furthermore, due to the large social inequalities in health during midlife in the United States, the SES-health association might be attenuated in old age due to a strong influence of selective mortality in earlier stages of life (Lynch, 2003). The situation in Germany is different in that universal health insurance is provided independent of age and the extent of social inequality in health is comparatively smaller, although still significant (Jürges, 2008). There are very few studies, however, examining age variations in the effect of SES on health in Germany, and the samples used either show limitations concerning the representation of older adults or only include old and very old individuals (Knesebeck, Lüschen, Cockerham, & Siegrist, 2003; Lampert, 2000; Lampert, Saß, Häfelinger, & Ziese, 2005).

Moreover, the studies conducted in German samples are purely cross-sectional in design. Cross-sectional analyses can give some first indication concerning age gradients in the SES-health association. The effects of SES on health may not only differ across age but also between birth cohorts (Lynch, 2006), however. As cross-sectional studies confound age and cohort effects, the age trends found may not only reflect life-span development but also historical trends, showing the need for additional longitudinal analyses. Results from the latter should also be interpreted with caution due to the fact that individuals who are older, have lower SES and worse health are more likely to drop out of studies (Chatfield, Brayne, & Matthews, 2005; Van Beijsterveldt, et al., 2002), which can lead to an underestimation of SES differences in health in old age and might contribute to converging trajectories. This is

particularly problematic if only people providing complete data are included in analyses of change. It is thus important to address selective dropout in longitudinal studies. Besides, the estimation of relative inequalities should be complemented by a comparison of absolute inequalities between the age groups as age gradients are likely to differ between these two measurement approaches (e.g., Huisman, et al., 2004).

Research Question 1: Development of the Association Between SES and Health in the Second Half of Life

Although it has been consistently shown that SES is important for health in midlife, there are contradictory assumptions (see Figure 1.1) and inconsistent results on how the SES-health association develops in the second half of life. Moreover, the few German studies on this topic show limitations concerning sample and design. Hence, additional research in representative samples covering both middle and older adulthood is needed to answer the following question: Does the association between socioeconomic status and health change in the second half of life ?

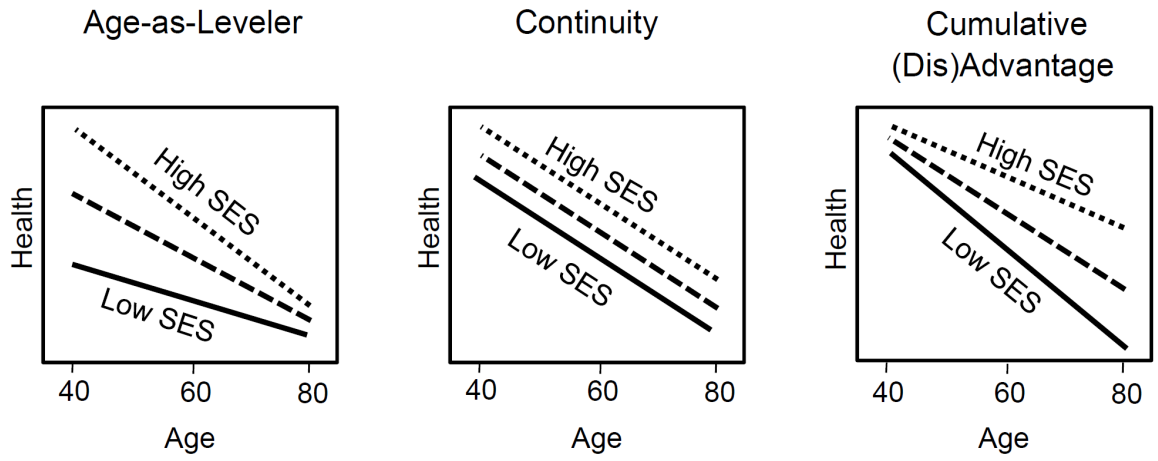

Figure 1.1. Assumptions on the development of the SES-health association in the second half of life.

This important question will be addressed in the present dissertation, with a particular focus on examining potential differences by SES facet and/or health aspect. Moreover, relative and absolute inequalities will be examined, and cross-sectional analyses will be complemented by longitudinal analyses, to explore possible differences that occur due to study design and measurement approach. The aim of this part of the thesis is to obtain a better understanding of social inequality in health in later life in Germany.

It is increasingly recognized that SES not only affects health but also plays an important role in psychosocial functioning (American Psychological Association, 2007). Moreover, it seems likely that SES moderates associations between psychosocial resources and health, which will be outlined in more detail in the following.

Psychosocial Resources and Health: Differential Effects According to Socioeconomic Status

Psychosocial resources play a central role in the Reserve Capacity Model, which provides a theoretical framework for understanding interrelationships between SES, psychosocial factors, and health (Gallo & Matthews, 2003). Within the model, optimistic beliefs about the self such as control beliefs, self-esteem and positive outcome expectancies (optimistic future orientation) have been discussed as *psychological resources* for health, because it has been demonstrated that they positively affect a range of health outcomes and physiological markers that may translate into health outcomes (McKean Skaff, 2007; Rasmussen, Scheier, & Greenhouse, 2009; Reitzes & Mutran, 2006). Optimistic self-beliefs are assumed to be relevant for health by acting as a stress buffer and by influencing healthy lifestyles. The latter is reflected in their central role in virtually all psychological theories of health behavior (e.g., Ajzen, 1991; Bandura, 1997; Schwarzer, 1999; for an overview, see

Armitage & Conner, 2000). *Social resources* are important for health as well. Individual perceptions of the availability of potentially helpful relations within a social network might be especially beneficial, because they constitute an individual-level resource, which moderates individual appraisals and buffers detrimental emotional and physiological reactions to stressful events (Cohen, 2004; Schwarzer & Leppin, 1991). The individual perception of available social support and mere structural aspects of a person's network do not necessarily correspond closely, but integration of these perspectives has been suggested by asking individuals about potentially helpful relations within their social network (Uchino, 2006). This also takes into account that a larger network, especially a greater number of close relationships, reflects more potential support. There is some evidence that the perception of available support positively affects functional and subjective health in later life (Janevic, et al., 2004; Rook, Mavandadi, Sorkin, & Zettel, 2007) and, although less conclusive, there are some studies linking social support to incidence of major disease (Uchino, 2009).

Psychological and social resources are not only related to various health outcomes, but they have also been theoretically and empirically linked to SES (Taylor & Seeman, 1999). The environment of socio-economically disadvantaged individuals offers fewer opportunities to build such resources. Moreover, the bank of resources (reserve capacity) of individuals with low SES might be depleted as they are exposed to more stressors in their physical and social environment compared to their higher SES counterparts, requiring greater use of resources (Gallo & Matthews, 2003; Taylor, Repetti, & Seeman, 1997). Evidence that psychosocial resources affect health and are related to SES led to the assumption that they may act as intermediate mechanisms, which means that individuals with higher SES possess more resources which, in turn, (partly) accounts for their better health compared to lower SES individuals. However, it has also been hypothesized that psychosocial resources act as a moderator, buffering the adverse effects of low SES on health. Viewed from a different angle,

this means that the availability of such resources primarily plays a role in low SES, which is assumed to constitute a major stressor to health. Both potential roles of psychosocial resources are part of the Reserve Capacity Model (Gallo, et al., 2009).

Although there is an increasing number of studies examining whether psychosocial resources act as intermediate mechanisms linking SES to health, providing some support for this assumption (for an overview, see Matthews, Gallo, & Taylor, 2010), the question whether such resources have differential effects on health according to SES has only been examined in a few studies. Gallo, Bogart, Vranceanu, and Walt (2004) found that women in low status jobs showed greater health benefits from high perceived control compared to women in higher status jobs. Furthermore, there is some evidence that high control beliefs are especially important for health in lower income groups (Lachman & Weaver, 1998). The studies that examined whether social resources are more important for individuals with low SES provide inconsistent results. There are studies reporting varying resources-health associations according to SES (Antonucci, Ajrouch, & Janevic, 2003; Gorman & Sivaganesan, 2007), and others that find no differential effects of social resources at different levels of SES (Grundy & Sloggett, 2003). One reason for such inconsistencies might be the use of different SES indicators.

SES is not only associated with stress, but also reflects health-relevant capabilities that differ at least partly according to SES facet, as outlined in more detail above. This might also imply different (compensatory) effects of optimistic self-beliefs and available support from a social network depending on whether individuals are challenged by low education or low income, for example. Although this is also acknowledged by the developers of the Reserve Capacity Model, who advise researchers to incorporate diverse SES indicators and to distinguish different kinds of resources in their studies (Gallo, 2009), this recommendation has only been taken up by a few studies so far.

Research Question 2: Differential Effects of Psychological and Social Resources on Health According to Socioeconomic Status

Given the theoretical and empirical background outlined above, the main question that will be addressed in the second part of this thesis is: Do psychological and social resources have differential effects on health according to socioeconomic status? Figure 1.2 depicts the proposed moderator role of SES in the association between psychosocial resources and health.

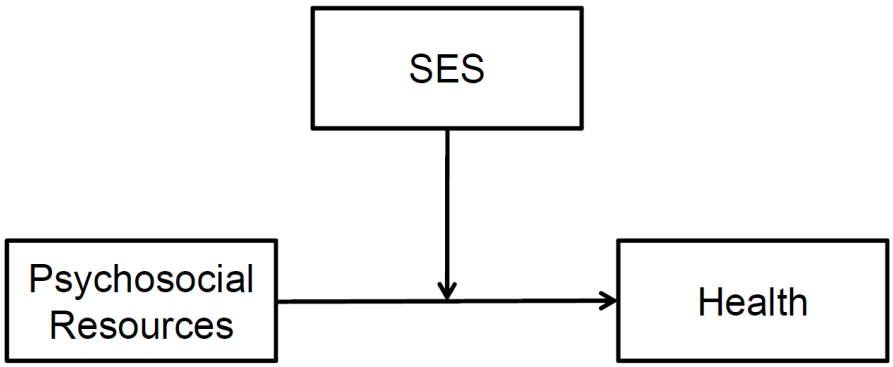

Figure 1.2. SES as a moderator in the association between psychosocial resources and health.

Adding to existing research, it will be explored whether the effects differ depending on SES facet and type of resource. Moreover, theories of human development and aging suggest that resource status also depends on the stage of the life course (e.g., Baltes, 1997). There is some empirical evidence that psychological and social resources are especially important for health at older ages (e.g., Quinn, Johnson, Poon, & Martin, 1999; Sherbourne, Meredith, Rogers, & Ware, 1992). This suggests including age as another moderator to examine the combined effect of lower SES and higher age, both indicators of higher vulnerability, in shaping the resources-health association.

Besides psychosocial resources, emotions are another important component of the Reserve Capacity Model (Gallo & Matthews, 2003). This is outlined in more detail in the

following section, focusing on potential differences in variation in and co-variation between emotions and health across SES groups.

Emotions and Health:
Variation and Co-Variation in Different SES Groups

Research on emotional functioning has demonstrated that it is possible and useful to distinguish broader dimensions of positive affect (PA) and negative affect (NA; Watson, Clark, & Tellegen, 1988). This is also indicated by different developmental trends for PA and NA in later life (Charles, Reynolds, & Gatz, 2001). Research on health, on the other hand, often focuses on specific emotions in examining their impact on disease and disability (Suls & Bunde, 2005). In later life, in particular, the association between affective symptoms of depression and functional health has received considerable attention (Meeks, Murrell, & Mehl, 2000; Ormel, Rijsdijk, Sullivan, van Sonderen, & Kempen, 2002).

Concerning the question of how emotions impact health, several mechanisms have been proposed, including health behavior and physiological mechanisms, that is, the functioning of the immune, endocrine, and cardiovascular system (Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002). Regarding the reverse effect, it can be assumed that persistent health problems such as chronic diseases and functional limitations have detrimental effects on emotional functioning as they are a source of chronic stress and pain and may lead to activity restrictions (Gayman, Turner, & Cui, 2008; Vilhjalmsson, 1998). Empirical results provide some support for both directions of influence, although there has been little direct study of bidirectional associations. A study covering midlife and early old age found, for example, that physical health was prospectively associated with both PA and NA (Burr, Santo, & Pushkar, 2009). Furthermore, there is some evidence that NA has effects in primary causation of

disease (for an overview, see Consedine, 2008). Besides, greater PA was found to be prospectively related to better health, often after controlling for NA (Ostir, Markides, Black, & Goodwin, 2000; Richman, et al., 2005).

Positive and negative emotions play a central role in the Reserve Capacity Model as intermediate mechanisms in the SES-health association (Gallo & Matthews, 2003). Although there is only limited direct evidence for the proposed mediator role (Matthews, et al., 2010), it has been demonstrated that lower SES is linked to higher negative emotions (Gallo & Matthews, 2003), and a positive correlation between SES and PA has been shown in a few studies (Gallo, Bogart, Vranceanu, & Matthews, 2005; Isaacowitz & Smith, 2003).

In sum, there is some evidence that SES does not only affect health but also emotional functioning. It seems likely, however, that these associations are not completely deterministic, but that there is substantial between-person variation in emotions and health *within* SES groups, potential sources being within-group differences in psychosocial resources and contextual circumstances. Two studies using the broader physical and mental component summary measures of the SF-36 and SF-12 (Ware & Sherbourne, 1992) showed that variability was especially pronounced at lower occupational status (Sacker, Head, Gimeno, & Bartley, 2009) and income levels (Ferrer & Palmer, 2004). In particular, there were individuals showing little physical and mental problems despite being socio-economically disadvantaged, which indicates that this is not only a topic of theoretical interest but also of practical relevance as such variation indicates potential for intervention. Given the paucity of research, however, it should first be investigated whether similar results can be obtained for education as another important facet of SES. Besides, only the study by Sacker and colleagues (2009) examined variance in both levels and changes of functioning.

Research Question 3: Variation in Emotions and Health in Different Education Groups

Given the theoretical and empirical background outlined above, the main question that will be addressed in the third part of this thesis is: Does between-person variation in levels and changes of emotions and health differ by education? Variation in levels is graphically displayed in Figure 1.3 for different education groups, reflecting the assumption of larger variability at lower levels of education. The focus here is not on the black lines which indicate the median, but on the grey areas which reflect variation around the median.

Further adding to existing research, this part of the thesis will focus on older adulthood. Differential aging is a central topic of gerontology (e.g., Nelson & Dannefer, 1992), and mean differences *between* SES groups have been discussed as one reason for heterogeneity in old age (Dannefer, 1987). In contrast, the between-person variation in levels and changes of emotional functioning and health *within* SES groups has not been examined specifically in this age group.

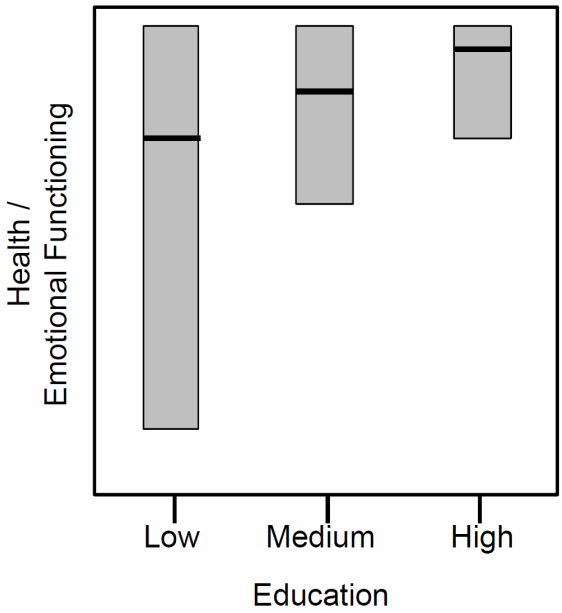

Figure 1.3. Box plot with variation around median levels of health and emotional functioning, respectively, in different education groups.

Moreover, not only the variation in but also the co-variation or cross-domain association between emotions and health might differ according to SES. As has been outlined in more detail above, a central tenet of the Reserve Capacity Model is that those with lower SES have a lower amount of psychosocial resources (Gallo & Matthews, 2003). Thus, they might be less equipped to deal with negative emotions, which are then more detrimental to their health. This explanation was put forward by Merjonen and colleagues (2008) who found that anger was only related to health at low but not higher levels of education in a sample of younger adults. Two studies on samples of middle-aged and older adults focused on financial aspects of SES and provided some evidence for a stronger impact of disability on depression at lower compared to higher levels of income or wealth (Carvalhais, et al., 2008; Smith, Langa, Kabeto, & Ubel, 2005). One explanation for the latter findings is that financial resources help people to deal with practical demands of a disability by enabling the purchase of goods and services. An alternative explanation involves the higher amount of psychosocial resources at higher levels of SES, which help individuals cope with health limitations and buffer their impact on emotional functioning (Bisschop, Kriegsman, Beekman, & Deeg, 2004). All the studies mentioned were either cross-sectional or focused on one direction of influence. As has been explicated above, however, it seems likely that the association between emotions and health is bidirectional.

Research Question 4: Differences in Dynamic Associations Between Emotions and Health According to Education

The fourth part of the present thesis deals with associations between emotional functioning and health in different SES groups, focusing on education and thus complementing the few existing studies on this topic that mainly concentrated on financial aspects of SES. The aim is to answer the following research question: Do dynamic associations between emotions and health differ by education? Given the plausibility of

bidirectional relationships between emotions and health, the present thesis investigates both potential directions of influence (see Figure 1.4). Moreover, both positive and negative emotions are taken into account.

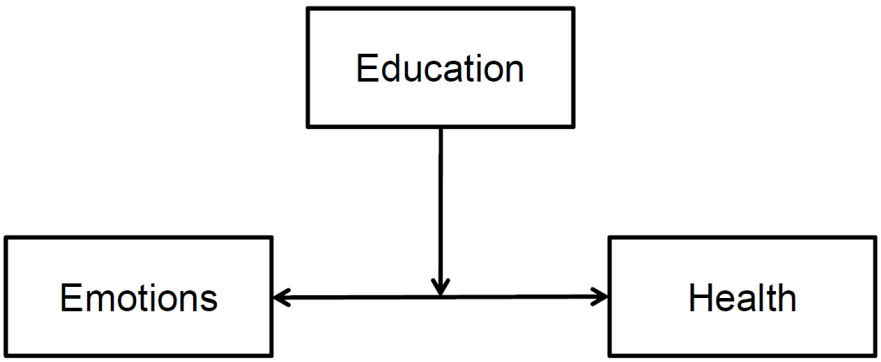

Figure 1.4. Education as a moderator in the potentially bidirectional association between emotions and health.

Study Design

To answer the questions outlined in the last sections, a data set is needed that fulfills several requirements. First, to examine social inequality in health in the second half of life in Germany, a nationwide representative sample of the German population covering a broad age range, that is middle and older adulthood, is essential. Second, a range of variables should be included, that is different facets of SES, diverse aspects of health and psychosocial factors, particularly measures for psychological and social resources as well as positive and negative emotions. Third, the design should allow for cross-sectional and longitudinal analyses. In the following, the study that builds the basis for the analyses of the present thesis will be introduced briefly.

The German Ageing Survey (DEAS) is an ongoing population-based, representative study of community dwelling persons living in Germany, with a cohort-sequential design. The

first sample of 40 to 85 years old people (N = 4,838, born between 1911 and 1956) was drawn in 1996 by means of national probability sampling and was systematically stratified by gender, place of residence (East or West Germany), and age (Engstler & Wurm, 2006). This sample was reassessed in 2002 and 2008. In 2002, another sample of 40 to 85 years old people (N = 3,084, born between 1917 and 1962) was drawn in the same way. This sample was reassessed in 2008. The current, latest baseline sample was drawn in 2008 (N = 6,200, born between 1923 and 1968). The design is displayed in Figure 1.5. As can be seen, it is possible to do cross-sectional analyses, analyses of social change over the points in time 1996, 2002 and 2008, and an investigation of intra-individual development over either six or twelve years (2002-2008, or 1996-2002-2008).

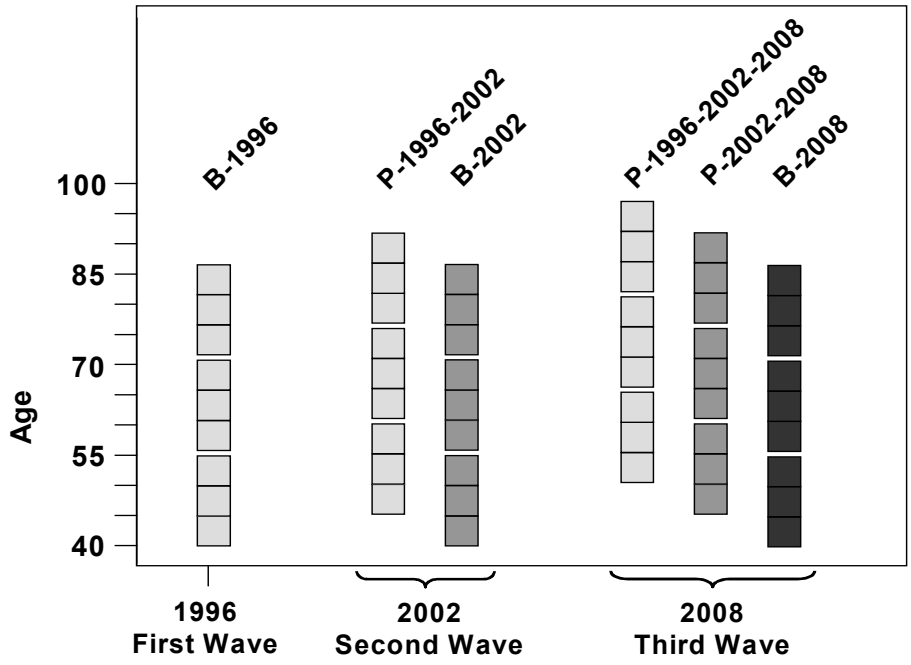

Figure 1.5. Design of the German Ageing Survey.

Data collection occurred via in-home interviews and additional self-administered questionnaires. The personal interviews were conducted by trained interviewers with a standardized questionnaire. The DEAS covers a broad range of topics such as economic and housing situations, social network and social participation, as well as health, well-being and self-beliefs. In most of the analyses of the present thesis, only those participants were included who completed both interview and questionnaire, as information on health and psychological functioning was mainly collected in the questionnaire. The assessment of health and psychological variables was largely expanded in 2002. Cross-sectional analyses of the present thesis thus focus on the 2002 baseline sample, and some longitudinal analyses investigate change over six years, that is, from 2002 to 2008. Other longitudinal analyses even include data collected at all three points in time (1996-2002-2008) as a selection of indicators for health and emotional functioning has been assessed continuously.

Structure of the Present Thesis

The following chapter (Chapter 2) focuses on Research Question 1, that is, whether and how the association between SES and health changes in the second half of life in Germany. Three aspects of both SES (education, income, and wealth) and health (physical health, functional health, and subjective health) are included to examine whether age gradients vary by SES indicator and/or health aspect. These facets were selected due to their theoretical significance and their appropriateness given the age range considered, i.e., middle and older adulthood. The cross-sectional analyses of this chapter, examining both relative and absolute inequalities, are complemented by longitudinal analyses in later chapters (see below).

Research Question 2, whether psychological and social resources have differential effects on health according to SES, builds the core of Chapter 3. It is examined whether effects depend on the particular SES facet (education or income) and type of resource (optimistic self-beliefs or available social support). Furthermore, three-way interactions between SES, psychosocial resources, and age are considered.

The remaining empirical chapters use longitudinal data and focus on emotional functioning and health. In Chapter 4, it is examined whether variation in levels and changes of emotions and health differs by education (Research Question 3). As the focus is on older adulthood (65+ years), affective symptoms of depression and functional health are chosen as indicators due to their particular importance in this age group.

Chapter 5 focuses on the question whether dynamic associations between emotional functioning and health differ by education (Research Question 4). Some information on this question is already provided in the preceding chapter, but analyses are extended here in important ways: First, different indicators are used to distinguish broader dimensions of positive and negative affect, and the focus is on physical health. Second, changes throughout the whole age range from 40 to 85+ years are estimated. Third, a method is used that allows for estimating linear and nonlinear change in both domains of functioning and testing the direction of effects at the same time. Additionally, this chapter and the previous one also provide some longitudinal information on the question whether there are converging, stable, or diverging socioeconomic differences in health in the second half of life in Germany.

The final part of the dissertation (Chapter 6) provides a general discussion of the findings. This chapter closes with an outlook on practical implications of the results.

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Chapter 2

Socioeconomic Status and Health in the Second Half of Life: Findings from the German Ageing Survey

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Abstract

This study examined social inequalities in health in the second half of life. Data for empirical analyses came from the second wave of the German Ageing Survey (DEAS), an ongoing population-based, representative study of community dwelling persons living in Germany, aged 40 to 85 years (N = 2,787). Three different indicators for socioeconomic status (education, income, financial assets as an indicator for wealth) and health (physical, functional, and subjective health) were employed. It could be shown that socioeconomic status was related to health in the second half of life: Less advantaged persons between 40 and 85 years of age had worse health than more advantaged persons. Age gradients varied between status indicators and health dimensions, but in general social inequalities in health were rather stable or increasing over age. The latter was observed for wealth-related absolute inequalities in physical and functional health. Only income-related differences in subjective health decreased at higher ages. The extent of social inequality in health as well as its development over age did not vary by gender and place of residence (East or West Germany). These results suggest that, in Germany, the influence of socioeconomic status on health remains important throughout the second half of life.

Keywords: health, social inequality, second half of life, cumulative advantage, age-as-leveler, continuity

Introduction

Consistently, it has been shown that lower socioeconomic status (SES) is related to worse health (e.g., Adler, et al., 1994; Mackenbach, Kunst, Cavelaars, Groenhof, & Geurts, 1997; Marmot, Ryff, Bumpass, Shipley, & Marks, 1997). From a life-span developmental perspective, it is important to explore whether the strength of this relationship varies with age (Alwin & Wray, 2005). Originally, studies examining social inequalities in health rarely paid attention to older people, but now evidence is mounting that socioeconomic status plays a role for health in later life (e.g., Avendano, Aro, & Mackenbach, 2005; Berkman & Gurland, 1998; Huisman, et al., 2005; Pérès, Jagger, Lièvre, & Barberger-Gateau, 2005). Using data from the representative German Ageing Survey (DEAS), the present paper addresses the question how the SES-health relationship develops over the adult life-span.

Dynamics of Social Inequalities in Health Across the Life-Span

Three contradictory theoretical assumptions concerning the influence of socioeconomic status over the life-span have been discussed in the literature (O'Rand & Henretta, 1999). Proponents of the *cumulation theory* (e.g., Dannefer, 1987; Ross & Wu, 1996) assume that the influence of SES on health increases continuously with age due to a socially stratified cumulation of resources as well as risks over the life-span leading to a cumulative advantage or disadvantage. In the context of minority aging, the double jeopardy hypothesis states that age-related losses in resources amplify the effects of race or SES on health (Dowd & Bengtson, 1978; Ferraro & Farmer, 1996).

In contrast, representatives of the *age-as-leveler hypothesis* suggest that the strength of the SES-health relationship decreases in old age relative to middle adulthood due to a variety of factors. First, retirement may end inequalities in the work context, and social policies may lead to less inequality in old age. Second, biological frailty could account for an accelerated

health decline of high SES people in old age leading to a convergence of the status groups (Herd, 2006). Third, selective survival might also eliminate socioeconomic differences in health in later life (Lynch, 2003). Finally, it has been suggested that the influence of socioeconomic status on health in the second half of life is characterized by *continuity* (O'Rand & Henretta, 1999). This perspective assumes that a person's status in earlier life still exerts an influence in later life and that SES continuously shapes life chances and activities in old age.

Inconsistencies in Empirical Results

Research has provided empirical evidence for all three potential age gradients mentioned above. A decrease of socioeconomic differences in morbidity and mortality in old age supporting the age-as-leveler hypothesis has been found by many investigators (Beckett, 2000; Herd, 2006; House, Lepkowski, Kinney, & Mero, 1994; Marmot & Shipley, 1996). There is, however, also evidence for continuity of social inequalities in health (Marmot & Fuhrer, 2004; Rostad, Deeg, & Schei, 2009; Yao & Robert, 2008), and support for an increasing impact of SES on health over the life-span (Kim & Durden, 2007; Ross & Wu, 1996). The use of different SES and health indicators may be one reason for inconsistent results across studies.

Measuring the *socioeconomic status (SES)* of older adults is particularly difficult. Each of the most widely used indicators — education, income, and occupation — entails problems (Grundy & Holt, 2001). Robert and House (1996) suggested that indicators of wealth like financial assets are more appropriate indicators for older people's SES and reflect cumulative processes better. Moreover, it is increasingly recognized that different SES facets have different meanings and indicate access to different personal resources (e.g., education implies knowledge about health and health behavior, income indicates the ability to purchase health services). Therefore, different indicators of SES cannot be used interchangeably (Geyer &

Peter, 2000). In addition, SES might have a different meaning for women and men. Gender might influence the association between SES and health and its development over age for various reasons, such as differential participation in the labor force (Broese van Groenou, Deeg, & Penninx, 2003; Huisman, Kunst, & Mackenbach, 2003; Lampert, 2000).

Moreover, it has long been recognized that *health* is a multidimensional construct as well. According to Liang (1986) there are three related but distinct aspects: the physical aspect (absence of disease), the functional aspect (capacity for task performance) and the subjective evaluation of one's health (taking into account more of the psychological aspect). Studies that address different health dimensions suggest that social inequalities might develop differently according to the health indicator considered. As Lampert (2000) has shown, for example, using a sample aged 70-100+ years, small socioeconomic differences in multimorbidity (physical aspect of health) up to the age of 90 were followed by significant differences in the group of 90+ years. A contrasting picture emerged for functional health where socioeconomic differences were significant at age 70-79 and disappeared in the older age groups.

Furthermore, there might be differences between countries in the development of social inequalities in health over the life-span due to different health insurance regimes and differences in the extent of social inequalities. As has been already mentioned, most studies seem to find decreasing influences of SES on health in old age, but the majority of these studies have been conducted in the United States and Great Britain. It is not clear whether these results also hold for Germany. One study using several SES and health indicators and a sample limited to an age range of 60 years and older showed only slight age variation in the effect of socioeconomic status on health in Germany, supporting the continuity hypothesis (Knesebeck, Lüschen, Cockerham, & Siegrist, 2003).

Germany, however, has a unique history. Between 1949 and 1989, there existed two German states with distinct differences in political and economic structure. Hence, place of residence, i.e. living in East Germany or West Germany, might be related to health in later life. On average, residents of the former East experienced lower standards of living and a worse health care system relative to those living in the former West. Differences in the treatment of diseases, related to the quality of the health care system, may partly explain differences in more distal health outcomes such as mortality and subjective health that have been reported (Lüschen, Niemann, & Apelt, 1997). Although a general health advantage for those living in West Germany is under debate (Mielck, et al., 2000), two studies found that older East Germans report worse health than their western counterparts, which has been attributed to an overall unfavorable situation for older people in the former East (Hillen, Schaub, Hiestermann, Kirschner, & Robra, 2000; Lüschen, et al., 1997). Of special interest in this context are the effects of region on socioeconomic differences in health. In communist societies such as the former East Germany, for example, income was distributed more equally and was less important for access to goods than in West Germany. Thus, some studies found income-related health inequalities to be greater in West Germany (Mielck, et al., 2000). As the studies mentioned here were conducted shortly after German reunification, an interesting question is whether differences in health as well as in the extent of social inequality in health between East and West Germany are still observed in more recent studies.

The Present Study

Thus far, there are comparatively few studies on the development of social inequalities in health in later life, especially in Germany. Moreover, empirical research has provided inconsistent results. We assume that some of the empirical ambiguity is due to between-study differences in the SES and health indicators used. Therefore, the present study examines the linkages of three SES indicators (education, income, financial assets as an indicator for

wealth) to three health aspects (physical, functional and subjective health). By using data from a nationally representative study covering a broad age range (40-85 years), the analyses allow a comprehensive understanding of the specific German situation regarding social health inequalities in the second half of life. We investigate the association between SES and health in relation to age in order to determine whether social inequality in health is characterized by an increase, decrease, or stability across adult development. An increase in the strength of the SES-health association is expected if the cumulative disadvantage or the age as double jeopardy hypothesis is true. A decreasing influence of SES on health is expected if the age-as-leveler hypothesis is true. Finally, the continuity hypothesis predicts only minor age differences or stability in the SES-health relationship. Theoretical assumptions suggest that gender and place of residence might influence the association between SES and health and its development. Thus, our analyses account for these influences.

Method

Sample

Data for empirical analyses came from the second wave of the German Ageing Survey (DEAS), an ongoing population-based, representative study of community dwelling persons living in Germany, aged 40 to 85 years. Data collection took place in 2002 and occurred via in-home interviews and additional self-administered questionnaires. The sample was drawn by means of national probability sampling. Here, only those respondents were included who completed both interview and questionnaire (N = 2,787), which is 90.4% of the original sample. Selectivity analyses using the method by Lindenberger and colleagues (2002) indicated that selectivity effects for the variables in this study were very small (d < .20; cf. Appendix A, Table A1).

The sample was systematically stratified by gender, region (about one third from East Germany) and age group (about equal proportions of 40-54, 55-69, and 70-85 year-old participants; Engstler & Wurm, 2006). The group of 40-54 year-old people represents those that are predominantly part of the labor force. The 55-69 year-olds are primarily situated shortly before, at, or shortly after the transition to retirement, whereas the oldest age group (70-85 years old) represents those who retired some time ago or the "young old" (e.g., Baltes & Smith, 2003). Information about the sample, by age group and in total, can be found in Table 2.1 (p. 38). Comparing the age groups, it can be seen that especially in the oldest age group a larger proportion of the sample had no partner, low education, low income (with a non-linear age trend regarding financial assets), and poor physical, functional and subjective health.

Measures

Socioeconomic and demographic indicators. Level of education, income, and financial assets were used as SES indicators. Participants reported their highest level of completed *school education* with reference to the German education scheme. Due to the limited extent of differentiation in the oldest age group, where 75% did not obtain any degree or had left school at the compulsory level, only two levels of education were distinguished: low (corresponding to less than 10 years of school education) and medium to high (at least 10 years of school education). Respondents provided the total net *income* per month for the household. To adjust for household size, this was divided by the weighted number of household members according to the new OECD scale[2] (Figini, 1998). Income was divided in tertiles for the analyses. Respondents specified the amount of *financial assets* owned by them or their partners, including bank accounts, life-insurances, and stocks, but excluding real estate. Three categories were distinguished (low: up to 5,000 €, medium: 5,000 € – up to 25,000 €, high:

[2] This scale assigns a value of 1 to the household head, of 0.5 to each additional adult member and of 0.3 to each child.

25,000 € or more) that divided the sample in roughly equal proportions. *Age* was used as a continuous variable but also split into the three groups (40-54 years, 55-69 years, 70-85 years) for some of the analyses. *Gender* (1 = men, 2 = women) and *place of residence* (1 = West Germany, 2 = East Germany) were included in all analyses. Moreover, we controlled for *partner status* (1 = no partner, 2 = partner) to avoid spurious associations of SES and health (Murphy, Glaser, & Grundy, 1997).

