

## I THEORETICAL BACKGROUND

### 1.1 Concepts of Heterogeneity and Differential Development Across the Lifespan

Lifespan developmental psychologists typically are interested in the study of psychological phenomena that change at any point in the course of life (P. B. Baltes & Goulet, 1970; Dixon & Lerner, 1988). They posit that phenomena of developmental change involve not only growth (gain), but also aspects of maintenance and loss. Domains of functioning do not necessarily develop in synchrony. Change in some domains may trigger change in others, either as causal factors or as prerequisite conditions. For example, the development of the sensory-motor system is thought to be a prerequisite for higher-level cognitive development in the first years of life (Piaget, 1970; Thelen, 1995). Change in other domains of functioning appear to be relatively independent. The idea that development occurs not only at multiple levels (multidimensionality), but also involves elements of gain, maintenance, and loss within and across domains of functioning suggests that, as a whole, behavior of an individual reflects a highly complex and dynamic system. Development in this broad sense is not completed at adulthood (maturity), but extends across the entire human life course and involves lifelong adaptive processes (P. B. Baltes, 1987).

A central lifespan question involves the extent to which individuals show common or differential developmental trajectories. Do individual and subgroup differences in patterns of systemic change contribute to heterogeneous trajectories of development? Does heterogeneity increase with age? Or is the architecture of ontogeny such that specific phases of the human lifespan are relatively well-programmed so that individuals exhibit highly similar change patterns? These prototypical questions of developmental psychology are the basis of this dissertation. I focus on developmental change of functioning in old age because this phase of life is not as well understood as development in childhood. Furthermore, it provides a context for elaborating the conceptual and methodological difficulties associated with the investigation of heterogeneity and differential development over time.

At a strategic level, developmental researchers share an interest in common (normative) changes that occur during the different phases of life as well as the underlying sources of diversity and plasticity of human development. Joint attention to regularities, interindividual differences, intraindividual plasticity in development, and a consideration of their age-related interplay represents the conceptual and methodological foundation of developmental research (P. B. Baltes et al., 1998; Lerner, 1986; Wohlwill, 1973). The study of *communalities* in development is important to recognize the nature and ‘zone’ of human development (Lerner,

1986; Schneirla, 1957). Focusing on developmental regularities is primarily rested upon the notion that psychological development is governed in general by a convergence of biological processes and generalized social structures that regulate the life course. For example, one of the developmental tasks during childhood is language acquisition and, universally, by a certain age the majority of children are reasonably capable of understanding and producing the primary language of their environment (Bloom, 1998). Language acquisition goes hand in hand with the acquisition of cultural knowledge as well as affective and cognitive development. This provides one example for the biocultural co-construction in the context of developmental regularities. The example also illustrates proposals that development at all ages involves gains and losses (P. B. Baltes, 1987; Dixon & Bäckman, 1995). Specifically, higher-level cognitive functions represent developmental progress, but also may well have their selective costs. With age and specialized language acquisition in a single culture, it becomes increasingly difficult to acquire a second language.

Each age period of the lifespan can be expected to have its own *developmental agenda* (P. B. Baltes et al., 1998; Havighurst, 1948). Hence, although fundamental processes of development (e.g., selection, optimization) are expected to operate throughout life, research often focuses on age-specific topics, for example, early-life interactions between the newborn and his or her environment, the acquisition of language and cognitive skills during childhood, the consolidation of personality structures during adolescence, the striving for mature relationships and professional advancement during adulthood, and the adaptation to outcomes of age-related losses in late life (Erikson, 1959; Lachman, 2001; Piaget, 1970). Among the objectives of lifespan developmental psychology is the identification and understanding of continuities and change between earlier and later developmental processes as well as the description and specification of biological and environmental opportunities and constraints that shape individual development across the entire life course. In this context, lifespan theorists advocate the importance of considering developmental outcomes at all phases of life as the product of dynamic biocultural co-constructivism (e.g., P. B. Baltes, Reuter-Lorenz, & Rösler, in press).

In addition to communalities, there are substantive *differences* between individuals in their developmental trajectories. These differences include level characteristics (e.g., initial and ultimate levels attained) as well as characteristics of change processes: People substantively differ in the onset, rate, direction and duration of change and in the precise shape of developmental trajectories over time (Birren, 1959; Shock, 1985; Smith, 1999; Thomae,

1979). Focusing on lifespan scripts about interindividual differences and plasticity stimulates a search for factors that may underlie differential development (e.g. exposure to risk factors) and highlights potentialities of development and their boundary conditions, including age-associated changes therein (P. B. Baltes, 1987; Lerner, 1984; Magnusson, 1988). In language acquisition, for example, children from the same social and cultural background vary in the onset and rate of learning and in the different strategies they use for processing and learning language. Such variability is due to both person characteristics (e.g., infant ability to discriminate external sounds from internal sound production; affect expression) and environmental characteristics (e.g., frequency of exposure to words; for review, see Bloom, 1998). Furthering our understanding of heterogeneity in developmental processes and outcomes requires, for example, a consideration of the systemic, multilevel interplay between nature and nurture. Examining mechanisms that potentially underlie continuities and discontinuities such as reactive, evocative, and proactive person/gene-environment interactions represents one step in this direction (for overview, see Caspi & Roberts, 2001; Plomin & Spinath, 2004; Rutter, 1997).

The extent to which similarities and differences in development prevail may vary across the life course. Substantive implications arise from lifespan scripts about the *architecture of ontogeny* (P. B. Baltes, 1997), which suggest that the evolutionary incompleteness of the overall architecture of the life course increases from childhood to old age. Among the main lines of argument is that evolutionary selection pressure operated primarily during the first half of life. From this follows that early phases of life are genetically well-programmed, which may leave relatively few space for interindividual differences. Evolution, however, neglected post-reproductive phases of life (Medawar, 1946) so that genes operating at later stages in life are more often deleterious or dysfunctional than those active in earlier phases of life (e.g., natural cell limit in its capacity to divide, Hayflick, 1998). Therefore, heterogeneity may increase in old age and chance factors can be expected to play a larger role than in previous life periods (Finch & Kirkwood, 2000).

The investigation of heterogeneity and differential development has taken different routes. Many studies have focused on development of a specific category of behavior or function. Such function-centered perspective is very important to better understand differences in change trajectories between particular functional domains and the mechanisms underlying domain differences. For example, it is largely recognized that fluid abilities of intelligence (mechanics) show more or less steep decline over the lifespan, whereas crystallized

abilities (pragmatics) are relatively stable (e.g., P. B. Baltes, 1987; Cattell, 1971; Horn, 1982).<sup>1</sup> These distinctive change slopes are suggested to be due to different linkages to biogenetic factors (mechanics) and environmental life-history factors (pragmatics).

An alternative and complementary research approach to heterogeneity and differential development is a systemic-wholistic perspective, where the unit of analysis is not the single category of behavior or function, but the profile of functions that is characteristic for a given individual (P. B. Baltes & Smith, 1997; Magnusson, 1996). In this approach, the individual is considered as a system and development is described as a sequence of age periods or states that form an overall pattern of lifetime individual development (P. B. Baltes et al., 1998; Magnusson & Stattin, 1998; Thelen & Smith, 1998).

Considering multiple domains of functioning simultaneously and taking into account linear as well as non-linear relations among them may further our fundamental understanding of developmental processes and their heterogeneity. This premise is central to this dissertation: One goal of the present study is to outline different patterns of change during old age using a systemic-wholistic approach. An additional goal is to join this approach together with general lifespan proposals about the nature of developmental change. Together, the systemic-wholistic and lifespan approaches may help to understand how heterogeneity in development comes about.

Because of the complex nature of human development and the conditions that shape its course (Brim & Kagan, 1980), lifespan theorists have long called for a consideration of multiple levels of explanation. In this vein, several meta-conceptions of lifespan theory have been proposed (for overview, see P. B. Baltes et al., 1998). The next sections highlight in some detail three of these meta-frameworks, which generated the central questions of the present dissertation study. The first meta-framework establishes a set of scripts about the mechanisms that conjointly determine regularities and differences in human development, namely sources of influence that are age-graded, history-graded, and non-normative. The second meta-framework outlines the overall architecture of lifespan development and points out that developmental mechanisms might be orchestrated differently at different phases of life. In particular, this second framework provides a reason for focusing on developmental change in old age. For this life phase, the ontogenetic architecture is incomplete. In contrast to earlier life phases that are structured by an intact architecture, different constellations of influences

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<sup>1</sup> Cattell (1971) and Horn (1982) used the terms fluid and crystallized abilities, whereas P. B. Baltes (1987) used the terms mechanics and pragmatics of intelligence. In the following, the terms fluid abilities and mechanics on the one hand and crystallized abilities and pragmatics on the other hand are used interchangeably.

on development may be observed and individual and subgroup differences may be enhanced in old age. The third lifespan script that is relevant to understanding heterogeneity and differential development is about the gain-loss dynamic. This script implies that the same overall outcome of a net sum of gains and losses can be brought about by very different constellations and constituting profiles of functioning. The next sections introduce these meta-conceptions in more detail.

## **1.2 What are the Mechanisms Underlying Heterogeneity and Differential Development Over Time?**

The three meta-frameworks that underlie this thesis involve lifespan scripts about the contexts of developmental change at the macro-level, the evolutionary and ontogenetic foundations of change, and the complex nature of these changes. These theoretical frameworks structure questions about regularities and differences in human development across the lifespan as well as the underlying mechanisms and outcomes of developmental change. After introducing the three meta-frameworks, I describe the specific implications for my dissertation research on heterogeneity and differential development in old age.

### 1.2.1 Macro-Contextual Systems of Influence on Development

Individuals throughout their life are exposed to and create contexts that facilitate and limit their developmental trajectories. Paul Baltes and colleagues (e.g., P. B. Baltes & Nesselrode, 1984; P. B. Baltes et al., 1980; P. B. Baltes & Smith, 2004) posited that biological and environmental contexts of development might be thought of as (a) age-graded, (b) history-graded, and (c) non-normative sources of influences. The joint occurrence and time-ordered interactions of these three closely intertwined sources co-produce similarities and differences in patterns of development across the lifespan. Figure 1 offers a schematic presentation of the three systems of influences.

*Normative age-graded* influences relate to those biological and contextual (environmental) factors that exhibit a strong correlation with chronological age. These factors affect the majority of individuals in a given society or subculture in highly similar ways by structuring the contexts and temporal sequence of development across the entire lifespan. Examples include age-based processes of physical maturation such as puberty and menopause as well as the temporal and domain structure of lifespan developmental tasks such as starting school and retirement (Havighurst, 1948). Normative age-graded influences also refer to

social expectations and ecologies of development such as the so-called neighborhood effects (for review, see Sampson, Morenoff, & Gannon-Rowley, 2002). One prominent example of differential development that reflects age-graded influences is the phenomenon that developmental processes are relatively resilient (Rutter, 1987, 2002). Specifically, despite differential exposure to certain risk factors that result in a delay of developmental processes, changes in environmental characteristics may compensate for initial disadvantages in the long-term. As a consequence, there are major individual differences in response to experiences of serious biological and psychosocial adversities (e.g., low-weight babies; institutional rearing), but a relatively large portion of children show reasonably good psychological functioning, at least in the long term. Of course, many different factors are involved in such resilience including prior and subsequent experiences as well as inherent qualities of the individual.

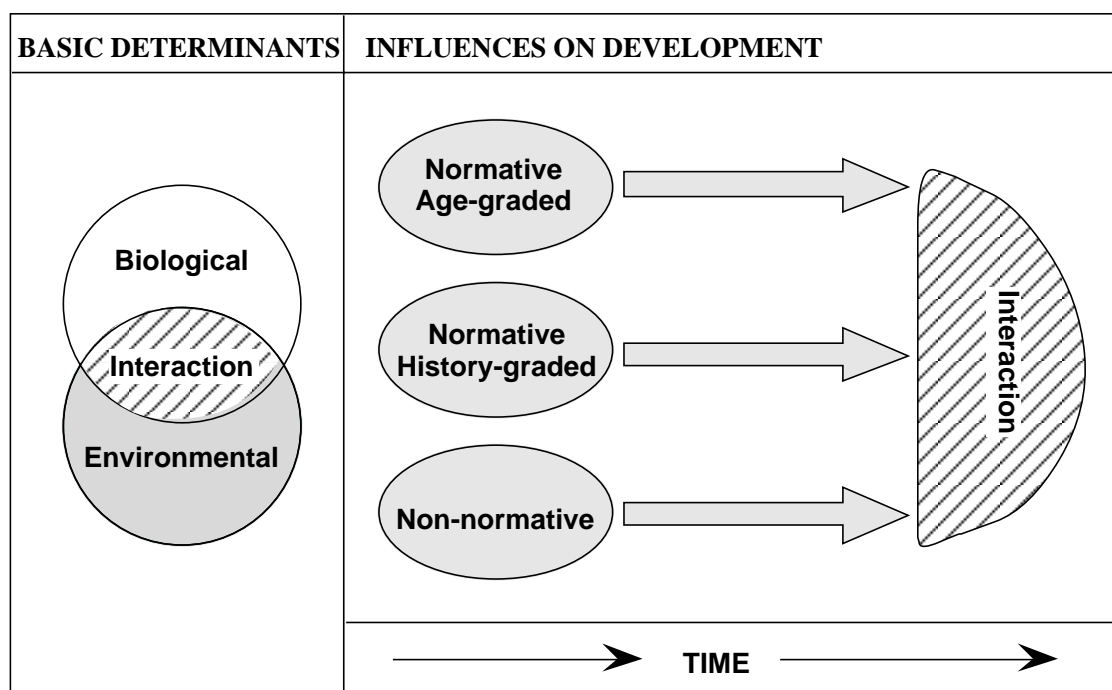


Figure 1. Three sources of influence that regulate the nature of lifespan development: Normative age-graded, normative history-graded, and non-normative influences.

Note. The sources of influence reflect systemic interindividual differences (e.g., by genetics, social class, and culture). Adapted from P. B. Baltes and Nesselroade (1984).

*Normative history-graded* influences refer to biological and contextual factors that exhibit a strong correlation with historical time. These factors are insofar normative as they are experienced by a given cultural subgroup (cohort) in association with biosocial change. Examples of historical circumstances that may make ontogenetic development different across historical cohorts and periods include economic depression, war, demographic changes, and

technological advances (P. B. Baltes, 1968; Elder, 1974; Riley, 1987; Schaie, 1965). Cohort effects in terms of differences in functional level and change over time have been found in a variety of domains, including functional health (Manton & Land, 2000; Manton, Stallard, & Corder, 1997), personality (Twenge, 2000, 2002), intelligence (Flynn, 1999; Schaie, 1996, in press), and longevity (Maier & Vaupel, 2003; Vaupel et al., 1998). Although historical change often brings about functional improvement, there are also indications of negative consequences. For example, later-born cohorts showed lower performance on cognitive tasks assessing numerical abilities as compared with earlier-born cohorts (Schaie, 1996). A good example of research on heterogeneity and differential development that is associated with historical time is Elder's examination of two birth cohorts who lived through the Great Depression and World War II. Later-born cohorts were more adversely influenced in their development by the economic collapse than were earlier-born cohorts because the former experienced the vulnerable years of childhood during the worst years of the Great Depression. Overall, the patterns found suggested that encountering historical events at different points in one's life may result in differential developmental effects (Elder, 1974, 1998).

*Non-normative (idiosyncratic)* influences represent biological and contextual factors that show significant effects on individual life histories, but at the same time they are highly person-specific, show no major correlation to both chronological age and historical time, and typically follow no universal temporal and spatial sequence (Brim & Ryff, 1980; Datan & Ginsburg, 1975). Idiosyncratic events are often neither predictable nor subject to personal or social control and may therefore be particularly challenging and taxing on personal resources. Examples include non-normative critical life events such as chance personal encounters, relocation, serious illnesses, or the unexpected death of significant others. According to the accentuation hypothesis (Caspi & Moffitt, 1993), life-course transitions that are unexpected and off-time are suggested to enlarge preexisting differences between individuals and thus contribute to heterogeneity. Caspi and Moffitt (1993) describe examples of differential development conditioned by non-normative influences such as problem behavior, psychological distress, or physical illness. At another level, research on person-specific bodies of knowledge such as expertise represents one sample case for studying the outcomes of idiosyncratic adaptive demands and opportunities (e.g., at the work place). Examples of classic domains of expertise research include chess (Charness, 1981), card games (Bosman & Charness, 1996) and professional expertise (Salthouse, 2003).

Clearly, in the lifespan contextualistic script, some systems of influence contribute more to communalities in development (e.g., age-graded, history-graded), whereas others (idiosyncratic) are likely to produce heterogeneity. Conjointly, they produce communalities and continuities as well as differences and discontinuities of development (P. B. Baltes et al., 1980). Furthermore, the three classes of influences are not uniform entities: There is room for interindividual variation within each class (see also Dannefer, 1984). For example, age-graded influences often vary systematically by macro-social indices such as gender or social class as well as more proximal factors such as genotype and health. Also, idiosyncratic influences can be moderated by more normative contexts (e.g., illness-related support groups: Elder, 1998; adoptive families in wealthy societies: Rutter, 1999).

What pieces of evidence have been used to illustrate that the above sources of influence produce heterogeneity and differential development at a general level? Research strategies have so far followed three major objectives. First, the great bulk of research findings has been derived from cross-sectional samples with an age comparative design. For example, a frequently cited study since the 1990s has been Nelson and Dannefer's (1992) comprehensive review of (cross-sectional) gerontological studies. Nelson and Dannefer concluded that the majority of studies reported increased variability with age and that this increase was not restricted to select domains (see also Maddox, 1987). This strategy is primarily aimed at the identification and description of the range of individual differences and its correlates.

A second piece of evidence in research on differential development has come from longitudinal studies that directly examine heterogeneity in developmental change trajectories over time and that link this change to potentially underlying factors. For example, function-oriented research reports ample evidence indicating that aging processes between and within domains of psychological functioning are multidimensional and multidirectional (P. B. Baltes, 1987; Birren & Cunningham, 1985; Busse, 1969; Schaie, 1996). A classic example of heterogeneity observed in longitudinal research is the distinctive age-gradients for the mechanics and pragmatics of intelligence that reflect the differential operation of biogenetic and cultural factors (Cattell, 1971; Horn, 1982). A third piece of evidence involves research on potential outcomes of similarities and differences of development. In the successful aging literature (P. B. Baltes & Baltes, 1990; Rowe & Kahn, 1997; Ryff & Singer, 1998), for example, individual and subgroup differences in well-being is often used as a subjective criterion measure and longevity as an objective criterion of more or less successful aging.



These three major pieces of evidence can be used to organize the key objectives in research on heterogeneity and differential development.

The relative strength of the above sources of influence for heterogeneity across the lifespan is largely an open question. This is so because of the overall architecture of human ontogeny, namely the relative weight of biological and environmental factors as basic determinants of development. Of course, interactions between biological and environmental factors are present at all stages of the lifespan, but – to put it into statistical terms – the percent of the variation linked to one or the other of these factors and the relative strength of these general determinants changes in ontogeny. These ideas have been summarized in three principles about the biocultural co-construction of the architecture of development, which are presented in the next section.

### 1. 2. 2 The Evolutionary and Ontogenetic Nature of Influences on Development:

#### Developmental Co-Constructivism and the Gain-Loss Dynamic

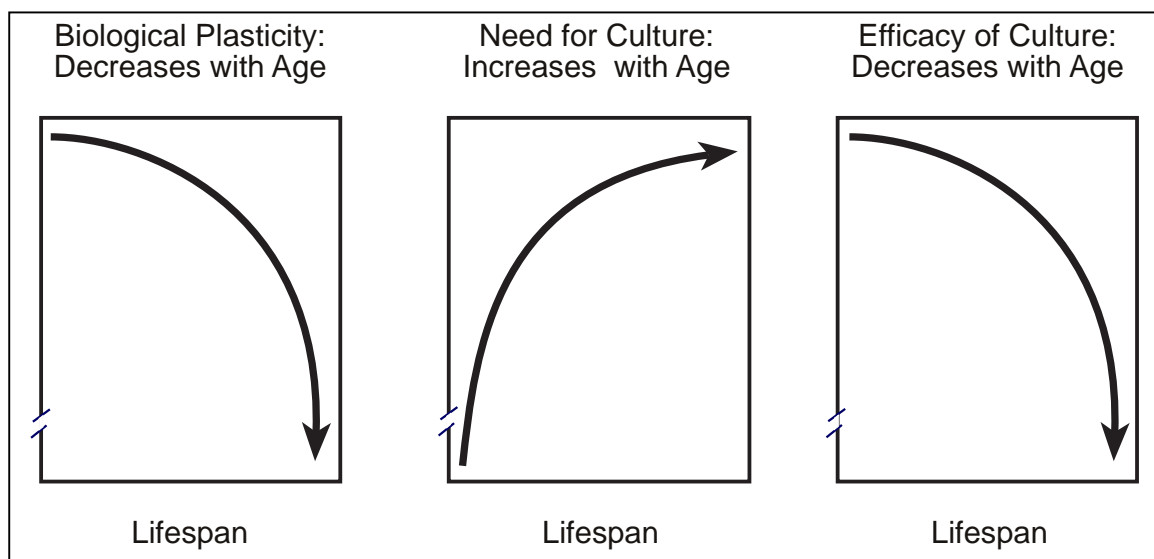
*Developmental Co-Constructivism.* Interactions between biology and environment (culture), the two basic determinants of development, and the lifespan contextual influences on these determinants were discussed above. At another level, however, it is also important to understand the general evolutionary and ontogenetic nature of biological and environmental interactions over the life course. P. B. Baltes (1997) offered three meta-theoretical propositions about the mechanisms of biocultural co-construction in his description of the lifespan architecture of human ontogeny. Figure 2 illustrates the three principles. It has to be mentioned that the overall direction and reciprocal interactions between the functions illustrated in this Figure are critical rather than their specific form (e.g., level, shape).