Health indicators. Comprehensive health measures were applied to include different aspects of health (Liang, 1986). *Physical health* was assessed by using a checklist of 11 health problems (e.g., cardiovascular diseases, diabetes; see Table A2 for the complete list). A sum score based on the absolute number of self-reported illnesses was computed for each person. Using a sum score has various advantages over the use of single self-reported illnesses, concerning, for example, parsimony and accordance between medical reports and self-reports (Ferraro & Farmer, 1996; Katz, Chang, Sangha, Fossel, & Bates, 1996). Furthermore, global scores of self-reported illnesses turned out to be a good predictor of 1-year mortality (Chaudhry, Jin, & Meltzer, 2005). Suffering from three or more diseases, a criterion that has been employed by other studies (Hewitt, Rowland, & Yancik, 2003), was used as an indicator of poor physical health in this study[3]. *Functional health* was measured by the subscale physical functioning of the SF-36 (version 1.0, Bullinger & Kirchberger, 1998; Ware & Sherbourne, 1992). Impairments in 10 activities (e.g., climbing stairs, walking several blocks) are rated on a three-point scale, higher values indicating less impairment. For the present analyses, a sum score was built and belonging to the lowest quartile of the distribution indicated poor functional health (Sekine, Chandola, Martikainen, Marmot, & Kagamimori, 2006; Stansfeld, Head, Fuhrer, Wardle, & Cattell, 2003). *Subjective health* was assessed by a

[3] Because a large portion (about 60%) of our sample had two or more diseases, we did not use the criterion of two or more diseases (e.g., Avendano et al., 2005). This ensured comparability with the cut off scores for the other two health indicators used here.

single item asking "How do you assess your current state of health?" (1 = very good to 5 = very bad). Consistent with other studies, we used a rating of "less than good", i.e. having a value of three to five, as indicator for poor subjective health (Huisman, et al., 2003; Kunst, et al., 2005).

Table 2.1

Sample Characteristics by Age Group and in Total: Percentage or Mean

Characteristics	40-54 years (n = 959)	55-69 years (n = 941)	70-85 years (n = 887)	Total (N = 2,787)
Age (years)	46.9	62.2	75.9	61.3
Female	51.6	49.2	48.5	49.8
East Germany	34.0	32.8	32.7	33.2
Partner	86.6	83.7	61.0	77.5
School education				
Low	31.9	63.5	75.5	56.5
Medium to high	68.1	36.5	24.5	43.5
Income				
Low	29.0	33.5	40.6	34.2
Medium	29.1	32.8	35.9	32.5
High	41.9	33.7	23.6	33.3
Financial assets				
Low	40.5	35.4	46.7	40.7
Medium	31.5	38.5	32.2	34.1
High	28.0	26.1	21.1	25.2
Physical health				
Three or more diseases	19.4	39.3	59.2	38.3
Functional health				
Lowest quartile	7.3	22.8	49.2	25.9
Subjective health				
Less than good	29.3	43.9	62.5	44.8

Statistical Analysis

Descriptive data analysis was done in SPSS 15.0. All further analyses were done with Mplus version 5.0. To examine the association between SES and health, we firstly estimated logistic regression models, containing the SES indicator, age, gender, place of residence and partner status as predictors. In the models examining the effect of income and financial assets, we also controlled for education. SES variables were treated as categorical, the most advantaged group being the reference category. Odds Ratios (OR) and 95% confidence intervals (CI) were estimated.

Age differences in the association between SES and health were explored in several ways. First, we added interaction terms between age and the SES indicator to the logistic regression models and tested whether this improved model fit significantly (Tabachnick & Fidell, 2007). A significant interaction suggests that relative differences in odds between the status groups vary by age. The interplay between SES, gender and place of residence, and age was examined by adding two- and three-way interaction terms to the regression models.

We also estimated absolute effects and absolute differences on a risk scale. For this purpose, we created dummy variables for the combination between socioeconomic status and three age groups (40-54 years, 55-69 years, 70-85 years), treating the 40-54 year-olds with high SES as reference group. The odds ratios obtained from these models, again controlling for the covariates, were calculated into risk ratios (Zhang & Yu, 1998). Finally, the risk ratios were multiplied with the prevalence rate in the reference group to estimate absolute effects, i.e. rates of poor physical, functional and subjective health by level of SES and age group. Applying model constraints (Muthén & Muthén, 1998-2007), we tested if rate differences between the two education groups were significant for each age group and whether they varied between age groups. For income and financial assets, we tested if there was a

significant linear increase in rates with decreasing socioeconomic status and whether this effect differed between the age groups.

Single missing values were supplemented by data imputation with the expectation maximization method (Dempster, Laird, & Rubin, 1977). Results were compared to those obtained by including only participants who provided complete data; the results were virtually identical.

We included the stratification variables age, gender, and place of residence in all analyses. Methodological studies have shown that unbiased coefficients are obtained if variables on which sampling is based are included in the models, nullifying the need for sample weights (Winship & Radbill, 1994). Repeating analyses with weighted data yielded largely equivalent results.

Results

The Association Between Socioeconomic Status and Health Over Age

Results are presented for each SES indicator (education, income, and financial assets) separately. Tables 2.2, 2.4, and 2.6 display ORs and 95% CIs obtained with logistic regressions. Tables 2.3, 2.5, and 2.7 show rates and rate differences across age and SES groups controlled for covariates. Statistically significant effects ($p < .05$) are indexed by an asterisk. Whether or not interactions between SES and age were significant can be found in the last rows of Tables 2.2, 2.4, and 2.6 and in the last columns of Tables 2.3, 2.5, and 2.7. In the text, we also report marginally significant results ($p < .10$) with exact p-values.

Education. As can be seen in Table 2.2a (p. 41), education was significantly related to physical health, functional health, and subjective health after adjusting for covariates (ps < .05). The interaction between education and age was not significant in any case (Table 2.2b).

Table 2.3 (p. 42) shows that level of education accounted for significant rate differences in poor physical and functional health in all age groups (*p*s < .05). For subjective health, level of education accounted for rate differences in the youngest and middle age group only (*p*s < .05), and just failed to reach significance for the oldest age group (*p* = .07). The rate differences due to education did not vary between age groups (interaction physical health: *B* = -0.01, *SE* = 0.03, *ns*; functional health: *B* = 0.03, *SE* = 0.02, *ns*; subjective health: *B* = -0.02, *SE* = 0.03, *ns*).

Table 2.2

Education and Health Over Age: Results of the Logistic Regression Models

(a) Main effects: Odds ratios (and 95% CIs) of poor physical, functional, and subjective health, by education and covariates

Predictor	Physical health		Functional health		Subjective health	
Gender (female)	0.95	(0.81-1.08)	1.74 *	(1.43-2.13)	0.90	(0.77-1.06)
Place of residence (East Germany)	1.11	(0.93-1.31)	1.16	(0.94-1.41)	1.33 *	(1.13-1.58)
Partner status (partner)	0.88	(0.72-1.08)	0.69 *	(0.55-0.87)	0.74 *	(0.61-0.90)
Age	1.06 *	(1.05-1.07)	1.09 *	(1.08-1.10)	1.04 *	(1.03-1.05)
Education (low)	1.43 *	(1.19-1.71)	1.57 *	(1.27-1.94)	1.50 *	(1.27-1.78)

(b) Interaction effect: Interaction between education and age

$\Delta\chi^2$ (1)	0.26 (*ns*)	0.17 (*ns*)	0.46 (*ns*)

Note. Reference categories for categorical predictors: male; West Germany; no partner; medium to high education.
*$p < .05$.

Table 2.3

Rates (%) of Poor Physical, Functional, and Subjective Health in the German Ageing Survey (N=2,787), by Level of Education and Age Group. Rate Difference by Age Group

	Medium-high education	Low education	Difference between levels of education	Interaction: Education by age
Physical health				
40-54 years	16.3	26.9	10.6 *	
55-69 years	35.0	42.2	7.2 *	*ns*
70-85 years	51.7	60.6	8.9 *	
Functional health				
40-54 years	5.7	11.3	5.6 *	
55-69 years	17.7	26.6	8.9 *	*ns*
70-85 years	40.0	50.8	10.8 *	
Subjective health				
40-54 years	26.5	37.1	10.6 *	
55-69 years	35.5	49.6	14.1 *	*ns*
70-85 years	56.2	63.1	6.9	

Note. Controlled for gender, place of residence, and partner status.
*$p < .05$.

Income. Table 2.4a (p. 43) shows that after controlling for confounders, income was significantly related to functional health and subjective health (ps < .05) but not to physical health (p = .09 for low income). The interaction between income and age was not significant for physical health and functional health, but was significant for subjective health (p < .05, Table 2.4b). The interaction effect was mainly due to the decreased influence of low income on subjective health at higher ages. For physical health, statistical tests revealed no significant linear increase in rates of poor health with decreasing income in any age group (Table 2.5, p. 44) and no significant variation in rate differences due to income between age groups (interaction: B = 0.00, SE = 0.01, *ns*). There was a significant linear increase in rates of poor functional health with decreasing income in the youngest and oldest age group (ps < .05), but not in the middle age group (p = .06). The effects due to income did not differ significantly

between the age groups (interaction: $B = 0.02$, $SE = 0.01$, *ns*). For subjective health, there was a significant linear increase in rates of poor health with decreasing income for the youngest and middle age group (*p*s < .05), but not for the oldest age group. The significant interaction ($B = -0.06$, $SE = 0.03$, $p < .05$) points to smaller rate differences in subjective health due to income in the oldest age group.

Table 2.4

Income and Health Over Age: Results of the Logistic Regression Models

(a) Main effects: Odds ratios (and 95% CIs) of poor physical, functional, and subjective health, by income and covariates

Predictor	Physical health		Functional health		Subjective health	
Gender (female)	0.95	(0.80-1.12)	1.71 *	(1.40-2.01)	0.89	(0.76-1.04)
Place of residence (East Germany)	1.06	(0.89-1.27)	1.02	(0.83-1.26)	1.20 *	(1.01-1.43)
Partner status (partner)	0.89	(0.73-1.10)	0.72 *	(0.57-0.90)	0.77 *	(0.63-0.94)
Education (low)	1.35 *	(1.11-1.64)	1.33 *	(1.06-1.67)	1.31 *	(1.09-1.57)
Age	1.06 *	(1.05-1.07)	1.09 *	(1.08-1.10)	1.04 *	(1.03-1.05)
Income (medium)	1.11	(0.89-1.38)	1.28	(0.98-1.66)	1.27 *	(1.03-1.55)
Income (low)	1.22	(0.97-1.52)	1.78 *	(1.36-2.31)	1.63 *	(1.31-2.01)

(b) Interaction effect: Interaction between income and age

$\Delta\chi^2$ (2)	0.58 (*ns*)	1.19 (*ns*)	7.93 *

Note. Reference categories for categorical predictors: male; West Germany; no partner; medium to high education; high income.
*$p < .05$.

Table 2.5

Rates (%) of Poor Physical, Functional, and Subjective Health in the German Ageing Survey (N=2,787), by Level of Income and Age Group. Rate Difference by Age Group

	High income	Medium income	Low income	Linear difference between levels of income	Interaction: Income by age
Physical health					
40-54 years	16.2	21.4	19.0	1.6	
55-69 years	33.3	32.5	40.0	3.3	*ns*
70-85 years	52.9	52.7	53.7	0.5	
Functional health					
40-54 years	4.2	6.0	11.3	3.5 *	
55-69 years	17.2	19.2	23.5	3.3	*ns*
70-85 years	35.7	40.8	48.1	6.4 *	
Subjective health					
40-54 years	21.9	27.2	36.8	7.4 *	
55-69 years	33.0	39.4	45.7	6.4 *	*
70-85 years	54.9	54.6	56.8	1.1	

Note. Controlled for gender, place of residence, partner status, and education.
*$p < .05$.

Financial assets. In the overall sample, physical health was largely unrelated to financial assets after controlling for confounders (p = .07 for low assets), as can be seen in table 2.6a (p. 45). In contrast, functional and subjective health were significantly associated with financial assets (ps < .05). For physical health, adding the interaction coefficients between financial assets and age to the regression did not significantly improve model fit (Table 2.6b). However, a post hoc test revealed that the positive interaction between low financial assets and age just failed to reach significance ($\Delta\chi^2$ (1) = 3.32, p = .07). For functional health and subjective health, adding the interaction terms hardly changed model fit (Table 2.6b). Analyses of rates and rate differences are depicted in Table 2.7 (p. 46). For physical health, there was a significant linear increase in rates of poor health with decreasing financial assets for the middle and oldest age group (ps < .05), but not for the youngest age

group. The significant interaction (B = 0.03, SE = 0.01, $p < .05$), pointed to greater absolute differences in poor physical health due to financial assets at higher ages. For functional health, there was a significant linear increase in rates of poor health with decreasing financial assets for all age groups (ps < .05). Again, the significant interaction indicates greater rate differences at higher ages (B = 0.04, SE = 0.01, $p < .05$). Linear increases in rates of poor subjective health with decreasing financial assets were significant in each case (ps < .05) but did not vary between age groups (interaction: B = 0.03, SE = 0.03, *ns*).

Table 2.6

Financial Assets and Health Over Age: Results of the Logistic Regression Models

(a) Main effects: Odds ratios (and 95% CIs) of poor physical, functional, and subjective health, by financial assets and covariates

Predictor	Physical health		Functional health		Subjective health	
Gender (female)	0.94	(0.79-1.11)	1.66 *	(1.36-2.04)	0.86	(0.73-1.02)
Place of residence (East Germany)	1.07	(0.90-1.24)	0.99	(0.81-1.22)	1.20 *	(1.01-1.42)
Partner status (partner)	0.91	(0.74-1.13)	0.79 *	(0.62-0.99)	0.82	(0.67-1.00)
Education (low)	1.37 *	(1.14-1.65)	1.29 *	(1.03-1.61)	1.32 *	(1.11-1.58)
Age	1.06 *	(1.05-1.07)	1.09 *	(1.08-1.10)	1.04 *	(1.03-1.05)
Fin. assets (medium)	1.05	(0.84-1.32)	1.56 *	(1.18-2.07)	1.28 *	(1.03-1.59)
Fin. assets (low)	1.23	(0.98-1.55)	2.62 *	(1.99-3.46)	1.91 *	(1.54-2.38)

(b) Interaction effect: Interaction between financial assets and age

$\Delta\chi^2$ (2)	3.87 (*ns*)	1.51 (*ns*)	0.50 (*ns*)

Note. Reference categories for categorical predictors: male; West Germany; no partner; medium to high education; high assets.
*$p < .05$.

Table 2.7

Rates (%) of Poor Physical, Functional, and Subjective Health in the German Ageing Survey (N=2,787), by Financial Assets and Age Group. Rate Difference by Age Group

	High assets	Medium assets	Low assets	Linear difference between levels of assets	Interaction: Assets by age
Physical health					
40-54 years	19.8	19.4	17.9	-0.9	
55-69 years	33.5	34.8	38.6	2.4 *	*
70-85 years	48.3	50.5	58.8	5.8 *	
Functional health					
40-54 years	3.4	5.6	10.3	3.9 *	
55-69 years	13.4	19.9	25.9	7.7 *	*
70-85 years	30.9	38.0	53.4	11.4 *	
Subjective health					
40-54 years	22.8	26.1	34.0	5.8 *	
55-69 years	34.0	37.6	47.5	6.9 *	*ns*
70-85 years	45.0	54.7	63.9	9.4 *	

Note. Controlled for gender, place of residence, partner status, and education.
*$p < .05$.

Effects of Gender and Place of Residence

As can be seen in Tables 2.2, 2.4, and 2.6, gender was significantly related to functional health above and beyond the other predictors (*p*s < .05). Further analyses (results not shown) revealed a tendency for stronger gender differences with increasing age to the disadvantage of older women (model with education: $p = .08$, model with income: $p = .09$, model with assets: $p = .05$). Moreover, people living in East Germany were more likely to report poor subjective health (*p*s < .05). For physical health as the outcome, there was a consistent significant interaction between age and place of residence (*p*s < .05). Age had a stronger influence for people living in East Germany than for their western counterparts. We did not, however, find stable and statistically significant interactions between SES and

gender, SES and place of residence, or between SES, gender/place of residence and age on any health outcome (results summarized in Appendix A3).

Discussion

This study examined social inequalities in health in the second half of life, using data from the German Ageing Survey (DEAS). Socioeconomic status was related to health in the second half of life: In general, less advantaged persons between 40 and 85 years of age had worse health than more advantaged persons. Our analyses showed that age gradients of social inequalities in health vary between SES indicators (education, income, financial assets), health dimensions (physical, functional, subjective) and measure (absolute vs. relative differences). A summary of results is displayed in Table 2.8.

Table 2.8

Summary of Results for the Relation Between Socioeconomic Status and Health in the Second Half of Life

SES facet	Measure	Physical health	Functional health	Subjective health
Education	Relative difference	Stability	Stability	Stability
	Absolute difference	Stability	Stability	Stability
Income	Relative difference	---	Stability	Decrease
	Absolute difference	---	Stability	Decrease
Financial assets	Relative difference	---	Stability	Stability
	Absolute difference	Increase	Increase	Stability

SES and Health in the Second Half of Life

Education had a stable effect on all three health measures across the adult life-span both in terms of relative differences in odds and absolute or rate differences between the groups. Hence, for education, our results lend some support to the continuity hypothesis. The educational background continuously shapes life chances and activities and thus influences health across the entire life-span, including old age.

Income was unrelated to physical health, exerted a stable influence across the second half of life on functional health, and had a decreasing influence on the subjective health of the oldest adults. Hence, for income, the results provide some evidence for the continuity hypothesis for functional health and the age-as-leveler hypothesis for subjective health.

Particularly in later life, income only partially reflects the financial situation. Thus, we used wealth indicated by financial assets as an additional predictor, which might also reflect cumulative processes over the life-span (e.g., Robert & House, 1996). For financial assets, we found a more complex picture. The association between financial assets and physical health increased with age, although the interaction only reached significance for absolute health inequalities (rate differences). The influence of financial assets on functional health was stable over age if one looks at relative differences in odds and increased with age if one looks at absolute or rate difference between the status groups. There was little age variation in the robust relationship between financial assets and subjective health. Hence, for financial assets, both cumulative (dis)advantage and continuity hypothesis seem plausible.

When analyzing the age gradient in the association between financial assets and functional health, we obtained differential results depending on the measure, i.e. relative differences in odds vs. absolute differences in rates. This difference is caused by the interaction of strong (relative) rate differences between asset groups at younger ages and the

strong age effect on functional health. To illustrate this, we predicted age trends for poor functional and subjective health by combining the linear increases associated with age with the rate differences between financial asset groups at younger ages (mean age = 46 years). The results are displayed in Figure 2.1.

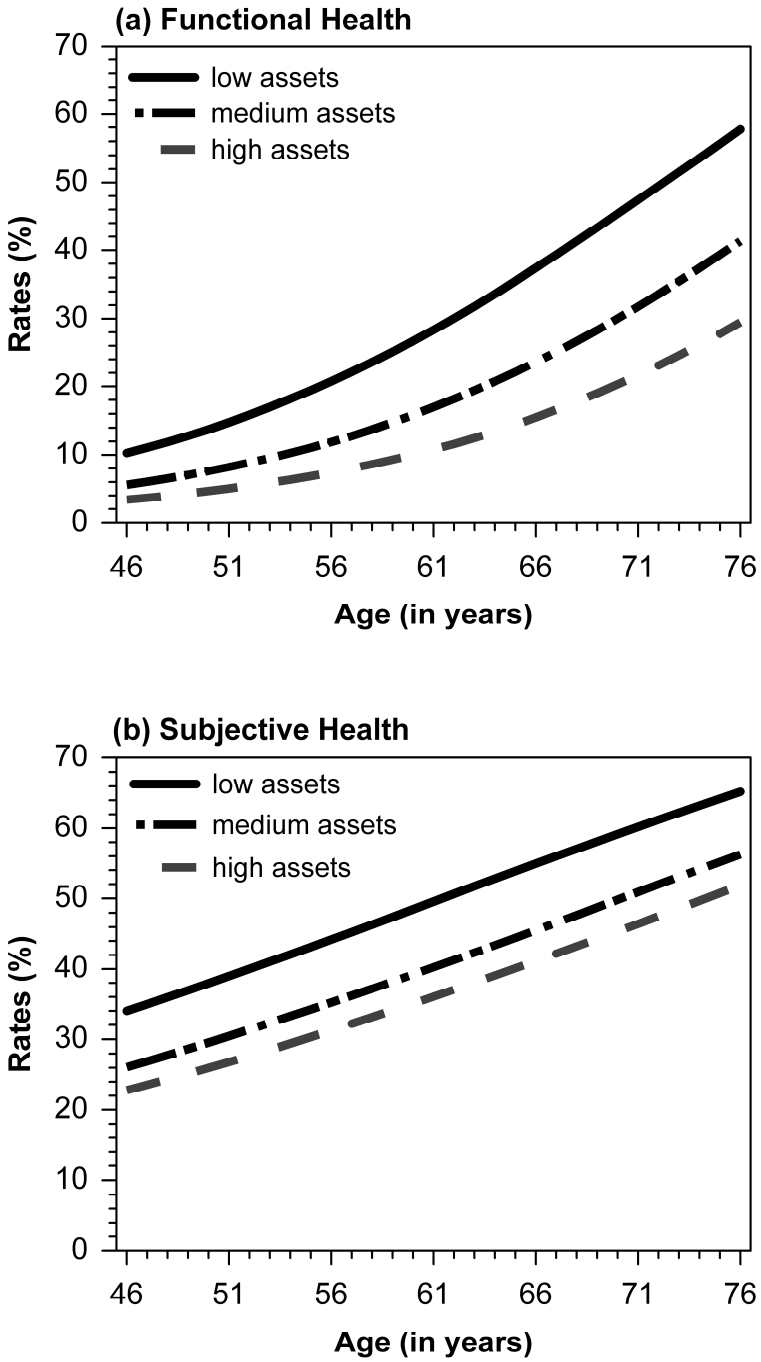

Figure 2.1. Age trends in rates of poor functional health (a) and poor subjective health (b) for three groups with different amount of financial assets (low, medium, high).

Figure 2.1 shows that these two factors lead to increasing absolute or rate differences in functional health (Figure 2.1a) but not in subjective health (Figure 2.1b), because in contrast to functional health the relative rate differences in subjective health at younger ages were smaller and the age trend less pronounced. In summary, although the relative increase of risk of poor functional health with age was the same for people belonging to different financial asset groups (continuity), looking at the greater absolute differences in rates at older ages one might still speak of a cumulation effect at the population level.

These results fit into the broader discussion on how to define and measure cumulative effects (Willson, Shuey, & Elder, 2007). Ideally, one would have to take into account the duration of exposure to certain factors, which makes it more likely to find diverging health inequalities for income as well (Kim & Durden, 2007). Moreover, as our results suggest, different perspectives, reflected by different measures, should be taken into account.

Continuity and Cumulation, But No Leveling Off?

In contrast to other studies, our results point to the continuity and the cumulative (dis)advantage hypothesis (only the association between income and subjective health decreased with age). Why is this the case? First of all, we did not include a measure of (former) occupational status in the analyses. The age trend may differ for this indicator as occupationally based measures most closely represent working conditions, which might lose their relevance for health upon retirement. Secondly, the oldest participants were 85 years of age, thus our sample does not include the oldest old. As some of the processes being discussed as potential sources of decreasing inequalities in old age, i.e. biological frailty, may have a stronger impact in the most advanced ages, this might have prevented us from detecting such changes.

The third reason might be a theoretically substantial one. The finding of continuing social inequalities across the life-span could be a consequence of the societal context. In contrast to the American health system, no change in the health insurance regime is associated with becoming 65 years in Germany. Furthermore, as there are greater social inequalities in health during midlife in the United States compared to Germany, the SES-health association in the USA might be attenuated in old age to a greater extent due to a stronger influence of selective mortality in earlier stages of life. These facts render the age-as-leveler hypothesis less likely in Germany (see also, Knesebeck, et al., 2003). One has to keep in mind, however, that there are German studies as well as European-wide studies including German samples that find decreasing inequalities in health with increasing age for some health indicators and in some subsamples (Huisman, et al., 2003; Lampert, 2000).

Effects of Gender and Place of Residence

Apart from replicating the well-known gender difference in functional health (e.g., Arber & Ginn, 1993), which is especially pronounced at higher ages, we did not find any systematic effects of gender. Of special interest was whether gender influences the degree of social inequality in health as well as its development over age, which was not the case. This is in line with other studies on this topic (e.g., Arber & Ginn, 1993). In contrast, Huisman and colleagues (2003) found that the influence of socioeconomic status decreased over age for women but not men. However, their sample was slightly older than ours, which might partly explain the inconsistencies between the studies.

We also looked at the effects of place of residence. Interestingly, more than a decade after German reunification, we still found people living in East Germany to be more likely to report poor subjective health than those living in West Germany. We also found older people in East Germany to be particularly disadvantaged with regard to physical health. This replicates and extends results from studies that were conducted shortly after the political

transition in 1989 (e.g. Hillen, et al., 2000; Lüschen, et al., 1997). Contrary to some of these studies, however, we did not find meaningful differences in the degree of health inequality and in age trends according to place of residence. In former communist societies, such as East Germany, income had been distributed more equally and was not such an important indicator for access to goods. After the political transition, however, income inequalities became greater in East Germany, which might have reduced differences in the extent of income-related health inequality between East and West Germany in the present study.

Limitations

The cross-sectional nature of the data set limits the interpretation of the results. No stringent conclusions about causality can be made. Particularly in the case of income and financial assets as indicators of SES, it would have been equally plausible for deterioration in health to exert a negative influence on socioeconomic status, at least for the younger groups. Although other studies suggest that these selection effects are not primarily responsible for social inequalities in health (Blane, Smith, & Bartley, 1993; Chandola, Bartley, Sacker, Jenkinson, & Marmot, 2003), this effect cannot be ruled out completely. Moreover, cross-sectional analyses confound age and cohort effects, which might cancel each other out (Lynch, 2003). In general, longitudinal data are preferable for investigating the processes unfolding over the life-span which underlie the hypotheses examined here.

Another limitation concerns the composition of the sample. The fact that institutionalized people are not included in the baseline samples of the German Ageing Survey limits the generalizability of the results. Moreover, as both poor health and low socioeconomic status are linked to higher risk of institutionalization (Gaugler, Duval, Anderson, & Kane, 2007), we probably underestimated SES differences in health in the oldest group (see also, Huisman, et al., 2003).

A final concern regards the indicators used. Firstly, the categorization we used for the SES indicators could be open to criticism. Concerning education, we distinguished only two levels as a large majority of the oldest age group had a low education. Regarding income, a study by Grundy and Sloggett (2003) found more consistent relations to a variety of health indicators than we did. Their income measure distinguished recipients of income-support from non-recipients only. While this might be more meaningful than using tertiles, it is an indicator of poverty and thus ignores some of the health differences between status groups. Secondly, health was measured only by self-reports. It thus cannot be concluded without doubt that the present findings generalize to objective measures of physical health. A high accordance between self-reported health and physician-evaluated health has been shown, however, for physical health (e.g., Bush, Miller, Goldsen, & Hale, 1989). Moreover, equally large educational inequalities in self-reported and performance-based measures of functional health and disability have been reported for older adults from the Netherlands (Huisman, et al., 2005).

Addressing Mechanisms: Outlook on Future Analyses

Future research needs to examine the mechanisms underlying the association between socioeconomic status and health in the second half of life. In this context, it should be considered that the influence of SES indicators varies by health aspect. Our results show that education was more consistently related to poor physical health than the financial indicators. Income, which was completely unrelated to physical health, was significantly related to functional and subjective health. We argue that this pattern of results is due to different mechanisms linking SES factors to varying aspects of health. Education exerts its influence on health via knowledge, attitudes towards health and health behavior (e.g., Geyer & Peter, 2000): These factors are relevant for the prevention of disease. In contrast, financial resources may be more important for dealing with and adapting to existing health problems. In line with

this view, a study by House and colleagues (2005) showed that education was more important for the onset of health problems, whereas income and financial assets were more relevant for the progression of functional limitations. In addition, it should be analyzed whether mechanisms relating SES to health differ over age. One of the few studies on this topic indicated that while health behavior mediated the association between education and functional health in a group of 55-70 year-old people, for older people psychosocial resources (control beliefs, social support) became more relevant (Koster, et al., 2006).

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Chapter 3

Resources for Health:

Differential Effects of Optimistic Self-Beliefs and Social Support According to Socioeconomic Status

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Abstract

Objective: This study examined whether socioeconomic status (SES) determines the degree to which psychological and social resources such as optimistic self-beliefs and social support affect health. *Design:* We used data from the representative German Ageing Survey (N = 2,454, aged 40-85 years). Structural equation modeling was employed to examine whether relationships between psychological (self-esteem, control beliefs, optimism) and social resources (perceived emotional and informational support, network size) and health differ between education and income groups. *Main Outcome Measures:* Self-reported physical health, functional health, and subjective health. *Results:* Psychological resources positively affected health in all groups, but were stronger predictors of functional and subjective health in low compared to higher educated participants. A higher level of social resources was associated with better functional and subjective health mainly in the low income group. Social resources were particularly important for financially disadvantaged older people. *Conclusion:* Our results provide evidence for differential effects of optimistic self-beliefs and social support on health depending on whether individuals are challenged by low incomes or low education. Future research, especially aimed at intervention, should consider that different aspects of SES have differential meanings and that the impact of health-protective factors may vary according to SES facet.

Keywords: socioeconomic status, health, psychosocial resources, optimistic self-beliefs, social support

Introduction

Health depends on a range of resources, which can be even more important for individuals who are at specific risks for worsening health, such as people on the lower end of the socioeconomic ladder. Socioeconomic status (SES) is one of the key factors affecting health, and there is evidence that this influence pertains to later life (e.g., Schöllgen, Huxhold, & Tesch-Römer, 2010). However, there is considerable variation in health at different levels of the SES continuum (Ferrer & Palmer, 2004), which suggests that there might be third factors affecting this association. Furthermore, SES is a multifaceted construct, which leaves the question of whether resources work differently in different facets of SES. This study examines whether individual differences in education and income determine the degree to which psychological and social resources such as optimistic self-beliefs and social support affect health, using the Reserve Capacity Model (Gallo & Matthews, 2003) as theoretical background.

The Reserve Capacity Model

The Reserve Capacity Model (Gallo & Matthews, 2003) explains the links between individual resources, SES and health and assumes (a) that low SES constitutes a major stressor to health, (b) that low SES challenges the individual reserve capacity (resource status), and (c) that SES differences translate into health outcomes by cognitive, emotional and behavioral pathways, depending on the resource status. Optimistic beliefs about the self and social support in particular have been discussed as resources for health (Gallo, 2009). The model implies that these psychological and social resources are primarily relevant for health at high levels of stress, and thus at low SES.

Psychological and Social Resources for Health: Differential Effects According to SES

Socio-economically disadvantaged individuals encounter more stressors in their physical and social environment (e.g., Adler & Snibbe, 2003) than less disadvantaged people. SES is not only associated with stress, but also reflects capabilities that are relevant for adopting and maintaining healthy lifestyles. Education, occupation, and income are central determinants of the ability and the opportunities to control everyday life and to shape one's future in positive ways (Ross & Mirowsky, 2003).

Besides environmental factors and actual abilities, optimistic self-beliefs are highly relevant *psychological resources* for lifestyles and health. Control beliefs, i.e. beliefs about one's ability to influence important aspects of life, are important predictors of health-related goal setting, health behaviors and, subsequently, health (Bandura, 1997; Seeman & Seeman, 1983). Similarly, positive expectations about one's future (optimistic future orientation) are related to healthy lifestyles and better health (e.g., Steptoe, Wright, Kunz-Ebrecht, & Iliffe, 2006). Self-esteem is also thought to positively affect health, as high levels of self-esteem both buffer external stressors (O'Donnell, Brydon, Wright, & Steptoe, 2008) and make people feel that their life is such that investing health behaviors is worthwhile (McAuley, Blissmer, Katula, Duncan, & Mihalko, 2000). Studies have shown that such optimistic self-beliefs are correlated and load on a single factor (e.g., Rini, Dunkel-Schetter, Wadhwa, & Sandman, 1999), which is in line with the assumption of the Reserve Capacity Model that resources tend to aggregate (Gallo & Matthews, 2003).

Optimistic beliefs could also fulfill a compensatory function, which would imply stronger health effects in low-SES individuals. In line with this moderator assumption, Gallo, Bogart, Vranceanu, and Walt (2004) found that control beliefs had stronger effects on health in women in low status jobs compared those in higher status jobs. Furthermore, there is some

evidence that high control beliefs are especially important for health in lower income groups (Lachman & Weaver, 1998).

Social resources are important for health as well (for an overview see, e.g., Cohen, 2004). Individual perceptions of the availability of helpful relations within a social network are especially beneficial, because they constitute an individual-level resource that moderates individual appraisals and buffers detrimental emotional and physiological reactions to stressful events (Cohen & Wills, 1985; Uchino, 2006). This has been suggested as a major pathway for social support influencing health. Individual perceptions of available support and the actual structure of networks do not necessarily correspond closely, but integration of these perspectives has been suggested by asking individuals about potentially helpful relations within their social network (Uchino, 2006). This approach takes into account that a larger network, especially a greater amount of close relationships, reflects more potential support.

Evidence for the question whether social resources are more important for the health of the socio-economically disadvantaged is inconclusive. There are studies reporting varying resources-health associations according to SES (e.g., Antonucci, Ajrouch & Janevic, 2003; Gorman & Sivaganesan, 2007), and others that find no differential effects of perceived support at different levels of SES (Grundy & Sloggett, 2003). One reason for such inconsistencies might be the use of different SES indicators. Social science research suggests that SES is multifaceted. Education and income are important dimensions as they - albeit related - represent partly different health-relevant capabilities (e.g., Herd, Goesling, & House, 2007). This is acknowledged by the developers of the Reserve Capacity Model who suggest incorporating multiple SES facets and different resources in studying their interplay (Gallo, 2009; Gallo & Matthews, 2003). However, this recommendation has only been taken up by a few studies so far. Vitaliano et al. (2001), for example, showed that social support was more health-promoting for individuals with lower incomes, but found no differential effects of

perceived support according to education. This might be due to the fact that income, in contrast to education, reflects the ability to buy assistance and help (Geyer & Peter, 2000). Thus, social support should have stronger effects on individuals with low income, because potentially available support from a private network may compensate for the lack of professional services.

Age, Socioeconomic Status, and Psychosocial Resources

In the Reserve Capacity Model, the amount and impact of resources depends on SES. However, theories of human development and aging suggest that resource status also depends on the stage of the life course (e.g., Baltes, 1997). There is some empirical evidence that psychological and social resources are especially important for health at older ages (e.g., Sherbourne, Meredith, Rogers, & Ware, 1992). This suggests examining age as moderator for the role of resources for health in different SES groups. Lower SES *combined with* higher age, both indicators of higher vulnerability, might be cumulative stressors for health. Psychosocial resources might thus be most important for the health of older people with low SES.