The first foundational principle states that *biological plasticity decreases with age* (see left panel of Figure 2). The proposal is based on evolutionary arguments suggesting that evolutionary selection pressure was oriented towards optimizing reproductive fitness rather than optimizing old age. The outcome is a lifespan trajectory of declining genetic fidelity with age and a lifespan accumulation of error in genetic replication and repair (e.g., Finch, 1990).

The middle panel of Figure 2 presents the second principle of the overall architecture of the life course, which summarizes the overall role of culture in lifespan development: *The need for culture increases with age*. This proposal is based on two lines of argument. First, the prospects of eliminating the inherent negative impact of the biological decline with in-

creasing age are minimal. Medical interventions may slow the processes or delay their onset, but not eliminate or reverse them completely. Second, cultural impact as a compensatory mechanism is needed. It was the conjoint increase in the content and dissemination of culture (i.e., material, technological, social, and psychological resources of humankind; e.g., Durham, 1991) rather than a change in the evolution-based genome (i.e., biology) that lies behind the extension of the life course and average life expectancy over the last century. More advanced levels of culture-based resources and practice are necessary to exploit the biogenetic potential that is inherent in the human genome.

The third principle is shown in the right panel of Figure 2: The *efficacy of culture decreases with age*. The older the individual, the more cultural input is necessary to achieve the same effect. That it is increasingly difficult for culture to compensate for losses is primarily due to age-related losses in biological potential. Cognitive training studies illustrate the reduced efficacy of a cultural resource. Older adults need more time than younger adults to reach the same learning gains, and it is more difficult for them to achieve further improvement at high levels of performance ( Craik & Salthouse, 2000; Kliegl, Smith, & Baltes, 1989).



*Figure 2.* Schematic representation of the three principles governing the dynamics between biology and culture that lead to an age-associated increase in the incompleteness of the biocultural orchestration of the life course.

*Note.* Adapted from P. B. Baltes (1997).

Taken together, the three principles that govern the dynamics between biology and culture have important implications for different phases of life. Early in ontogenetic life, the need for culture is small, relatively speaking, and cultural efficacy is relatively high. Of course, children require cultural input and support because the human organism is still bio-

logically immature (P. B. Baltes et al., 1998). However, support during childhood is primarily restricted to basic levels of functioning (e.g., nutrition, sensory stimulation) and empirical findings that indicate the resilience of developmental processes (e.g., Rutter, 2002) are consistent with the three principles. With increasing age, in contrast, more and more advanced and differentiated cultural resources are required to provide individuals with the opportunity to continue developing across life (see also Cole, 1996).

With increasing age, the three principles lead to an increase in the incompleteness of the biocultural orchestration of the life course. The most radical form of incompleteness can be observed at the end of life. Research on 90- and 100-year-olds has demonstrated dramatic age-related losses, particularly when the overall profiles of aging trajectories across a number of different functional domains is considered (Crimmins et al., 1996; Jorm et al., 1998; Mayer, Baltes et al., 1999; Smith & Baltes, 1997, 1998; Smith & Gerstorf, in prep.; Suzman, Manton, et al., 1992). Findings of increased dysfunctions in this age period gain in significance if one acknowledges that these individuals represent an increasingly positive selection of their birth cohort.

The triangulated theoretical framework of age-associated changes in the biocultural architecture of the life course is a dynamic and evolving one. For example, because the culture of old age is still evolving, future input from cultural, technical, and scientific advances might result in an elongation of the  $x$ -axes in Figure 2 to higher ages. However, the central principles are unlikely to change: The biocultural incompleteness of the architecture and its related risks and diminished plasticity will manifest in the direction of age-associated changes (P. B. Baltes & Smith, 2004).

*Gain-Loss Dynamic.* The lifespan script about gain-loss dynamics exemplifies the idea that development at any phase of life is characterized by simultaneous multidirectional and multidimensional change (P. B. Baltes, 1987; Brandtstädter & Wentura, 1995). According to this script, development always reflects a conjoint expression of gains and losses: New adaptive capacities are gained and previously existing capacities are lost (see language acquisition example in Section 1.1). The overall architecture of age-related dynamics between biology and culture results in a proportional shift in the sum total and ratio of gains and losses in adaptive capacity over the course of life. Relatively speaking, gains prevail in early life and with age the gain-loss balance is increasingly biased towards losses.

In the context of research on heterogeneity and differential development, the gain-loss dynamic is highly relevant. It allows, for example, that various profiles of functioning may

underlie the same developmental outcome and the same overall gain-loss-balance. A loss in one domain of functioning may be compensated by a gain in another and the locations of gains and losses within a profile might vary across subgroups and individuals.

Up to this point, meta-theoretical propositions from lifespan psychology were presented that can be used as a meta-framework to ask questions about heterogeneity and differential development and its underlying mechanisms and outcomes. Implications that arise from these propositions for heterogeneity and differential development in the second half of life and particularly old age are reviewed in the next section.

### 1. 2. 3 Implications of Lifespan Meta-Conceptions for Heterogeneity and Differential Development in Old Age

For the early phases of life, there is a relatively large body of knowledge about the nature and mechanisms of communalities and differences in development (e.g., Damon, 1998). In this context, a number of different sets of biological and psychosocial conditions have been identified that act as risk factors for differential developmental trajectories over time. Examples of risk factors include low birth weight, parental psychiatric disorders, and disadvantaged families (for overview, see Cicchetti & Cohen, 1995). In contrast, much less is known about this for later phases in life such as adulthood and old age.

The meta-propositions about developmental contextualism and the overall architecture of lifespan development suggest that heterogeneity continues to be evident in old and very old age (see also Maddox, 1987; Nelson & Dannefer, 1992), but the underlying mechanisms and the constellation of factors may be different from those in early life (P. B. Baltes, 1997; P. B. Baltes & Smith, 2004; Riley & Riley, 1986; Suzman, Manton et al., 1992). Five intertwined implications for research on heterogeneity and differential development in old age can be drawn: (1) age-graded factors may be of increasing importance in advanced old age, (2) individuals vary in their efficacy to adopt strategies that help in maintaining a positive balance of gains over losses in old age, (3) old age can be considered to comprise different phases of life rather than a single phase, (4) advanced old age may involve more discontinuity of development than previously thought, and (5) research design issues need to be considered to thoroughly examine questions about differential development. After providing a brief summary of what differential development is about, these implications are elaborated.

The concept of differential development in old age captures the essence of concerns about generalizations of research findings across variables (domains), groups of persons, and

time (Birren, 1959; Shock, 1985; Smith, 1999; Thomae, 1979). Likewise, the term has a number of different connotations. One connotation refers to differential change trajectories within individuals: For example, a person may change simultaneously in different domains of functioning and there may be multiple forms of change, which may or may not be interrelated. Another connotation relates to differences between individuals: For example, people may show different patterns of change across domains. A third connotation involves issues of time and timing: Differences within and between individuals can be expected in the onset, rate, and duration of developmental change throughout life.

A first implication of the lifespan scripts is that the relative weight of the sources of influence on development differs at varying phases in the lifetime (e.g., P. B. Baltes, 1987). Specifically, normative aspects of biological and cultural forces can be expected to be primarily important in child development, weaken with increasing age, and get important again at the very end of life. This notion is consistent with both evolutionary-biological theories (e.g., less evolutionary control over post-reproductive phases of life; Kirkwood, 2002) and sociological theories (e.g., relative absence of social roles for the elderly; Featherman, Smith, & Petersen, 1990; Uhlenberg, 1988). Genetic control over later phases in life is reduced because evolution did not select a biological program for the post-reproductive phases of life (Finch, 1996). This is evinced, for example, by research on the prediction of mortality: The predictive strength of many genetic risk factors for mortality attenuates in very late life (Christensen & Vaupel, 1996; Ljungquist, Berg, & Steen, 1996). Similarly, fewer socio-cultural constraints in terms of roles and expectations in old age contribute to the increasing importance of non-normative (idiosyncratic) factors for development in the second half of life (for review, see Dannefer, 2003). In turn, the importance of idiosyncratic factors such as environmental conditions for heterogeneity has been illustrated by behavior genetics research: Genetic variation contributes to individual differences in virtually all behavioral domains (McGuffin, Riley, & Plomin, 2001), but the actual size of the contribution can be altered dramatically by environmental variation (Gottlieb, 2002; Li, 2003).

In very late life, age-graded factors may again become important because they are associated with growing frailty. For example, cross-sectional data on lifespan samples as well as samples in very old age suggest that sensory functioning becomes more and more important in regulating intellectual functioning in late life: Individual differences in sensory systems (i.e., vision, hearing) accounted for up to 60% of the age-related variance in intellectual performance (Lindenberger & Baltes, 1997; Salthouse, Hancock, Meinz, & Hambrick, 1996).

Such strong relationship is in contrast to earlier periods of adulthood, in which intercorrelations are much lower.

The role of history-graded factors in old age is largely an open question. Tenets about the overall architecture of the life course propose an age-related decrease in cultural efficacy (P. B. Baltes, 1997). However, such decrease may depend on the specific cultural-historical context. For example, Maier and Vaupel (2003) reported that mortality rates in old age differed drastically in 1989 between the former East Germany and the former West Germany. However, over a relatively short period of six years following re-unification (1990-1996) this gap was reduced by more than half. This finding was taken to indicate that history-graded cultural factors still shape human development in old age, at least in the sample case of longevity extension.

A second implication of the lifespan scripts for heterogeneity and differential development in old age relates to the gain-loss metaphor: Because of age-related changes in adaptive capacity over the life course, the joint occurrence of growth (gains) and decline (losses) is shifted towards a negative balance in that there are fewer gains (P. B. Baltes, 1987; Brandtstädter & Wentura, 1995). Successful development, at a very broad level, has been defined as the *relative* maximization of gains and the minimization of losses (P. B. Baltes & Baltes, 1990; for other models of successful development, see Rowe & Kahn, 1997; Ryff & Singer, 1998). In this vein, gains in late life may be small in an absolute sense, but still important with regard to the normative functional profile of individuals in old age. To maintain a positive ratio of gains over losses, the allocation of available resources into developmental tasks changes with age: Relatively more resources are directed towards maintenance/recovery and regulation of losses (e.g., adequate functioning at lower levels) rather than growth (e.g., approaching higher levels of functioning; Brandtstädter & Greve, 1994; Brim, 1988; Dixon & Bäckman, 1995; Staudinger, Marsiske, & Baltes, 1995). It is not only the relative shift in resource allocation that is of interest to developmental researchers, but also age-related changes in the efficacy of the above functions. For example, older individuals can be expected to take a longer time to adapt or recover than younger individuals.

One telling example of potential mechanisms underlying heterogeneity relates to the differential use of strategies that allow individuals adjust to age-related losses. Following the notion of development as a dynamic gain-loss relation, compensatory strategies have been demonstrated to play a major role in maximizing gains and minimizing losses, particularly when resources become limited in old age (P. B. Baltes & Baltes, 1990; Brandtstädter &

Greve, 1994; Dixon & Bäckman, 1995; Heckhausen & Schulz, 1995). For example, the developmental agenda of the interplay between autonomy and dependency changes over the lifespan. In the first half of life, the maximization of autonomy is the primary focus, whereas in old age, the effective use of dependency becomes critical to adjust to and compensate for age-related losses. Dependent behaviors in select domains have been demonstrated to help in maintaining independence in other domains and free up resources for personal efficacy and growth (M. M. Baltes, 1996; Johnson & Barer, 1992). Of course, individuals vary in their efficacy to adopt compensatory means and may thus also differ in central outcomes of successful (effective) adaptation such as well-being and longevity. In addition, from the lifespan script about developmental co-constructivism arise substantive implications for maintaining a gain-loss balance at the end of life. In very old age, the increasing incompleteness of the biocultural orchestration of the life course may result in the functional breakdown of those systems that contribute to a positive ratio of gains over losses (Smith, 2003a; see also Birren, 1988; Uttal & Perlmutter, 1989).

A third implication of lifespan scripts is to consider different phases in old age. This illustrates one late-life consequence of the three principles underlying the overall architecture of the lifespan. Following earlier work (Laslett, 1991; Neugarten, 1974; Suzman, Manton et al., 1992),<sup>2</sup> Paul Baltes (1997) distinguished between the Third Age and the Fourth Age. In the Third Age, age-related losses are suggested to be domain-specific so that stability prevails, and the functional reserves (i.e., plasticity) are larger than previously thought (e.g., Rowe & Kahn, 1997; Schaie, 1996; for recent findings at the neuronal level, see Cabeza, 2002; Reuter-Lorenz, 2002). Longitudinal and intervention studies have shown that a relatively speaking large amount of resources can be recruited for growth (e.g., new learning: Kliegl et al., 1989). In the Fourth Age, in contrast, biological plasticity is substantively weakened and the efficacy of cultural and psychosocial resources is largely reduced (Crimmins et al., 1996; Olshansky, Carnes, & Dèsesquelle, 2001; Jorm et al., 1998; Kirkwood, 2002; Smith & Baltes, 1997). As a consequence, age-related losses generalize across domains and accumulate, and an increasing amount of resources (though being less effective) has to be invested into maintenance and compensation of losses. Unlike any other age strata, current cohorts of the oldest old are typically characterized by frailty, cognitive impairment, social

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<sup>2</sup> Bernice Neugarten (1974), for example, described the emergence of a large new group of elderly people being healthy, vital, well-integrated in their communities, and politically active. This group of the young old were in clear contrast to the old old who were associated with all the negative images of old age (e.g., frailty, need for care). Neugarten proposed the age of approximately 75 years as a possible turning point although she cautioned that the boundary was not so much based on chronological age, but on health status and social engagement.

losses, institutionalization, and an unique excess of women over men. These characteristics can hence be considered normative age-graded. The Fourth Age is thus a phase of life that places great demands on the regulatory and adaptive characteristics and it can be characterized as a kind of testing-the-limits situation for psychological resilience.

Findings of large heterogeneity illustrate that plasticity, though being substantively reduced, continues to be evident late in life (Brim & Kagan, 1980; Lerner, 1998, Maddox, 1987). Specifically, Suzman, Harris, Hadley, Kovar, and Weindruch (1992) described a group of persons among the oldest old who aged ‘robustly’ because they were not institutionalized, had few disabilities and were thus relatively autonomous. Their needs for medical and care services were temporarily restricted in that they transited in and out of different states of incapacity (see also Manton et al., 1997). Similarly, Crimmins and colleagues (1996) estimated that 70-year-olds can expect to spend 20% of their remaining lifetime in a dysfunctional-inactive state (measured using indicators of everyday competence and independent living), whereas this proportion increased to 60% among 90-year olds. This finding indicates substantive reductions in quality of life for the majority of individuals after age 80 or so. At the same time, however, the oldest old can expect to live a significant portion of their remaining years in relative independence.

Attempts to consider different phases in old age have in common that the definition of the threshold between the phases is a heuristic one that is based on somewhat arbitrary cut-off criteria (for discussion, see P. B. Baltes & Smith, 2003). At the population level, it is difficult to define precisely the exact boundary conditions because the age distribution in industrialized countries is continuously changing. A dynamic strategy would define the onset of the Fourth Age as the age where 50% of a birth cohort have died and hereby link the boundary to historical and contextual influences. This strategy would define the boundary in developed countries at around 80-85 years (Vaupel et al., 1998). At the individual level, individual variation in biological aging and patterns of psychological decline can be taken into account, and the entry into the Fourth Age can be defined by a certain amount of time before natural death (e.g., 5 to 10 years).<sup>3</sup> Based on this individual-specific approach, the Fourth Age could begin at very different chronological ages, for example, around 60 for some people or around 90 for others (Finch, 1996; Fries, 1990; Manton, 2001). Independent of the boundary definition, one approach to illustrate the utility of the proposed age phases is to demonstrate that

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<sup>3</sup> This individual-specific approach can be seen in the tradition of the terminal decline concept (Kleemeier, 1962; Riegel & Riegel, 1972; for review, see Bosworth & Siegler, 2002; I. Siegler, 1975; Small & Bäckman, 1999). which suggests that change is associated with impending death. However, because many age-associated changes are not related to morbidity and mortality, the approach presented is conceptually independent.



the potential for growth is substantively reduced among the oldest old as compared to earlier phases in life (e.g., loss prevails in quality of life, well-being, etc.). An examination of transition periods such as those between the Third Age and the Fourth Age may reveal evidence for sensitive phases of the life course in which sources of differential development are turned on, added to, multiplied, or diminished (Dannefer, 1984; Finch, 1996; Smith, 1999; Vaupel et al., 1998).

A fourth implication of the lifespan meta-theoretical framework is that there may be less continuity between different phases in old age than previously thought. Ideas about discontinuities of developmental and aging processes in old age underlie proposals about qualitative transitions such as cascading error models (Finch & Kirkwood, 2000; McEwen & Stellar, 1993), disability models (Verbrugge, 1994), models of terminal decline (Kleemeier, 1962; Riegel & Riegel, 1972), and threshold models (Birren, 1959). The classic threshold hypothesis (Birren, 1959) represents one sample case of cross-domain associations in the human organism and states that approaching critically low limits of functioning in a single vital domain may, at least in the long run, ultimately impede other areas of functioning. Given the importance of cognitive functioning for maintaining independent living, it seems reasonable to argue that marked cognitive decline and its underlying mechanisms may trigger decline in other psychological areas of functioning (for discussion, see Smith, 1999).

A fifth implication of the lifespan scripts is a methodological one that arises from the three major objectives in research on heterogeneity and differential development, which have been organized around three major aspects: (a) The identification and description of the range of individual differences and its correlates, (b) the direct examination of heterogeneity in developmental change trajectories over time and its potentially underlying factors, and (c) the examination of potential outcomes of similarities and differences in development (see Section 1.2.1). To realize these objectives and to thoroughly examine questions derived from lifespan scripts about development, researchers need to fulfill a number of design issues. Some of these design issues are the following: examining multiple domains of (psychological) functioning, studying age-heterogeneous samples of individuals in old as well as advanced old age, and utilizing longitudinal data to examine functional change over time.

To start with, to gain insights into the orchestrated interplay of the different domains involved in the overall functioning and development of individuals, it is essential to have available a broadly-based measurement approach. According to lifespan scripts about developmental contextualism, biological and environmental contexts interact at different levels to

co-produce similarities and differences between individuals (P. B. Baltes & Nesselroade, 1984). Thus, even if the primary interest is to study developmental processes at the domain-specific level (e.g., different cognitive abilities), a deeper understanding profits from the consideration of its relations to other domains of functioning both at the intra-psychological level (e.g., personality), and at a cross-disciplinary level (e.g., health, socio-economic status).

In addition, lifespan scripts about developmental co-constructivism (P. B. Baltes et al., 1998) suggest that studying communalities and differences within and between the two phases of old age necessitates that participants over a sufficiently large range of age have to be investigated. Because the early or middle eighties have repeatedly been suggested to represent a heuristic threshold between the two phases (Jorm et al., 1998; Smith & Baltes, 1997; Suzman, Manton et al., 1992), it would be desirable to examine an ample number of participants in these highest age ranges.

Finally, cross-sectional data can be used to draw inferences about interindividual differences in psychological functioning, which can be interpreted to reflect the conjoint outcomes of broadly-defined developmental processes that occurred prior to the point of measurement (e.g., different lifestyles and pathways into old age). However, only longitudinal data allow researchers to ask questions about individual and group differences in (a) intraindividual change, (b) the shape of intraindividual change in terms of discontinuity and multidirectionality, (c) the structural relationship among intraindividual changes (i.e., some domains might change, whereas others stay stable over time), (d) the determinants of intraindividual change (e.g., biological and environmental risks and protective factors), and (e) the outcomes of developmental processes (e.g., well-being, longevity), etc. (P. B. Baltes & Nesselroade, 1979). Thus, longitudinal data can be used to examine, for example, whether individuals who developed differently into old age also continue to develop differently during old age.

Considering these selected research design issues that are implied by lifespan scripts about development reveals that a deeper understanding of heterogeneity and differential development in old age profits from the simultaneous implementation of these issues in a given study.

It is beyond the scope of the present dissertation to fill out the concepts of heterogeneity and differential development over time. Instead, the framework provides a general context to ask research questions about differential development in old age as well as its underlying mechanisms and outcomes. For example, pursuing the question as to why and how individuals differ from one another in the way they show functional decline in old age may reveal

insights into the conjoint outcomes of biogenetics of aging and different lifestyles and pathways into old age as well as their development and change during old age. To do so, the present study opts for a systemic-wholistic approach. The utility of that approach has been demonstrated in research on differential development in the first half of the life course, as evinced in a series of monographs published by David Magnusson and colleagues (Bergman, Cairns, Nilsson, & Nysted, 2000; Gustafson & Magnusson, 1991; Magnusson, 1988, 1996; Bergman, Magnusson, & El-Khoury, 2003). For the second half of life, the approach promises also to be useful given that lifespan theorists have long recognized the multidimensionality and multidirectionality of human development and aging (P. B. Baltes, 1987; Birren & Cunningham, 1985; Busse, 1969; Schaie, 1996; Lehr & Thoma, 1987). Taking a systems perspective may best capture the most salient aspects of an individual's functioning across multiple domains and the systemic interplay of these domains within an individual. In this context, the approach allows to consider the dialectics and interdependencies among domains in terms of gains, maintenance, and losses (Smith, 2003a). The systemic-wholistic approach is used as a heuristic device to emphasize structural and functional interdependencies and so to complement function-, element-, and mechanism-specific research (P. B. Baltes & Smith, 1997).