The Present Study

This study examines differential effects of psychological and social resources for health in SES groups using a multifaceted approach by differentiating income and education. Two general assumptions guide our expectations. First, individuals with lower SES are disadvantaged with regard to both stress and health-relevant capabilities compared to those with higher SES. Optimistic self-beliefs and social support might compensate for some of these deficits, having stronger effects in low SES individuals. More specifically, as both low education and low income reflect a reduced ability and limited opportunities to control everyday life and to shape one's future in positive ways, we hypothesize that psychological

resources (optimistic self-beliefs) have stronger effects on health at both low education and low income as compared to higher education and higher income levels (Hypothesis 1).

Second, different facets of SES, albeit related, have partly different implications. For example, income, unlike education, reflects the ability to buy assistance and help. We thus assume that social resources (available support from a social network) show stronger associations with health at low compared to higher income levels, whereas we expect no differential effects of social resources on health according to level of education (Hypothesis 2). Finally, we will explore whether age *and* SES interact in modifying the association between psychological and social resources and health.

Method

Sample

Data are taken from the German Ageing Survey (DEAS), an ongoing population-based, representative study of community-dwelling adults in Germany aged 40 to 85 years. Data was collected in 2002 (in-home interviews and self-administered questionnaires). The sample was drawn by means of a national probability sampling and was systematically stratified by gender, place of residence (33.3% from East and 66.7% from West Germany) and age group (about equal proportions of 40-54, 55-69, and 70-85 years old participants; Engstler & Wurm, 2006). Interviews were conducted with 3,084 people. For this study, we included only those who completed both interview and questionnaire, as health-related information was collected in the questionnaire. We also excluded participants with missing information on education or income to form grouping variables, which leaves a final sample of 2,454 people.

Measures

Socioeconomic status. Participants were asked to report their highest level of school education with reference to the German education scheme. As more than 50% had low education, only two levels of education were distinguished to avoid unequal group sizes: low (corresponding to less than 10 years of school education; 56.9% of the sample) and high (at least 10 years of school education; 43.1% of the sample). For income, participants were asked to provide the total net income per month for the household. To adjust for household size, this was divided by the equivalent weights of the household members according to the new OECD scale (Figini, 1998). Income was divided in tertiles for the analyses. Such categorization of income is frequently used in research on social inequalities in health, as it has been shown that there is no linear relationship between income and health (e.g., Herd et al., 2007).

Health. Physical health was assessed by summing up answers to a checklist of 11 health problems (e.g., cardiovascular diseases, diabetes, gastrointestinal diseases). Such sum scores have proved valid in comparison to medical records (Katz, Chang, Sangha, Fossel, & Bates, 1996). The sum score was reverse scored, so that higher values indicate better health. Functional health was assessed using the physical functioning subscale of the SF-36 (Ware & Sherbourne, 1992). Impairments in 10 everyday activities (e.g., climbing stairs, carrying shopping bags) are rated on a three-point scale, higher values indicating less impairment. A sum score was built. Subjective health was assessed using a single item asking "How do you assess your current state of health?" (1 = very bad to 5 = very good).

Psychological and social resources. Self-esteem was measured with the German version of the Rosenberg scale (Cronbach's Alpha = .82; Ferring & Filipp, 1996). To assess general control beliefs, we used the Hope Scale (Snyder et al., 1991). It assesses the belief that one can achieve goals (agency; 4 items) and has strategies for achieving these goals (pathways; 4 items). These components are highly correlated and were thus combined in a

single factor (Cronbach's Alpha = .83; Roesch & Vaughn, 2006). Hope is conceptually close to general self-efficacy (Snyder et al., 1991). To assess optimism, we employed the "Affective valence of future perspectives" scale (Brandtstädter & Wentura, 1994; Cronbach's Alpha =.85). Five items assess optimistic and pessimistic expectancies about one's future. Social resources were assessed using a two-way strategy: First, participants could name up to six persons from whom they would be likely to get comfort and encouragement (emotional support), and up to six persons from whom they would be likely to get advice (informational support). The number of people named was used as a measure for perceived available support. Second, network size, another indicator of support potential, was calculated by adding the number of persons living in the same household and the number of persons mentioned in a personal network matrix of close contacts, adjusting for persons named twice.

Covariates. The sample stratification factors age, gender (1 = men, 2 = women) and place of residence (1 = West Germany, 2 = East Germany) were used as control variables.

Data Analysis

Descriptive data analysis and data screening was done in SPSS 15.0. All further analyses used structural equation modeling in Mplus 5.0. We used robust maximum likelihood (MLR) estimation to account for deviations from normality and missing values (Yuan & Bentler, 2000). Multiple group analysis was used to determine whether relationships differ between SES groups. We started with separate measurement models for social and psychological resource factors. The social resources factor consisted of perceived emotional and informational support as well as network size. The psychological resources second-order factor consisted of the first-order factors self-esteem, control beliefs (hope), and optimism. Item parcels were used to increase parameter estimates stability and improve the normality of the distributions (Little, Cunningham, Shahar, & Widaman, 2002). Modification indices suggested a correlation between the error terms of two self-esteem parcels. These

measurement models were fitted in each of the education and income groups separately, allowing all parameters to be freely estimated. In a second step, we tested for metric invariance by fixing all factor loadings to be equal across the SES groups. We found strong evidence for invariance of the factor loadings (except for the non-invariant loading of the second parcel on the self-esteem factor across education groups). This suggests that the factors that described the individual resources were comparable across different SES groups (Horn & McArdle, 1992). The fit of the models with invariant factor loadings was very satisfactory (results not shown). Table 3.1 shows the factor loadings of the latent constructs.

Table 3.1

Standardized Factor Loadings of Psychological and Social Resources According to Education and Income Group

	Education		Income		
Construct	Low (n = 1,397)	High (n = 1,057)	Low (n = 818)	Medium (n = 793)	High (n = 843)
Psychological resources					
Self-esteem	0.88	0.86	0.87	0.88	0.89
Parcel 1	0.85	0.87	0.87	0.84	0.86
Parcel 2	0.75	0.79	0.76	0.76	0.75
Parcel 3	0.64	0.63	0.63	0.63	0.63
Control beliefs (Hope)	0.97	0.94	0.94	0.98	0.95
Parcel 1	0.83	0.81	0.85	0.80	0.82
Parcel 2	0.76	0.73	0.78	0.72	0.74
Parcel 3	0.77	0.78	0.77	0.75	0.79
Optimism	0.81	0.80	0.81	0.80	0.80
Parcel 1	0.91	0.91	0.90	0.91	0.91
Parcel 2	0.81	0.78	0.80	0.78	0.79
Social resources					
Emotional support	0.75	0.75	0.75	0.73	0.75
Informational support	0.75	0.74	0.77	0.74	0.73
Network size	0.42	0.47	0.42	0.42	0.47

We set up separate multiple group models with either education or income as the grouping factor to examine the effects of resources on health in different SES groups. Each of the models included one resource factor (psychological or social resources) as predictor and all three health indicators (i.e., physical health, functional health and subjective health) as outcomes. Age, gender, and place of residence were controlled for. Health indicators and covariates were included as single indicators. The fit of these models was satisfactory: For education and psychological resources, χ^2 (122, N = 2,454) = 590.77, RMSEA = 0.056, CFI = 0.96, and SRMR = 0.040; for income and psychological resources, χ^2 (188, N = 2,454) = 696.58, RMSEA = 0.058, CFI = 0.96, SRMR = 0.041; for education and social resources, χ^2 (26, N = 2,454) = 124.43, RMSEA = 0.056, CFI = 0.97, SRMR = 0.030; for income and social resources, χ^2 (40, N = 2,454) = 120.11, RMSEA = 0.049, CFI = 0.98, SRMR = 0.030.

We compared R^2 for models with and without the resource factors to examine the amount of variance in health explained by psychological or social resources over and above covariates. We also tested whether the relationship between psychological or social resources and health differed between the education or income groups by constraining the unstandardized regression paths to be equal across the groups and examining whether this resulted in a significant ($p < .05$) loss in model fit compared to the unconstrained model. As there were pronounced ceiling effects in the functional health indicator, we replicated the analyses for functional health using a two-part model with a log-transformed dependent variable (Huang et al., 2008), with largely equivalent results.

Table 3.2

Sample Characteristics: Descriptive Statistics and Pearson Correlations of the Study Variables

		Psychological resources			Social resources			Health			Covariates	
Variable	*M* (*SD*)	1	2	3	4	5	6	7	8	9	10	11
1 Self-esteem	3.41 (0.42)	-										
2 Control beliefs (hope)	3.09 (0.47)	**.67**	-									
3 Optimism	2.97 (0.62)	**.57**	**.66**	-								
4 Emotional support	1.84 (1.45)	**.11**	**.08**	**.11**	-							
5 Informational support	1.98 (1.42)	**.11**	**.07**	**.07**	**.56**	-						
6 Network size	4.81 (2.36)	**.12**	**.15**	**.17**	**.34**	**.33**	-					
7 Physical health	8.71 (1.89)	**.24**	**.22**	**.32**	**.04**	.04	**.08**	-				
8 Functional health	26.59 (4.77)	**.23**	**.23**	**.35**	**.04**	**.08**	**.14**	**.46**	-			
9 Subjective health	3.50 (0.87)	**.30**	**.31**	**.46**	**.07**	**.06**	**.13**	**.44**	**.60**	-		
10 Age (years)	61.28 (12.48)	**-.05**	**-.08**	**-.20**	**-.09**	**-.08**	**-.18**	**-.39**	**-.43**	**-.29**	-	
11 Female (%)	49.1	-.02	**-.05**	.00	**.16**	**.07**	.04	.01	**-.10**	.03	-.02	-
12 East Germany (%)	33.9	-.02	-.04	**-.09**	**-.04**	-.04	**-.06**	.00	-.03	**-.06**	-.02	-.01

Note. Descriptive statistics are shown as means with standard deviations in parentheses, unless marked for percentage (%). Coefficients printed in bold are significant ($p < .05$).

Results

Table 3.2 (p. 72) shows correlations between study variables as well as descriptive information for the whole sample. Psychological resources – self-esteem, control beliefs (hope), and optimism – were more strongly correlated with health than social resources. Correlations between social resources (emotional support, informational support, and network size) and health were very small in the total sample (for correlations in different education and income groups, see Appendix B, Table B1 and Table B2). Mean comparisons suggested that participants with lower education and lower income had worse health, less psychological and social resources and were older than those with higher education and income (see Table B3 and Table B4).

Associations Between Psychosocial Resources and Health in Different SES Groups

Results for the multiple group structural equation models are shown in Table 3.3 (education, p. 74) and Table 3.4 (income, p. 75). Again, psychological resources were more strongly related to health than social resources. Psychological resources explained 4 - 19% of the variance in health within the education and income groups over and above age, gender and place of residence. Social resources only explained up to 2.2% additional variance.

Table 3.3 shows the relationships between psychosocial resources and health for different levels of education. For physical health, the impact of psychological resources did not differ across the education groups ($\Delta\chi^2(1) = 0.68$, $p = .41$). The positive associations between psychological resources and functional health ($\Delta\chi^2(1) = 12.17$, $p < .05$) as well as between psychological resources and subjective health ($\Delta\chi^2(1) = 4.10$, $p < .05$) differed, however, according to education. As expected, the relationships were stronger in the low education group. The association between social resources and health did not statistically differ between the education groups for any health indicator.

Table 3.3

Unstandardized and Standardized Regression Coefficients of Structural Equation Models Predicting Physical Health, Functional Health, and Subjective Health According to Level of Education (N = 2,454)

	Physical health				Functional health				Subjective health			
	Low education		High education		Low education		High education		Low education		High education	
Predictor	*B*	β	*B*	β	*B*	β	*B*	β	*B*	β	*B*	β
Age	**-0.31**	**-.35**	**-0.25**	**-.35**	**-0.95**	**-.40**	**-0.59**	**-.39**	**-0.20**	**-.25**	**-0.15**	**-.22**
Female	0.04	.05	-0.03	-.04	**-0.23**	**-.11**	**-0.16**	**-.11**	0.03	.04	0.02	.02
East Germany	0.00	.00	0.01	.01	-0.06	-.02	-0.04	-.02	**-0.06**	**-.07**	**-0.04**	**-.06**
R^2_{cov}		.122		.123		.175		.156		.074		.051
Psychological resources	**0.20**	**.26**	**0.22**	**.28**	**0.65_a**	**.32**	**0.35_b**	**.21**	**0.31_a**	**.44**	**0.24_b**	**.33**
$R^2_{cov+psych}$		.188		.202		.272		.197		.259		.157
Social resources	0.01	.02	-0.01	-.01	**0.15**	**.06**	0.03	.02	**0.06**	**.07**	0.02	.03
$R^2_{cov+social}$		.122		.123		.179		.156		.079		.052

Note. Coefficients printed in bold are significant ($p < .05$). Coefficients with different subscripts indicate that the association between the resource factor and the health outcome differs between the education groups according to significant change in chi-square ($p < .05$) when the coefficients are constrained to be equal across groups. Observed variables with extremely low or high variances were rescaled for SEM analyses to avoid estimation problems, which does not affect between-group comparisons (Kline, 2005). cov = covariates, psych = psychological resources, social = social resources.

Table 3.4

Unstandardized and Standardized Regression Coefficients of Structural Equation Models Predicting Physical Health, Functional Health, and Subjective Health According to Level of Income (N = 2,454)

	Physical health						Functional health						Subjective health					
	Low income		Medium income		High income		Low income		Medium income		High income		Low income		Medium income		High income	
Predictor	*B*	β	*B*	β	*B*	β	*B*	β	*B*	β	*B*	β	*B*	β	*B*	β	*B*	β
Age	**-0.30**	**-.39**	**-0.30**	**-.39**	**-0.28**	**-.37**	**-0.90**	**-.42**	**-0.86**	**-.44**	**-0.69**	**-.42**	**-0.17**	**-.23**	**-0.21**	**-.31**	**-0.20**	**-.29**
Female	0.01	.01	0.02	.02	0.01	.01	**-0.30**	**-.14**	-0.12	-.06	**-0.18**	**-.11**	0.01	.01	0.03	.05	0.02	.01
East Germany	0.01	.01	0.02	.03	0.03	.03	-0.08	-.04	0.08	.04	-0.02	-.01	-0.04	-.05	-0.01	-.01	-0.04	.03
R^2_{cov}		.150		.153		.142		.209		.196		.183		.057		.103		.085
Psychological resources	**0.19**	**.26**	**0.25**	**.30**	**0.19**	**.24**	**0.63**	**.31**	**0.48**	**.22**	**0.51**	**.29**	**0.29**	**.42**	**0.29**	**.40**	**0.26**	**.36**
$R^2_{cov+psych}$		.214		.240		.198		.302		.244		.265		.229		.251		.208
Social resources	0.04_a	.05	0.02_{ab}	.02	$\mathbf{-0.06_b}$	**-.07**	$\mathbf{0.36_a}$	**.15**	0.01_b	.01	-0.06_b	-.04	$\mathbf{0.11_a}$	**.13**	0.05_a	.07	-0.03_b	-.04
$R^2_{cov+social}$		.152		.153		.147		.231		.195		.184		.073		.107		.086

Note. Coefficients printed in bold are significant ($p < .05$). Coefficients with different subscripts indicate that the association between the resource factor and the health outcome differs between the income groups according to significant change in chi-square ($p < .05$) when the coefficients are constrained to be equal across groups. Observed variables with extremely low or high variances were rescaled for SEM analyses to avoid estimation problems, which does not affect between-group comparisons (Kline, 2005). cov = covariates, psych = psychological resources, social = social resources.

Table 3.4 (p. 75) shows the relationships between psychosocial resources and health for different levels of income. There were no differences between the three income groups in the effect of psychological resources on any health indicator. Social resources, however, showed a stronger association with functional health in the low compared to the medium ($\Delta\chi^2(1) = 7.42$, $p < .05$) and the high ($\Delta\chi^2(1) = 13.71$, $p < .05$) income group. The relationship of subjective health and social resources was stronger in the low compared to the high income group ($\Delta\chi^2(1) = 9.25$, $p < .05$), but there was no significant difference between the low and the medium income group ($\Delta\chi^2(1) = 1.31$, $p = .25$). Unexpectedly, there was a small but significant negative association between social resources and physical health in the high income group, whereas social resources were unrelated to physical health in the low and medium income group. The regression coefficients differed between low and high income group ($\Delta\chi^2(1) = 5.37$, $p < .05$).

Interactions Between Resources and Age

In the last step, we explored how the combination of age and SES differences affects the association between resources and health. We examined interactions between resources and age where we found differential associations of psychological or social resources and health according to education or income, and compared these interactions between SES groups. We used a random slopes approach, which has the advantage of allowing for full information maximum likelihood estimation (Klein & Moosbrugger, 2000). We tested whether model fit improved significantly ($p < .05$) upon addition of the interaction terms.

There was a significant interaction between psychological resources and age in the low ($B = 0.12$, $SE = 0.02$, $p < .05$) and high ($B = 0.08$, $SE = 0.04$, $p < .05$) education group for functional health as the outcome. The interaction terms did not differ between the groups ($\Delta\chi^2(1) = 1.06$, $p = .30$). Adding the interaction terms to the model resulted in a significant

improvement in fit ($\Delta\chi^2(2) = 22.26$, $p < .05$). These interactions point to a stronger association between psychological resources and functional health at higher ages for low and higher educated people. For physical and subjective health as outcomes, the model fit did not improve significantly by adding interactions in the education groups.

There were significant interactions between social resources and age for physical health ($B = 0.04$, $SE = 0.01$, $p < .05$), functional health ($B = 0.09$, $SE = 0.04$, $p < .05$) and subjective health ($B = 0.04$, $SE = 0.01$, $p < .05$) in the low income group only. The interaction terms differed between the low and the high income groups. Adding the interaction terms in the low income group significantly improved model fit (physical health: $\Delta\chi^2(1) = 6.82$, $p < .05$; functional health: $\Delta\chi^2(1) = 5.87$, $p < .05$; subjective health: $\Delta\chi^2(1) = 7.86$, $p < .05$).

To illustrate these results, we estimated the relationship between social resources and health at -1 *SD* below the mean age (i.e., for people in their late 40's), the mean age (i.e., for people about 60 years of age), and +1 *SD* above the mean age (i.e., for people in their early 70's) for each income group separately (simple slopes analysis; Aiken & West, 1991). Results for subjective health are displayed in Figure 3.1 (p. 78) and results for physical health are displayed in Figure 3.2 (p. 79); only the low and high income groups are shown.

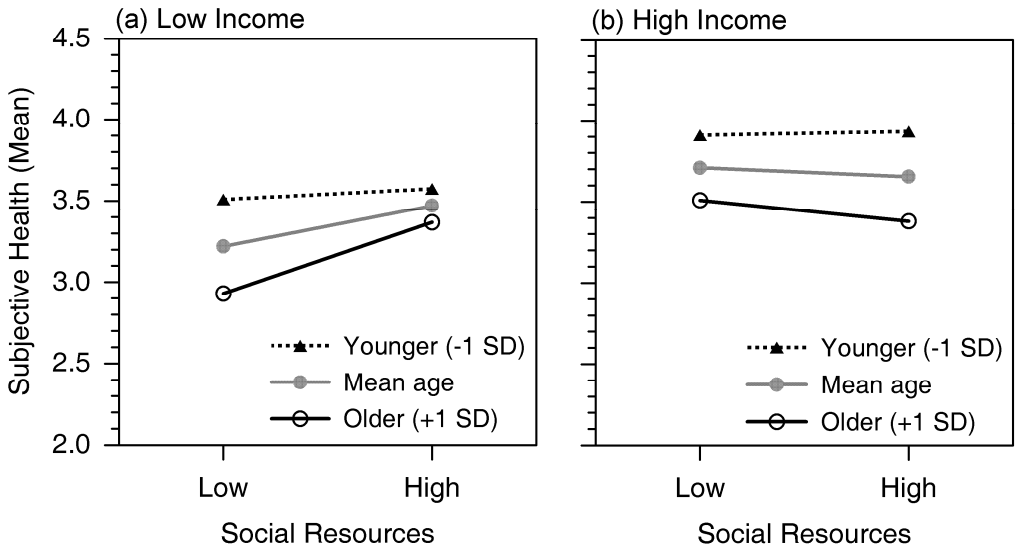

Figure 3.1. Interaction of social resources and age on subjective health according to income. The figure depicts the value of mean subjective health as predicted by social resources, age, and the interaction social resources x age for people with (a) low income and (b) high income.

As can be seen in Figure 3.1 and Figure 3.2, social resources mainly made a difference for the health of older people with low income, with older individuals with low income but high social support having better health than those with both low income and low support. The slightly negative effect of social resources on physical health in the high income group did not seem to get stronger at higher ages, whereas there was a positive effect for older people with low income (Figure 3.2, p. 79). It can also be seen that, at low levels of social resources, older people with low income had worse health than those with high income, whereas these differences apparently diminished at higher levels of resources.

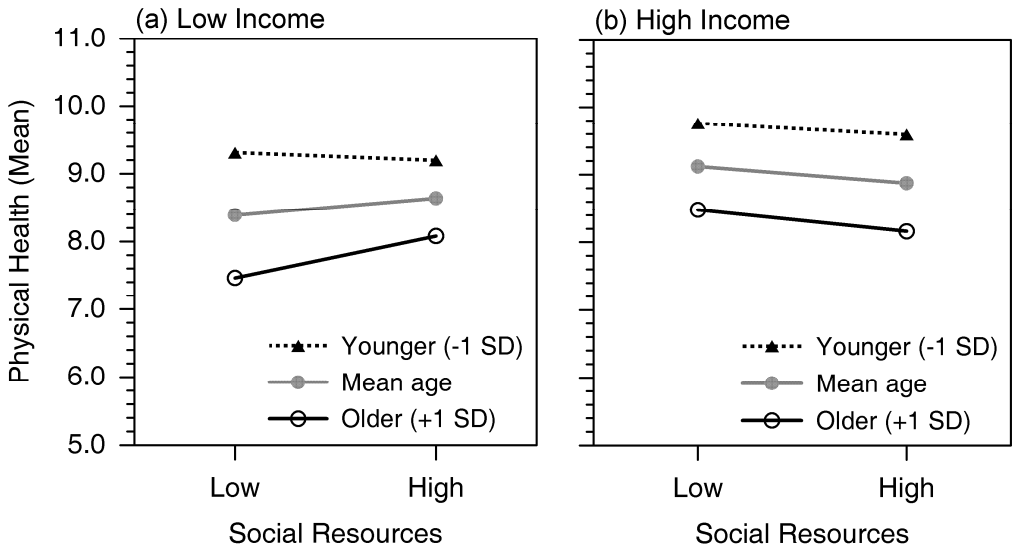

Figure 3.2. Interaction of social resources and age on physical health according to income. The figure depicts the value of mean physical health as predicted by social resources, age, and the interaction social resources x age for people with (a) low income and (b) high income.

Discussion

This study examined the moderator role of SES for the effects of psychological resources (optimistic self-beliefs) and social resources (available support from a social network) on physical, functional and subjective health in a representative sample of middle-aged and older adults. It is one of the first studies to distinguish SES groups differentiated by either education or income, which provides more detailed information on the resources most important for health in these groups.

There were positive relations between *psychological resources* and health in all SES groups, but the effects were stronger in the low than in the high *education* group for subjective and functional health. No differences in the effects of psychological resources on any health indicator were found between the income groups. *Social resources* had a stronger

effect on functional and subjective health at low compared to (medium and) high *income* levels, whereas there were no differential effects between the two education groups.

Differential Effects of Resources on Health Depending on Socioeconomic Status

Individuals with low SES are disadvantaged with regard to both stress and health-relevant capabilities compared to those with higher SES (Adler & Snibbe, 2003; Ross & Mirowsky, 2003). Based on the Reserve Capacity Model (Gallo & Matthews, 2003), we assumed that psychological and social resources might compensate for some of these deficits, thus being more important for the health of those with low SES, which we defined as those having low education or low income[4]. Furthermore, we assumed that different facets of SES represent partly different capabilities (Geyer & Peter, 2000), which also implies differential resources according to SES facet.

An important pathway relating income to health is the ability to buy professional assistance and help for mastering demanding situations (Geyer & Peter, 2000). We had thus hypothesized that social resources (available support from a social network) show stronger associations with health at low than at higher income levels, whereas we expected no differential effects of social resources on health according to level of education. This was mainly supported. Potentially available support was primarily beneficial for the functional and subjective health of those with a low income. For physical health, only older adults showed this effect. Vitaliano et al. (2001) suggest that the importance of tangible support does not vary by income, whereas emotional support should be more beneficial for health at lower than at higher levels of income. This relates to the findings of the present study, as our measure primarily assessed perceived emotional and informational support. These types of support have been shown to buffer a wide range of stressors (Cohen & Wills, 1985). Potentially available emotional and informational support from a private network may thus be

[4] A measure of occupational status was not included due to the fact that a large part of the sample were retirees.

particularly important for individuals with a low income, as they have less possibility to access professional assistance and help such as counseling.[5]

As both low education and low income reflect a reduced ability and limited opportunities to exert control in everyday life and to shape one's future in positive ways, we had hypothesized that psychological resources (optimistic self-beliefs) show stronger associations with health at both low education and low income as compared to higher education and higher income levels. This assumption was partially supported: psychological resources were more important for individuals with low compared to higher education, whereas they were equally important for all income groups.

Optimistic self-beliefs affect health by fostering a healthy lifestyle (Schwarzer & Fuchs, 1996; Steptoe et al., 2006). This is also acknowledged by the central role such beliefs play in virtually all psychological theories of health behavior (Noar & Zimmerman, 2005). Moreover, a recent review (Pampel, Krueger, & Denney, 2010) concludes that there are strong effects of education on health behavior: Individuals with lower education exercise less, smoke more, and are more likely to be obese. Optimistic self-beliefs might thus be more important in low-education groups with lower prevalence of health-promoting behaviors, because higher resource status then can make a difference in individual lifestyle. While the effects of education on health behavior largely persist after controlling for other SES variables such as income, however, the effects of income diminish (Pampel et al., 2010). It thus seems to be the case that part of the relevance of income for health behavior is due to its association with education. In the sample of middle- and older-aged people we used here, the relationship

[5] As an anonymous reviewer pointed out, there might be a confounding between retirement and income; being retired (as opposed to having a low income) could increase benefits from social support. Additional analyses revealed, however, that those who are retired do not benefit more from social resources than those who are employed and that differential associations of social resources with health according to income are still observed if employment status is taken into account (see Table B5).

between education and income was rather weak, however[6]. This means that the low income group is somewhat heterogeneous regarding education, i.e. it also contains people with higher education who might find ways of exerting health-promoting behavior despite limited financial resources. The heterogeneity in educational background and hence probably in the prevalence of health-promoting behaviors might thus have prevented us from finding differential effects of psychological resources on health according to income.

If health behavior plays a role in explaining our results, why did we not find differential effects of psychological resources on physical health according to education? Although certain health behaviors are clearly beneficial for preventing diseases, it has been shown that an existing disease is one of the strongest motivators for increasing health-promoting behavior, supposedly by influencing individual beliefs about (vulnerability to) health threats (Leventhal, Rabin, Leventhal, & Burns, 2001). Moreover, given the age range of our sample and the high prevalence of (multiple) diseases (Schöllgen et al., 2010), health behavior might gain increasing importance for preventing the consequences of diseases for functional as well as subjective health in comparison to the prevention of a disease. Differential associations between psychological resources and health behavior according to education might thus underlie the differential effects of optimistic self-beliefs on functional and subjective health, but may not be reflected in associations between psychological resources and physical health.

Taken together, our findings add considerably to the literature and to theorizing on the Reserve Capacity Model (Gallo & Matthews, 2003), because they show that SES should be conceptualized along different facets, as there are differential impacts of resources depending on whether individuals are challenged by low incomes or low education. The model implies

[6] The effect size was on the borderline between small and moderate ($r = .30$, $p < .05$; Cohen, 1988). It has been shown that the association between education and income has increased for younger cohorts (e.g., Day & Newburger, 2002).

that psychological and social resources primarily play a role for health at low SES due to its association with higher levels of stress. Our differential results suggest a more complex explanation. Future studies should thus examine the role of both stress and specific health-relevant capabilities in explaining varying associations between optimistic self-beliefs as well as social support and health according to SES.

Interactive Effects of Age and Socioeconomic Status

To explore how age *and* SES shape the association between psychological and social resources and health, we examined interactions between resources and age in the multiple group models whenever there were differential associations of resources and health according to education or income. In the education groups, there were significant interactions pointing to a stronger association between psychological resources and functional health at higher ages for low and higher educated people. There were also significant positive interactions between social resources and age in the low income group for physical health, functional health, and subjective health: Apparently, older individuals with low income but high social support had better health than those with both low income and low support. The results indicate that social resources mainly make a difference for the health of *older* people with low income. These individuals seem to be particularly vulnerable to a lack of support as can be seen in Figure 3.1 (p. 78) and Figure 3.2 (p. 79). This vulnerability might be due to the concurrence of more chronic stressors in older adulthood (Aldwin, Sutton, Chiara, & Spiro, 1996) and the limited ability of individuals with low income to buy professional assistance and help for mastering demanding situations, increasing the relevance of support from a private network.

Our findings provide further support for the central role of psychosocial resources in successful aging which is implicated by related theories (for an overview see, e.g., Baltes & Carstensen, 1999). Although some of these models already incorporate SES (e.g., Kahn &

Antonucci, 1980), the results of the present study suggest that differential effects of psychological and social resources according to SES facet should be given more attention.

Limitations and Strengths

There are some limitations to our findings. Our data are cross-sectional, which limits the causal interpretation of our results. In particular, the effects of psychological resources on health could be debated. However, there are some studies showing that control beliefs (Seeman & Seeman, 1983), optimism (for an overview, see Rasmussen, Scheier, & Greenhouse, 2009) and self-esteem (e.g., Reitzes & Mutran, 2006) can in fact promote future health. Moreover, what must be kept in mind when interpreting the interaction effects of age is that cross-sectional analyses confound age- and cohort-effects. As the central aim of this study was to examine the association between psychological and social resources and health in different socioeconomic status groups, we did not attempt to build a comprehensive model of physical, functional and subjective health. We did not, therefore, include other variables that may be related to health, which might have improved the accuracy of the models and increased the amount of variance explained. Health was measured by self-reports. It thus cannot be concluded whether the present findings generalize to objective measures of physical health, although the validity of self-reported morbidity has been shown in several studies (e.g., Katz et al., 1996). The present study used a nationally representative sample of the community-dwelling German population in the second half of life, which is important for questions dealing with SES. Institutionalized people were not included in the sample, however, which limits generalizability to this group. As institutionalization is related to age and also constitutes an indicator of vulnerability, this might have led to an underestimation of interaction effects between age and resources.

A particular strength of our study is that we assessed different facets of SES, namely education and income. These have been shown to be independently related to health (e.g., Schöllgen et al., 2010) and reflect partly different meanings and mechanisms (Geyer & Peter, 2000). For the same reason, we differentiated between psychological and social resources. Resources were represented by latent factors, which account for measurement error and thus are an advantage over single observed variables. The selection of constructs was theoretically grounded (Gallo & Matthews, 2003). It might be beneficial, however, to also include indicators that directly address the perceived quality of relationships and supports in future studies, particularly if the focus is on later life (Carstensen, Isaacowitz, & Charles, 1999). Quantitative support measures, as they were used in the present study, might be less affected by cognitive bias compared to other indicators and might thus more closely reflect actually available support, on the other hand.

Implications

In sum, our results suggest that the effects of psychological and social resources on health vary by SES. Viewed differently, our findings help to explain the fact that there is a group of resilient people exhibiting good health despite their disadvantaged status (Ferrer & Palmer, 2004). These people probably possess a high degree of psychological or social resources. If our results can be replicated in other, preferably longitudinal studies, this has important implications for interventions to improve health, especially for individuals in the low SES groups. While strengthening optimistic self-beliefs is a promising pathway for health promotion in all individuals (see also Hankonen, Absetz, Haukkala, & Uutela, 2009) and particularly in those with low education, interventions targeting embeddedness in social networks as a help and assistance resource are probably the most promising for (older) individuals with low incomes.

It needs to be taken into consideration, however, that later-life outcomes are the result of developmental processes over the life-span. Evidence is mounting that childhood SES and psychosocial factors affect adult functioning (e.g., Schwartz, et al., 1995). Interventions at earlier stages of the life course might thus have long-lasting benefits and could possibly mitigate a socially stratified accumulation of resources and risks over the life-span. Besides, interventions should also take into account the broader contexts in which individuals live, including neighborhoods, states and countries, as these affect health independently or in combination with individual-level factors (Deeg & Thomése, 2005; Subramanian & Kawachi, 2004).

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Chapter 4

The Interplay of Physical Functioning and Depressive Symptoms in Old Age: A Longitudinal Study on Variations Within and Between Different Education Groups

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Abstract

Objectives: The study investigated mean differences in levels and changes of physical functioning and depressive symptoms according to education. Moreover, two rarely asked questions were examined: Does between-person variation in levels and changes of physical functioning and depressive symptoms differ by education in older adulthood? And do cross-domain associations differ by education in older adults?

Methods: Longitudinal data from the nationally representative German Ageing Survey were used, including community-dwelling participants aged 65 years and older at baseline (N = 1,947). Multiple group latent change score models were employed for the analyses.

Results: Individuals with lower education had more physical limitations and depressive symptoms on average than those with higher education. The average six-year changes, however, did not differ between the groups. Substantial between-person variation in levels and changes was found within groups, with mostly larger variance at lower education levels. Moreover, cross-domain associations between changes in physical functioning and depressive symptoms were stronger for lower educated older adults.

Discussion: Sizeable health differences within education groups and stronger associations between declines in physical functioning and increases in emotional distress at lower education levels suggest potential and need for intervention in older adulthood.

Keywords: physical functioning, depressive symptoms, education, socioeconomic status, latent change score models

Introduction

Physical functioning is an important aspect of health, especially in later life, with sharply increasing rates of physical disability for those aged 65 years and older. Concerning mobility as a central aspect of physical functioning, a study on community-dwelling persons found disability prevalences of only 7.4% for the population aged 16 years and older, but the respective proportions for those aged 65 to 74 and 75 or over were 17.8% and 36.7% (Picavet & Hoeymans, 2002; see also, Freedman & Martin, 1998). Regarding the affective dimension of mental health, depressive symptoms are recognized as prevalent in older adulthood (e.g., Blazer, 1994).

Moreover, there is ample evidence that physical functioning and depressive symptoms are interrelated, and it has been suggested that this association is particularly strong in older adults (Turner & Noh, 1988). Depressive symptoms have been shown to prospectively influence physical functioning, directly via neural, hormonal, and/or immunological pathways as well as indirectly via health behaviors (e.g., Kiecolt-Glaser & Glaser, 2002; Penninx, Leveille, Ferrucci, Van Eijk, & Guralnik, 1999). On the other hand, physical limitations increase the risk of depression – presumably because they represent a source of chronic stress and pain, decrease the sense of control and restrict a person's level of (social) activities (e.g., Gayman, Turner, & Cui, 2008; Yang, 2006). Studies examining both directions of influence mainly conclude that the effect of physical functioning on depressive symptoms is stronger than the reverse (Aneshensel, Frerichs, & Huba, 1984; Meeks, Murrell, & Mehl, 2000; Ormel, Rijsdijk, Sullivan, van Sonderen, & Kempen, 2002). Only a few studies have, however, directly investigated the association between *changes* in disability and depression (Ormel et al., 2002; Taylor & Lynch, 2004).