The above sections introduced the concepts of heterogeneity and differential development, reviewed lifespan conceptions about underlying mechanisms, reviewed some theoretical as well as research design implications that arise for the study of heterogeneity and differential development in old age, and presented the *raison d'être* of the present dissertation. The next step is to ask how researchers have attempted to capture heterogeneity and differential development as well as its underlying mechanisms and which difficulties arise in such endeavors. The next sections present one approach that seems to be particularly promising to better understand heterogeneity and differential development because it focuses on developmental processes in multiple domains of functioning and their systemic interplay.

### **1.3 How to Capture Differential Development and Its Underlying Mechanisms: The Systemic-Wholistic Approach**

In the forthcoming sections, the systemic-wholistic approach is presented in detail and it is specifically asked how research on heterogeneity and differential development and its underlying mechanisms and outcomes may benefit from adopting the approach. In a further

step, strategies used to implement the systemic-wholistic approach are outlined and selected research findings are reviewed to illustrate the utility of that approach.

### 1. 3. 1 General Characteristics of the Systemic-Wholistic Approach

For a long time, function-oriented approaches have been and still are the major organizing principle in research on human development and aging (Bergman, 1998; Wohlwill, 1970). Studying particular domains (variables) of functioning, their development over time, and using a linear-relationship framework to consider associations among these domains may well have their limitations in understanding the structural interconnectedness and functional integration of these domains (Bergman, 1998). In contrast, a systemic-wholistic perspective is characterized by viewing the different domains involved in developmental processes in their combination to refer to the individual as an integrated totality rather than a mere summation of his or her structural and functional parts (Bergman & Magnusson, 2001; Magnusson, 1995, 1996). That is, the domains under consideration do not stand for themselves, but their significance in a given system emerges from their interactions and from the role these domains play as components in the structure and functioning of the system in total (Lövdèn, Bergman et al., submitted). Thus, there is more to systemic-wholistic thinking than simply examining multiple variables across different domains: The individual rather than a single function is the key conceptual and analytical unit (Bergman, 1998).

Systemic-wholistic thinking is not new in psychology, but goes back to classic psychologists in the early 20<sup>th</sup> century such as Gordon Allport (1937) or Kurt Lewin (1935). These authors argued that information about a person as an integrated and wholistic organism is by no means reducible and divisible. The so-called doctrine of epigenesis states that the whole is more than and different from the plain sum of its parts. Function- or variable-oriented approaches try to catch the meaning of a picture by studying its single parts separately (Bergman et al., 2000). In contrast, systemic-wholistic approaches consider, by definition, all variables defining a given profile simultaneously. By the 1950s and 1960s, however, this approach became out of fashion and only in recent years two research streams have repeatedly advocated a renaissance of these ideas.<sup>4</sup>

One of these streams was led by David Magnusson (1996) and his colleagues who argued that a modern systemic-wholistic view is more than assigning new names to old ideas.

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<sup>4</sup> For recent research focusing on gestalt-theoretical principles in the domain of (emotional) experiences, see Ariely and Carmon (2003) and Fredrickson and Kahneman (1993).

Individual functioning and development can be regarded as the outcome of continuously ongoing, reciprocal interaction processes between the different levels of the individual (e.g., cellular, cognitive, behavioral) rather than simple unidirectional cause-effect relations of traditional views. The concept also extends the boundaries of the individual and includes the specific (e.g., culturally different) proximal and distal properties of his or her environment (Magnusson, 2000). To understand the complex nature of individual functioning and development, Magnusson argues that it is necessary to establish dynamic-process models that specify the interdependent properties of mental factors, biological factors, and behaviors as well as environmental conditions. He also suggested that it is important to consider mainstream systems theories such as chaos theory (Barton, 1994), catastrophe theory (Zeeman, 1976), and general systems theory (von Bertalanffy, 1968). These theories and their underlying principles including self-organization should be adjusted to psychological factors such as intentionality, emotions, values, and experiences (for review, see P. B. Baltes & Graf, 1996; Ford & Lerner, 1992; Li, 2003; Spencer & Thelen, 2003).

The second major research tradition advocating a multilevel and systemic approach are lifespan theorists who have established meta-theoretical frameworks about ontogeny (P. B. Baltes et al., 1998; Lerner, 1986; Overton & Reese, 1973; Riegel, 1976). A systemic-wholistic perspective is inherent to lifespan scripts about ontogenetic development and its co-construction through biological and environmental determinants as well as through macro-contextual systems of influences constituted by age-graded, history-graded, and non-normative factors (see Section 1.2). Among the overarching propositions from this perspective are the recognition of multidirectionality and multidimensionality of ontogenetic change and the dynamic and continuous interplay between constancy and change in behavior throughout the life course.

In the present study, the term systemic-wholistic is selected to refer to an integrated perspective on the various structural and functional components involved in individual functioning and development. Specifically, *systemic* relates to the idea of “common to a system” (*Merriam Webster’s Third New International Dictionary*, 1986, p. 2323) and *wholistic* represents the notion of “constituting the total ... entity” (*Merriam Webster’s Third New International Dictionary*, 1986, p. 2611). Although the term (w)holistic signifies the doctrine of epigenesis, gestalt-theoretical conceptions rarely viewed humans as complex systems. The combined attributes systemic-wholistic is selected because it relates to the interconnectedness as well as to the wholeness of the person (see also P. B. Baltes & Smith, 1997).

### 1. 3. 2 The Systemic-Wholistic Approach and Differential Development Over Time

The objectives of research on differential development over time from a lifespan perspective have been organized around three major aspects: (a) The identification and description of the range of individual differences and its correlates, (b) the direct examination of heterogeneity in developmental change trajectories over time and its potentially underlying factors, and (c) the examination of potential outcomes of similarities and differences in development (see Section 1.2.1). In the following, it is asked how the systemic-wholistic approach may contribute to each of these objectives.

*Identification and Description of the Range of Heterogeneity and Its Correlates.* Standard applications of function-oriented research (e.g., factor analyses, structural equation modeling) use variance-covariance matrices as the basic unit of analysis that, by definition, disregard higher-order interactions that may be present in the data. These standard measurement models to examine interindividual differences provide only limited information to understand differences within individuals (e.g., Molenaar, Huizenga, & Nesselroade, 2003). In contrast, systemic-wholistic approaches consider similarities and differences among individuals without specifying a certain structure underlying the functional profile that is characteristic of individuals. It is thus possible to take into account linear as well as non-linear relationships among the constructs that defined a given profile and so acquire insights otherwise not gained (Bergman, 1998). In the face of multidimensionality and multidirectionality of developmental processes (P. B. Baltes, 1997; Birren & Cunningham, 1985; Schaie, 1996), using the systemic-wholistic approach to view the interplay of different domains of functioning may be a particularly promising tool to guide research on communalities and differences in development. This is even more so in old and advanced old age when fundamental consequences of the biological and cultural incompleteness of the architecture of human ontogeny arise (P. B. Baltes, 1997). For example, to examine a potential relative shift in the multisided and multifunctional nature of development with increasing age, analyses that take into account interdependencies and non-linear associations among the constituting domains may complement rather function- and domain-specific research.

*Examination of Heterogeneity in Developmental Change Trajectories Over Time and Its Underlying Factors.* The complementary potential of the systemic-wholistic approach lies, for example, in the fact that the focus is not on identifying one single developmental change trajectory and variability around it. Instead, heterogeneity in change trajectories is portrayed as being due to a finite number of developmental patterns that are distinct across subpopula-

tions (e.g., variety of pathways into old age; Bergman & Magnusson, 1997). That developmental processes often do not characterize the majority of a given sample, but are (partly) specific to certain (subgroups of) individual(s) is in analogy to the complex nature of the three sets of macro-contextual systems that shape human development (P. B. Baltes et al., 1980). Whereas function-oriented analyses may contribute to detecting *general* risks and protective factors for psychological functioning, systemic-wholistic research may detect risks and protective factors that are *specific* to certain subgroups of individuals (Schulenberg, Wadsworth, Malley, Bachman, & Johnston, 1996). By using a combined variable- and person-oriented approach, Schulenberg et al. (1996), for example, found in adolescents that being male, possessing low self-efficacy, and drinking primarily 'to get drunk' were unconditional adolescent risk factors for increased binge drinking over time. In contrast, other adolescent risk factors such as low conventionality were found to be conditional on initial level of binge drinking. Generally speaking, consistencies between findings from variable-oriented and person-oriented approaches can be interpreted as indicating unconditional antecedents, whereas inconsistencies may indicate precursors that operate conditionally.

Examining differential development from a systemic-wholistic perspective also opens up speculations whether similarities and differences in profiles of functioning across multiple domains remain relatively stable in the long term. It is an interesting, but rarely examined question to what extent constellations of functioning that are characteristic of individual functioning at one point in time remain distinct over time and what underlying factors moderate such persistence.

*Examination of Potential Outcomes of Similarities and Differences in Development.* Combining the systemic-wholistic approach with the perspective of gain-loss relations in old age, it appears reasonable to argue that the very same developmental outcome of a net sum of gains and losses has been produced by different profiles of functioning or a variety of underlying pathways that may also vary across domains of functioning. In addition, differences in profiles across multiple domains of functioning can be interpreted to represent both the outcomes of differential development and potential sources for continued differentiation (Aldwin, Spiro, Levenson, & Cupertino, 2001; Liang et al., 2003; Smith, 2003a). The systemic-wholistic approach permits a consideration of the systemic nature of gain-loss dynamics by examining, for example, interrelations among the functional domains in terms of gains, maintenance, and losses. In analogy to systems theory (e.g., Bateson, 1996; Finch, 1996), the underlying idea is that the systemic composition and operation of the profile in total cannot

completely be accounted for by studying interrelations among the profile-defining domains. This is so, for example, because minor variations in the constituting domains as well as small and unknown interactions may add up and result in substantive changes at the system level. In turn, changes at the system level have consequences for future development in that the system shows a different trajectory from that predicted by the constituting domains. Self-organization, for example, is such a property of open systems that results in the emergence of new structures: The operating components of each (sub-)system organize themselves to maximize the functioning of the subsystems as well as that of the system in total (Thelen, 1989). In addition, models of self-organizing criticality suggest that the developmental functions of profile maintenance, reorganization, and breakdown are influenced by different sets of factors (e.g., Bak & Chen, 1991; Schroots & Yates, 1999).

A systemic-wholistic approach can, of course, be applied to a number of different levels of analysis. For example, questions can be examined at a domain-specific level (e.g., different cognitive abilities), across domains at an intra-psychological level (e.g., between cognitive functioning and personality), and across domains at a cross-disciplinary level (e.g., cognitive functioning and health; Smith & Baltes, 1997). Of course, a single study can only cover a small portion of the whole picture, and the use of cross-disciplinary factors may be particularly helpful to determine how the different systems of influence (i.e., age-graded, history-graded, and non-normative) affect individual development. One example illustrating the utility of the systemic-wholistic approach comes from research on developmental trajectories of social behavior during the first half of life: The long-term trajectories of boys with persistent, transient, and no criminal offending were characterized by distinctly different patterns of biological and psychosocial factors (e.g., motor restlessness, concentration; Magnusson & Mahoney, 2003). Systemic-wholistic research on the second half of life has investigated, for example, the increasing crystallization of life history trajectories and their late-life outcomes (Dannefer, 2003; Moen, Elder, & Lüscher, 1995; Mumford, 1991), and the cumulative (cascading) effects of system breakdown (Birren & Schroots, 1996). The ensuing section reviews in more detail strategies researchers have repeatedly used to implement the systemic-wholistic approach.

### 1. 3. 3 Strategies Used to Implement The Systemic-Wholistic Approach

A number of different strategies have been used to implement a systemic-wholistic approach (Herzog & Nesselrode, 2003) and these strategies also vary by scientific discipline.



One way to categorize these strategies, is to separate strategies that proceed top-down from those that proceed bottom-up. The *top-down* strategy relates to a classification of individuals into predetermined categories based on theory or clinically relevant criteria. Examples of predefined cut-off points for group membership include socio-economic criteria (e.g., high vs. low standing in social class or education), measures of psychopathology (e.g., depressed vs. non-depressed) and physical functioning (e.g., disabled vs. non-disabled). This strategy is rarely applied in psychological research because there are few functionally significant criteria that can be used for categorization purposes.

*Bottom-up* strategies to identify subgroups of individuals refer to a more data-based ‘inductive’ categorization of individuals. This methodological stance has a long history in developmental research and has been conducted since the 1960s, particularly in the contexts of the Kansas City (Neugarten et al., 1968; Williams & Wirths, 1965), Duke (Palmore, 1974), and Bonn Studies (Lehr & Thome, 1987). Bottom-up classifications allow the researcher to explore the data at hand. Rather than pre-specifying the group characteristics in advance, groups of individuals are identified empirically. Methods that have repeatedly been used in the context of bottom-up strategies include longitudinal or configural frequency analyses (CFA; von Eye, 1990), latent class or latent transition analysis (Collins & Wugater, 1992), and cluster analysis (Bergman et al., 2003).<sup>5</sup> Cluster analysis, for example, uses information about level and shape of the profiles to classify individuals into homogeneous subgroups so that (a) members of one subgroup share communalities in the subgroup-defining constructs and (b) subgroups differ from one another on these constructs (Gustafson & Magnusson, 1991). Once the groups have been identified, theory can be used to help in the post-hoc interpretation and labeling of patterns and groups. Table A.1 in Appendix A lists exemplar studies that have used bottom-up strategies to define subgroups of individuals: the Seattle Longitudinal Study (Bosworth & Schaie, 1997), the Gothenburg H-70 study (Maxson et al., 1996), the Berlin Aging Study (Smith & Baltes, 1997, 1998), and the Betula study (Lövdèn, Bergman et al., submitted).

Both the top-down and the bottom-up strategy to implement a systemic-wholistic approach have their specific advantages and limitations. Opting for one of the two strategies of person classification depends upon its flexibility and suitability for the specific research questions asked. The separation into top-down and bottom-up strategies is primarily of heu-

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<sup>5</sup> For recent methodological developments that combine pattern-oriented methods with classic Latent Growth Curve modeling approaches to identify heterogeneity in latent space, see Collins and Sayer (2001), Little, Schnabel, and Baumert (2000), and Muthèn and Muthèn (2000).

ristic value to classify the different procedures researchers have used. The separation is historically based in the distinction between deductive and inductive research strategies (for overview, see Westmeyer, 2001). To avoid implicitly jumping between deductive and inductive arguments, more recent systemic-wholistic research, as well as the present study, use a combination of both strategies and make explicit where theory comes into play. Given the relative dearth of systemic-wholistic research in old age, bottom-up methods seem to be most appropriate to explore a given data set and so provide a way to structure and describe heterogeneity. Theory plays a major role already before the identification of subgroups in that it forms the basis for selecting the subgroup-defining constructs (i.e., the constructs entered into the cluster analysis). After subgroup identification, theory is again used to interpret the subgroup characteristics and embed them into the existing literature. Theory is particularly important in decisions about the constructs used to externally validate the subgroups. The objective in this step is to demonstrate that the subgroups identified show meaningful and interpretable relations to constructs that were not involved in defining the subgroups.

When opting for a bottom-up strategy, one may question to what extent a pattern-oriented approach can preserve an idiographic focus on the individual. This concern relates to the fact that pattern-oriented methods are nomothetical research tools that study individuals from an interindividual perspective. Such an approach may thus not be well-equipped to study, strictly idiographically speaking, the infinite number of idiographic patterns of functioning and development. However, the perspectives are compatible with each other insofar as the individual is the organizing principle in pattern-oriented approaches. Rather than immediately aggregating across individuals and afterwards examining which variables coincide, pattern-oriented methods such as cluster analysis determine how variables coincide in the individual before comparing individuals or groups with one another (Nesselrode & Ghisletta, 2000). At a more global and aggregate level, there are often communalities and differences of functioning and development between idiographic patterns of functioning and development that allow to classify individuals into groups (Bergman & Magnusson, 1991). To the extent that pattern-oriented methods preserve the theoretical focus on the individual as a whole, they serve well as a tool to study the interplay of the different domains involved in individual functioning and development.

There is a long-standing debate about how to adequately interpret groups of individuals and the differences between them (Bergman et al., 2003). In many applications, grouping individuals together does not represent a taxonomy, but is simply based on similarities and

dissimilarities in multivariate space in a given data set. Differences between the subgroups may or may not be qualitatively distinct, but often represent just quantitative differences. As long as the groups cannot be expected to differ qualitatively from one another, groups of persons represent fuzzy sets (see Zetenyi, 1988). Conceptually, this implies that subgroups are not clearly separated from each other even in multivariate space and that a certain amount of vagueness is always involved in assigning individuals to groups. The usefulness and validity of a bottom-up classification approach rests on additional criteria, which involve follow-up analyses that link the subgroups identified to constructs that were not part of the group definition and that may represent antecedents, correlates, and consequences of profile differences between the groups (Cairns & Rodkin, 1999; Smith & Baltes, 1997). From a lifespan theoretical perspective, this involves the selection of external factors thought to contribute to differential development as well as outcomes of differential development (e.g., well-being, longevity).

The above sections introduced some general assumptions underlying the systemic-wholistic approach as well as some of the strategies used to implement the approach. The present study opts for the systemic-wholistic approach as a tool to examine questions about heterogeneity and differential development in old age. The ensuing section thus reviews a selection of earlier systemic-wholistic research to demonstrate the utility of the approach for this purpose.

#### 1. 3. 4 Previous Research on Differential Development in Old Age From The Systemic-Wholistic Perspective

A selective review of previous research from a systemic-wholistic perspective aimed at studying communalities and differences of development in old age (see Appendix A for Table A.1) revealed that the research design implications of the lifespan scripts for studying heterogeneity and differential development in old age (see Section 1.2.3) are rarely covered simultaneously within a given study. Instead, many studies have utilized one or two of these design issues.

With regard to examining multiple domains, research often used classification approaches that are based on multiple dimensions, but these dimensions are derived from a single functional domain such as health (e.g., Evert, Lawler, Bogan, & Perls, 2003) or cognition (e.g., Schaie, 1990). Studies to examine cross-domain linkages have primarily been conducted from an epidemiological perspective and have typically used basic cognitive and

physical abilities (e.g., Berkman et al., 1993). Few person-oriented researchers have focused on multiple domains of psychological functioning (one exception is Bosworth & Schaie, 1997). Few studies have examined samples of participants who covered a large age range. Those that explicitly focused on individuals in old age as well as in advanced old age, however, offer insights into an increasing likelihood of broadly-based dysfunctionality (e.g., Jorm et al., 1998; Smith & Baltes, 1997). Apart from research using epidemiological data (e.g., Manton & Land, 2000), there are few studies that have used the person-oriented approach with longitudinal data. One exception is the study by Lövdèn, Bergman et al. (submitted) who defined their subgroups from a psychological perspective.

In the context of top-down strategies to subgroup identification, theoretical criteria developed in the MacArthur studies of Successful Aging (Rowe & Kahn, 1997; see also Berkman et al., 1993) are often used to identify subgroups representing successful, normal (i.e., usual), and pathological aging. According to the Rowe and Kahn model, successful aging encompasses three essential components: (a) avoiding disease and disability, (b) maintaining high cognitive and physical functioning, and (c) preserving an engagement with life through social and productive activities. A similar approach was used to examine data in the AHEAD study of the oldest-old (Garfein & Herzog, 1995): 38% of the sample were identified as less robustly aging and the remaining 62% were classified as aging robustly according to at least one of their criteria. Further examples for a top-down strategy come from the OCTO study in Sweden (Zarit, Johansson, & Berg, 1993), and the Australian Longitudinal Study on Aging (Andrews, Clark, & Luszcz, 2002). A selection of studies is listed in Table A.1 in Appendix A.

One study that illustrates the potential of the systemic-wholistic approach to examine lifespan questions about differential development in aging is that of Maxson and colleagues (1996). It is informative to consider this study in some detail because it sets the scene for some design and methodological issues associated with the present dissertation study.

*A Specific Example of Systemic-Wholistic Research in Old Age.* Maxson and colleagues (1996) used cluster analysis as a bottom-up strategy to identify five subgroups in a sample of 70-year-olds based on their overall functional profile across the domains of cognition, social contacts, well-being, physical health, and functional capacity. This study used multiple domains of functioning to define the subgroups and followed the groups over a period of nine years. Each participant was 70 years of age at study enrollment. This age-homogeneous

design has the disadvantage that the possibility of finding subgroup differences in profiles of functioning was restricted at baseline assessment. However, the availability of longitudinal data enabled an examination of differential trajectories of change over time.

Subgroup characteristics can be obtained from Table 1. Overall, it was not one particular difference at baseline assessment that distinguished the subgroups from one another, but the profile across a wide range of functions. Members of Subgroup C, for example, were cognitively fit, socially embedded, and reported feelings of well-being. However, these participants were found to show moderate constraints in physical health. This finding demonstrates two major strengths of a systemic-wholistic approach in research on differential development. First, the positive manifold across the profile-defining domains as suggested by function-oriented analyses may characterize the majority of a given sample, but there are groups of individuals for whom such a pattern is not true. These individuals did not show domain-generalized low functioning, but were able to compensate for specific deficits in the health domain or, alternatively, their cognitive, social, and self-related resources buffered against further health decline. Thus, in general terms, the methodological tool of cluster analysis revealed evidence for differential patterns of gains and losses.