Differences in Levels and Changes of Physical Functioning and Depressive Symptoms Between Socioeconomic Status Groups

A central aim of existing research has been to identify determinants of physical functioning or depressive symptoms. These studies have shown consistently that individuals with lower socioeconomic status (SES), i.e., education, income/wealth, and occupation, have more physical limitations and higher levels of depression than those with higher SES (e.g., Breeze, Fletcher, Leon, Marmot, Clarke, & Shipley, 2001; Lorant, Deliège, Eaton, Robert, Philippot, & Ansseau, 2003).

The role of SES in health *changes* in later life is more controversial. Although an average decline in physical functioning is observed at all levels of SES, there are some studies indicating that more rapid changes for those with higher SES lead to *converging* inequalities in old age (Beckett, 2000; Herd, 2006). Other studies, however, point to *diverging* social inequalities in physical functioning over the adult life-span (Kim & Durden, 2007; Ross & Wu, 1996). In relation to depressive symptoms, diverging differences according to education but converging trajectories according to income have been reported (Kim & Durden, 2007). Longitudinal studies on social inequalities in health have mainly been conducted in the US, and the results are not easily transferable to other countries due to differences in health care regimes. Of relevance in the present context are cross-sectional studies with German samples that provided little evidence for age differences in the association between SES and physical functioning as well as for the relationship between SES and depression (Knesebeck, Lüschen, Cockerham, & Siegrist, 2003; Schöllgen, Huxhold, & Tesch-Römer, 2010). These results support the assumption of continuity in socioeconomic differences in health (O'Rand & Henretta, 1999). In a longitudinal study, continuity would be indicated by SES groups starting at different levels but showing similar rates of change.

Within-Group Variation in and Cross-Domain Associations Between Physical Functioning and Depressive Symptoms

An interesting addition to investigating differences in mean levels and changes *between* SES groups is to look at variation *within* SES groups. This perspective can eventually lead to the identification of more vulnerable or resilient subgroups as well as factors accounting for a differential susceptibility. Only two studies have examined this so far, using summary measures of physical health (including physical functioning) and mental health (including depressive mood): In a survey of the US population, Ferrer and Palmer (2004) found considerable cross-sectional variability within SES groups, with larger variation at lower levels of income. Furthermore, a longitudinal study mainly covering the period of midlife demonstrated greater interindividual variability at lower compared to higher occupational grades both in levels and rates of change in mental and physical health (Sacker, Head, Gimeno, & Bartley, 2009). We consider it particularly important to study such variation in old age. Differential aging is a central topic of gerontology (e.g., Nelson & Dannefer, 1992), and mean differences *between* SES groups have been discussed as one reason for heterogeneity in functioning in old age (Dannefer, 1987). In contrast, between-person variation in levels and changes of emotional and physical functioning *within* SES groups has not been examined specifically in this age group.

Moreover, given the substantial co-variation or cross-domain association between emotional and physical functioning in older adulthood (Turner & Noh, 1988), it should be further investigated whether similar relationships are found in different SES groups. There is some evidence for stronger effects of disability on depression at lower compared to higher levels of income and wealth in later life (Carvalhais, Lima-Costa, Peixoto, Firmo, Castro-Costa, & Uchoa, 2008; Smith, Langa, Kabeto, & Ubel, 2005). One explanation for these findings is that financial means help people to deal with disability by enabling the purchase of

goods and services. An alternative explanation might be that those with higher SES have a higher amount of psychosocial resources (Gallo & Matthews, 2003), which helps them cope better with stress caused by limitations in physical functioning, thus buffering its detrimental effect on emotional functioning.

Education is supposed to be central for the development of psychological resources such as control beliefs (Mirowsky & Ross, 2007). Moreover, education has been found to be related to depressive symptoms and physical functioning in later life independent of other aspects of SES (Berkman & Gurland, 1998; Ladin, 2008). To our knowledge, however, differential variation in and associations between physical functioning and depressive symptoms according to education have not been studied so far.

Research Questions

The present study investigates education-related differences in physical functioning and depressive symptoms in old age. Using data from the nationally representative German Ageing Survey, we examine three research questions:

Q1) Do mean levels and changes in physical functioning and depressive symptoms differ by education in older adulthood?

Q2) Does between-person variation in levels and changes of physical functioning and depressive symptoms differ by education in older adulthood?

Q3) Do cross-domain associations between levels and changes of physical functioning and depressive symptoms differ by education in older adults?

We hypothesize that older adults with lower education show higher mean levels of depressive symptoms and lower levels of physical functioning than those with higher education. In line with previous age group-comparative studies in Germany, we expect, however, to find

comparable changes in all education groups (Q1). We further assume that there is more variation in levels and changes of physical functioning and depressive symptoms for older people with lower education (Q2). Finally, we expect stronger cross-domain associations between levels and changes of physical functioning and depressive symptoms at lower compared to higher levels of education (Q3).

Method

Sample

The present study uses longitudinal data from the German Ageing Survey (DEAS). DEAS is an ongoing population-based, representative study of community-dwelling persons living in Germany, with a cohort-sequential design. Data were collected via in-home interviews and additional self-administered questionnaires. The first sample of 40 to 85 years old people (B_96 cohort, N = 4,838) was drawn in 1996 by means of national probability sampling and was systematically stratified by gender, place of residence (East or West Germany), and age. This sample was reassessed in 2002 and 2008. In 2002, another sample of 40 to 85 years old people (B_02 cohort, N = 3,084) was drawn in the same way. This sample was also reassessed in 2008. In 1996, about 50% of those contacted agreed on an interview, whereas the response rate in 2002 was 37.1%. These response rates are typical for German survey studies and confirm the trend of historically declining participation rates (Neller, 2005). Analyses have shown, however, that the DEAS samples are largely representative of the German population of middle-aged and older adults (Engstler & Motel-Klingebiel, 2010).

In this study, we use data from 2002, which is thus considered as baseline (T1) here, and 2008 (T2), as physical functioning and depressive symptoms were not assessed in 1996. As our focus was on older adults, we only included participants aged 65 years and older at

baseline (N = 1,948; M_{age} = 73.78, SD = 5.65; 48% female; 66% living in West Germany). This age limit is commonly used in research on aging (e.g., Schaie & Willis, 2002) and reflects the current legal transition age into retirement. After finishing the assessment in 2002, 67.9% of the participants aged 65 years and older agreed to take part in a follow up. The addresses of the other participants were deleted in line with the German data-protection laws. The sample that could be contacted again in 2008 was further reduced due to mortality and relocation to an unknown address. Of this reduced sample, 51.9% were in fact re-interviewed, leading to a sample size of N = 581 at T2. In line with other longitudinal studies on aging (for an overview, see, Chatfield, Brayne, & Matthews, 2005), the follow-up participants were not only healthier, but also younger and better educated than the baseline sample. Analyses using the method developed by Lindenberger and colleagues (2002) showed, however, that all selectivity effects were below 0.5 *SD* units and thus small (see Appendix C, Table C1). The statistical procedures implemented in this study attempt to deal with this attrition by using all available data, regardless of whether a person stayed in the sample over time, under the assumption that the data are missing at random, conditioned on the observed data (Little & Rubin, 2002). We only excluded one participant with missing information on education to form grouping variables, which leaves a final sample of 1,947 people.

Measures

Education. Participants reported their highest degree of school and further education with reference to the German educational system. Based on this information, they were classified into three categories according to ISCED (international standard classification of education, UNESCO, 1997): low (levels 0-2; pre-primary, primary and lower secondary education; 21.8% of the sample), medium (levels 3-4; upper secondary and post-secondary non-tertiary; 53.9%) and high (levels 5-6; tertiary education; 24.2%).

Physical functioning (PF) was measured by the subscale physical functioning of the SF-36 (version 1.0, Bullinger & Kirchberger, 1998; Ware & Sherbourne, 1992). Impairments in 10 activities (e.g., climbing stairs, walking several blocks) are rated on a scale from 1 (limited a lot) to 3 (not limited at all), higher values thus indicating higher physical functioning.

Depressive symptoms (DS) were assessed with an established German 15-item version of the CES-D (Hautzinger, 1988). On a scale from 0 (not at all/rarely) to 3 (almost all the time), respondents indicated the frequency with which they have experienced depressive symptoms during the past week. In line with other studies on depression-health associations (Meeks et al., 2000), we excluded six items from the somatic subscale to avoid a measurement confound (e.g., get going, effort; Radloff, 1977). The nine remaining items predominantly assess depressive affect (e.g., depressed, sad), with two items covering well-being or rather its absence as they were recoded. Items from these subscales have been shown to be least biased by illness and disability in old age (Grayson, Mackinnon, Jorm, & Creasey, 2000).

Covariates. In line with other studies using data of multiple cohorts (e.g., Schnittker, 2005), we included a variable indicating cohort in all analyses (B_96 or B_02). The sample stratification factors age, gender and place of residence were also employed as control variables in all analyses, which nullifies the need for sample weights (Winship & Radbill, 1994). We controlled for partner status at baseline (partner or no partner) to avoid spurious education-related differences in PF and DS due to partner status (Goldman, Koreman, & Weinstein, 1995). Analyses on the cross-domain associations also included a measure for physical illnesses at baseline, which was a sum score of 11 health problems (e.g., cardiovascular diseases, diabetes), to ensure that associations found are not solely due to the

fact that both PF and DS are affected by disease (Bruce, 2001). Levels and changes of depressive symptoms and physical functioning were regressed on the covariates centered at the sample mean because of the different distributions between education groups (Sacker et al., 2009).

Analyses

For all analyses, structural equation modeling with Mplus 5.21 was employed. We used robust maximum likelihood (MLR) estimation to account for deviations from normality and missing values (Yuan & Bentler, 2000). Multiple group analysis allowed to determine whether parameters differ between the three education groups (Kline, 2005). The alpha level was set at .05. To build latent factors for PF and DS, item parceling with two parcels for each factor was used to increase the stability of the parameter estimates and improve the normality of the distributions (T. D. Little, Cunningham, Shahar, & Widaman, 2002). Reliability was computed according to Raykov (2004) and was high in the overall sample ($\rho_{DS,T1}$ = .85, $\rho_{DS,T2}$ = .84, $\rho_{PF,T1}$ = .95, $\rho_{PF,T2}$ =.94).

We proceeded by fitting the longitudinal measurement models in each of the education groups, allowing all parameters to be freely estimated. For the purpose of identification, we fixed one of the factor loadings of each latent factor to one. To identify the means, we fixed one of the intercepts of each factor to zero. We tested for metric invariance by fixing all factor loadings to be equal across measurement occasions and education groups. We found strong evidence for invariance of the factor loadings ($\Delta\chi^2(10) = 15.14$, $p > .05$), which are shown in Table 4.1 (p. 103). This suggests that the factors reflect the same attributes and are therefore comparable across groups and measurement occasions (Horn & McArdle, 1992). The intercepts were also set equal over time and over groups ($\Delta\chi^2(10) = 13.64$, $p > .05$), which allowed us to compare means. Model fit with these restrictions was very good:

$\chi^2(62, N = 1{,}947) = 81.12, p > .05$; CFI = 0.998, RMSEA [90% CI] = .022 [.000-.034], SRMR = .033.

Table 4.1

Standardized Factor Loadings for Physical Functioning and Depressive Symptoms by Level of Education

Construct	Education Low (n = 425)	Medium (n = 1,050)	High (n = 472)
Physical functioning T1			
Parcel 1	0.97	0.92	0.91
Parcel 2	0.96	0.98	0.95
Physical functioning T2			
Parcel 1	0.91	0.93	0.91
Parcel 2	0.97	0.98	0.95
Depressive symptoms T1			
Parcel 1	0.86	0.84	0.82
Parcel 2	0.85	0.88	0.80
Depressive symptoms T2			
Parcel 1	0.92	0.87	0.85
Parcel 2	0.81	0.87	0.70

Educational differences in means and variances of levels and changes of PF and DS (questions Q1 and Q2) were examined with a series of nested models, testing the equality of estimates across education groups. Changes were estimated using latent change score (LCS) models (McArdle, 2009; McArdle & Prindle, 2008). The T2 variable was regressed with a weight of 1 on the T1 variable and a LCS was estimated with a weight of 1 on the T2 variable (cf. Figure 4.3, p. 109). Compared to autoregressive models, this has the advantage that change is directly included in the model. Finally, we added a path from change in physical functioning to change in depressive symptoms, as this has been shown to be the main direction of influence (Aneshensel et al., 1984; Meeks et al., 2000; Ormel et al., 2002), and

included crossed and lagged regression paths from T1 to the LCS. We then examined whether the associations between levels and changes of PF and DS differ according to education (Q3).

Results

The results for each research question are presented in separate paragraphs. Estimates for means and variances in physical functioning and depressive symptoms can be found in Table 4.2 (p. 105), and estimates for cross-domain associations are shown in Figure 4.3 (p. 109). For each parameter, we tested if there was a significant linear difference between the groups. If the results suggested that there might be non-linear differences between the groups, we additionally conducted post-hoc tests with an adjusted alpha level of 0.017 (0.05/3).

Differences in Mean Levels and Changes of Physical Functioning and Depressive Symptoms According to Education (Q1)

The upper portion of Table 4.2 shows the results on means in levels and changes of PF and DS. The first three columns show the parameter estimates in three groups with different levels of education, followed by a column depicting change in model fit ($\Delta\chi^2$) if the parameter was set equal across the groups. In the last column of Table 4.2, significant linear differences between the groups are reported. Significant results on non-linear differences are reported in the text.

As expected, there were differences in mean levels in that older adults with lower education showed lower levels of physical functioning and higher levels of depressive symptoms than those with higher education. The differences in PF were reduced after adjustment for covariates (age, gender, place of residence, partner status, cohort). Levels of depressive symptoms declined linearly with higher education, but there was some evidence for a non-linear difference in PF, with the high education group showing higher levels of

physical functioning than groups with low and medium education (B = 0.10, SE = 0.03, $p < .017$). There was a decline in physical functioning over time ($\Delta\chi^2(3) = 41.13$, $p < .05$, if $\Delta PF = 0$) that did not differ significantly between the groups (although the change parameter was not significant in the low education group). Depressive symptoms did not show any significant change over time on average ($\Delta\chi^2(3) = 2.76$, $p > .05$, if $\Delta DS = 0$) and no differential change according to education.

Table 4.2

Maximum Likelihood Estimates of Means and Variances in Levels and Changes of Physical Functioning (PF) and Depressive Symptoms (DS) by Level of Education

Parameter	Education Low	Medium	High	$\Delta\chi^2(2)$	Significant linear difference between education levels
Mean					
Level PF (T1)	2.38 (.04)	2.41 (.02)	2.51 (.03)	10.09	0.07 (.02)
Level DS (T1)	0.64 (.03)	0.55 (.02)	0.44 (.02)	33.01	-0.10 (.02)
Change (Δ) PF	-0.07 (.06) [a]	-0.16 (.04)	-0.23 (.04)	3.13 [a]	-
Change (Δ) DS	-0.07 (.06) [a]	0.01 (.03) [a]	-0.05 (.03) [a]	2.04 [a]	-
Variance					
Level PF (T1)	0.35 (.02)	0.29 (.02)	0.23 (.02)	12.83	-0.06 (.02)
Level DS (T1)	0.20 (.02)	0.17 (.02)	0.11 (.02)	12.25	-0.05 (.01)
Change (Δ) PF	0.29 (.07)	0.27 (.04)	0.16 (.04)	6.00	-0.09 (.04)
Change (Δ) DS	0.15 (.05)	0.18 (.02)	0.13 (.03)	1.76 [a]	-

Note. Unstandardized estimates and standard errors are presented. Adjusted for covariates (age, gender, place of residence, partner status, cohort). $\chi^2(122, N = 1{,}947) = 234.23$, $p < .05$; CFI = 0.982, RMSEA = .038 [.030-.045], SRMR = .029. $\Delta\chi^2(2)$ signifies change in model fit if a parameter was set equal across groups.
[a] not significant at the $p < .05$ level.

Variation in Physical Functioning and Depressive Symptoms: Differences According to Education (Q2)

The lower portion of Table 4.2 shows estimates of variances in levels and changes of PF and DS in the three education groups. As expected, the variance in level of physical functioning was significantly higher at lower levels of education. Comparable results were obtained for the variance in level of depressive symptoms except that there was a non-linear difference, with the high education group showing a smaller variance compared to the groups with low and medium education (B = -0.07, SE = 0.02, $p < .017$). Variances in change of PF and DS were significant in all education groups, but only differed between the groups with regard to physical functioning. The highest education group in particular showed lower variability in change of PF (B = -0.12, SE = 0.05, $p < .017$). In the following, equality constraints were applied for parameters that did not differ between the education groups to retain the most parsimonious model.

To better illustrate the within-group variation and to make results more comparable across indicators, the saved factor scores for physical functioning and depressive symptoms were standardized to the T metric (M = 50, SD = 10 at T1). Variation in levels is displayed in box and whisker plots (Figure 4.1, p. 107). As can be seen, the greater overall variability at lower education was mainly due to more variability in the lower portions of the physical functioning distribution and the upper portions of the depressive symptoms range. At the same time there were individuals with few physical limitations and little depressive symptoms in all education groups.

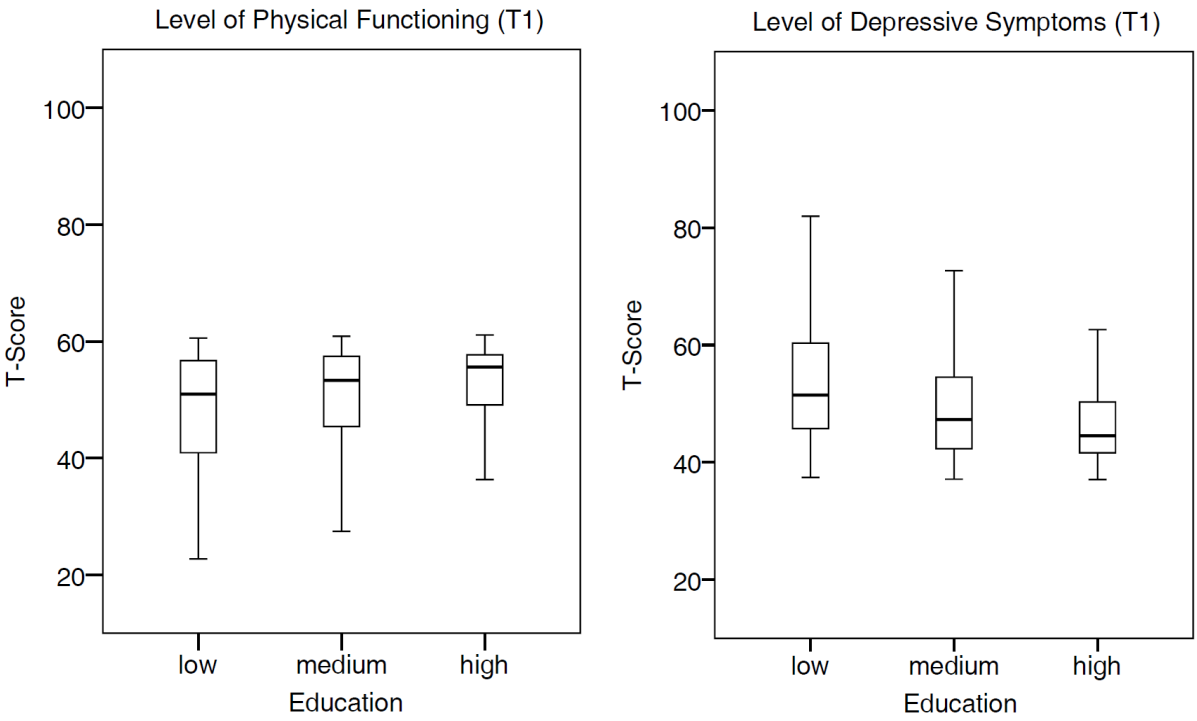

Figure 4.1. Box and whisker plots for level of physical functioning and level of depressive symptoms for groups with low, medium, and high education. The centre line of each plot displays the median score; the box's lower and upper ends display the lower and upper quartiles, respectively; the ends of the whiskers depict the farthest points that are not outliers (i.e., that are within 1.5 times the interquartile range). Outliers are not displayed for presentation purposes.

Variation in change of physical functioning is illustrated in Figure 4.2 (p. 108), showing estimated trajectories of 20 randomly selected individuals with low and high education. It can be seen that, although trajectories in both groups ranged from substantial declines to stability or even increases in physical functioning, considerable changes of more than one-half of a standard deviation were less prevalent in high-educated individuals.

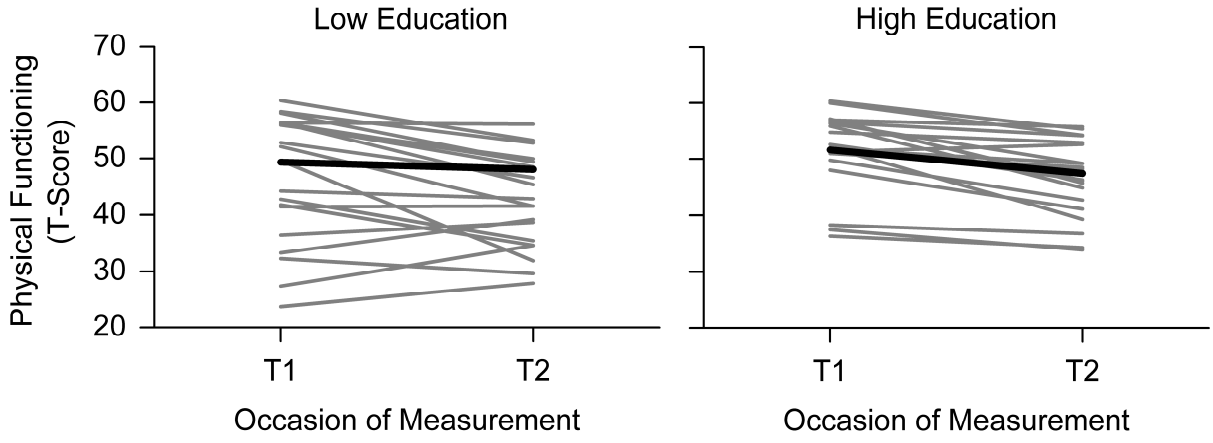

Figure 4.2. Estimated mean change in physical functioning and trajectories of 20 randomly selected individuals with low and high education. Black lines represent mean change controlling for the effects of the covariates age, gender, place of residence, partner status, and cohort.

Education-Related Differences in Cross-Domain Associations Between Physical Functioning and Depressive Symptoms (Q3)

The full model including the path from change in physical functioning to change in depressive symptoms, crossed and lagged regression paths from levels to changes as well as all covariates (age, gender, place of residence, partner status, cohort, and physical illnesses) had a good fit to the data: $\chi^2(140, N = 1{,}947) = 250.55$, $p < .05$; CFI = 0.983, RMSEA = .035 [.028-.042], SRMR = .033. Results are displayed in Figure 4.3 (p. 109).

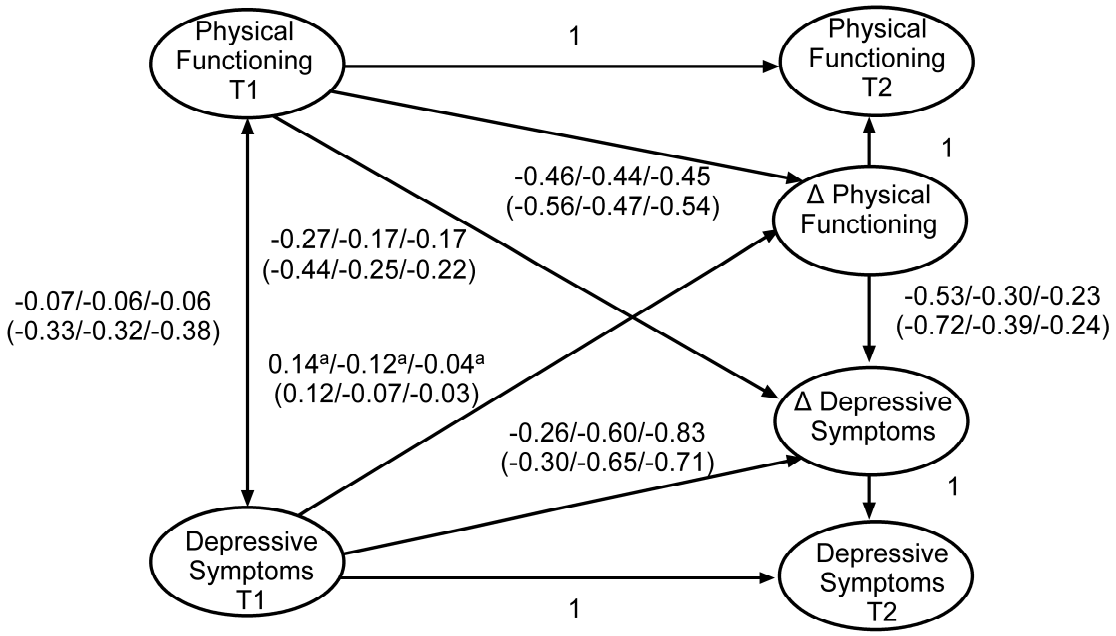

Figure 4.3. Numerical results from a bivariate latent change score SEM with invariant common factors, investigating associations between levels (T1) and changes (Δ) of depressive symptoms and physical functioning. Numbers are maximum likelihood estimates with standardized estimates in parentheses for groups with low education/medium education/high education. Factor loadings, means, variances, and error variances are omitted for presentation purposes. Effects of the covariates age, gender, place of residence, partner status, cohort, and physical illnesses on levels and changes are also excluded here, but were estimated in the model. [a] not significant at the $p < .05$ level.

As can be seen in Figure 4.3, there was a significant association between baseline levels of PF and DS, which did not differ according to education and could be set equal across groups ($\Delta\chi^2(2) = 0.84$, $p > .05$). Setting the crossed and lagged regression paths from levels to changes equal in the education groups, however, resulted in a significant loss in model fit, ($\Delta\chi^2(8) = 28.06$, $p < .05$). Further tests revealed that the significantly negative path from level of physical functioning to change in PF, indicating stronger declines for those with higher baseline levels, as well as the non-significant path from level of depressive symptoms to change in physical functioning, could be set equal across groups. The significantly negative

path from level of depressive symptoms to change in DS was stronger at higher levels of education (linear trend: B = -0.28, SE = 0.08, $p < .05$). There was also some indication that the effect of level of physical functioning on change in depressive symptoms, indicating more of an increase in DS for those with lower baseline levels of PF, was stronger at lower levels of education ($\Delta\chi^2(2) = 30.10$, $p < .05$). The non-linear trend, with the low education group showing stronger associations than groups with medium and high education, failed to reach significance according to the adjusted alpha level (B = 0.10, SE = 0.04, $0.017 < p < 0.05$), however. Finally, the negative path from change in physical functioning to change in depressive symptoms differed according to education ($\Delta\chi^2(2) = 7.11$, $p < .05$). There was a significant linear trend with stronger associations at lower levels of education (B = 0.13, SE = 0.07, $p < .05$).

Discussion

The present study investigated education-related differences in physical functioning and depressive symptoms in individuals aged 65 years and older. Using longitudinal data from the German Ageing Survey, we examined whether means and variances in levels and changes as well as cross-domain associations between levels and changes of physical functioning and depressive symptoms differ by education.

Differences in Physical Functioning and Depressive Symptoms Between and Within Education Groups

As we had hypothesized and in line with existing studies (e.g., Berkman & Gurland, 1998; Ladin, 2008), we found that older adults with lower education show higher mean levels of depressive symptoms and slightly lower levels of physical functioning compared to those with higher education. As would be expected in this age range, physical functioning declined

on average over the examined period of six years. However, average rates of change did not differ by education. Differences in level but not in change point to continuity in educational differences in health (O'Rand & Henretta, 1999). The finding of continuity is consistent with cross-sectional findings from German studies (Knesebeck et al., 2003; Schöllgen et al., 2010), while most US studies tend to support a leveling-off of education-related inequality in physical functioning in old age (e.g., Beckett, 2000; Herd, 2006). These diverging results might be a consequence of the societal context, particularly of differences in welfare systems and health care regimes. As there are larger social inequalities in health during midlife in the United States compared to Germany, the SES-health association in the US might be attenuated in old age to a larger extent due to a stronger influence of selective mortality in earlier stages of life (Knesebeck et al., 2003).

Regarding depressive symptoms, we observed no significant changes, on average, over a period of six years. As we used items from the CES-D mainly assessing depressive affect, this result is in line with existing studies (e.g., Nguyen & Zonderman, 2006). Moreover, as we had hypothesized, average rates of change in depressive symptoms did not differ by education. This result is in line with the finding of no age differences in the association between education as well as other aspects of SES and depression from a cross-sectional German study on older adulthood (Knesebeck, et al., 2003).

Additionally to the analysis of mean differences *between* groups, we examined variation *within* education groups in older adulthood. In line with our assumptions, we found a higher variance in levels of physical functioning and depressive symptoms at lower compared to higher levels of education. Concerning variance in change, significant differences were found for physical functioning, but not for depressive symptoms. It has been suggested in the literature that the higher mortality rate in low SES populations could truncate

the bottom of their health distribution in representative samples, which may not only reduce observable mean differences between groups (see above), but may also limit within-group variation at lower levels of SES in old age (Ferrer & Palmer, 2004). This is not supported by our finding of substantial and mostly larger interindividual variability in (change in) emotional and physical functioning at lower education levels. Overall, our results and those of two other studies (Ferrer & Palmer, 2004; Sacker et al., 2009) point to substantial within-group variances in physical and mental health (change), with larger variation at lower levels of SES, throughout the adult life-span. Thus, two important questions are "What does this variation imply?" and "What accounts for this variation?" On the one hand, the greater overall variability in levels of health at lower SES is mainly due to more variability in the lower portions of the health status distribution, which might indicate an accumulation of risks (Ferrer & Palmer, 2004). On the other hand, there is a subgroup of socio-economically disadvantaged people with good or even excellent physical and mental health as well as few declines in functioning.

The identification of vulnerable and resilient subgroups within different SES groups is only a first step, however. Future studies, particularly those aimed at intervention, should now try to identify factors accounting for this differential susceptibility. Ferrer and Palmer (2004) suggested differences in psychosocial resources, such as control beliefs and social support, as a plausible reason for within-group variability in levels of functioning, particularly at low levels of SES. Indeed, in another study (Schöllgen, Huxhold, Schüz, & Tesch-Römer, in press) we found that, within the boundaries of education, those with a higher amount of psychological resources such as control beliefs, optimism and self-esteem showed better physical functioning, and the impact of psychological resources was more pronounced for those with low compared to those with higher education.

Variability in change might require more complex explanations. Between-person variation in change in physical and emotional functioning may not only be due to differences in levels of psychosocial resources but might also be associated with differential resource change. Conservation of resources theory (Hobfoll, 2001) suggests that change in resources, particularly resource loss, has a stronger impact on those with low baseline levels of resources, such as individuals with low SES (Gallo & Matthews 2003). This might partly explain the larger variance in change of physical functioning at low compared to high education found in the present study as well as the larger variation in change of physical and mental health at lower occupational grades reported in another study (Sacker, et al., 2009). Individual growth curves presented by Sacker and colleagues (2009) give some first indication that within-individual variability over time might also be greater among individuals with low SES, which could be due to a stronger reactivity to life events.

Education-related Differences in Cross-Domain Associations Between Physical Functioning and Depressive Symptoms

In the present study, we also examined cross-domain associations between physical functioning and depressive symptoms in older adulthood. In line with existing research (Ormel et al., 2002; Taylor & Lynch, 2004), both levels and changes were significantly related to each other in that lower levels of physical functioning were associated with higher depressive symptoms at baseline and lower levels and stronger declines in physical functioning related to higher increases in depression.

Our study provides an important addition to the literature as we compared cross-domain associations between different education groups. Although there were no education-related differences in the association between baseline levels, there was a trend for *level* of physical functioning to more strongly affect *change* in depression in the low compared to the higher

education groups. The finding most clearly in line with our hypothesis was the stronger effect of *change* in physical functioning on *change* in depressive symptoms at lower levels of education. This adds to existing research which mainly focused on income and wealth and suggests that SES differences in the impact of physical limitations on depressive symptoms may be due to differences in financial means that help people deal with the practical demands of a disability (Carvalhais, et al., 2008; Smith, Langa, Kabeto, & Ubel, 2005). When we replicated our analyses comparing groups with different amounts of financial assets (as an indicator for wealth; see Appendix C, Table C2 and Table C3), we did not, however, find substantial differences in the effect of change in physical functioning on change in depressive symptoms, suggesting that this is not a valid explanation for our finding of a differential association according to education. Our results also differ somewhat from those of Sacker and colleagues (2009) as they found differences in the association between levels, but not between changes, in physical and mental health, according to occupational grade.

Although this suggests that different SES facets may contribute differently to varying cross-domain associations in either levels or changes of functioning, overall it can be concluded that there is some indication of higher physical and mental health comorbidity among people with lower SES (Sacker et al., 2009). A possible explanation is the lower amount of psychosocial resources, on average, of socio-economically disadvantaged individuals compared to those more privileged (Gallo & Matthews, 2003). Psychosocial resources may not only account or compensate for SES differences in one domain of functioning, but may also be relevant for buffering detrimental associations between (increases in) physical limitations and emotional distress. This is particularly relevant in older adulthood as this is the period of life when both functional limitations and depressive symptoms are prevalent and when the cross-domain association seems to be particularly strong (Turner & Noh, 1988).

Limitations and Strengths

This study has several limitations. First of all, there was a large dropout in the DEAS panel. As outlined in more detail above, however, selectivity was not strong for all of the measures employed. Furthermore, we used all available data, regardless of whether a person stayed in the sample over time or not, to minimize this bias. Moreover, we included health in our analyses, which is one of the strongest predictors of missingness in the DEAS as well as other studies (e.g., Lindenberger et al., 2002). The present study used a subsample of older adults (65 years and older) from a nationally representative study of the community-dwelling German population in the second half of life. As institutionalized people were not included in the baseline samples of the DEAS and only few data points were available for the oldest old (85+ years), this limits the generalizability of our results regarding these groups.

Physical functioning was measured by self-report. It thus cannot be conclusively deduced that the present findings would be the same using objective measures of physical limitations. There are studies, however, employing performance based measures of physical functioning that also found significant associations with depression (e.g., Penninx, Guralnik, Ferrucci, Simonsick, Deeg, & Wallace, 1998). Moreover, in line with other questionnaire based studies on depression-health associations (Meeks et al., 2000), we excluded six items from the somatic subscale of the CES-D to avoid measurement confound.

Another limitation of the present study is the fact that the indicators used have only been assessed on two measurement occasions. This prevented us from examining non-linear changes in physical functioning and depressive symptoms. Moreover, this limited the examination of direction of effects. Based on previous findings from other studies (Aneshensel et al., 1984; Meeks et al., 2000; Ormel et al., 2002), a regression path was set from change in physical functioning to change in depressive symptoms. However, the

direction of this effect could not be tested directly, and an effect of change in depression on change in physical functioning would also have been plausible – despite the fact that the level of depressive symptoms was not related to change in physical functioning in the present study. Testing the direction of effects and estimating linear and nonlinear change in both variables at the same time is possible in studies with more occasions of measurement, using bivariate dual change score models (e.g., Lövdén, Ghisletta, & Lindenberger, 2005). The method of analysis we employed in the present study (i.e., latent change score models) still has important advantages over simple cross-lagged models, as change is explicitly part of the model, thus allowing the description of change parameters and the testing of group differences in means, variances and cross-domain associations in change (McArdle, 2009).

Conclusion

The findings provide some evidence for stronger detrimental associations between declines in physical functioning and increases in emotional distress in older adults with lower education, indicating a need for intervention. On the other hand, there is substantial variation in physical and emotional functioning within education groups which suggests that SES differences do not necessarily and completely translate into health differences. There seem in fact to be vulnerable and resilient subgroups within SES groups, particularly within socio-economically disadvantaged older adults. A central aim is thus to further identify factors accounting for this differential susceptibility that are amenable to intervention**.**

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Chapter 5

Dynamic Associations Between Emotions and Physical Health in the Second Half of Life: Interindividual Differences According to Socioeconomic Status

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Abstract

The importance of socioeconomic status (SES) for psychological functioning over the life-span is increasingly acknowledged in psychological research. The Reserve Capacity Model by Gallo and Matthews (2003) suggests that SES is not only linked to physical health but also to the experience of positive and negative emotions. Moreover, due to differential amounts of psychosocial resources, cross-domain associations between emotions and health might differ according to SES. The present study examined age-related developments in positive affect (PA), negative affect (NA), and physical health, as well as dynamic associations between health and emotions in the second half of life. We looked at differences in these trajectories and their interrelationships according to education. We used data of up to three waves spanning 12 years from the nationally representative German Ageing Survey (N = 4,034, Age_{T1} = 40-85 years). Applying multiple-group dual change score models, we found differential age-related change in PA and physical health, but not in NA, in two groups differing in level of education. NA did only affect change in physical health in low-educated individuals, whereas physical health was equally strongly related to change in PA in both education groups. These results not only underline the importance of education, a central aspect of SES, for positive emotional functioning in later life, but also indicate that education modifies the detrimental impact of emotional distress on health.

Keywords: emotions, physical health, socioeconomic status, education, dual change score models

Introduction

The link between emotions and physical health has been a central topic of psychological research for some time (for an overview, see, Consedine, 2008; Leventhal & Patrick-Miller, 1993). It is particularly interesting to study this connection in later life. On the one hand, it has been noted that general developmental trends for emotional functioning and physical health diverge such that affective well-being is largely maintained, at least until young old age, while there are average declines in physical health with increasing age (Scheibe & Carstensen, 2010). On the other hand, the inter-domain connection between emotions and health may be particularly strong in later life (Chida & Steptoe, 2008; Meeks, Murrell, & Mehl, 2000).

Psychological research increasingly acknowledges the importance of socioeconomic status (SES) for psychological functioning over the life-span (for an overview: American Psychological Association, 2007). In the Reserve Capacity Model by Gallo and Matthews (2003), the authors hypothesize that SES is not only linked to physical health but also to the experience of positive and negative emotions. Moreover, the model implies that cross-domain associations between emotions and health might differ according to SES. Given this background, the present study examines interindividual differences in the development of positive and negative affect and physical health as well as in the dynamic associations between emotions and physical health in the second half of life according to education as one aspect of SES.

Emotions and Physical Health in Later Life: Developmental Trends and Interindividual Differences

It has been convincingly demonstrated that positive and negative affect are largely independent rather than reflecting the ends of a continuum, especially if assessed over longer

periods of time and if measured with the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). Developmental trends for these two components of emotional functioning also differ. Most longitudinal studies suggest a decrease in negative affect (NA) from young to middle adulthood until about age 60, followed by stability (Charles, Reynolds, & Gatz, 2001; Herbrich, 2006). Regarding positive affect (PA), existing longitudinal studies mainly point to stability from young to middle adulthood or even young old age, followed by decreases in old age (Charles, et al., 2001; Ferring & Filipp, 1997; Griffin, Mroczek, & Spiro, 2006; Herbrich, 2006).

Although there are some studies investigating change trajectories of functional and subjective health (e.g., Liang, et al., 2008; Liang, et al., 2005), there is little research on long-term trends in physical health, which has been defined as the absence of disease (Liang, 1986). One study has shown that physical symptoms, that is, a mixture of minor symptoms and chronic conditions, on average increase linearly with age (Aldwin, Spiro, Levenson, & Cupertino, 2001).

A central proposition in research on human development is that there are interindividual differences in trajectories of psychological and physical functioning (Baltes, 1987). In sociological research, social-structural predictors like race/ethnicity and SES are receiving ongoing attention, and numerous studies show that African Americans and those with low SES have worse physical health than White Americans and those with higher SES (e.g., Ferraro & Farmer, 1996; Robert & House, 1996). In psychological research, the association between social structure, especially SES, and emotional functioning has gained increasing attention in recent years. Positive and negative emotions play a central role in the Reserve Capacity Model as potential mediators of the SES-health association. Gallo and Matthews (2003) show that lower SES is linked to higher negative emotions. The association

between SES and PA has seldom been investigated. There is, however, some evidence for a positive correlation (Gallo, Bogart, Vranceanu, & Matthews, 2005; Isaacowitz & Smith, 2003). Although the Reserve Capacity Model evolved in the context of understanding the roles of psychosocial factors in health gradients, the developers explicitly refer to developmental research, stating that the proposed associations should be studied in multiple age groups or, ideally, with longitudinal methodologies (Gallo & Matthews, 2003).

While there is some support for an association between SES and levels of physical health as well as emotional functioning, its role in age trajectories of health and affect is less clear. Different hypotheses have been put forward concerning the development of the SES-health association in the second half of life. Representatives of the *age-as-leveler* hypothesis suggest that there is a convergence in the health trajectories of different SES groups in old age relative to middle adulthood (Herd, 2006). Other authors suggest that the influence of SES on health is characterized by *continuity*, that is, the SES groups start at different levels but show similar rates of change (O'Rand & Henretta, 1999). Finally, the effect of SES on health might increase over the life-span, leading to diverging health trajectories in later life (*cumulative disadvantage;* Dannefer, 1987). Results of multi-wave longitudinal studies provide evidence for all three patterns of age gradients (e.g., Herd, 2006; Kim & Durden, 2007; Yao & Robert, 2008). There are, however, only two longitudinal studies, limited to two occasions of measurement, which include the number of chronic diseases as an indicator of physical health, (Beckett, 2000; House, Lepkowski, Kinney, & Mero, 1994). Besides, these studies were conducted in the US, and the results are not easily transferable to other countries due to differences in health care regimes and the extent of social inequality. A cross-sectional study using data from the German Ageing Survey found education to be related to physical health independent of other aspects of SES and showed little age differences, indicating continuity in the education-health association, which guides our expectations for the present study

(Schöllgen, Huxhold, & Tesch-Römer, 2010). Concerning emotional functioning, the very few studies including SES as predictor did not find an effect on change in PA and NA (Charles, et al., 2001; Herbrich, 2006).

Interrelationships Between Emotions and Health

Interrelationships between emotions and health have been studied from three perspectives which will be outlined in the following. In large part, this research concentrated on one direction of influence, either conceptualizing health as predictor and emotions as outcome or studying the effects of emotions on health. There are a few studies, however, considering both directions of influence, which will be reviewed at the end of this paragraph.

Earlier studies suggested that NA, but not PA, is affected by health (Bradburn, 1969; Watson & Pennebaker, 1989). Based on the results of the Berlin Aging Study, Kunzmann (2008) developed a refined model, distinguishing different health components. She proposes that objective health-related competencies such as performance-based functional health, which facilitate one's level of social engagement, are central predictors of PA, whereas the subjective evaluation of one's health is more associated with NA. This might also help to explain the differential trajectories for PA and NA outlined above. Different aspects of health are related to each other, however. Physical health may have indirect effects on PA by affecting functional health, but it also has an impact on subjective health and might thus affect NA as well. In line with this argument, a study covering midlife and early old age found that an indicator of physical health was prospectively associated with both PA and NA (Burr, Santo, & Pushkar, 2009).

The potentially health-damaging effects of NA have also been examined to some extent. Studies including more objective measures of physical health often focus on a specific aspect of negative emotionality, which might partly explain inconsistencies in the results (Suls

& Bunde, 2005). There is, however, some evidence for shared contributions of anger, anxiety, and depression to the incidence of coronary heart disease (Kubzansky, Cole, Kawachi, Vokonas, & Sparrow, 2006). More generally, a review by Consedine (2008) compiles evidence that the global construct of NA does have effects in primary causation of disease. Besides, evidence is mounting that greater PA is prospectively related to better health, often after controlling for NA (for an overview, see Pressman & Cohen, 2005). Richman and colleagues (2005), for example, found PA to be associated with a decreased likelihood of having and developing physician-diagnosed hypertension, diabetes mellitus, and respiratory tract infections. Several mechanisms have been proposed linking PA and NA to health, among those health behavior and physiological mechanisms, that is, the functioning of the immune, endocrine, and cardiovascular system (Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002).

Additional insight can be gained from studies estimating both pathways, that is, from health to emotions and from emotions to health. These studies provide some evidence for a reciprocal relationship (e.g., Aneshensel, Frerichs, & Huba, 1984; Meeks, et al., 2000; Ormel, Rijsdijk, Sullivan, van Sonderen, & Kempen, 2002), although a measure of illnesses as an indicator of physical health has only partly been included. Besides, these studies focused on more specific aspects of emotional functioning (primarily depression), which raises the question whether results can be transferred to broader dimensions of PA and NA. Furthermore, the widely used methods to study bidirectional relationships suffer from some limitations, which will be outlined in more detail below.

Interindividual Differences in Interrelationships Between Emotions and Health: The Role of Socioeconomic Status

Besides their effect on levels, and possibly trajectories, of physical health and emotional functioning, social-structural factors like SES might also influence emotion-health

couplings. The Reserve Capacity Model can be used to develop expectations. A central tenet of this model is that individuals with lower SES have a lower level of psychosocial resources (Gallo & Matthews, 2003). Thus, they might be less equipped to deal with negative emotions which are then more detrimental to their health. This explanation was put forward by Merjonen and colleagues (2008), who found that anger was only related to physical health (subclinical atherosclerosis) at low but not higher levels of education in a sample of younger adults. A study on older adults provided some evidence for a stronger association between depressive symptoms and the number of chronic diseases at low compared to higher levels of income (Carvalhais, et al., 2008). As both studies are cross-sectional, the results also allow for the interpretation that health affects NA more strongly in individuals with low SES. The lower level of psychosocial resources of the socio-economically disadvantaged could also limit their ability to cope with stress caused by health limitations, thus exacerbating its detrimental effect on emotional functioning.

To our knowledge, differential associations between positive emotions and physical health according to SES have not been studied. It is hence not clear whether similar effects, that is, stronger links between emotions and health at low levels of SES, can be found for PA. If it is assumed that those with low SES do not only have problems to down-regulate their negative emotions but also to maintain positive emotional states, does that imply that the effect from PA to health is weaker compared to those with higher status? It could also be hypothesized, however, that PA has stronger effects on health for those with low SES, given their higher levels of stress and lower levels of psychosocial resources, due to its potential role as a stress buffer and resource generator (Fredrickson, 1998; Pressman & Cohen, 2005).

The Present Study

The present study examines long-term development and dynamic associations of physical health and emotional functioning, extending existing research in several ways. First, we use broad and well-validated measures of PA and NA. Second, we use an advanced method of analysis that provides a statistical framework for evaluating dynamic longitudinal growth in single variables as well as multivariate interrelationships between these change processes, namely dual change score models (McArdle, 2001; McArdle & Hamagami, 2001). Third, and probably most important, we examine interindividual differences in both long-term development and cross-domain associations of physical health and emotional functioning according to socioeconomic status. More specifically, we focus on education as one aspect of SES. Education is supposed to be central to the development of psychological resources such as control beliefs (Mirowsky & Ross, 2007) and might thus shape the emotion-health link.

Employing data from the German Ageing Survey (DEAS), a nationally representative panel study of people aged 40 to 85 years at baseline, we first examine the age-related development of emotional functioning and physical health in later life in groups with different levels of education. Based on the results of existing studies, we hypothesize that there is an accelerating decline in PA and a decelerating decline in NA. We also assume that there is a decline in physical health, but the lack of studies precludes hypotheses about its functional form. Building on the results of previous studies, we further hypothesize that those with higher education start at higher levels of physical health and PA as well as lower levels of NA than those with low education, but that the education groups show similar rates of change.

Second, we investigate the interrelationships between emotions and physical health. Reciprocal associations seem most plausible theoretically and empirically. Hence, we assume that physical health affects change in PA and NA and that PA and NA influence change in

physical health. Based on the assumptions of the Reserve Capacity Model, we further hypothesize that the dynamic associations between NA and physical health are stronger at low than at higher levels of education. Differential couplings between PA and health by education level are also examined in an exploratory manner.

Method

Sample

Longitudinal data from the German Ageing Survey (*Deutscher Alterssurvey*; DEAS), collected over three measurement occasions covering a 12-year period, were used in the present study. DEAS is an ongoing population-based, representative panel study of community-dwelling persons living in Germany, aged 40 to 85 years at baseline. Data collection took place in 1996, 2002, and 2008 and occurred via in-home interviews and additional self-administered questionnaires. The sample was drawn in 1996 (T1) by means of national probability sampling and was systematically stratified by gender, region (West or East Germany) and age (Engstler & Motel-Klingebiel, 2010). About 50% of those contacted agreed to take part in an interview (N = 4,838). The response rate corresponds to that in other large German survey studies (Neller, 2005). Of those interviewed, 83.4% additionally completed a questionnaire; they did not differ to a great extent from those only completing the interview (d < 0.20; see Appendix D, Table D1) according to selectivity analyses using the method developed by Lindenberger and colleagues (2002). The participants completing both interview and questionnaire constitute our baseline sample as we use data predominantly assessed within the questionnaire (N = 4,034; M_{age} = 60.05 years, SD = 12.18; 48.8% female, 66.1% living in West Germany).

When asked after the first interview if they were willing to be re-interviewed at a later point in time, 61.4% of the survey participants agreed. The addresses of the other participants were deleted in line with German data-protection laws. The sample that could be contacted for a second time was further reduced due to mortality and relocation to an unknown address. 64% of this reduced sample were in fact re-interviewed, leading to a sample size of $N = 1{,}363$ in 2002 (T2), given the baseline sample we used here; others refused because of illness or without giving any reason (see also, Wurm, Tesch-Römer, & Tomasik, 2007, for more information about the T2 sample). A similar procedure led to a sample size of $N = 894$ in 2008 (T3), which includes more than 200 people who had not participated at T2. In total, 1,585 people provided data on at least two measurement occasions and 672 people took part at all three measurement occasions; those were on average younger, healthier, and better educated than the baseline sample at T1, which is an established finding in research on aging (for an overview: Chatfield, Brayne, & Matthews, 2005). Selectivity analyses showed, however, that all of these effects were below 0.50 *SD* units and thus small (Cohen, 1988; see Table D2).

The statistical procedures implemented in this study attempt to deal with this attrition by using all available data to estimate average change, regardless of whether a person stayed in the sample over time, under the assumption that the data are missing at random (Little & Rubin, 2002). We only excluded 11 participants with missing information on education to form grouping variables. Concerning single constructs, sample sizes for those providing at least one data point were: $n = 3{,}886$ for PA, $n = 3{,}888$ for NA, and $n = 3{,}975$ for physical health. As all available data are used, this means that sample sizes vary slightly in the analyses to follow.

Measures

Positive and negative affect. We measured PA and NA with the PANAS (Watson, et al., 1988), a well-validated measure. Participants rated how frequently they experienced 10 positive emotions (e.g., felt excited, energetic, determined) and 10 negative emotions (e.g., felt distressed, nervous, angry) within the last months on a five-point scale ranging from "never" to "very often". Cronbach's Alpha at T1was .87 for PA and .81 for NA. Measures were standardized to the T metric (M = 50, SD = 10 at T1), with the T1 sample serving as the reference. This ensures a common metric across variables while maintaining the psychometric properties of the scores and the longitudinal changes in means and variances (Gerstorf, Lövdén, Röcke, Smith, & Lindenberger, 2007).

Health. Physical health was assessed by using a checklist of 11 health problems (e.g., cardiovascular diseases, diabetes, back or joint diseases). A sum score based on the absolute number of self-reported illnesses was computed for each person. Using a sum score has various advantages over the use of single self-reported illnesses, related, for example, to parsimony and accordance between medical reports and self-reports (Ferraro & Farmer, 1996; Katz, Chang, Sangha, Fossel, & Bates, 1996). Global scores of self-reported illnesses are good proxies for functional disability (Marengoni, Von Strauss, Rizzuto, Winblad, & Fratiglioni, 2009), and they are a good predictor of 1-year mortality (Chaudhry, Jin, & Meltzer, 2005). Scores were recoded so that higher values indicate better physical health. Measures were standardized to the T metric (M = 50, SD = 10 at T1), with the T1 sample serving as the reference.

Education. Participants reported their highest level of completed school education with reference to the German education scheme. As more than 50% had low education, only two levels of education were distinguished to avoid largely unequal group sizes: low

(corresponding to less than 10 years of school education; 63.3% of the sample) and high (at least 10 years of school education; 36.7% of the sample).

Covariates. Gender, place of residence (i.e., West Germany or East Germany), and partner status at baseline were used as covariates as they have been shown to be related to emotional functioning and health (e.g., Hillen, Schaub, Hiestermann, Kirschner, & Robra, 2000; Smith, Borchelt, Maier, & Jopp, 2002).

Analyses

Dual change score models (DCSM), based on latent difference score (LDS) models, are employed as they permit evaluations of different kinds of change, that is, constant or additive change and proportional or multiplicative change (McArdle, 2001; McArdle & Hamagami, 2001). These models offer several advantages over related approaches such as latent growth models (LGM). The DCSM estimates all parameters of an LGM, but additionally allows for estimation of relations between the score of a variable at a given point in time and their error-free subsequent changes (Lövdén, Ghisletta, & Lindenberger, 2005). In the bivariate extension (BDCSM), the sequential dependency between different variables can be studied, which is a further advantage compared to LGMs which can only estimate correlations between changes in two variables without testing for directionality of influence. Cross-lagged correlation models, which have been a popular approach to address lead-lag hypotheses, exhibit some widely recognized problems such as a bias toward assigning a stronger leading role to the variable with the highest reliability or strongest stability and questionable assumptions of stationary processes (Rogosa, 1980). The DCSM accounts for differential reliabilities and stabilities of the variables in estimating cross-domain effects and simultaneously analyzes and thus separates within-variable change and across-variable effects (for a more extensive discussion, see Lövdén, et al., 2005). This is an important advantage as

it has been noted that differential developmental trends can bias cross-domain correlations (Hofer & Sliwinski, 2001). Furthermore, these models can be extended to be simultaneously estimated in multiple groups, so that interindividual differences in change trajectories and couplings between variables can be studied (McArdle, 2007). DCSMs have been successfully used to investigate a number of research questions on coupled developmental processes in adulthood, for example couplings between well-being and cognition (Gerstorf, et al., 2007), social participation and perceptual speed (Lövdén, et al., 2005), and between different components of cognitive functioning (Finkel, Reynolds, McArdle, & Pedersen, 2007; Ghisletta & de Ribaupierre, 2005; Ghisletta & Lindenberger, 2003).

In this study, as with many others, the participants were not all measured at the same initial ages, making the choice of the time scale for the analyses more complex as ‘‘time of measurement’’ is not equivalent to ‘‘age of measurement’’. As we are interested in chronological age change, however, we decided to use a time scale based on the observed or chronological age at the occasion of measurement (see also, McArdle, et al., 2004). The full age range in the DEAS spanned 56 years, from the first assessment of the youngest (at 40 years) to the last assessment of the oldest participant (at 96 years). The data for the constructs were too sparse after age 87 to support statistical modeling, especially if the sample was split into education groups; therefore only data up to this age were included in the present analyses. Using a 3-year age interval simplified the analyses and allowed us to maximize the age range that could be included in the analyses (cf. Finkel, et al., 2007; McArdle, et al., 2004). This implies that all one-unit changes will represent change over three years. Table 5.1 (p. 137) shows the number of data points available for the constructs in each 3-year interval as a function of age at assessment and level of education. Sample sizes diminished at the higher ages as a result of attrition.

Table 5.1

Means, Standard Deviations, and Number of Data Points in Each 3-Year Age Interval as a Function of Age at Assessment and Education

Age at assessment	Positive affect						Negative affect						Physical health					
(mean)	Low education			High education			Low education			High education			Low education			High education		
	M	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*
40-42 (41)	50.3	10.1	94	53.0	8.8	198	52.9	10.8	94	51.9	10.1	198	55.2	8.2	93	57.0	5.7	199
43-45 (44)	51.8	9.3	133	53.2	8.7	169	51.9	9.6	132	51.4	8.8	169	55.5	7.9	130	56.2	6.8	168
46-48 (47)	53.8	10.0	164	54.2	9.0	236	49.9	10.3	163	52.3	10.7	237	54.5	7.8	164	55.6	7.6	240
49-51 (50)	53.5	9.2	138	53.6	8.0	211	51.5	9.5	140	50.7	9.5	210	53.1	8.3	139	53.8	7.7	212
52-54 (53)	51.2	9.7	242	53.6	8.0	242	50.7	9.7	241	51.1	9.0	242	52.8	8.9	241	54.9	8.5	241
55-57 (56)	51.6	9.6	303	54.7	7.7	238	51.2	10.4	303	49.9	8.3	239	50.2	9.2	308	53.2	7.3	238
58-60 (59)	50.1	9.4	333	54.7	8.3	213	50.7	9.6	333	49.8	9.5	213	50.2	9.1	329	52.6	8.2	210
61-63 (62)	51.0	9.3	315	54.7	8.1	165	49.9	10.5	317	48.2	8.6	165	48.0	9.7	316	51.5	9.3	164
64-66 (65)	50.1	9.5	289	53.7	8.7	143	48.7	9.0	287	48.0	9.9	144	48.9	9.2	289	50.5	8.3	139
67-69 (68)	50.0	9.5	263	54.1	8.8	123	47.3	9.9	265	48.0	9.4	124	47.1	9.9	269	49.7	8.8	120
70-72 (71)	48.0	10.5	315	52.3	9.7	142	48.4	10.3	318	47.8	8.7	142	47.3	10.0	322	47.4	10.4	139
73-75 (74)	47.9	10.2	287	52.6	8.9	93	47.1	9.5	285	49.0	9.6	91	45.1	10.0	308	47.5	10.8	92
76-78 (77)	46.7	11.0	247	50.9	10.4	101	47.4	10.2	245	45.2	9.8	101	44.3	10.7	252	47.4	9.5	102
79-81 (80)	47.5	10.9	148	51.8	10.2	53	46.8	9.7	147	45.1	9.7	54	44.0	9.9	156	45.0	9.6	55
82-84 (83)	44.3	11.6	122	49.1	10.4	75	47.5	11.3	121	46.2	9.0	73	44.6	10.7	129	42.7	11.3	78
85-87 (86)	44.6	10.1	33	51.5	5.6	15	48.3	11.1	33	46.1	10.3	15	47.2	9.4	35	44.8	10.8	14

Univariate analyses. Univariate DCSMs were employed to investigate age-related changes in each of the three indicators, that is, PA and NA as well as physical health. As can be seen in Figure 5.1 (p. 139), the model is based on latent difference scores to create a growth curve, which is thus not based on scores at a certain age but on change from one age to the next. The labeling of the parameters reflects the mean age of the 3-year intervals, for example, 41 for the 40-42 years interval. Thus, *Y*41 represents the observed score of measure *Y* at mean age 41 (40 to 42), with *y*41 indicating the latent true score and u_y41 signifying error. The latent true score at mean age 44 is a function of both the score at age 41 and the change between ages 41 and 44 (Δy44). The DCSM focuses on predicting changes in the latent true score as a function of constant trends across time (constant change α) and added change given the previous score (proportional change β). Constant change α is related to the slope factor y_s. Equation 1 depicts the model for change in *Y* at time point *t*:

$$\Delta y[t] = \alpha\, y_s + \beta\, y[t\text{-}1] \tag{1}$$

The values of α and β are assumed to be constant over time, although this is a testable assumption (Hawley, Ho, Zuroff, & Blatt, 2006). Commonly, α is set to 1 and β differs from zero to the extent that there is nonlinear longitudinal change. The DCSM also includes an intercept y_0, that is, an estimate of the initial level. There are parameters for mean intercept (μ_0) and mean slope (μ_s) as well as for individual variation around the group mean intercept and slope and their covariance (σ_0^2, σ_s^2 and $\sigma_{0,s}$). The residual variance σ_u^2 is assumed to be constant at each age. A time-invariant covariate can be added which influences the latent intercept and the latent difference scores.

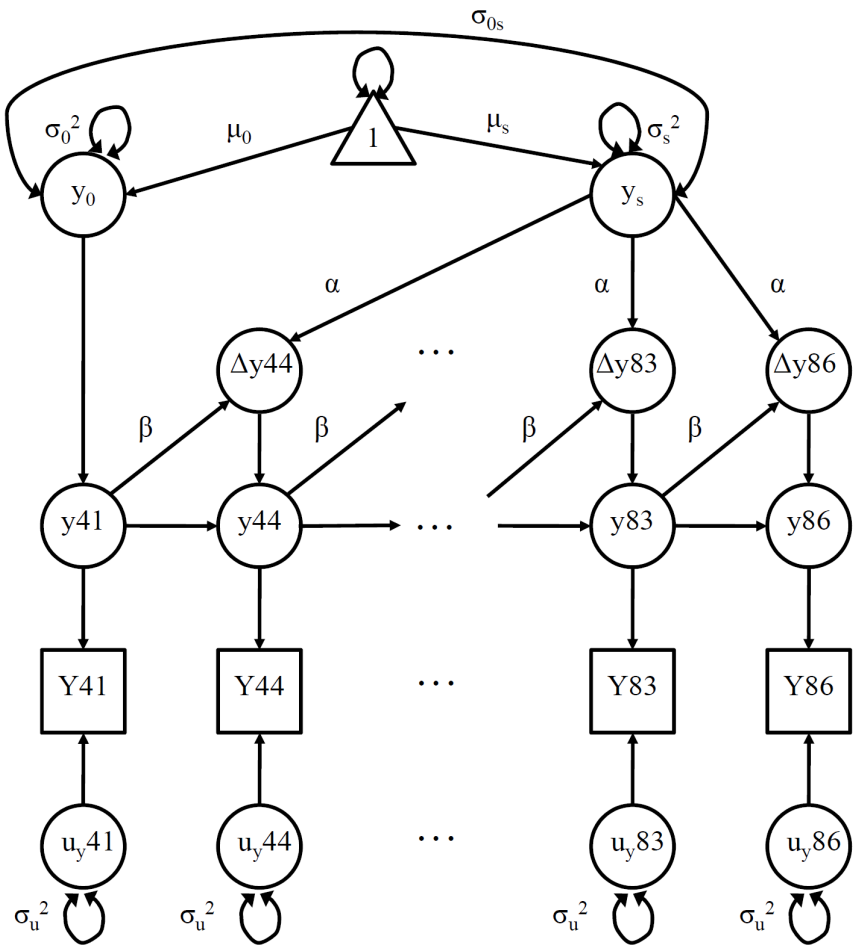

Figure 5.1. A univariate dual change score model to examine age-related changes in one construct (*Y*). Residual variance σ_u^2 is assumed to be constant at each age; α represents constant change and is related to the slope factor y_s; β represents proportional change. The model includes an estimate for intercept y_0 and slope y_s, mean intercept (μ_0) and mean slope (μ_s) as well as for individual variation around the group mean intercept and slope and their covariance (σ_0^2, σ_s^2 and $\sigma_{0,s}$).

Bivariate analyses. Bivariate DCSMs are used to examine dynamic relationships between age changes in health (*X*) and emotional functioning (*Y*). The model is depicted in Figure 5.2 (p. 140).

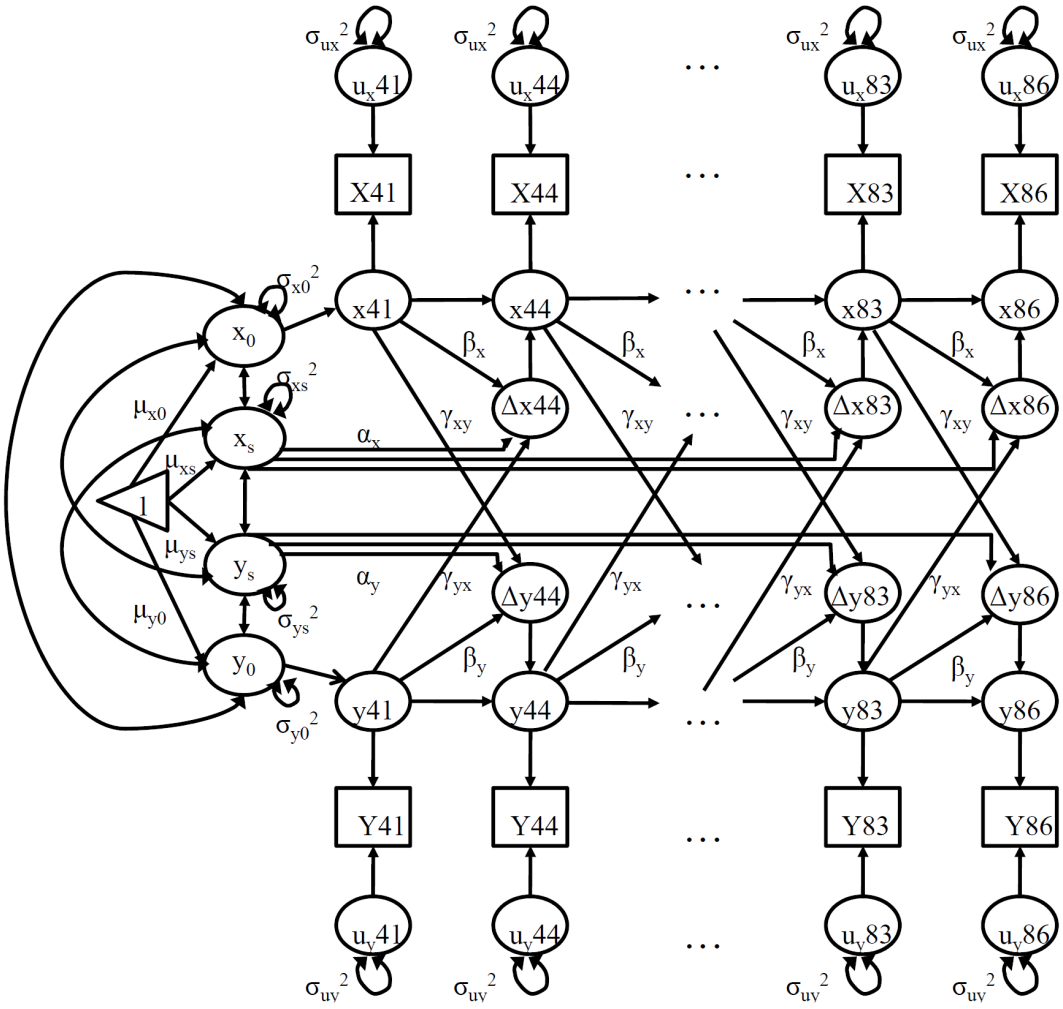

Figure 5.2. A bivariate dual change score model to examine the relationship between age-related changes in two constructs (*X* and *Y*). Residual variance σ_u^2 is assumed to be constant at each age within each construct; α_y and α_x represent constant change related to the slope factors y_s and x_s; β_y and β_x represent proportional change; cross-domain coupling is indicated by γ_{yx} and γ_{xy}. The model includes estimates for intercepts y_0 and x_0 and slopes y_s and x_s, mean intercepts (μ_{y0} and μ_{x0}) and mean slopes (μ_{ys} and μ_{xs}) as well as for individual variation around the group mean intercepts and slopes and their covariances (σ_{y0}^2, σ_{ys}^2 and $\sigma_{y0,s}$; σ_{x0}^2, σ_{xs}^2 and $\sigma_{x0,s}$).

As can be seen in Figure 5.2, the extension includes a coupling parameter (γ) where true change in *X* depends on the previous value of *Y* (γ_{yx}) and true change in *Y* depends on the previous value of *X* (γ_{xy}). Together with four additional parameters, that is, covariances among intercepts and slopes, these capture the dynamic interrelationships between changes in the two constructs. The coupling parameters are assumed to be constant over time, although this constraint can be relaxed (Hawley, et al., 2006). Change in one construct is thus a time-based function of both itself and another construct (see Equations 2 and 3):

$$\Delta y[t] = \alpha_y y_s + \beta_y y[t\text{-}1] + \gamma_{xy} x[t\text{-}1] \quad (2)$$

$$\Delta x[t] = \alpha_x y_s + \beta_x x[t\text{-}1] + \gamma_{yx} y[t\text{-}1] \quad (3)$$

Through restrictions on model parameters and examination of changes in model fit, we can evaluate dynamic hypotheses. First, a form of dynamic coupling may exist in which the relationship between the two variables is bidirectional, such that *X* (e.g., health) affects changes in *Y* (e.g., emotional functioning) and *Y* affects changes in *X* (i.e., both γ_{yx} and γ_{xy} are non-zero). Next, we can test whether the dynamic relationship functions in one direction only, either with *X* as a leading indicator of change in *Y* (i.e., γ_{yx}=0), or with changes in *Y* preceding changes in *X* (i.e., γ_{xy}=0).

Multiple-group models. All (B)DCSMs in this study are set up as multiple-group structural equation models. Through restrictions on model parameters and examination of changes in model fit it can be determined whether the changes in *X* (health) and *Y* (emotional functioning) as well as the dynamic links between *X* and *Y* systematically differ between groups, e.g. those with low and higher education (for further details, see McArdle, 2007).

We employed Mplus 5.0 for all analyses and used full information maximum likelihood (FIML; Wothke, 2000) to accommodate incomplete data by using all available data points, that is, all participants providing at least one data point are included and no incomplete data are imputed. One underlying assumption of this technique is that data are missing at random (Little & Rubin, 2002). The FIML algorithm is enhanced by including variables that are strong predictors of dropout in this data set, for example, health. Model fit was evaluated by the root-mean-square error of approximation (RMSEA). Values of RMSEA < .06 indicate acceptable fit (Hu & Bentler, 1999). We additionally report chi-square and degrees of freedom (χ^2/df), but use this statistic mainly to compare nested models. The alpha level was set at .05.

Results

In the first section, we present results from the univariate analyses, examining change trajectories of PA, NA, and physical health, and investigating whether those differ between groups with low and high education. We then present results of the bivariate analyses, studying interrelationships between physical health on the one hand and PA as well as NA on the other hand and testing whether these couplings differ according to level of education. The results displayed are from models not including covariates. We also did all main analyses including gender, place of residence, and partner status as covariates, which provided virtually identical results.