A second major strength of the systemic-wholistic approach was the profile of high and low scores across the different domains, which illustrates that a broad and systemic perspective has the potential to complement and extend the literature on between-domain links. If the groups were extracted from the physical-functioning and cognitive domains only, the picture of group differences would have been limited and very different. Considering all five domains, in contrast, allowed the authors to classify Subgroup C as aging successfully despite impairments (relative losses) in the domain of health.

To demonstrate the validity and meaningfulness of their subgroups, Maxson and colleagues (1996) linked the five subgroups to outcomes of successful aging over time, dementia incidence and mortality. With regard to mortality, the authors reported evidence for the functional consequences of moderate multi-domain impairments as well as for the functional importance of specific domains. The functional significance of impairments across multiple domains was revealed by the finding that mortality rates were high for Subgroup D and Subgroup E, which were characterized by functional decrements across different domains. Interestingly, these mortality rates were similar to those observed for Subgroup B, which was characterized by pronounced impairment in cognitive functioning, but average levels or minor constraints in all other functional domains. This pattern of results can be interpreted to

mean that relatively good performance across multiple domains might not outweigh poor functioning in one central domain, which is in analogy to the threshold hypothesis (Birren, 1959). The pattern also exemplifies that the mechanisms underlying (psychological) functioning may vary between groups of individuals, and these different processes may nevertheless have the same functional outcome (i.e., equifinality).

Table 1

*Profile Characteristics of the 5 Subgroups Extracted From Cluster Analysis in the Gothenburg Study (Maxson et al., 1996)*

Measures	Subgroups				
	A (n = 84)	B (n = 138)	C (n = 51)	D (n = 43)	E (n = 29)
<b>Profile-Defining</b>					
Cognition	++	--	+++	+	-
Social Contacts	+	-	++	--	-
Well-Being	+	+	+	--	-
Physical Health	+++	-	-	----	--
Functional Capacity	+	+	+	+	----
<b>External Criteria</b>					
Dementia Incidence	+	-	+++	++	--
Mortality	+++	+	++	--	-

*Note.*  $N = 335$ . Positive and negative signs for the profile-defining measures indicate the following: '+++ $\geq 1$  SD above sample mean; '++ $\geq 0.5$  SD above sample mean; '+ $< 0.5$  SD above sample mean; '- $< 0.5$  SD below sample mean; '-- $\geq 0.5$  SD below sample mean; '--- $\geq 1$  SD below sample mean. The external criteria were not on a metric comparable to the profile-defining measures. Hence, positive and negative signs for dementia incidence and mortality were used to rank order the subgroups: '- $=$  high incidence; '+ $=$  low incidence. Subgroup B lived significantly shorter than Subgroups A and C, but there were no significant differences to Subgroups D and E, respectively.

### 1. 3. 5 The Utility of the Systemic-Wholistic Approach: A Summary

Throughout this chapter, I have discussed the utility of the systemic-wholistic approach to examine questions about heterogeneity and differential development in old age. In particular, I have tried to show that the systemic-wholistic approach can be used as a tool to examine key questions about differential development. The approach provides evidence about individual and subgroup differences in functional profiles and heterogeneity in trajectories of change. Furthermore, subgroups identified by the statistical methods associated with this approach can be entered in theory-guided follow-up analyses, for example, to determine outcomes of profile differences.

Few studies so far have applied a systemic-wholistic approach to examine lifespan proposals about differential psychological development in old age (P. B. Baltes et al., 1998; see Section 1.2). Underlying these proposals are ideas about the possible range and limits to heterogeneity of psychological profiles in old age, biological and cultural (environmental) correlates of heterogeneity, and predictors and consequences of change over time (e.g., successful vs. less successful aging). In part, this deficit lies in the absence to date of longitudinal data and studies that have included both a broad range of psychological measures as well as indicators of biological and cultural (environmental) determinants of heterogeneity and differential development over time.

The advantage of longitudinal data was illustrated in the Maxson et al. study (1996). Repeated measures analyses in this study revealed significant interaction effects between age and the group-defining domains indicating that group characteristics changed differentially over the nine years of observation. The groups found at baseline assessment not only differed from one another nine years later, but also showed different trajectories of change over time. Some subgroups (e.g., Subgroup A; see Table 1) reported higher subjective well-being over time, whereas all other groups reported less well-being. For some subgroups (Subgroup D and Subgroup E) this was accompanied by higher rates of mortality.

Another very recent example of using longitudinal data in the context of a person-oriented approach comes from the Betula Prospective Cohort Study in Sweden and was conducted by Lövdèn, Bergman and colleagues (submitted). These authors were restricted to various measures of cognitive functioning such as semantic and episodic memory and used cluster analysis to empirically identify subgroups. Their objective was to demonstrate individual differences in multivariate patterns of change over ten years. Specifically, typical paths of development associated with normal aging, dementia, and mortality were identified. Whereas function-oriented research reports that cognitive changes in old age are highly inter-correlated (e.g., Wohlwill, 1970), these authors showed that subgroups actually showed multiple patterns of change. One typical progression trajectory that was linked to dementia involved a developmental cascade of poor performance that was specific to declarative memory, followed by increasing dedifferentiation of cognitive performance towards task-generalized low performance, dementia diagnosis, and death. Another subgroup trajectory instead was characterized by relative stability of the cognitive system over time. Still other typical developmental paths were represented by a major drop in spatial visualization ability with minor changes in other abilities.

The evidence reviewed shows that a combination of the systemic-wholistic approach with longitudinal observations may provide insights into whether individuals who developed differently into old age also continue to develop differently during old age. Questions about differential development can be examined at various closely intertwined levels. At the level of the subgroups, one set of questions relates to the stability of subgroup membership over time: Do participants who were grouped together at one point in time remain grouped together later in time? At the level of the subgroup-defining profiles, another set of questions relates to why and how subgroups vary in their risk for functional decline. In this context, lifespan scripts about the biocultural incompleteness of the lifespan architecture (P. B. Baltes, 1997) suggest that systemic patterns of functional decline may be more pronounced in the transition period between the Third Age and the Fourth Age rather than in earlier phases of life.

Another step in elaborating profile differences between subgroups of individuals is to identify and examine factors that may have acted as antecedents, correlates, or consequences of differences in functional status and change over time. Lifespan scripts about developmental contextualism (P. B. Baltes et al., 1980) highlight the importance of examining the relative roles of biological and cultural factors in explaining differential development. Investigations of long-term outcomes that may arise from differences in profiles of psychological functioning and systemic change over time also add to the credibility of a systemic-wholistic approach. In this context, well-being and longevity are the obvious outcome measures associated with proposals about successful aging (P. B. Baltes & Baltes, 1990; Rowe & Kahn, 1997; Ryff & Singer, 1998).

The above proposals form the background to the present dissertation. The thesis aims, at a general level, to shed some light on specific components of the broad concept of heterogeneity and differential development over time. To this end, the lifespan perspective is combined with a systemic-wholistic approach, in which multiple domains of functioning are used to define subgroups of individuals in an age-heterogeneous sample, and longitudinal data is used to examine questions about differential change and outcomes over time. This dissertation extends initial cross-sectional work from the Berlin Aging Study (Smith & Baltes, 1997) into a longitudinal context. The next section introduces the Smith and Baltes work in more detail, because it provides the foundation for the present dissertation.



## II THE PRESENT STUDY

The present study is based on earlier cross-sectional work from a broad and systemic perspective (Smith & Baltes, 1997). The following sections are devoted to an in-depth presentation of this previous study. This includes the rationale underlying the selection of the psychological factors that defined the groups as well as the cross-disciplinary factors that were external to the group definition. Deciding about the number and scope of constructs is essential in each and every application of person-oriented research because this largely determines the characteristics of the subgroups to be identified. Overall, the section serves to provide some background knowledge to better understand the potentials and constraints that arise from a longitudinal extension of this study to examine questions about heterogeneity and differential development in old age.

### 2.1 Previous Systemic-Wholistic Work From the Berlin Aging Study: Smith and Baltes (1997)

Smith and Baltes (1997) applied a systemic-wholistic approach to study differential development in old age in the relatively large and age-heterogeneous sample of the Berlin Aging Study (BASE;  $N = 516$ ; P. B. Baltes & Mayer, 1999). They empirically identified nine subgroups by cluster analysis of performance in multiple psychological domains: Cognition, personality and self-related functioning, and social integration (12 constructs, in total). The subgroups not only differed substantively from one another on these profile-defining measures, but also on a set of cross-disciplinary factors that were selected as external variables to broadly signify past and current developmental contexts. Meaningful relations of the groups were found to age, gender, health, and life-history factors. The multivariate, person-oriented approach used by the authors allowed the detection of striking individual differences at the level of combinations of variables even when differences were not significant or were relatively small at the single variable level.

Why did Smith and Baltes select measures from the cognitive, personality, and social domains to identify psychological profiles of functioning in old age? The following paragraphs summarize their reasoning on this. First, adequate levels of cognitive functioning have long been proposed and empirically demonstrated to be important for successful aging, particularly because these abilities have substantial implications for maintaining independent living and efficiency in everyday life (P. B. Baltes & Baltes, 1990; Rowe & Kahn, 1997). There is a strong consensus in the literature that two dimensions of cognitive functioning,

fluid and crystallized intelligence, are essential to characterize functional capacity across the life span (P. B. Baltes, 1987; Cattell, 1971; Horn, 1982). Fluid abilities refer to the content-poor and more biology-based cognitive components that reflect “*fundamental organizational properties of the central nervous system*” (Lindenberger, 2001, p. 8851). Fluid abilities encompass the speed, accuracy, and coordination of basic processing operations including perceptual speed and memory. Crystallized abilities represent the content-rich and more culture-based cognitive components that accumulate through experience. That is, crystallized abilities comprise culturally transmitted bodies of declarative and procedural knowledge. A large body of evidence indicates the divergent age trajectories for both components. Studies of psychometric intelligence evinced that the fluid abilities start to show linear decline in mid-adulthood, while crystallized abilities remain relatively stable or even increase (e.g., Schaie, 1996). It is only in the highest age range when crystallized components tend to decline (T. Singer et al., 2003). A variety of person-oriented studies have used measures of cognitive functioning to define groups (e.g., Lövdèn, Bergman et al., submitted; Schaie et al., 1994).

Second, measures of personality dispositions, self-related beliefs, and self-regulation processes are often used to examine questions about adaptation to old and very old age. Smith and Baltes (1997) selected five measures of personality and general self-regulatory beliefs. Personality traits can be defined as dimensions of interindividual differences in tendencies to show patterns of thoughts, feelings, and actions that are relatively stable across different points in time and in different types of situations (i.e., enduring dispositions; Costa & McCrae, 1997; Endler & Magnusson, 1977). Two basic traits of personality were examined, neuroticism and extraversion (Costa & McCrae, 1985; Eysenck, 1967). Neuroticism refers to a disposition of emotional lability, which includes facets such as bad-temperedness, anxiety, hostility, enduring negative emotions, and vulnerability. Extraversion refers to a dispositional interest in being with others, which includes attributes such as self-confidence, outgoingness, sociability, and positive emotions. Both personality dispositions have been repeatedly found to show structural stability with age, and age-related differences in mean levels were rather small, at least up to age 80 (e.g., McCrae et al., 1999). Personality dispositions have often been used in person-oriented research (Aldwin et al., 2001; Lawton, Ruckdeschel, Winter, & Kleban, 1999; Neugarten et al., 1968).<sup>6</sup>

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<sup>6</sup> For recent studies examining differential change trajectories in personality research, see Helson, Jones, and Kwan (2003), and Mroczek and Spiro (2003).