Univariate Analyses

In the first set of analyses, the univariate DCSM was fit to PA and NA as well as physical health separately in both education groups to verify the shape of the change trajectories. For each construct, three models were fit to the data: a full DCSM with free

estimation of all parameters, a reduced constant change model in which β was set to zero to test if there was nonlinear change over age, and a model where all parameters involved in the estimation of change were set equal in the education groups. As can be seen from Equation 1 (p. 138), this does not only concern the constant change parameter α and the proportional change parameter β but also the mean level μ_0 as this is one of the [t -1] parameters involved in the estimation of change. We additionally estimated a model where only the intercept was set equal; results are reported in the text. Parameter estimates (and standard errors) for the full model along with fit statistics and change in model fit if β was set to zero and change parameters were set equal are displayed in Table 5.2 (p. 144). As can be seen, all models provided an acceptable fit to the data.

Table 5.2

Parameter Estimates and Fit Statistics From the Univariate Dual Change Score Models, by Level of Education

	Positive affect		Negative affect		Physical health	
Parameter	Low education	High education	Low education	High education	Low education	High education
Constant change α	1	1	1	1	1	1
Proportional change β	0.14 (0.05)	-0.02 (0.09) [a]	0.02 (0.05) [a]	-0.01 (0.04) [a]	0.03 (0.01)	0.06 (0.01)
Mean intercept μ_0	52.03 (0.45)	53.46 (0.39)	52.30 (0.59)	52.65 (0.48)	54.76 (0.35)	56.47 (0.28)
Mean slope μ_s	-7.68 (2.52)	1.08 (4.92) [a]	-1.15 (2.68) [a]	-0.03 (2.21) [a]	-2.59 (0.37)	-4.17 (0.42)
Intercept variance σ_0^2	35.81 (6.38)	41.44 (8.32)	43.95 (9.36)	47.89 (7.16)	23.64 (3.30)	14.79 (1.96)
Slope variance σ_s^2	0.85 (0.53) [a]	0.58 (0.46) [a]	0.21 (0.21) [a]	0.10 (0.15) [a]	@0	@0
Intercept-slope correlation $\rho_{s,0}$	-0.98 (0.03)	-0.34 (0.47) [a]	-0.63 (0.53) [a]	-0.32 (0.87) [a]	@0	@0
Residual variance σ_u^2	59.84 (2.81)	36.60 (2.04)	63.43 (2.95)	48.57 (2.29)	50.15 (2.18)	37.33 (1.65)
χ^2/df	192.68/102		152.70/102		213.94/106	
RMSEA (90% CI)	0.021 (0.017-0.026)		0.016 (0.010-0.021)		0.023 (0.018-0.027)	
Set $\beta = 0$: $\Delta\chi^2/\Delta df$	10.04/2		0.12/2 [a]		96.02/2	
Set α, β, and μ_0 equal: $\Delta\chi^2/\Delta df$	134.44/3		4.74/3 [a]		57.50/3	

Note. Standard errors in parentheses. All noncorrelation estimates are unstandardized. The significance tests assigned to the correlations refer to the corresponding covariances. Slope variances for physical health were small and negative and thus set to zero (including the intercept-slope covariance).
RMSEA = root-mean-square error of approximation; CI = confidence interval.
[a] not significant at the $\alpha = .05$ level.

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For *positive affect*, the mean slope was significantly negative, whereas the proportional parameter β was significantly positive for the low education group (Table 5.2). Although both parameters are non-significant in the high education group, setting the β parameters to zero resulted in a significantly worse fit, suggesting there is nonlinear change in at least one of the groups. As can be seen in Figure 5.3 (p. 146), there was an accelerating decline in the low education group, whereas the high education group exhibited relatively stable levels of PA over the entire age range. This difference in trajectories was underlined by a significant loss in model fit upon setting the change parameters equal. The low education group started at slightly lower levels ($\Delta\chi^2(1) = 5.12$, $p < .05$, if only the mean intercept was set equal), and the differences between the groups increased over age. If we had set the mean intercept to another value like the mean age at T1 as is often done in studies examining change over time, we would thus have obtained stronger group differences in this parameter. As can be seen in Table 5.2, there was only significant variance around the mean level, but not around the mean slope in both groups. We still obtained a very high correlation between intercept and slope in the low education group. As has been shown in other studies, the large value for the intercept-slope correlation often obtained in DCSMs should be treated with caution, but it does not affect the other parameter estimates (Ghisletta & Lindenberger, 2003; Lövdén, et al., 2005), and thus we dismissed it.

For *negative affect,* the constant and the proportional change parameters were non-significant and there was no significant variance around the mean slope in the full DCSM (Table 5.2). A model in which β was set to zero did not fit the data significantly worse. A "no change" model where, additionally to $\beta = 0$, α was also set to zero, showed a much worse fit, however ($\Delta\chi^2(8) = 163.26$, $p < .05$). In fact, after β was excluded from the model, the constant change parameter was significantly negative in both groups. Change trajectories - including the intercept ($\Delta\chi^2(1) = 0.20$, $p > .05$, if only the mean intercept was set equal) - did not differ

by education. As can be seen in Figure 5.3, both groups showed a moderate linear decline in NA with increasing age.

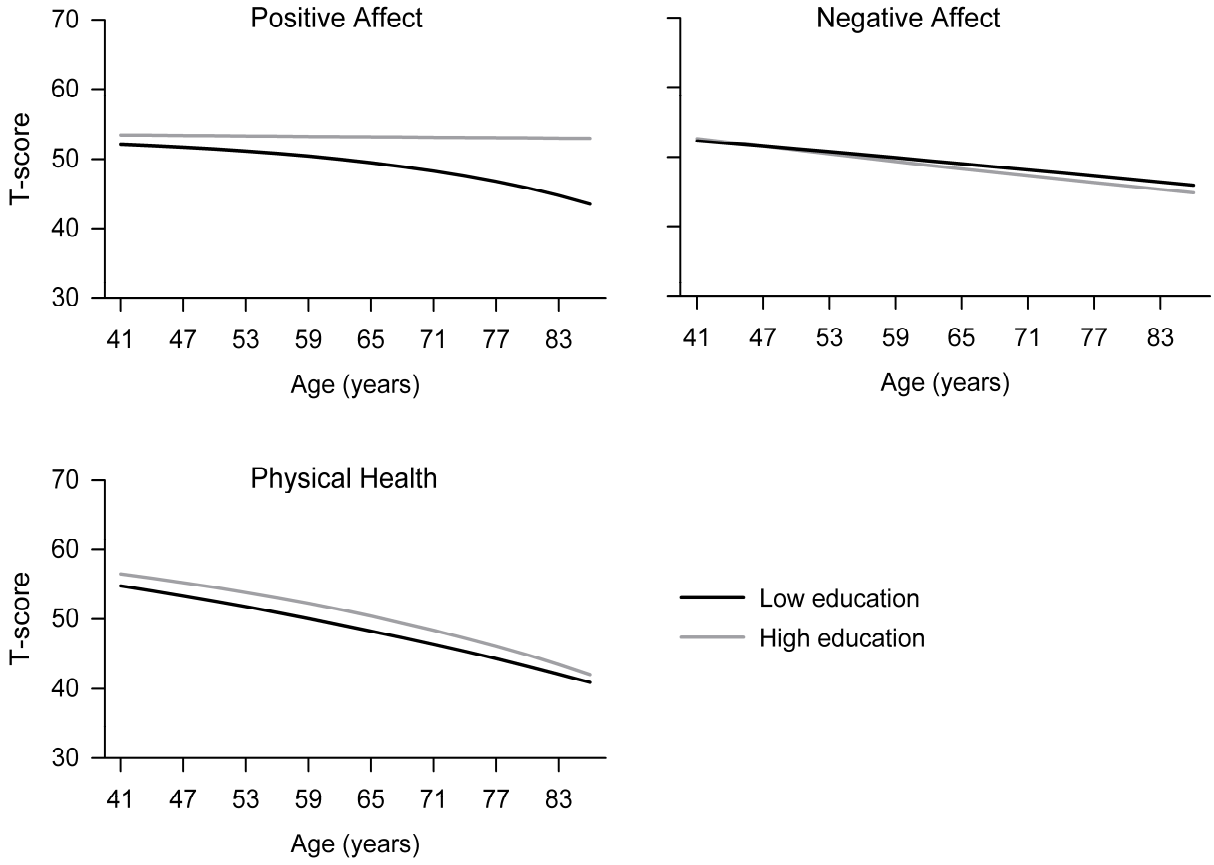

Figure 5.3. Change trajectories for the low and the high education group resulting from fitting the univariate dual change score model to the three constructs.

For *physical health,* variance around the mean level was significant, but not around the mean slope in both groups. In fact, we obtained a small negative value for the estimate of the slope variance in the high education group, with the confidence interval for both groups overlapping zero (low education [-0,197, 0,159], high education [-0,199, 0,677]), which indicates that there are no reliable differences in constant change[7]. We therefore set the slope variance and level-slope covariance to zero and re-estimated the model to obtain the solution

[7] The finding of non-significant slope variances is probably due to a lack of power to detect interindividual differences in constant change (Hertzog, von Oertzen, Ghisletta, & Lindenberger, 2008). The estimation of coupling parameters in bivariate models does not necessitate variances in the linear slopes (Lövden, et al., 2005).

displayed in Table 5.2 (p. 144). As can be seen, the slope mean is significantly negative, whereas the proportional parameter β is significantly positive in both groups. A model in which β was set to zero had a significantly worse fit. The change parameters can only be interpreted in combination. In this case, the results suggest an accelerating decline with age (Finkel, et al., 2007), especially for the high education group. The significant loss in model fit upon setting the parameters equal indicates that the change trajectories differed by education group. As can be seen in Figure 5.3, the low education group started at lower levels ($\Delta\chi^2(1) = 14.09$, $p < .05$, if only the mean intercept was set equal) and showed a more linear change in physical healthcompared to the high education group. This leads to the pattern of converging trajectories from about 80 years on. The overall change in physical health over the period from 40 to 87 years amounted to more than one standard deviation for both education groups.

Bivariate Analyses

We used multiple-group BDCSMs to test hypotheses about the dynamic relationship between emotional functioning and health in different education groups. Parameter estimates (and standard errors) along with fit statistics for the full bidirectional coupling model and change in fit when testing the reduced models, that is, unidirectional coupling and equal coupling in the low and high education groups, can be found in Tables 5.3 and 5.4 (estimates of the correlations fit in each bivariate model are available upon request). It can be seen from Table 5.3 (p. 148) and Table 5.4 (p. 150) that the full models examining couplings between physical health and PA as well as NA showed an adequate fit to the data. In line with the univariate results, we set the slope (co)variances in physical health to zero.

Table 5.3

Parameter Estimates and Goodness-of-Fit from the Bivariate Dual Change Score Model of Physical Health and Positive Affect (PA), by Education Group

	Low education		High education	
Parameter	Health	PA	Health	PA
Constant change α	1	1	1	1
Proportional change β	0.05 (0.01)	0.07 (0.10) [a]	0.06 (0.01)	-0.09 (0.06) [a]
Coupling $\gamma_{PA\text{-}HEALTH}$	-0.04 (0.02) [a]		0.00 (0.02) [a]	
Coupling $\gamma_{HEALTH\text{-}PA}$		0.06 (0.06) [a]		0.11 (0.03)
Mean intercept μ_0	54.59 (0.35)	51.64 (0.58)	56.37 (0.29)	52.29 (0.47)
Mean slope μ_s	-1.24 (0.95) [a]	-7.24 (2.70)	-4.09 (0.72)	-0.96 (3.24) [a]
Intercept variance σ_0^2	24.82 (3.35)	36.92 (7.78)	15.15 (1.98)	45.71 (7.32)
Slope variance σ_s^2	@0	0.59 (0.37) [a]	@0	0.99 (0.43)
Residual variance σ_u^2	49.92 (2.16)	59.88 (2.83)	37.27 (1.64)	36.38 (1.86)
χ^2/df	566.68/336			
RMSEA (90% CI)	0.019 (0.016-0.021)			
$\Delta\chi^2/\Delta df$ Equal coupling $\gamma_{PA\text{-}HEALTH}$	1.69/1 [a]			
$\Delta\chi^2/\Delta df$ Equal coupling $\gamma_{HEALTH\text{-}PA}$	0.60/1 [a]			
$\Delta\chi^2/\Delta df$ Coupling $\gamma_{PA\text{-}HEALTH} = 0$	2.31/2 [a]			
$\Delta\chi^2/\Delta df$ Coupling $\gamma_{HEALTH\text{-}PA} = 0$	18.33/2			

Note. All estimates are unstandardized. Standard errors in parentheses. Slope variances for physical health were small and negative and thus set to zero (including the intercept-slope covariance). RMSEA = root-mean-square error of approximation; CI = confidence interval.

[a] not significant at the $\alpha = .05$ level.

In the model examining couplings between *physical health and PA*, the positive coupling parameter from physical health to PA was only significant in the high education group, but the model comparison revealed that the coupling did not differ between the education groups (Table 5.3). Taken together with the significant loss in model fit if $\gamma_{HEALTH\text{-}PA}$ was set to zero, this indicates that, regardless of level of education, those with higher physical health show less decline in PA. The previous level of PA did not affect change in physical health above and beyond previous health, however. This is underlined by the non-

significant loss in model fit if $\gamma_{PA\text{-}HEALTH}$ is set to zero. The coupling parameter did not differ between groups. Not surprisingly, incorporating the coupling parameters in the model resulted in changes in the other estimates. Compared to the univariate models, it can be seen from Table 5.3 that the negative slope or constant change parameter for physical health was not significant anymore in the low education group and that the proportional change parameter of PA was not significant in both groups.

In the model including *physical health and NA*, the β parameters for NA were very small and non-significant in both groups, as was already the case in the univariate model. We thus set those parameters to zero, which did not affect the other parameter estimates as well as the model fit and represents the more parsimonious model. Results are shown in Table 5.4 (p. 150). The coupling parameters from physical health to NA were non-significant in both groups and did not differ between the groups. This indicates that, regardless of level of education, physical health does not affect change in NA. There was a significantly negative effect of NA on future physical health in the low education group, however. Comparisons revealed that the models setting the $\gamma_{NA\text{-}HEALTH}$ parameters equal or fixing them at zero fit the data significantly worse than the full model. This indicates that, in the low education group, those with higher NA show negative deviations from the mean change, that is, more of a decline in physical health. This is illustrated in Figure 5.4 (p. 151) where we varied the initial sample mean for NA by half a standard deviation of the corresponding education group (see Table 5.4) while keeping the initial sample mean for physical health constant.

Table 5.4

Parameter Estimates and Goodness-of-Fit from the Bivariate Dual Change Score Model of Physical Health and Negative Affect (NA), by Education Group

	Low education		High education	
Parameter	Health	NA	Health	NA
Constant change α	1	1	1	1
Proportional change β	0.00 (0.01) [a]	@0	0.07 (0.01)	@0
Coupling $\gamma_{NA\text{-}HEALTH}$	-0.07 (0.02)		0.02 (0.02) [a]	
Coupling $\gamma_{HEALTH\text{-}NA}$		0.00 (0.03) [a]		-0.03 (0.03) [a]
Mean intercept μ_0	55.87 (0.49)	52.76 (0.63)	56.26 (0.32)	52.99 (0.46)
Mean slope μ_s	2.48 (1.52) [a]	-0.25 (1.29) [a]	-5.51 (1.16)	0.88 (1.36) [a]
Intercept variance σ_0^2	18.50 (3.70)	42.47 (8.62)	15.70 (2.09)	45.82 (6.74)
Slope variance σ_s^2	@0	0.19 (0.16) [a]	@0	0.03 (0.15) [a]
Residual variance σ_u^2	50.29 (2.20)	65.13 (2.98)	37.18 (1.63)	48.72 (2.27)
χ^2/df	564.10/338			
RMSEA (90% CI)	0.018 (0.016-0.021)			
$\Delta\chi^2/\Delta df$ Equal coupling $\gamma_{NA\text{-}HEALTH}$	11.78/1			
$\Delta\chi^2/\Delta df$ Equal coupling $\gamma_{HEALTH\text{-}NA}$	0.39/1 [a]			
$\Delta\chi^2/\Delta df$ Coupling $\gamma_{NA\text{-}HEALTH} = 0$	12.94/2			
$\Delta\chi^2/\Delta df$ Coupling $\gamma_{HEALTH\text{-}NA} = 0$	1.09/2 [a]			

Note. All estimates are unstandardized. Standard errors in parentheses. Slope variances for physical health were small and negative and thus set to zero (including the intercept-slope covariance). β parameters for NA were very small and non-significant in both groups (see univariate model) and were thus set to zero, which did not affect the other parameter estimates as well as the model fit and represents the more parsimonious model. RMSEA = root-mean-square error of approximation; CI = confidence interval.

[a] not significant at the $\alpha = .05$ level.

The purpose of Figure 5.4 is to better understand the differential magnitude of the coupling parameter $\gamma_{NA\text{-}HEALTH}$ and its effects over time rather than depicting exact change trajectories (see Gerstorf, et al., 2007, for a similar presentation of results). The left-hand panel shows model-implied change over age for those with low education in the hypothetical case that all participants showed similar physical health at age 41 (40-42) but differed in their initial levels of NA. As can be seen, the change trajectories considerably differ from one another in that participants with low initial levels of NA showed shallower decline in physical health compared to those with high initial levels of NA. In the right hand panel of Figure 5.4, the same procedure was applied to those with high education. It can be seen that the trajectories of physical health varied much less as a function of initial NA.

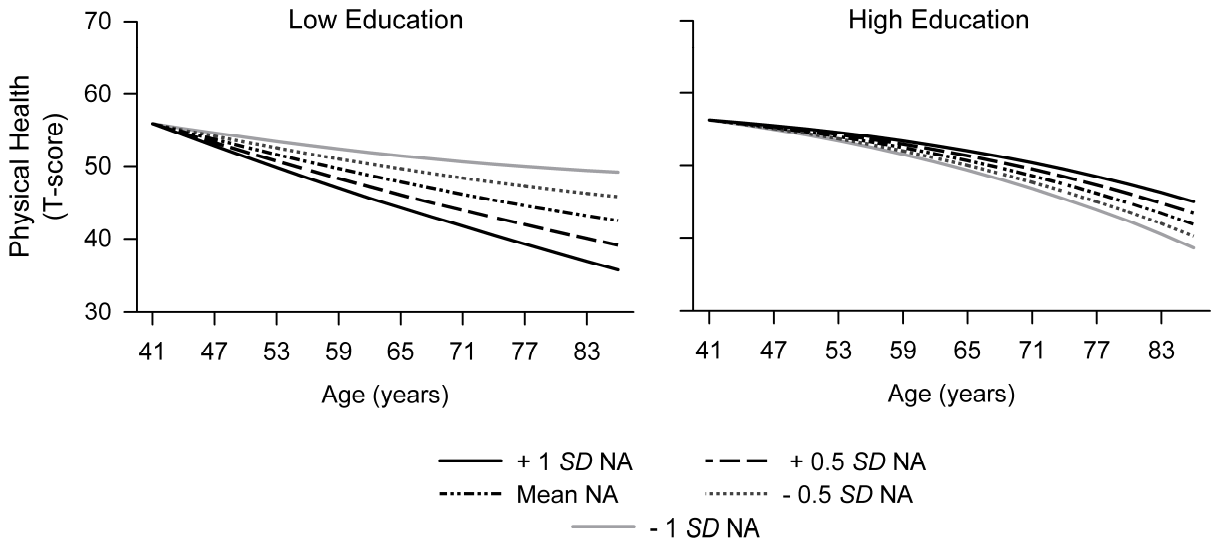

Figure 5.4. Graphical illustration of the differential magnitude of the coupling parameter $\gamma_{NA\text{-}HEALTH}$ and its effect over age in the low and the high education group. Model-implied change over age for the hypothetical case that the initial sample mean for negative affect (NA) was varied by half a standard deviation of the corresponding education group while keeping the initial sample mean for physical health constant.

Discussion

In this study employing data from the German Ageing Survey, a nationally representative sample of people aged 40 to 85 years at baseline, we first examined the age-related development of emotional functioning and physical health in later life in two groups with different levels of education. The main focus of our analyses was the question whether dynamic associations between emotions and health differ between the low and the higher educated.

Development of Emotional Functioning and Physical Health in Later Life: Differences According to Education

We found an accelerating decline in PA for the low education group and stability for the high education group, whereas NA showed a slight linear decline in both groups. At the same time, physical health showed the expected decline, which was accelerating in the high and more linear in the low education group, amounting to more than one standard deviation over a period of more than 40 years for both groups. One conclusion that can be drawn is that, especially in the high education group, emotional well-being does not deteriorate to the same extent as health. In contrast, there was no increase in NA which would have indicated worsening well-being.

Theoretical models such as socioemotional selectivity theory have been used to explain the maintenance of reasonably high levels of emotional well-being on average. In general, motivation and competence to regulate one's emotions seem to play a central role (Scheibe & Carstensen, 2010). Still, there was substantial decline in PA after midlife in the low education group in our study. Declining PA in the absence of increases in NA has been reported before in research on aging (Charles, et al., 2001; Herbrich, 2006). Given limited resources in later life, and especially for those with lower SES (Gallo & Matthews, 2003), the

regulation of negative emotions might be more important than the maximization of PA. Indeed, recent research has shown an increasing motivation to reduce NA and a decreasing motivation to enhance PA at higher ages (Riediger, Schmiedek, Wagner, & Lindenberger, 2009). Moreover, the PANAS assesses high arousal emotions; item examples for PA are "active", "excited" and "interested". Especially in this conceptualization, PA depends strongly on "doing" or an outward focus involving actual interactions with the external world (Kunzmann, 2008). It is likely that differences in such activities between groups with different levels of education increase after retirement, that is, when work-related interactions largely cease to exist. Social participation outside the work environment, including work as a volunteer and pursuing further education, is linked to education in later life, with less participation at lower levels of education (Bukov, Maas, & Lampert, 2002). This might help to explain the accelerating decline in PA for the low educated. Together with the observed stability for the higher educated, these results provide some evidence for the cumulative (dis)advantage hypothesis (Dannefer, 1987). Based on previous research (Charles, et al., 2001; Herbrich, 2006), we had expected differences in PA levels but similar rates of change (in the form of an accelerating decline) in the education groups. The limited number of studies suggests that effects of SES on long-term trajectories of emotional functioning should be investigated more.

Given the central role negative emotions play in the Reserve Capacity Model (Gallo & Matthews, 2003), it is surprising that we did not find an effect of education on NA which we had expected at least for levels of NA. There might be several reasons for this, one being the indicators used in the present study. Looking more closely at the review by Gallo and Matthews (2003), it seems that associations with NA are stronger for other SES indicators like income than they are for education. We still decided to focus on education here as education is central to the development of psychological resources which are assumed to play an

important role in emotion-health couplings (Mirowsky & Ross, 2007). Other advantages are applicability to diverse population groups and temporal stability of formal education upon entering midlife. Future studies should test, however, if our results can be generalized to other SES facets having different meanings, that is, occupational status, income, and wealth. Furthermore, the findings supporting a relationship with SES are more conclusive for some facets of negative emotionality than for others (Gallo & Matthews, 2003). Some other studies using a global measure of NA did not find an association with SES either, similar to our results (Gallo, et al., 2005; Isaacowitz & Smith, 2003). Another, more substantial reason for not finding different levels and trajectories of NA for those with low compared to higher levels of education might be the potential focus on the regulation of negative emotions in later life, especially for those with low SES, as explicated above.

Contrary to our expectations, we did find differences in physical health trajectories according to education. The education-related differences were largely stable over most of the age range studied, followed by somewhat declining inequalities from about 80 years on. Education might continuously shape life chances and activities and thus remain important for health up to very old age when biological frailty leads to an accelerated health decline of higher educated people and thus to a convergence of the status groups (Herd, 2006). Our findings are an important addition to studies conducted in the US, which provide evidence for a leveling-off already at younger ages (e.g., Beckett, 2000). Societal differences, that is, differences in health care regimes and the overall extent of social inequality, might play a role in explaining these diverging results.

Dynamic Associations between Emotions and Health

Most importantly, on the couplings between emotions and health, we found a differential effect of NA on change in physical health which was stronger at low than at higher levels of education, as we had hypothesized. To our knowledge, this is the first study

which shows this effect with longitudinal data and thus extends the cross-sectional results by Merjonen and colleagues (2008) who found that anger was only related to health at low but not higher levels of education. The results indicate that, at low levels of education, those with higher NA showed a stronger health decline, whereas NA did not significantly affect the health of the higher educated. According to the Reserve Capacity Model, those with lower SES have a lower amount of psychosocial resources (Gallo & Matthews, 2003). Thus, they might be less equipped to deal with negative emotions which are then more detrimental to their health.

To understand the educational differences in the effects of NA on health, and taking into account that there were no education-related differences in NA trajectories, it might be helpful to have a closer look at the concept of emotion regulation. First, emotion regulation is a process which can be subdivided into "antecedent-focused" emotion regulation, occurring before a full emotional response is elicited, and "response-focused" emotion regulation to influence emotional reactions (Gross, 2008). It may be that education-related differences mainly occur at this later stage, that is, after negative (or positive) emotions have already been experienced. Second, different strategies can be used to regulate emotions. It might be that those with low education use strategies that are effective in reducing NA but that have detrimental consequences for their health. A recent review (Pampel, Krueger, & Denney, 2010) suggests that unhealthy behavior like smoking and overeating helps regulate mood among those with lower SES. Although these explanations of our findings seem plausible, they remain speculation, as in a large survey study like the DEAS it is difficult to examine mechanisms in more detail. There is other research, however, supporting the assumption of differences in emotion regulation according to SES, although there is a lack of studies in later life (Gianaros, et al., 2007; Raver, 2004).

We did not find an effect of physical health on change in NA, which is contrary to what we had expected. Chronic diseases, on which our measure was based, might have a more indirect effect on NA by causing worse subjective health. NA is strongly affected by self-evaluations such as the subjective rating of one's health (Kunzmann, 2008). It has been shown, however, that comparison and adaptation processes attenuate the effect of physical health on subjective health, especially at higher ages (Jylhä, 2009). This might, in turn, reduce the effect of physical health on change in NA. Another potentially important point is the time frame. Some studies suggest that the effect of health on negative emotionality is rather short-term compared to the reverse (e.g., Meeks, et al., 2000). This could explain why another study of middle-aged and older adults covering a shorter time span did find an effect of physical health on NA (Burr, et al., 2009).

We observed, however, that physical health had a positive effect on change in PA (as expected), which did not differ between the education groups. This coupling effect indicates that, regardless of education, those with better physical health show less decline in PA compared to those with worse health or more chronic diseases. There was no effect of PA on change in physical health in any of the groups, which is contrary to our expectations and to the results of other studies finding an effect of PA on health in later life. These studies often employed a subset of four items from the CES-D, covering happiness and enjoyment as a component of PA (e.g., Ostir, Markides, Black, & Goodwin, 2000; Ostir, Markides, Peek, & Goodwin, 2001). Besides, this scale and some other measures used to assess PA also tap related constructs such as hope (Pressman & Cohen, 2005; Richman, et al., 2005). In contrast, the PANAS, which has been used in the present study, was developed as a pure measure of PA, and the pleasantness or happiness component of positive emotionality is not directly included in this scale, which might partly explain our divergent results.

Limitations and Strengths

This study has several limitations. First of all, there was a large dropout in the DEAS, particularly from T1 to T2. As outlined in more detail above, however, selectivity was rather weak for all of the measures employed. Furthermore, we used all available data, regardless of whether a person stayed in the sample over time, to minimize this bias and included health in our analyses, which is one of the strongest predictors of missingness in the DEAS as well as other studies (e.g., Lindenberger, et al., 2002). Given the scarcity of data, however, the oldest old were not well represented in the analyses. This might have led to an underestimation of general developmental trends and cross-domain associations, as some studies suggest that decline in health and positive emotional functioning is stronger in the oldest old and that emotion-health couplings get stronger with increasing age (e.g., Meeks, et al., 2000; Smith, et al., 2002).

Another issue is the time lag between points of measurement as well as the choice of the time scale for the present study. As we have outlined in more detail above, different couplings might require distinct intervals. Moreover, with shorter time frames, as employed by most other studies on this topic, it might be more likely to detect cross-domain associations than it was with the 6-year measurement interval of the DEAS. Still, our results show that there were some substantial coupling effects over this longer interval, and thus provide an interesting addition to the literature. Furthermore, there has been some debate whether one should study development over time or over age, and there are arguments pro and con both approaches (Mendes de Leon, 2007; Shaw, Krause, Liang, & Bennett, 2007a, 2007b). Given the structure of the dataset we used, with a broad age range at the first point of measurement and no real meaning of time as would be the case in an intervention study, however, it is preferable to study age-related change, as we did in this study (see also, McArdle, et al., 2004).

Health is a multidimensional construct, including physical, functional, and subjective health. We focused on physical health in the present study, higher values indicating less chronic diseases. Although this was a self-assessment, a high accordance with physician-evaluated health has been shown, especially for summary measures like the one we used (e.g., Bush, Miller, Goldsen, & Hale, 1989; Katz, et al., 1996). These sum scores have also been shown to be a good approximation of functional health (Marengoni, et al., 2009). While it is preferable for some research questions to also include the global subjective evaluation of a person's health, this might be problematic in the present context, as subjective health is assumed to be conceptually close to emotional well-being, and concerns have been raised as to which conclusions can be drawn if associations are found (Pressman & Cohen, 2005). The measure we used was thus the best approximation for an objective measure of health, as it is often not feasible to conduct extensive testing in large survey studies.

Besides using a nationally representative sample covering a broad age range, a major strength of this study is the method of analysis we used, that is, the uni- and bivariate dual change score model. This allowed us to combine the estimation of linear and nonlinear change with the investigation of cross-domain associations between emotions and health, offering several improvements over methods commonly used such as LGMs and cross-lagged correlation models (Lövdén, et al., 2005). Moreover, the extension to multiple-group models allowed not only for examination of interindividual variations in change trajectories, which is central to life-span developmental theory, but also made it possible to study systematic variations in dynamic cross-domain associations, which offers unique opportunities to enrich existing research.

Conclusion and Outlook

The present study examined long-term developmental trends in and cross-domain associations between PA as well as NA and physical health in later life, focusing on

differences according to education as one aspect of SES. Our results suggest that individuals with low education show stronger declines in PA than their higher educated counterparts. Moreover, NA only affects change in physical health at low levels of education. This not only underlines the importance of SES for emotional functioning over the life-span, but also shows that being socio-economically disadvantaged may amplify the detrimental impact of emotional distress on health. Future studies should also consider differences in emotion-health couplings according to other socio-structural factors such as ethnicity and gender as is suggested by developmental functionalism perspective (Consedine, 2008). Furthermore, the mechanisms behind those differences should be examined in more detail.

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Chapter 6

General Discussion

Summary

The aim of this dissertation was to demonstrate the usefulness of combining sociological and psychological perspectives on health in later life. Research has for some time now demonstrated the importance of socio-structural characteristics, particularly socioeconomic status (SES), for health in midlife (e.g., Marmot, Ryff, Bumpass, Shipley, & Marks, 1997). It was a largely open question, however, whether there is a change in the association between SES and health in the second half of life (Research Question 1). Furthermore, extending research on the impact of psychological and social resources on health in the overall population of middle-aged and older adults (e.g., Berkman, 1995; Kempen, et al., 2005), it was examined whether such resources have differential effects on health according to SES (Research Question 2). The final questions dealt with variation in and co-variation between emotions and health in different SES groups. First, it was investigated whether between-person variation in levels and changes of emotions and health differs by education as a central aspect of SES (Research Question 3), before turning to the question whether dynamic associations between emotions and health differ by education (Research Question 4).

To answer these questions, a combination of cross-sectional and longitudinal data from the German Ageing Survey (DEAS), a nationally representative study including middle-aged and older adults, was used. The first part of this chapter provides a summary of the results, with the main findings displayed in Table 6.1 (p. 171).

Table 6.1

Summary of the Main Results of the Present Thesis

Question	*Aim*	*Findings*	*Conclusion*
(1) Does the association between SES and health change in the second half of life? (Chapter 2, 4, 5)	To obtain a better understanding of social inequality in health in later life in Germany. To investigate if results differ by SES and health facet as well as measurement approach and design.	Results point to stability of social inequality in health except for income-related differences in subjective health (decrease) and wealth-related absolute inequality in physical and functional health (increase). Education-related differences in physical health might decrease in very old age.	These results suggest that, in Germany, the influence of SES on health remains important up to older adulthood.
(2) Do psychological and social resources have differential effects on health according to SES? (Chapter 3)	To examine whether the resource status of optimistic self-beliefs and social support depends on whether individuals are challenged by low education or low income, and higher age.	Psychological resources were stronger predictors of functional and subjective health in low compared to higher educated participants. Social resources were positively related to health mainly in (older) people with low income.	Different facets of SES have partly differential meanings and the impact of health-protective factors may thus vary according to SES facet.
(3) Does between-person variation in levels and changes of emotions and health differ by education? (Chapter 4)	To investigate variation in health and emotions within education groups and to test whether variation is more pronounced at low levels of education in older adulthood.	There were substantial variances in levels and changes of functional health and depressive affect within the education groups in older adulthood, with larger variation mostly in lower education groups.	A subgroup of disadvantaged individuals with few problems and declines in functioning shows potential for intervention.
(4) Do dynamic associations between emotions and health differ by education? (Chapter 4, 5)	To examine dynamic associations between health and both negative and positive emotions and to compare them across groups differing in level of education.	The association between changes in functional health and depressive affect as well as the effect of negative affect on change in physical health were stronger in low educated individuals. The effect of health on positive affect did not vary by education.	Differential associations between emotional distress and health may partly be due to education-related differences in dealing with negative emotions.

Chapter 2 focused on the question whether the association between SES and health changes in the second half of life (Research Question 1). It was examined whether results vary by SES facet and health aspect (see Figure 6.1). Relative and absolute differences were estimated. Using data from the second wave of the DEAS, it could be shown that less socio-economically advantaged persons between 40 and 85 years of age had worse health than more advantaged persons, with education being more consistently related to poor physical health than income and wealth. Age gradients varied somewhat by SES and health facet, but social inequalities in health were predominantly stable over age. Only income-related differences in subjective health declined. An increase was observed for wealth-related absolute inequalities in physical and functional health. These results suggest that, in Germany, the influence of SES on health remains important up to older adulthood.

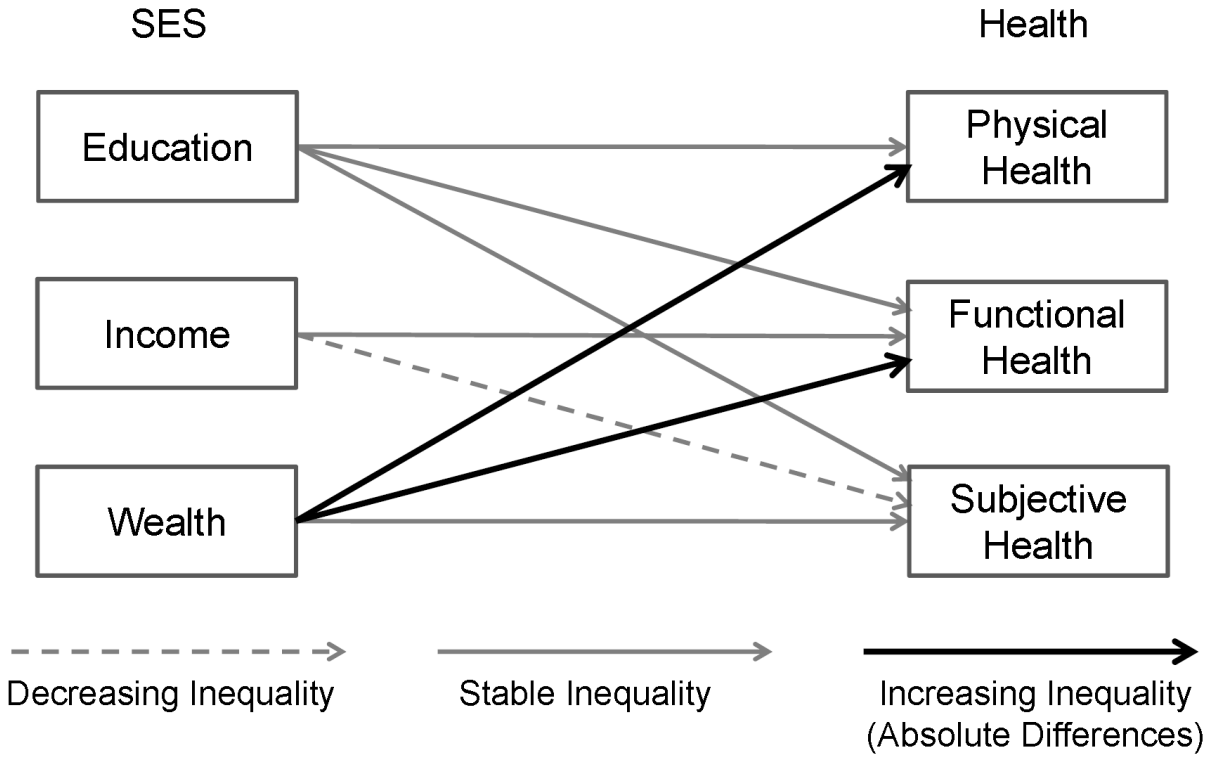

Figure 6.1. Summary of cross-sectional results on the SES-health association in the second half of life in Germany.

Chapter 3 dealt with the question whether SES moderates the effects of psychological resources and social resources on health (Research Question 2). Using data from the second wave of the DEAS, multiple-group structural equation modeling was employed to examine whether the relationship between optimistic self-beliefs as well as available social support and health differs between education and income groups. It was shown that psychological resources positively affected health in all groups, but these resources were stronger predictors of functional and subjective health in low compared to higher educated participants. The impact of social resources on health did not differ according to education but did vary by level of income. A higher amount of social resources was mainly associated with better health in the low income group. Analyses additionally looking at interactions with age showed that potentially available support was particularly important for the health of financially disadvantaged *older* people (see Figure 6.2). The results imply that different facets of SES have partly differential meanings and that the impact of health-protective factors may thus vary according to SES facet.

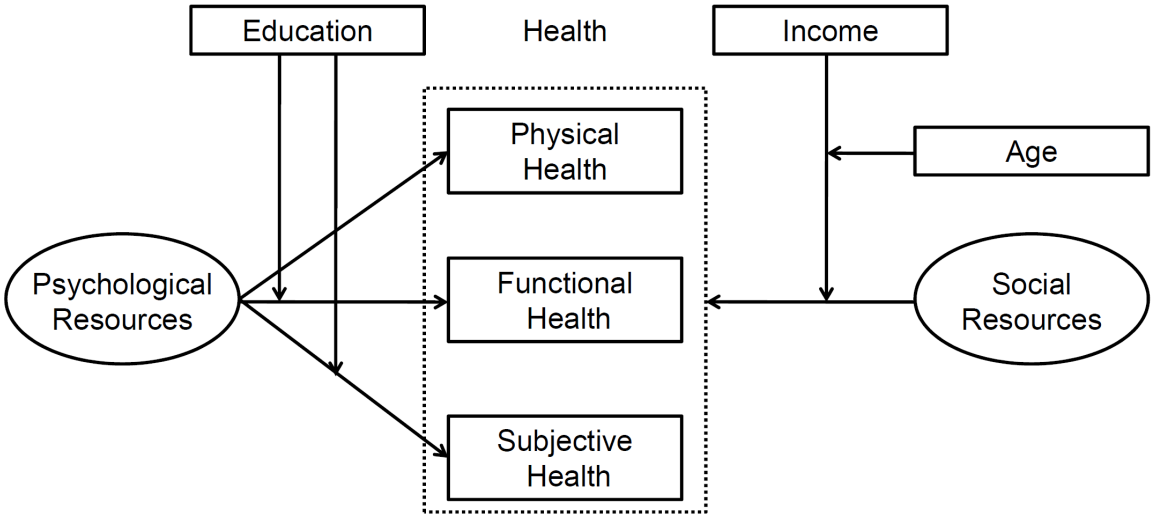

Figure 6.2. Summary of results showing differential health effects of psychological resources according to education and varying effects of social resources on health depending on income and age.

The two remaining chapters dealt with variation in and co-variation between emotions and health in different SES groups and also provided some longitudinal evidence on the question whether there are converging, stable, or diverging socioeconomic differences in health. In *Chapter 4,* it was examined whether between-person variation in levels and changes of emotional functioning and health differs by education (Research Question 3). This study used longitudinal data from the DEAS, collected in 2002 and 2008, including participants aged 65 years and older at baseline, and employed multiple group latent change score models. Besides providing some evidence that educational differences in functional health neither converge nor diverge over time, the results show that there are substantial within-group variances in levels and changes of health and depressive affect in older adulthood, with larger variation mostly in lower education groups (for variation in levels, see Figure 6.3). In particular, there were older individuals with hardly any problems and declines in functional health as well as few affective symptoms of depression despite being educationally disadvantaged, which points to potential for intervention.

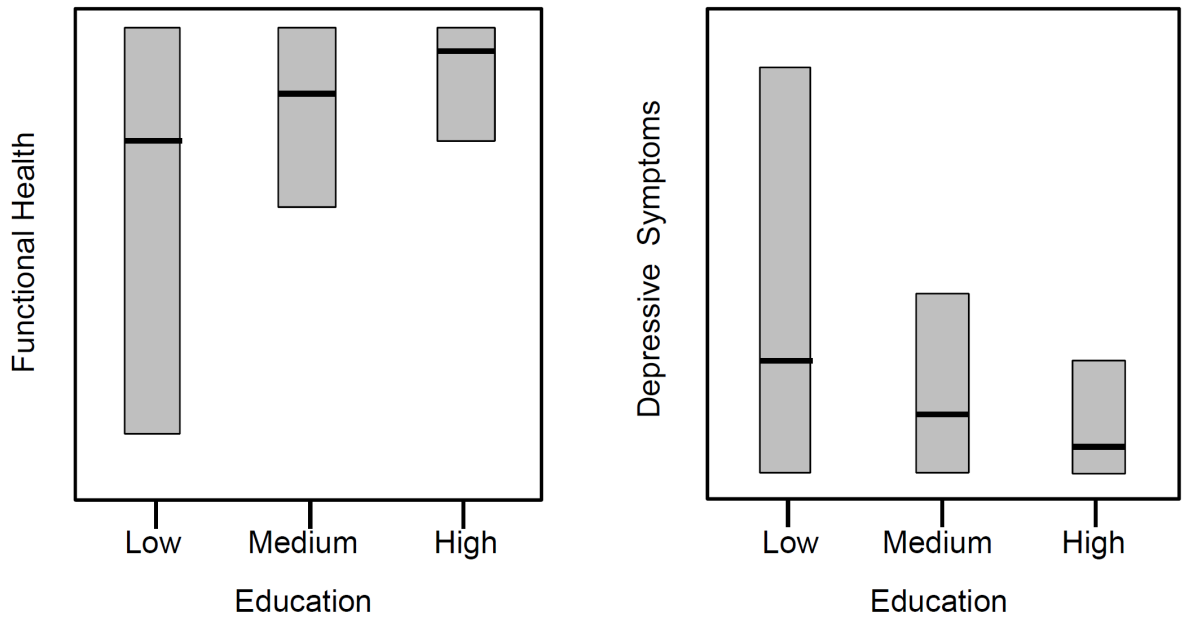

Figure 6.3. Box plot with variation around median levels of functional health and depressive symptoms in different education groups, showing larger variation at lower levels of education.

Chapter 5 focused on the question whether dynamic associations between emotions and health differ by education (Research Question 4). The preceding chapter already provided some evidence for stronger links between declines in physical functioning and increases in depressive affect at lower levels of education, but analyses were extended here: Measures for both positive and negative affect were incorporated and dual change score models were employed. Data of up to three waves spanning 12 years from the DEAS were used, and changes over the whole age range from 40 to 85+ years were estimated. Besides indicating that educational differences in physical health decline somewhat at about 80+ years, the results show that physical health has an effect on change in positive affect, which is equally strong in both education groups. Most importantly, there was a differential effect of negative affect on change in physical health, which was stronger at low compared to higher levels of education (see Figure 6.4); the reverse effects (e.g., physical health affecting negative affect) were not significant. The results point to education-related differences in dealing with negative emotions, so that their detrimental impact on health is stronger at low education levels.

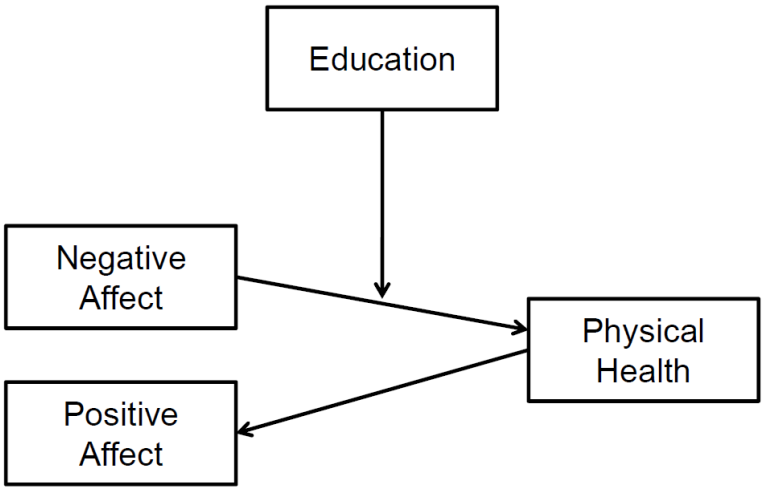

Figure 6.4. Summary of results on dynamic associations between positive and negative affect and physical health as well as the moderating effect of education. Reverse effects (from health to negative affect and from positive affect to health) were not significant in any education group.

In the following, the results of the present dissertation are integrated and discussed against the background of theoretical models from life-course and medical sociology as well as life-span developmental and health psychology. To this end, selected aspects of the discussions of the previous chapters will be elaborated in the following three sections. Subsequently, a critical reflection of limitations and strengths of the present study as well as implications for future research are provided. The chapter ends with a conclusion, highlighting practical implications.

The Association Between Socioeconomic Status and Health in Later Life

There are contradictory assumptions – age-as-leveler (decrease), continuity (stability), and cumulative (dis)advantage (increase) – and inconsistent results from international studies regarding the question of whether the association between SES and health changes in the second half of life (e.g., Herd, 2006; Lynch, 2003; Ross & Wu, 1996). The aim of the present thesis was to add to the literature by analyzing the German situation concerning social inequality in later life. To this end, comprehensive cross-sectional analyses were conducted (Chapter 2). Different facets of SES and health were included, assuming that the arguments underlying the different hypotheses may not apply equally, leading to varying age gradients. Moreover, complementary longitudinal analyses on education-related differences in trajectories of physical health and functional health were accomplished. Differences in age gradients according to SES and health facet, design and measurement approach (relative vs. absolute differences) are discussed in the following.

Concerning education-related inequality in physical health, no significant age variation was shown in cross-sectional analyses. Longitudinal analyses, however, provided evidence for significantly different trajectories of physical health in groups with low and higher

education. As can be seen in Figure 6.5, the education-related differences were largely stable over most of the age range studied, followed by somewhat declining inequalities from about 80 years on.

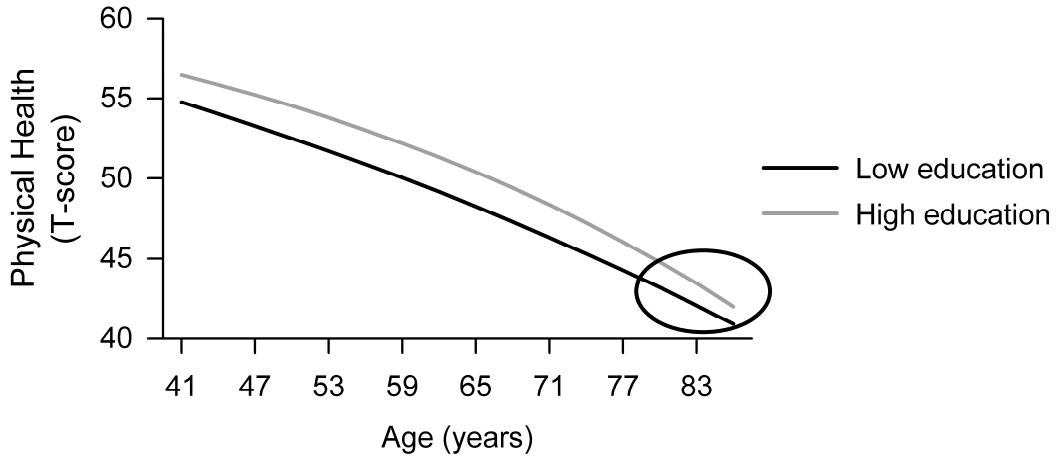

Figure 6.5. Longitudinal change trajectories for the low and the high education group resulting from fitting the univariate dual change score model to physical health.

It can be assumed that the larger amount of data points available for higher ages compared to the cross-sectional analysis and the approach to data analysis (cf. Chapter 5) increased the chance to detect these age variations in the longitudinal analysis. According to the literature, non-significant differences in social inequality in health between age groups in cross-sectional data may also be due to a significant age trend being canceled out by a complementary historical trend (Lynch, 2003). Applied to the results of the present thesis, this means: If the declining inequalities in very old age indicated by longitudinal data more closely reflect the age trend, this would require the effect of education on physical health to weaken in younger compared to the oldest cohorts, to account for the non-significant age variations found in cross-sectional data. The latter is not likely, given that existing research indicates stable or slightly increasing education-related health inequalities over the course of the 20th century (Lynch, 2006). Besides, it could be argued that longitudinal analyses are not only influenced by selective mortality but also by experimental selectivity, which might lead

to an underestimation of SES differences in health at older ages. As selectivity effects were small and - to minimize this bias - all available data was used in the present thesis regardless of whether a person stayed in the sample over time, this does not, however, seem to be sufficient explanation for the results displayed in Figure 6.5 (cf. Chapter 5).

Looking at the results for education-related differences in functional health, again, no significant age variation was shown in cross-sectional analyses. The respective longitudinal analyses on older adults with a mean age of 74 years at the first occasion of measurement and a mean age of 80 years at follow-up found that the education-related differences in rates of change over time were non-significant, although there was a tendency for stronger declines at higher levels of education (cf. Chapter 4). Had it been possible to apply the same method of analysis as for the physical health data, the longitudinal findings for functional health might have been more similar to those shown in Figure 6.5. Overall, these results indicate that education-related differences in health are largely stable in the second half of life up to an age of about 80 years and may decline at higher ages. Education might continuously shape life chances and activities and thus remain important for health up to older adulthood. In very old age, however, universal biological frailty may lead to a convergence of the education groups (Herd, 2006). The latter is also reflected in the general propositions on the architecture of life-span development by Baltes (1997) who states that cultural factors, e.g. education, lose their effectiveness at higher ages due to age-related biological losses, which is particularly apparent in very old (or fourth) age. In the context of social inequality in health, most international studies, particularly those conducted in the US, seem, however, to provide evidence of more pronounced age variations in social inequality in health and a leveling-off at younger ages already (e.g., Herd, 2006). Societal differences might play a role in explaining these diverging results. In contrast to the American health system, no change in the health insurance regime is associated with reaching the age of 65 in Germany. Furthermore, as there are greater social

inequalities in health during midlife in the United States compared to Germany, the SES-health association in the US might be attenuated in older adulthood to a larger extent due to a stronger influence of selective mortality in earlier stages of life (see also, Knesebeck, Lüschen, Cockerham, & Siegrist, 2003).

The findings presented here complement those of the study by Knesebeck and colleagues that provided some first indication for largely stable socioeconomic differences in health in Germany up to older adulthood. This was particularly true for subjective health as the outcome (Knesebeck, 2002). The results presented in Chapter 2 are mainly in line with this finding, except for decreasing income-related differences in subjective health. Moreover, income did not have an impact on poor physical health, operationalized as having three or more coexistent chronic diseases, after the effect of education was accounted for. This might be due to the fact that low education reflects life-long exposure to a range of risk factors, which contribute to an accumulation of chronic diseases in middle and older adulthood (Tesch-Römer & Wurm, 2009), whereas the measure of income used in most studies including the present thesis reflects the current situation to a higher degree. Hence, this result can be regarded as theoretically meaningful rather than challenging the use of income as an indicator of SES in later life. Indeed, above and beyond education, income had a continuous effect on functional health in the present thesis (see also Knesebeck, et al., 2003).

Cumulative effects may not only be reflected in measures of multimorbidity but also in indicators of wealth (e.g., Robert & House, 1996). Indeed, it was shown in the present thesis that, although the relative increase of risk of poor physical and functional health with age was the same for people belonging to different financial asset groups (continuity), looking at the larger absolute differences in rates at older ages one might still speak of a cumulation effect at the population level. These results give some first indication of the complexity of defining and measuring cumulative effects, which is outlined in more detail in cumulative

inequality theory (Ferraro & Shippee, 2009). Ideally, this requires a life-course approach representing the magnitude, onset, and duration of socially-structured exposure to advantage and disadvantage in multiple life domains. According to cumulative inequality theory, later-life outcomes are not only shaped by adverse or favorable experiences or events accumulating over the life-span, but also by psychosocial resources, which will be discussed in more detail in the following.

Differential Health Benefits of Psychosocial Resources According to SES

Psychosocial resources play a central role in the Reserve Capacity Model, which provides a theoretical framework for understanding interrelationships between SES, psychosocial factors, and health (Gallo & Matthews, 2003). It is hypothesized that those with lower SES have less psychosocial resources, which might partly explain their worse health. This mediator assumption has been tested in a number of studies and has received some support (Matthews, Gallo, & Taylor, 2010). In line with cumulative inequality theory, the model further assumes that psychosocial resources may act as a moderator, buffering the adverse effects of low SES on health (Gallo, de los Monteros, & Shivpuri, 2009). Viewed from a different angle, this means that the availability of such resources primarily plays a role at low SES, which is assumed to constitute a major stressor to health. Research in social science and the results of the present thesis suggest that this general assumption requires some qualification.

Most importantly, the multifaceted nature of SES needs to be taken into account. An important differentiation is along education and income, which do not only reflect different points in the life-span as discussed in the previous paragraph but also in part represent different health-relevant capabilities (see also, Herd, Goesling, & House, 2007). An important

pathway relating income to health is the ability to buy professional assistance and help for mastering demanding situations (Geyer & Peter, 2000). As available support from a social network may compensate for the lack of professional services, it had been hypothesized that this social resource shows stronger associations with health at low compared to higher income levels, whereas differential effects of social resources on health according to education were not expected. This was mainly supported by the results presented in Chapter 3 as potentially available support was primarily a resource for health in individuals with low income (see also, Vitaliano, et al., 2001).

On the other hand, it has been suggested that both low education and low income reflect a reduced ability and limited opportunities to exert control in everyday life and to shape one's future in positive ways (Ross & Mirowsky, 2003). It had thus been assumed that psychological resources (optimistic self-beliefs) fulfill a compensatory function and show stronger effects on health at both low education and low income as compared to higher education and higher income levels. This was partly supported. Psychological resources were positively related to health in all SES groups, which suggests that it is adaptive for socio-economically disadvantaged individuals to believe in themselves and their ability to exert control and to expect that they will experience positive outcomes[8], although these beliefs may not accurately reflect their actual abilities and opportunities (see also, Lachman & Weaver, 1998). Differential effects of these optimistic beliefs were only found according to education, however, but not according to income (see Figure 6.2, p. 173).

Optimistic self-beliefs have been shown to affect health by fostering a healthy lifestyle (e.g., Schwarzer & Fuchs, 1996). Moreover, a recent review (Pampel, Krueger, & Denney,

[8] It should be noted at this point that control beliefs (self-efficacy) and positive outcome expectancies, representing functional or adaptive optimism, need to be distinguished from optimistic bias in risk perception, which was not included in this study. The latter, belonging to the broader construct of defensive optimism, may hinder the adoption of health-promoting behaviors and thus be maladaptive (Schwarzer, 1994).

2010) concludes that education has strong effects on health behavior: for instance people with lower education are more likely not to exercise, to smoke and to be obese. Optimistic self-beliefs might thus be more important in the low-education group with lower prevalence of health-promoting behaviors, because higher resource status then can make a difference in individual lifestyle. At least part of the relevance of income for health behavior is due to its association with education (Pampel, et al., 2010). In the sample of middle- and older-aged people we used here, the relationship between education and income was rather weak (r = .30). This means that the low income group is somewhat heterogeneous regarding education, i.e. it also contains people with higher education who might find ways of exerting health-promoting behavior despite limited financial resources. The heterogeneity in educational background and hence probably in the prevalence of health-promoting behaviors might have reduced the chance of finding differential effects of optimistic self-beliefs on health according to income (cf. Chapter 3).

Although optimistic self-beliefs play a central role in virtually all psychological theories of health behavior (e.g., Ajzen, 1991; Bandura, 1997; Schwarzer, 1999), it has rarely been tested whether the proposed associations differ in population subgroups with varying SES (see Hankonen, Absetz, Haukkala, & Uutela, 2009, for an exception). As these theories clearly distinguish between different optimistic self-beliefs, with increasingly precise sub-facets emerging from recent research (Schwarzer, 2008), this would be an important addition to research based on the Reserve Capacity Model using combined measures of resource status (e.g., Matthews, Räikkönen, Gallo, & Kuller, 2008). In contrast to the latter, psychological resources and social resources were distinguished in the present thesis, which is supported by their differential effects on health according to either education or income. This does not imply that social support and optimistic self-beliefs are related to health only via completely separate pathways, which would be in contrast to theoretical assumptions (Bandura, 1997)

and results from other studies showing, for example, that both types of resources can act as a stress buffer (Turner & Noh, 1983). Rather, their differential impact on health must be seen in relation to the particular SES facet and its associated meaning for health.

Resource status may not only be determined by SES but also by the stage of the life-course. The central role of psychological and social resources in successful aging is implicated by related theories (Brandtstädter, 2006; Carstensen, Isaacowitz, & Charles, 1999; Rowe & Kahn, 1997; Schulz & Heckhausen, 1996). Although some of these models already incorporate SES (e.g., Kahn & Antonucci, 1980), the results of the present thesis suggest that differential effects of psychological and social resources according to SES facet should be given more attention. In particular, there was some evidence that age and income interact in modifying the association between social resources and health such that available support from a social network was particularly important for the physical, functional, and subjective health of *older* people with low income (cf. Chapter 3). On the one hand, older people with low income seem to be particularly vulnerable to a lack of support from a private network, probably due to the concurrence of more chronic stressors in older adulthood (Aldwin, Sutton, Chiara, & Spiro, 1996) and the limited ability of individuals with low income to buy professional assistance and help for mastering demanding situations. Apparently, the accumulation of low income, higher age and a low amount of social resources is the most detrimental to health. On the other hand, at high levels of available support, the health of older people with low income parallels the health status of older individuals with high income, which indicates resilience in the face of disadvantage.

Taken together, the results discussed in this paragraph indicate that the association between SES and health is not completely deterministic. Rather, they provide some evidence for variation in health within SES groups, which has also been examined more directly in the present thesis as explicated in the following.

Emotions and Health:

Variations and Dynamic Associations in Different Education Groups

Variation within age groups, particularly in older adulthood, has been a topic of interest in developmental research for some time (Maddox, 1987; Nelson & Dannefer, 1992). The socially stratified cumulation of advantage and disadvantage, that is, increasing differences *between* SES groups, has been discussed as one reason for heterogeneity in functioning in old age (Dannefer, 1987). In contrast, between-person variation *within* SES groups has rarely been examined although this is a topic not only of theoretical interest but also of practical relevance. This has been investigated in the present thesis, including both health and emotional functioning, as emotions also play a central role in the Reserve Capacity Model (Gallo & Matthews, 2003).

Focusing on older adulthood and examining both levels and changes of functional health and of affective symptoms of depression, substantial variation within education groups was found, with larger variances mostly at lower rather than higher education (cf. Chapter 4). These findings do not support the notion that the higher mortality rate in low SES populations could truncate the bottom of their health distribution in representative samples, which may not only reduce observable mean differences between groups (see above), but may also limit within-group variation at lower levels of SES in old age (Ferrer & Palmer, 2004). As can be seen in Figure 6.3 (p. 174), the greater variation in levels of functioning in groups with lower education was mainly due to more variability in the lower portions of the health distribution and the upper portions of the depressive symptoms range, which might indicate an accumulation of risks. Put differently, “the largest effect of lower socioeconomic position is in lowering the floor of worst possible outcomes […]” (Ferrer & Palmer, 2004, p. 383), which provides some justification for the focus on poor health in research on social inequality (see

also, Chapter 2). On the other hand, the findings of the present thesis suggest that there is a subgroup of older individuals with few problems and declines in functional health as well as low depressive symptoms despite being educationally disadvantaged. Overall, our results and those of two other studies (Ferrer & Palmer, 2004; Sacker et al., 2009) point to substantial within-group variances in (change in) physical and emotional functioning, with larger variation at lower levels of SES, throughout the adult life-span including older adulthood.

While these findings may not seem surprising at first sight, they have broader implications in that they contribute to a different perspective on social inequality in health. Research in social science has conceptualized SES as a "fundamental cause" of disease, arguing that the main concern for intervention is to minimize societal differences in, for example, income (Link & Phelan, 1995). Although it is undeniable that large (and historically increasing) inequalities in SES are a societal concern (Wilkinson, 1996), the results on variation in health within groups suggest that SES differences do not necessarily and completely translate into health differences. In fact there do seem to be vulnerable and resilient subgroups within SES groups, particularly within the socio-economically disadvantaged. This finding indicates a potential, and at the same time, a need for intervention. A central aim is thus to further identify factors accounting for this differential susceptibility. In line with the results discussed in the preceding section, differences in control beliefs and social support have been suggested as a reason for variation in levels of functioning, particularly at low levels of SES (Ferrer & Palmer, 2004). Variations in change might require more complex explanations. Between-person variation in change in health and emotional functioning may not only be due to differences in levels of psychological and social resources but might also be associated with differential resource change. Conservation of resources theory (Hobfoll, 2001) suggests that change in resources, particularly resource loss, has a stronger impact on those with low baseline levels of resources, such as individuals with

low SES. This might partly explain the larger variance in change of functional health at low compared to high education depicted in Chapter 4 as well as the larger variation in change of physical and mental health at lower occupational grades reported in another study (Sacker, et al., 2009). It should be borne in mind, however, that in the light of the results discussed above, different resources might be relevant depending on the SES facet. Individual growth curves presented by Sacker and colleagues (2009) give some first indication that within-individual variability over time might also be greater among low SES individuals, which could be due to a stronger reactivity to life events.

The present thesis went beyond investigating variations in single domains of functioning and also examined co-variations or cross-domain associations between emotions and health in different education groups, adding to existing research that mainly focused on financial aspects of SES (Carvalhais, et al., 2008; Smith, Langa, Kabeto, & Ubel, 2005). In fact, as was shown in Chapter 4, the association between changes in functional health and changes in depressive affect clearly differed according to education, with stronger links at lower compared to higher levels, but did not differ depending on wealth, as additional analyses suggested. Complementing the cross-sectional results of Merjonen and colleagues (2008), this can be seen as first evidence for education-related differences in dynamic associations between emotional distress and health.

Adding to this, the analyses presented in Chapter 5 revealed that negative affect (NA) had an impact on change in physical health in individuals with low education: Those individuals with low education experiencing low negative affect show rather shallow decreases in physical health. On the other hand, experiencing high NA seems to be particularly detrimental for health at low levels of education. At higher levels of education, the impact of NA on physical health was weaker and non-significant (cf. Chapter 5).

To understand the educational differences in the effects of NA on health, and taking into account that there were no education-related differences in NA levels and trajectories (cf. Chapter 5), it might be helpful to have a closer look at the concept of emotion regulation. First, emotion regulation is a process which can be subdivided into "antecedent-focused" emotion regulation, occurring before a full emotional response is elicited, and "response-focused" emotion regulation to influence emotional reactions (Gross, 2008). It may be that education-related differences mainly occur at this later stage, that is, after negative emotions have already been experienced. Second, different strategies can be used to regulate emotions. Those with low education might be more likely to use strategies that are effective in eventually reducing NA but that have detrimental consequences for their health. It has been suggested, for example, that unhealthy behavior like smoking and overeating fulfills the function of regulating mood among those with lower SES (Pampel, et al., 2010).

In the Reserve Capacity Model (see Figure 6.6, p. 188), emotions are assumed to fulfill a mediator role, with those with lower SES experiencing more negative and less positive emotions, which partly explains their worse health (Gallo & Matthews, 2003). The limited support for this assumption from existing research (for an overview, see Matthews, et al., 2010) and the results of the present thesis suggest that the associations might be more complex. Positive affect (PA), although being related to education, did not have an impact on change in physical health. Instead, there was some evidence for health affecting PA. Rather than focusing on one direction of influence as the mediator model implies, this suggests that reverse effects from health to emotional functioning should also be taken into account. Moreover, the differential associations between emotional distress and health according to education discussed above indicate that it is beneficial to consider SES as a moderator of emotion-health associations. Although no differences in the link between physical health and PA according to education were found in the present study, more research including positive

emotions as well as other SES facets and different health outcomes is needed before definite conclusions can be drawn.

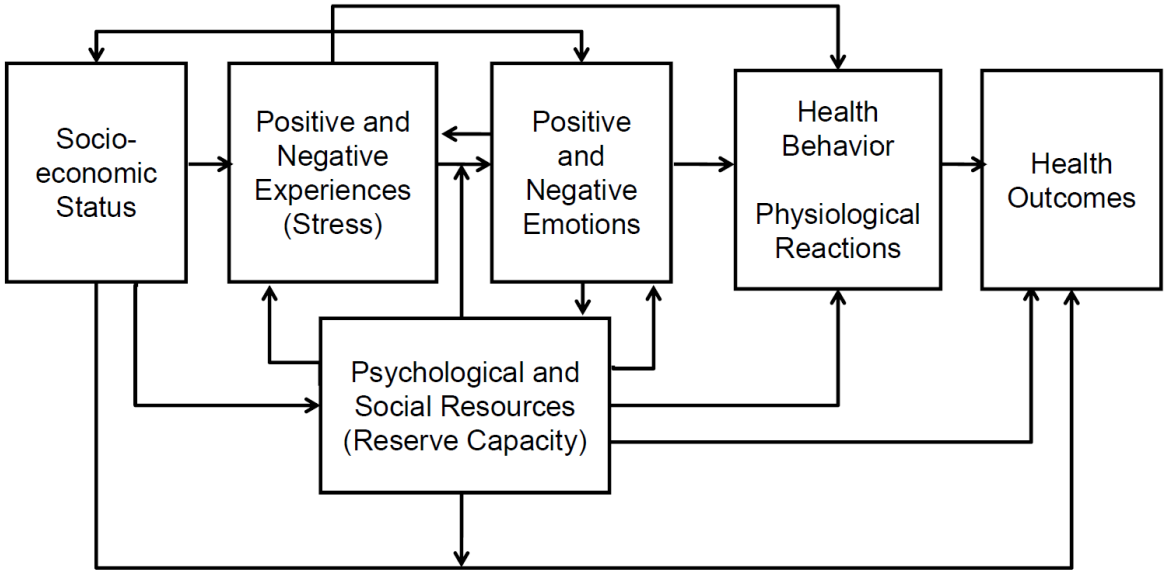

Figure 6.6. The Reserve Capacity Model (adapted and modified from Gallo, Bogart, Vranceanu, & Matthews, 2005; Gallo, et al., 2009; Gallo & Matthews, 2003).

In line with the Reserve Capacity Model, psychological resources and emotions were treated as separate constructs in the present thesis. On the other hand, positive affect, particularly if assessed in a rather trait-like format as was the case in the present data set, might also be considered a psychological resource. However, although significant associations between PA and control beliefs, optimism, as well as self-esteem have been documented, correlations are largely below r = .50 (Snyder, et al., 1991) and thus of a moderate size (J. Cohen, 1988). This suggests that one can speak of closely (and possibly bi-directionally) related, yet distinct constructs (see also, Gallo & Matthews, 2003; Pressman & Cohen, 2005). Still, the distinctness would be clearer if emotions were measured on a state-level, which ideally requires studies with shorter time intervals. The latter will be discussed, among other issues, in the following paragraph on limitations and strengths of the present thesis as well as implications for future research.

Limitations and Strengths: Implications for Future Research

Sample and selectivity

It is a strength of the present thesis that data from the nationally representative German Ageing Survey, covering a broad age range, that is, 40+ years, was used. This is important for investigating social inequality in health in the second half of life, particularly for examining age variations in the SES-health association. Representativeness of the DEAS samples for the community-dwelling population of middle-aged and older adults has been largely confirmed (Engstler & Motel-Klingebiel, 2010), but is limited concerning very old and institutionalized people. As both poor health and low SES are linked to higher risk of institutionalization (Gaugler, Duval, Anderson, & Kane, 2007), SES differences in health in the older participants were probably underestimated. Furthermore, as some of the processes being discussed as potential sources of decreasing inequalities in old age, i.e. biological frailty, may have a stronger impact in the most advanced ages, the limited coverage of the very old might have reduced the probability of detecting levelling-off effects.

Research focusing on very old age is not suitable for studying the accumulation of inequality, however (Ferraro & Shippee, 2009). Even surveys like the DEAS that begin observing their respondents in midlife are limited in this regard as selective mortality, that is, those with low SES having higher rates of mortality at younger ages (partly due to their worse health), may have already led to changes in the population. Only studies starting in early childhood and following their participants over the life-span provide an opportunity to compare survivors' characteristics to those of individuals of the same cohort who did not survive to middle age to take SES differences in premature mortality into account in examining cumulative inequality. Such data sets are rarely available, however (see Blane, Berney, Smith, Gunnell, & Holland, 1999, for an exception).

Besides mortality-associated sample attrition, an additional concern for longitudinal studies is selective dropout due to other reasons (experimental selectivity). For example, those with worse health and lower SES have been shown to be less likely to participate in follow-up studies (e.g., Chatfield, Brayne, & Matthews, 2005; Van Beijsterveldt, et al., 2002). Analyses indicated that overall longitudinal selectivity effects were small in the DEAS samples (see Chapter 4, 5). Furthermore, to minimize this bias and to prevent loss of power, all available data was used, regardless of whether a person stayed in the sample over time, using full information maximum likelihood (FIML; Wothke, 2000). One underlying assumption of this technique is that data are missing at random, conditioned on the observed data (Little & Rubin, 2002). The FIML algorithm was enhanced by including variables that are strong predictors of dropout such as health. Nevertheless, future studies should additionally examine the effect of explicitly estimating the selectivity mechanism in joint models on longitudinal response and dropout (Demirtas, 2004).

Design and Analyses

The fact that cross-sectional analyses on age-related changes in the SES-health relationship were complemented by longitudinal analyses in the present thesis is an advantage over existing national studies (e.g., Knesebeck, et al., 2003; Lampert, Saß, Häfelinger, & Ziese, 2005) and also a large part of the international research (for an overview see, e.g., Kim & Durden, 2007). Longitudinal change in health was compared across different SES groups to examine whether trajectories converge or diverge over time and age, respectively. Given the broad age range of the DEAS samples at baseline, future studies should explicitly test whether distinct patterns of results can be found in different cohorts to further disentangle age and cohort effects (Willson, Shuey, & Elder, 2007).

The main analyses with longitudinal data focused on (formal) education, which is largely completed upon entering midlife. This avoids questions of reverse causation, which

cannot be ruled out for potentially changing aspects of SES such as income and wealth (Chandola, Bartley, Sacker, Jenkinson, & Marmot, 2003). It might be useful, however, to explicitly consider their dynamic nature. Following up on the approach to build SES groups based on information at one point in time[9], groups with changing as well as stable-low and stable-high income or wealth over the course of a study could be distinguished (Kim & Durden, 2007; Willson, et al., 2007). This simple approach can be seen as a first step to model the duration of exposure to advantage and disadvantage (Ferraro & Shippee, 2009). Likewise, different health transitions should be taken into account in future studies. There is some evidence, for example, that the distinctness of education and income emerges more clearly if onset and progression of disease and functional limitations are distinguished (Herd, et al., 2007; Zimmer & House, 2003). Shorter time intervals or retrospective information covering the time between two occasions of measurement would be beneficial for such an endeavor, because otherwise a substantial amount of transitions will be missed (Laditka & Wolf, 2006).

Despite the long interval of six years between the occasions of measurement, longitudinal associations between emotions and health were discovered in the present study. Advanced methods were employed for examining these emotion-health couplings. The method of analysis used in Chapter 5, that is, the uni- and bivariate dual change score model, allowed combining the estimation of linear and nonlinear change with the investigation of bidirectional associations between emotions and health, offering several improvements over commonly used methods such as LGMs and cross-lagged correlation models (Lövdén, Ghisletta, & Lindenberger, 2005; McArdle, 2001). Moreover, the extension to multiple-group models made it possible to study systematic variations in dynamic cross-domain associations, which offers unique opportunities to enrich existing research. As has been demonstrated in Chapter 4, latent change score models are also a valuable method of analysis if only two

[9] For a discussion on the categorizational operationalization of SES, see Chapter 2 and 3.

occasions of measurement are available, as was the case for functional health and depressive symptoms. Change is explicitly part of the model, thus allowing a description of change parameters and testing of group differences in means, variances and cross-domain associations in change (McArdle & Prindle, 2008).

Future studies should apply this kind of dynamic conceptualization to the links between psychological and social resources and health. The fact that these relationships were only examined cross-sectionally in the present dissertation is a clear limitation. The differential nature of the results presented in Chapter 2 and findings from other studies showing that optimistic self-beliefs and social support can in fact promote future health (e.g., Janevic, et al., 2004; Kempen, et al., 2005; Rasmussen, Scheier, & Greenhouse, 2009) lend some support to the assumption that the associations found at least partly reflect effects of resources on health. However, reverse effects are likely to occur as well (e.g., Reitzes & Mutran, 2006) and, more importantly, taking resource changes into account may provide additional insights compared to a static conceptualization (Hobfoll, 2001; cf. p. 185f).

Concepts and Measures

Three aspects of health that have been shown to be important in later life were included in the present thesis – physical, functional, and subjective health (Liang, 1986). It is a limitation that in the DEAS, physical and functional health were assessed by self-report rather than more objective measures based on medical examination or performance. Although a high accordance between self-reported health and physician-evaluated health has been shown for physical health (Bush, Miller, Goldsen, & Hale, 1989), for example, future studies should aim at replicating the results of the present thesis with more objective measures. As comprehensive health assessment is often not feasible in large-scale surveys, mortality can be taken as a first approximation.

Different facets of SES – education, income, and wealth (financial assets) - that are considered appropriate for middle and older adulthood were included in the present dissertation, with some analyses including all three and others focusing on a subset of these indicators. The decision not to include an occupation-based measure was in line with theoretical considerations questioning the applicability of such indicators to those not or no longer part of the labor force (Grundy & Holt, 2001; cf. Chapter 1) and with definitions of SES used in other studies on later life (e.g., Knesebeck, Wahrendorf, Hyde, & Siegrist, 2007; Robert & House, 1996).

The role of psychosocial factors in the SES-health relationship has gained increasing attention in the last decade (for an overview, see Matthews & Gallo, 2011). However, the definition of what constitutes ”psychosocial factors” has been very inconsistent. It is thus important to have a theoretical framework guiding the selection of constructs. The present thesis focused on psychological and social resources as well as emotions as these are central components of the Reserve Capacity Model (Gallo & Matthews, 2003). It is a strength that, besides taking into account the multidimensional nature of SES and health, the present dissertation distinguished between psychological and social resources and included different aspects of emotional functioning. The differential results obtained give some indication regarding potential refinements and extensions of the model.

This dissertation did not, however, provide a comprehensive test of the pathways depicted in the Reserve Capacity Model (Figure 6.6, p. 188; see also, Gallo, et al., 2009; Gallo & Matthews, 2003). Most importantly, more proximal predictors of health, that is, health behavior and physiological mechanisms, which are considered central pathways linking psychosocial resources and emotions to health (Adler & Snibbe, 2003; Matthews, et al., 2010), were not taken into account. This is thus an important task for future studies. As biomarkers reflecting functioning of the autonomic nervous system, the immune system, and

cardiovascular system are increasingly included in large, representative survey studies (Love, Seeman, Weinstein, & Ryff, in press), it will be possible to conduct analyses on the effects of psychosocial factors on physiological mechanisms in different SES groups. Besides, studies are needed that allow for more fine-grained analyses to test the interplay between SES facets, psychological and social resources, daily-life stressors, and emotions (Gallo, et al., 2005). Measurement-burst study designs, wherein data are obtained across multiple time scales, can provide a solution to capture these dynamic processes as well as their potential longer-term influence on health (Ram & Gerstorf, 2009). Gaining more insight into these processes will help to inform interventions as is discussed below.

Conclusion and Practical Implications

This dissertation shows that, in Germany, socioeconomic status (SES) is important for health in the second half of life up to older adulthood. The substantial variation within SES groups suggests, however, that socioeconomic differences do not necessarily and completely translate into health differences. It is in fact the interplay between facets of SES on the one hand, and psychological and social resources as well as (negative) emotions on the other hand, that is crucial for health. These findings not only demonstrate the usefulness of combining sociological and psychological perspectives in research on health in later life but also have practical implications, which will be outlined in the following.

Social inequality in health in later life should be taken seriously. It can be assumed that, due to historically increasing life expectancies even for the low SES groups, health inequality in old and even very old age will be a growing concern in the following decades (Lampert, 2000). This is even more important as historically increasing inequalities in SES

might not only lead to increasing health disparities but also to worse health in the population in general (Wilkinson, 1996). Societies should thus aim at narrowing this gap.

Furthermore, it is critical that the greater overall variability in health at low levels of education was mainly due to more variability in the lower portions of the health distribution, which might indicate an accumulation of risks. Indeed, such cumulative tendencies were mainly visible if additional factors besides low SES were considered. For example, older people with low income seemed to be particularly vulnerable to a lack of support from a private network. Put differently, the accumulation of low income, higher age and a low amount of social resources was apparently the most detrimental to health. In addition, individuals with low education mainly showed a strong decline in health if they also experienced high levels of negative affect. There was a resilient subgroup of individuals with low education, however, that showed little impairment and no decline in functional health, which might partly be due to their higher amount of psychological resources.

These results show the potential and the need for intervention at the level of the individual and his or her private network. Given the central role that optimistic self-beliefs and social support play in theories on successful aging, it is increasingly recognized that strengthening such resources might be beneficial for later-life health and well-being (Forstmeier, Uhlendorff, & Maercker, 2005). The findings presented here suggest further specification in that the educational background and financial status of individuals might determine the impact of different types of resources. For example, interventions targeting the embedding in social networks as resources for help and assistance are probably most promising for older individuals with low income. Moreover, while (older) adults have been found to be effective in regulating their emotions (Scheibe & Carstensen, 2010), there may be differences according to SES in the strategies employed, e.g., disadvantaged individuals using smoking for dampening negative affect (Layte & Whelan, 2009), that eventually translate into

health differences. Improving strategies and competencies for emotion regulation in individuals with low education might thus be an important mechanism in reducing detrimental effects of negative emotions on health.

From a life-span developmental perspective it can be discussed when interventions should take place. On the one hand, there is a higher need for psychological and social resources with increasing age because of declining biological potentials. On the other hand, for the same reason, the efficiency of psychosocial interventions decreases in old age (Baltes, 1997). The pervasive effect of childhood SES and psychosocial factors on functioning in middle and older adulthood also shows that interventions starting at earlier stages of the life-course might have long-lasting benefits and could possibly mitigate a socially stratified accumulation of resources and risks over the life-span (S. Cohen, Janicki-Deverts, Chen, & Matthews, 2010). Still, interventions targeting today's middle-aged and older adults are demonstrably beneficial, probably also for adults with low SES (Hankonen et al., 2009), and necessary.

Besides, solely focusing on individual-level factors such as control beliefs and social support for improving health would be too short-sighted. Instead, the broader context individuals live in, beyond their closer social network, needs to be taken into account. Studies are beginning to show that the regional context, particularly the neighborhood environment, affects health and health behavior, especially in later life (Yen, Michael, & Perdue, 2009). Moreover, given the stronger health limitations and reduced mobility of older individuals with low SES, it can be assumed that the neighborhood environment is particularly important for the socio-economically disadvantaged. For example, increasing the quality as well as the access to professional social services in their neighborhood may be an alternative way of providing older individuals with low income with the necessary assistance and help for mastering demanding situations.

All in all, it can be seen that interventions to enable healthy aging for all population groups should incorporate several factors. Health psychology theory can provide a framework for such an endeavor as it contains assumptions on the mechanisms that translate individual-level characteristics into health outcomes. It needs to be taken into account, however, how sociodemographic and environmental characteristics interact with social-cognitive factors in influencing health and its proximal determinants. This approach increases complexity, but might eventually lead to more targeted interventions (Marks, 1996).

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Appendix

Appendix A: SES and Health in Later Life

In Chapter 2, the development of social inequality in health in the second half of life was investigated. Data from the second wave of the German Ageing Survey (DEAS) were used. Only those respondents were included who completed both interview and questionnaire. Hence, it was examined whether this analysis sample differs from the total sample regarding study variables (Table A1).

Physical health was one of the health indicators used in these analyses and in other parts of the dissertation – Table A2 shows the list of health problems assessed in the DEAS that build the basis for this measure.

In the last part of Appendix A (Appendix A3), the results on differences in the extent of social inequality in health as well as its development over age according to gender and place of residence are summarized.

Table A1

Descriptive Statistics of the Study Variables[a] *for the Total Sample and the Sample Used for Analysis*

	Total sample (N = 3,084)		Analysis sample (N = 2,787)		
Variable	*M*	*SD*	*M*	*SD*	Selectivity
Functional health	26.41	5.00	26.55	4.85	0.03
Subjective health	2.52	0.88	2.51	0.87	-0.01
Education					
(1=low, 2=medium-high)	1.43	0.50	1.43	0.50	0
Income (in €)	1451.91	796.56	1458.84	806.99	0.01
Age (in years)	61.38	12.59	61.28	12.48	-0.01
Gender (1=male, 2=female)	1.50	0.50	1.50	0.50	0
Place of residence					
(1=West, 2=East Germany)	1.33	0.47	1.33	0.47	0
Partner status					
(1=no partner, 2=partner)	1.77	0.42	1.77	0.42	0

Note. Selectivity effects were computed using the following formula: $(M_{analysis} - M_{total})/SD_{total}$ (Lindenberger, Singer, & Baltes, 2002). All effects were very small ($d < .20$).

[a] Variables assessed in the interview.

Table A2

The Complete List of Health Problems Assessed in the German Ageing Survey

Cardiovascular diseases
Circulatory problems
Back or joint diseases
Diabetes
Gastro-intestinal diseases
Respiratory diseases
Cancer
Liver or kidney diseases
Bladder trouble
Diseases of the eye
Diseases of the ear

Appendix A3

Differences According to Gender and Place of Residence

The interplay between SES, gender and place of residence, and age was examined by adding two- and three-way interaction terms to the logistic regression models and testing whether this improved model fit significantly. In most cases, interactions were not significant. There was a significant three-way interaction - income x age x place of residence - suggesting that there was an age trend in income-related inequality in functional health in East Germany only ($\Delta\chi^2(2) = 7.33$, $p < .05$). Besides, there was a significant two-way-interaction between financial assets and place of residence indicating that there was a stronger influence of (medium) financial assets on physical health in East Germany ($\Delta\chi^2(2) = 8.36$, $p < .05$).

Appendix B: Resources for Health

In Chapter 3, it was examined whether there are differential effects of psychological and social resources on health according to SES. Multiple group structural equation modeling was used to compare resources-health associations between education and income groups. Table B1 and Table B2 show correlations of the study variables in different education and income groups.

Table B3 and Table B4 show descriptive statistics for the income and education groups. Moreover, the results of difference tests are summarized in the last column of these tables. Differences between the three income groups were examined with one-way analysis of variance (ANOVA) and the chi-square test (for categorical variables). Differences between the two education groups were examined with the independent samples t-test and the chi-square test.

As there might be a confounding between retirement and income - being retired (as opposed to having a low income) increasing the benefits from social support - additional regression analyses were conducted. Interactions between employment status and social resources and interactions between level of income and social resources were included simultaneously. Results are shown in Table B5.

Table B1

Pearson Correlations of Study Variables in Groups With Low and High Education

	Psychological resources			Social resources			Health			Covariates	
Variable	1	2	3	4	5	6	7	8	9	10	11
1 Self-esteem	-										
2 Control beliefs	**.67/.65**	-									
3 Optimism	**.57/.55**	**.67/.62**	-								
4 Emotional support	**.12/.08**	**.10**/.03	**.11/.08**	-							
5 Informat. support	**.11/.08**	**.11**/-.01	**.08**/.03	**.55/.56**	-						
6 Network size	**.17**/.02	**.23**/.00	**.21/.07**	**.34/.31**	**.32/.33**	-					
7 Physical health	**.24/.19**	**.20/.20**	**.32/.27**	.02/.02	.05/-.01	**.09**/.01	-				
8 Functional health	**.25/.13**	**.27/.11**	**.37/.27**	04/-.02	**.07**/.06	**.15/.07**	**.45/.40**	-			
9 Subjective health	**.32/.22**	**.33/.22**	**.48/.37**	**.06**/.05	**.06**/.02	**.14/.08**	**.43/.40**	**.61/.54**	-		
10 Age (years)	**-.06/.07**	**-.09**/.03	**-.20/-.11**	-.05/-.05	**-.06**/-.05	**-.20/-.11**	**-.35/-.35**	**-.40/-.38**	**-.26/-.22**	-	
11 Female	-.02/.00	**-.06**/-.03	-.01/.02	**.10/.08**	**.06/.08**	.-.02/**.12**	.04/-.01	**-.11/-.08**	.03/.04	.01/**-.08**	-
12 East Germany	-.03/.03	-.03/**-.07**	**-.10/-.12**	-.04/-.01	**-.07**/-.01	**-.09**/-.03	**-.06**/.06	**-.09**/.04	**-.11**/-.03	**.16/-.16**	.00/-.02

Note. Correlations in the low education group are displayed before the diagonal slash, and correlations in the high education group are displayed after the slash. The descriptive use of the pairwise deletion option resulted in different sample sizes for single cells (low education: n_{min}=1,357, n_{max}=1,397; high education: n_{min}=1,030, n_{max}=1,057). Coefficients printed in bold are significant ($p < .05$).

Table B2

Pearson Correlations of Study Variables in Groups With Low, Medium and High Income

	Psychological resources			Social resources			Health			Covariates	
Variable	1	2	3	4	5	6	7	8	9	10	11
1 Self-esteem	-										
2 Control beliefs	**.67/.66/ .67**	-									
3 Optimism	**.55/.58/ .57**	**.65/.65/ .64**	-								
4 Emot. support	**.16/.10/** .04	**.12/.10/** -.01	**.13/.13/** .04	-							
5 Informat. support	**.15/.10/** .05	**.12**/.06/ -.02	**.14**/.04/ -.01	**.57/.54/ .56**	-						
6 Network size	**.22/.10/** .00	**.27/.12/** .01	**.24/.16/** .05	**.36/.34/ .29**	**.36/.30/ .32**	-					
7 Physical health	**.19/.27/ .23**	**.17/.24/ .21**	**.33/.31/ .28**	.06/.06/ -.03	.07/.04/ -.01	**.13**/.05/ .02	-				
8 Functional health	**.24/.16/ .21**	**.24/.16/ .25**	**.34/.30/ .37**	**.11**/.00/ -.04	**.14**/.05/ .00	**.18/.10/ .10**	**.45/.48/ .44**	-			
9 Subjective health	**.30/.30/ .24**	**.30/.29/ .28**	**.46/.43/ .42**	**.10/.09/** .00	**.12**/.06/ -.03	**.14/.10/ .11**	**.40/.46/ .44**	**.60/.59/ .59**	-		
10 Age (years)	-.03/-.02/ -.06	-.07/**-.08/** -.06	**-.12/-.19/ -.26**	**-.09/-.09/ -.08**	-.07/-.07/ **-.08**	**-.24/-.14/ -.14**	**-.39/-.39/ -.38**	**-.43/-.43/ -.41**	**-.23/-.32/ -.29**	-	
11 Female	.01/-.01/ -.02	-.05/-.01/ **-.08**	-.03/.05/ -.02	**.13/.15/ .21**	.04/.05/ **.12**	.03/.02/ .08	-.02/.05/ .03	**-.17**/-.04/ **-.08**	-.01/.07/ .06	.07/-.06/ **-.08**	
12 East Germany	**-.07**/.04/ **.09**	-.02/.02/ -00	**-.11**/-.05/ .02	.00/-.07/ .00	-.05/-.03/ .02	-.06/-.05/ .01	.01/.02/ **.07**	-.03/.04/ .04	-.05/-.02/ -.01	-.02/.01/ **-.12**	.01/-.05/ -.03

Note. Correlations in the low income group are displayed before the diagonal slash, correlations in the medium income group are displayed after the slash, and the lower coefficient shows correlations in the high income group. The descriptive use of the pairwise deletion option resulted in slightly different sample sizes (low income: n_{min}=790, n_{max}=818; medium income: n_{min}=768, n_{max}=793; high income: n_{min}=826, n_{max}=843). Coefficients printed in bold are significant ($p < .05$).

Table B3

Descriptive Statistics for Groups with Low, Medium, and High Income, and Summary of Results of ANOVA or Chi-Square Test

	Low income			Medium income			High income			
Variable	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	F / χ^2
Self-esteem	3.34	0.46	818	3.42	0.40	791	3.48	0.40	842	24.98*
Control beliefs (Hope)	3.01	0.52	818	3.08	0.43	792	3.18	0.44	842	27.83*
Optimism	2.82	0.66	817	2.97	0.59	788	3.11	0.57	840	44.27*
Emotional support	1.70	1.39	818	1.82	1.44	793	1.98	1.51	843	7.84*
Informational support	1.89	1.32	818	1.91	1.36	793	2.14	1.53	843	7.37*
Network size	4.49	2.40	818	4.86	2.37	793	5.06	2.26	843	12.44*
Physical health	8.50	1.94	793	8.60	1.91	773	9.01	1.78	829	17.05*
Functional health	25.69	5.25	815	26.51	4.89	789	27.55	3.92	840	34.92*
Subjective health	3.34	0.90	818	3.47	0.84	793	3.68	0.82	841	35.22*
Age (years)	62.67	12.42	818	62.08	12.58	793	59.42	12.00	843	16.41*
Female (%)	51.3		818	48.7		791	47.2		843	2.91
East Germany (%)	46.5		818	36.8		791	19.1		843	142.89*

Note. *$p < .05$

Table B4

Descriptive Statistics for Groups With Low and High Education, and Summary of Results of T-Test or Chi-Square Test

	Low education			High education			
Variable	*M*	*SD*	*n*	*M*	*SD*	*n*	t / χ^2
Self-esteem	3.37	0.44	1,396	3.47	0.40	1,055	-6.08*
Control beliefs	3.04	0.49	1,396	3.15	0.43	1,056	-6.01*
Optimism	2.89	0.65	1,392	3.07	0.56	1,053	-7.62*
Emotional support	1.71	1.38	1,397	2.00	1.52	1,057	-4.81*
Informational support	1.88	1.34	1,397	2.11	1.51	1,057	-3.87*
Network size	4.62	2.39	1,397	5.06	2.29	1,057	-4.66*
Physical health	8.36	1.95	1,362	9.17	1.71	1,033	-10.89*
Functional health	25.62	5.26	1,390	27.88	3.66	1,054	-12.51*
Subjective health	3.36	0.90	1,396	3.69	0.78	1,056	-9.78*
Age (years)	65.47	11.01	1,397	55.93	12.06	1,057	20.14*
Female (%)	50.2		1,397	47.6		1,057	1.62
East Germany (%)	31.7		1,397	36.9		1,057	7.22*

Note. *$p < .05$

Table B5

Regression Analyses of Physical, Functional, and Subjective Health Examining Whether Employment Status and Income Moderate the Effect of Social Resources on Health

	Physical health		Functional health		Subjective health	
Predictor	*B*	β	*B*	β	*B*	β
Age	-0.05	-.35*	-0.13	-.33*	-0.01	-.19*
Female	0.01	.01	-0.22	-.11*	0.01	.03
East Germany	0.09	.02	-0.04	-.003	-0.06	-.03
Retired (vs. employed)	-0.18	-.05	-1.21	-.13*	-0.20	-.12*
Other non-employed[a] (vs. employed)	-0.03	-.01	-0.37	-.03	-0.08	-.03
Medium income (vs. low income)	0.08	.02	0.62	.06*	0.12	.06*
High income (vs. low income)	0.33	.08*	1.10	.11*	0.24	.13*
Social resources[b]	0.11	.05	0.61	.11*	0.08	.08
Retired x social resources	-0.08	-.03	0.15	.02	0.03	.02
Other non-employed x social resources	0.16	.03	0.52	.04	0.08	.03
Medium income x social resources	-0.04	-.01	-0.67	-.07*	-0.05	-.03
High income x social resources	-0.21	-.06*	-0.86	-.10*	-0.13	-.08*
	R^2=.16		R^2=.22		R^2=.11	

Note. [a] Includes unemployed and permanently sick or disabled individuals as well as homemakers.
[b] Factor scores.
*$p < .05$

Appendix C: Variations Within and Between Education Groups

Chapter 4 examined education-related differences in mean levels and changes of and between-person variation in levels and changes of physical functioning and depressive symptoms as well as cross-domain associations, with a focus on older adulthood. Longitudinal data from the DEAS were used, collected in 2002 and 2008.

Table C1 shows descriptive statistics for the baseline sample as well as for the longitudinal sample participating at both measurement occasions. Selectivity effects are shown in the last column of the table.

Additional analyses investigated differences in mean levels and changes, between-person variation in levels and changes, as well as cross-domain associations between physical functioning and depressive symptoms according to level of financial assets (wealth). To ensure comparability with the analyses on education-related differences regarding sample size, missing values on the financial assets variable were imputed using the expectation maximization method (cf. Chapter 2). Results on means and variances are shown in Table C2, and results on cross-domain associations are displayed in Table C3.

Table C1

Descriptive Statistics (T1) of the Study Variables for the Baseline Sample and the Longitudinal Sample, and Selectivity Effects

	Baseline sample (*N*=1,948)		Longitudinal sample (*N*=581)		
Variable	*M*	*SD*	*M*	*SD*	Total Selectivity
Physical functioning[a]	72.22	27.67	81.06	21.32	0.32
Depressive symptoms[b]	4.84	4.10	3.90	3.46	-0.23
Education (1=low to 3=high)	2.02	0.68	2.16	0.67	0.20
Age (in years)	73.78	5.65	72.11	5.20	-0.29
Gender (1=male, 2=female)	1.48	0.50	1.47	0.50	-0.02
Place of residence (1=West, 2=East Germany)	1.34	0.47	1.32	0.47	-0.05
Partner status (1=no partner, 2=partner)	1.66	0.47	1.74	0.44	0.16
Physical illnesses	3.09	1.95	2.85	1.87	-0.12
Financial assets[c]	3.58	2.50	4.23	2.42	0.26

Note. Selectivity effects were computed using the following formula: $(M_{longitudinal} - M_{baseline}) / SD_{baseline}$ (Lindenberger, Singer, & Baltes, 2002).

[a]Transformed to a scale ranging from 0 to 100 (Bullinger & Kirchberger, 1998).

[b]Excluding somatic symptoms.

[c]Based on categorization used for assessment (0=no financial assets to 10=500.000 € or more).

Table C2

Maximum Likelihood Estimates of Means and Variances in Levels and Changes of Physical Functioning (PF) and Depressive Symptoms (DS) by Level of Financial Assets (Wealth)

	Financial assets			
Parameter	Low (*n*=736)	Medium (*n*=818)	High (*n*=393)	$\Delta\chi^2(2)$
Mean				
Level PF (T1)	2.35 (.02)	2.43 (.02)	2.56 (.03)	25.81
Level DS (T1)	0.58 (.02)	0.56 (.02)	0.44 (.02)	20.17
Change (Δ) PF	-0.11 (.05)	-0.16 (.05)	-0.27 (.05)	5.04 [a]
Change (Δ) DS	-0.09 (.04)	-0.01 (.04) [a]	0.02 (.04) [a]	3.25 [a]
Variance				
Level PF (T1)	0.34 (.02)	0.28 (.02)	0.19 (.03)	13.88
Level DS (T1)	0.18 (.02)	0.17 (.02)	0.13 (.02)	5.31[a]
Change (Δ) PF	0.31 (.05)	0.25 (.04)	0.17 (.04)	5.23[a]
Change (Δ) DS	0.21 (.05)	0.16 (.03)	0.12 (.03)	3.11[a]

Note. Unstandardized estimates with standard errors in parentheses. Adjusted for covariates (age, gender, place of residence, partner status, cohort). $\chi^2(122, N=1{,}947) = 224.21$, $p < .05$; CFI=0.983, RMSEA=.036 [.028-.043], SRMR=.028. $\Delta\chi^2(2)$ signifies change in model fit if the parameter was set equal across groups.
[a] not significant ($p > .05$)

Table C3

Maximum Likelihood Estimates of Associations Between Levels and Changes of Physical Functioning (PF) and Depressive Symptoms (DS) by Level of Wealth (Financial Assets)

	Low assets		Medium assets		High assets		
Parameter	*B*	β	*B*	β	*B*	β	$\Delta\chi^2(2)$
Level PF ←→ level DS	-0.06	-.31	-0.08	-.38	-0.05	-.29	3.53[a]
Level PF → change PF	-0.46	-.57	-0.46	-.52	-0.44	-.43	0.40 [a]
Level PF → change DS	-0.19	-.28	-0.22	-.31	-0.18	-.20	2.11 [a]
Level DS → change PF	0.08[a]	.07	0.01[a]	.01	-0.20[a]	-.17	2.27 [a]
Level DS → change DS	-0.68	-.67	-0.48	-.51	-0.71	-.71	4.03 [a]
Change PF → change DS	-0.29	-.34	-0.37	-.47	-0.22	-.26	2.12 [a]

Note. Unstandardized and standardized estimates. Adjusted for covariates (age, gender, place of residence, partner status, cohort, illnesses). $\chi^2(144, N=1{,}947) = 256.86$, $p < .05$; CFI=0.983, RMSEA=.035 [.028-.042], SRMR=.043. $\Delta\chi^2(2)$ signifies change in model fit if the parameter was set equal across groups.

[a] not significant ($p > .05$)

Appendix D: Emotions and Physical Health

In Chapter 5, interindividual differences in dynamic associations between emotions and health according to education were investigated. Data from up to three waves of the DEAS were used. Only those respondents were included who completed both interview and questionnaire. Hence, it was examined whether this analysis sample differs from the total sample regarding study variables (Table D1).

Table D2 shows descriptive statistics for the baseline sample as well as for the longitudinal sample of those individuals participating at all three measurement occasions. Selectivity effects are shown in the last column of the table.

Table D1

Descriptive Statistics of the Study Variables[a] *for the Total Sample and the Sample Used for Analysis*

	Total sample (N=4,838)		Analysis sample (N=4,034)		
Variable	*M*	*SD*	*M*	*SD*	Selectivity
Education (1=low, 2=high)	1.36	0.48	1.37	0.48	0.02
Age (in years)	60.09	12.19	60.05	12.18	-0.003
Gender (1=male, 2=female)	1.49	0.50	1.49	0.50	-0.01
Place of residence (1=West, 2=East Germany)	1.33	0.47	1.34	0.47	0.02
Partner status (1=no partner, 2=partner)	1.78	0.42	1.78	0.41	0.01

Note. Selectivity effects were computed using the following formula: $(M_{analysis} - M_{total})/SD_{total}$ (Lindenberger, Singer, & Baltes, 2002). All effects were very small ($d < .20$).

[a] Variables assessed in the interview.

Table D2

Descriptive Statistics (T1) of the Study Variables for the Baseline Sample and the Longitudinal Sample, and Selectivity Effects

Variable	Baseline sample (*N*=4,034)		Longitudinal sample (*N*=672)		
	M	*SD*	*M*	*SD*	Total Selectivity
Positive affect[a]	50.00	10.00	52.27	8.99	0.23
Negative affect[a]	50.00	10.00	50.56	9.49	0.06
Physical health[a]	50.00	10.00	51.89	8.89	0.19
Education (1=low, 2=high)	1.37	0.48	1.53	0.50	0.34
Age (in years)	60.05	12.18	55.30	9.68	-0.39
Gender (1=male, 2=female)	1.49	0.50	1.50	0.50	0.02
Place of residence (1=West, 2=East Germany)	1.34	0.47	1.31	0.46	-0.06
Partner status (1=no partner, 2=partner)	1.78	0.41	0.84	0.36	0.14

Note. Selectivity effects were computed using the following formula: $(M_{longitudinal} - M_{baseline}) / SD_{baseline}$ (Lindenberger, Singer, & Baltes, 2002).
[a] Standardized to the T metric, with the baseline sample serving as the reference.

CURRICULUM VITAE

Der Lebenslauf ist in der Online-Version aus Gründen des Datenschutzes nicht enthalten.

LIST OF PUBLICATIONS

* indicates papers which are part of this dissertation

Journal articles

2010

*Schöllgen, I., Huxhold, O., & Tesch-Römer, C. (2010). Socioeconomic status and health in the second half of life: Findings from the German Ageing Survey. *European Journal of Ageing, 7*, 17-28.

in press

*Schöllgen, I., Huxhold, O., Schüz, B., & Tesch-Römer, C. (in press). Resources for health: Differential effects of optimistic self-beliefs and social support according to socioeconomic status. *Health Psychology.*

Submitted for publication

*Schöllgen, I., Huxhold, O., & Schmiedek, F. (2010). *Dynamic associations between emotions and physical health in the second half of life: Interindividual differences according to socioeconomic status.* Manuscript submitted for publication.

*Schöllgen, I., Huxhold, O., & Wurm, S. (2010). *The interplay of physical functioning and depressive symptoms in old age: A longitudinal study on variations within and between different education groups.* Manuscript submitted for publication.

Schüz, B., Wurm, S., Schöllgen, I., & Tesch-Römer, C. (2010). *What do self-ratings of health mean? Differential findings according to health status in community-dwelling older adults.* Manuscript submitted for publication.

Book chapters

Wurm, S., Schöllgen, I., & Tesch-Römer, C. (2010). Gesundheit [Health]. In A. Motel-Klingebiel, S. Wurm & C. Tesch-Römer (Eds.), *Altern im Wandel. Befunde des Deutschen Alterssurveys (DEAS)* (pp. 90-117). Stuttgart, Germany: Kohlhammer.

Published abstracts (first authorships only)

2010

Schöllgen, I. (2010). Psychosoziale Ressourcen und gesundheitliche Ungleichheit in der zweiten Lebenshälfte: Ergebnisse des Deutschen Alterssurveys (DEAS) [Psychosocial resources and inequality in health in the second half of life: Findings from the German Ageing Survey]. *Zeitschrift für Medizinische Psychologie, 19*, 63.

Schöllgen, I., Huxhold, O., & Tesch-Römer, C. (2010). Dynamische Beziehungen zwischen Emotionen und Gesundheit in der zweiten Lebenshälfte [Dynamic associations between emotions and health in the second half of life]. In F. Petermann, & U. Koglin (Hrsg.), *47. Kongress der Deutschen Gesellschaft für Psychologie* (p. 119). Lengerich, Germany: Pabst Science Publishers.

2009

Schöllgen, I., Huxhold, O., & Tesch-Römer, C. (2009). Variations in health within and between social status groups: The role of psychosocial resources. Paper presented at the Gerontological Society of America 62nd Annual Scientific Meeting in Atlanta, Georgia.

2008

Herbrich, I., & Tesch-Römer, C. (2008). Verändert sich die Bedeutung subjektiver Gesundheit im Alter? Die Rolle von Depressivität, Multimorbidität und funktionalen Einschränkungen [Does the meaning of subjective health change in old age? The role of depressive symptoms, multimorbidity, and functional limitations]. In P. Warschburger, W. Ihle, & G. Esser (Hrsg.), *Seelisch gesund von Anfang an: Programm und Abstracts des 26. Symposiums der Fachgruppe Klinische Psychologie und Psychotherapie der Deutschen Gesellschaft für Psychologie* (p. 65). Potsdam: Universitätsverlag.

Schöllgen, I., Huxhold, O., & Tesch-Römer, C. (2008). Social inequality, psychological resources, and health in adulthood: Findings from the German Ageing Survey. *International Journal of Psychology, 43*, 202.

ERKLÄRUNG ZUR DISSERTATION

Hiermit versichere ich, dass ich die vorliegende Arbeit selbstständig verfasst habe. Andere als die angegebenen Hilfsmittel habe ich nicht verwendet. Die Arbeit ist in keinem früheren Promotionsverfahren angenommen oder abgelehnt worden.

Berlin, 06. Dezember 2010 Ina Schöllgen