As measures of self-related functioning, Smith and Baltes (1997) selected two general self-regulatory beliefs (internal control and external control) and an index of goal investment. Self-related functioning can be regarded a summary term for the description of a variety of diverse constructs such as coping and control beliefs, self-efficacy and emotional regulation, and self-evaluative and goal-related processes (Bandura, 1989; Brandtstädter & Greve, 1994; J. Heckhausen & Schulz, 1995; Schwarzer, 1995; Thomaе, 1970). Self-regulatory beliefs refer to the perceived locus of control to cope with one's circumstances (Rotter, 1966). Individuals may believe that one's efforts can influence an outcome (i.e., internal control beliefs) or they may believe that other persons such as powerful others exert control over one's life (i.e., external control beliefs). Internal control beliefs usually do not differ with age, but external control beliefs show strong negative age gradients, which illustrates the independence of both constructs (Lachman, 1986; Skinner, 1995). One measure of goal investment was included to signify the intensity of investment across various life domains in old age such as health and family (Staudinger, Freund, Linden, & Maas, 1999). The processes expected to be involved range from selecting among different goals, bridging motivation and volition, to action regulation in realizing one's goals (H. Heckhausen, 1991; Schwarzer, 1992). Despite a relative scarcity of age comparative studies, evidence suggests that age gradients of goal investment might be lower than previously thought ( $r = -.17$ ). Measures of self-related functioning have a long history in person-oriented research (Ford & Taylor, 1983; Lawton et al., 1999; Magai et al., 2003; Reichard et al., 1962).

The third domain covered in the Smith and Baltes study (1997) was social integration, which can be regarded a key resource for adaptation in old age, although every relationship involves costs and benefits (Smith & Goodnow, 1999; for review, see Antonucci, 2001; Rook, 1998; Seeman, 2000). The beneficial effects are, for example, due to buffering the amount of strain experienced in times of stress (Cohen & Wills, 1985). To examine different aspects of social integration, three measures from BASE were utilized. One measure indexed the overall number of close confidants and was used as an indicator of overall network size that alludes to both quantitative and qualitative aspects. Socioemotional selectivity theory (Carstensen, 1991, 1993; Lang & Carstensen, 2002) suggests negative age gradients for social network size: With increasing scarcity of available resources in old age (e.g., limitations in time perspective and subjective competence), a relative shift in social motivation occurs from more information seeking to more emotional support. Because the measure used reflected emotionally close relations, age differences can be expected to be of minor size.

Two further measures of social integration indicated feelings of loneliness (Russell, Cutrona, Rose, & Yurko, 1984). Social loneliness refers to perceptions of social isolation such as being precluded from belonging to a social group and the general availability of trusted others. Emotional loneliness refers to perceptions of emotional distance from others such as being alone. Russell and colleagues (1984) reported that both factors show stronger links to subjective satisfaction measures than to (overall) network size. Cross-sectional age gradients for emotional loneliness are stronger than for social loneliness ( $r = .29$  vs.  $r = .13$ ; Smith & Baltes, 1999). Measures of social integration have repeatedly been used in a number of person-oriented studies (e.g., Bosworth & Schaie, 1997; Maxson et al., 1996).

The selection of the subgroup-defining psychological domains in the Smith and Baltes study (1997) was aimed at broadly representing central characteristics of the psychological make-up in old age as suggested by the literature. Of course, the selection of dimensions within these domains was arbitrary and largely determined by the data structure available in BASE (P. B. Baltes & Mayer, 1999). Nevertheless, many person-oriented studies have used a subset of the three domains (see Appendix A for Table A.1) and each domain was measured by several different dimensions. In general, the choice of the three domains reflects a reasonable overall picture of psychological functioning in old age.

### 2. 1. 1 Subgroup Characteristics

By applying cluster analysis to scores on these three domains of psychological functioning in the total cross-sectional BASE sample, Smith and Baltes (1997) empirically identified nine subgroups. The subgroups differed from one another substantively across the profile-defining dimensions. In an attempt to characterize and evaluate the groups, they rank-ordered the subgroups in terms of functionality or desirability status. In a first step, scores on each dimension examined were categorized as indicating either desirable (positive) or less desirable (negative) characteristics for adjustment in old age. Less desirable characteristics included, among others, low cognitive functioning, high levels of loneliness, and external control beliefs. Desirability status of the 12 dimensions was set empirically by linking desirable psychological functioning to above-average performance (i.e., above a T score of 50) and less desirable functioning to below-average performance.<sup>7</sup> In a second step, the overall mean level of desirability (functional status) of the subgroup profiles was computed and used

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<sup>7</sup> All scores were T scores with a *mean* of 50 and *SD* of 10. Note that neuroticism, external control, social loneliness, and emotional loneliness were regarded as less desirable characteristics and thus were recoded so that high scores on these variables represent more desirability (e.g., few feelings of social loneliness).

to rank order the subgroup profiles from 1 to 9. The subgroups were thus characterized by systemic-wholistic profiles of social desirability or psychological efficacy of the functional status. Table 2 shows the subgroup characteristics on the profile-defining dimensions as well as on external validation variables that were not part of the clustering procedure.

Table 2  
*Profile Characteristics of the 9 Subgroups Extracted From Cluster Analysis in the Total Cross-Sectional BASE Sample (Smith & Baltes, 1997)*

Measure	Desirable Subgroups				Less Desirable Subgroups				
	1 n=50	2 n=29	3 n=119	4 n=42	5 n=75	6 n=44	7 n=64	8 n=55	9 n=32
<b>Profile-Defining</b>									
Perceptual Speed	+++	+	++	++	-	+	--	--	---
Memory	+++	+	+	++	-	+	--	--	---
Knowledge	+++	+	++	++	-	+	--	--	---
Neuroticism <sup>a</sup>	+	+	++	-	--	--	+	++	--
Extraversion	+++	++	+	--	-	-	-	-	---
Internal Control	+	+	-	--	-	+	++	+	---
Other Control <sup>a</sup>	+	+	++	++	--	+	---	+	-
Goal Investment	++	++	+	-	++	+	--	--	---
Social Loneliness <sup>a</sup>	++	+	+	--	+	--	+	--	---
Emotional Loneliness <sup>a</sup>	++	++	++	-	--	---	+	+	---
Perceived Support	++	+	+	-	++	--	-	--	---
Close Others	+	+++	+	--	+	-	-	-	--
Overall Desirability	++	+	+	-	-	-	-	-	---
3-Domain Desirability	++	++	+	+	-	-	-	-	---
<b>External Criteria</b>									
Health	++	+	+	+	-	-	+	-	+
IADL	++	+	++	+	--	-	-	-	--
Education	++	+	+	+	-	-	--	-	--
Sensory Functioning	++	+	+	+	-	+	--	-	--
Well-Being	++	+	+	-	--	--	+	++	--
3-Year Survival	+	+	+	+	-	+	-	-	-

Note.  $N = 510$ . Six participants were excluded from cluster analysis. Scores standardized to mean of 50 and standard deviation of 10. <sup>a</sup>Scores on these dimensions were reverse-coded to calculate the desirability (functional status) score. Positive and negative signs for all measures indicate the following: '+++<sup>a</sup>'  $\geq 1$  SD above sample mean; '++'  $\geq 0.5$  SD above sample mean; '+'  $< 0.5$  SD above sample mean; '-'  $< 0.5$  SD below sample mean; '--'  $\geq 0.5$  SD below sample mean; '---'  $\geq 1$  SD below sample mean.

Of the nine cluster groups identified, the first four groups (47% of the sample) reflected desirable clusters with scores ranging from average to positive functional status. These groups were different in the dimensions, which defined the peaks of their profiles and in the size and location of these peaks. For example, members of Subgroup 1 were cognitively very fit, enjoyed a sociable and outgoing lifestyle, and were involved in a number of personal life projects. The other five groups exhibited, on average, a less desirable profile (53% of the sample). For example, participants in Subgroup 9 showed a generally negative profile with severe cognitive impairment, high neuroticism and loneliness, and low extraversion and internal control. Different profiles within the categories can be interpreted to reflect different strategies and mechanisms of successful and less successful aging (e.g., life styles).

### 2. 1. 2 External Criteria Used to Link the Subgroups to Theory

A key objective within lifespan psychology is to understand the construction of heterogeneity of functioning and the consequences of heterogeneity for further differential development. To this end, Smith and Baltes study (1997) selected a set of cross-disciplinary measures broadly signifying past and current life contexts and reflecting different constellations of age-graded, history-graded, and idiosyncratic influences on development (P. B. Baltes & Nesselrode, 1984). These measures can be interpreted to have acted as potential predictors, correlates, or consequences of differential aging as manifested in subgroup differences. Specifically, three sets of measures were selected: (1) Demographic characteristics including age and gender, (2) measures of physical functioning and life history, and (3) subjective well-being and longevity to represent outcomes of successful aging. Due to the cross-disciplinary design of that work, causal directions could not be examined in more detail.

First, lifespan scripts about development suggest to consider different phases of old age (see Section 1.2.3) and various life course sociological theories propose that gender-related differences in objective life conditions and life history have enduring and far-reaching consequences for functional profiles in old age (e.g., Elder, 1998; Moen, 1996). For example, the opportunity structures for current cohorts of older women have been constrained by lower education and less chances for financial prosperity and empirical evidence indicates that these structural disadvantages have negative effects on the everyday life of older women (Mayer, Maas, & Wagner, 1999; Troll, 1994; Smith & Baltes, 1998; Verbrugge, 1990).

Second, to represent biological and contextual factors that act within the different classes of influence proposed by lifespan contextualism (P. B. Baltes et al., 1980), measures

of sensory functioning, absence of severe illnesses, and life-history factors (years of education) were selected. In terms of biological factors, for example, objective health conditions such as moderate or severe chronic illnesses constitute a major constraint for life in old age and a risk factor for decline in psychological variables (Bäckman, Small, Wahlin, & Larsson, 2000; Verhaeghen, Borchelt, & Smith, 2003). In terms of life-history factors, for example, educational status may be linked to a number of factors that exert a positive influence on cognitive functioning such as neuronal growth during critical periods in life, cognitive stimulation, physical health, and the use of memory strategies (Schaie, 1996).

Third, subjective well-being and three-year survival were selected as key outcomes of successful aging. Well-being involves affective components such as happiness and perceived stress as well as cognitive components such as purpose in life and a general evaluation of people's lives (Diener, Suh, Lucas, & Smith, 1999). Despite proposals about considerable stability of well-being over time (stability-despite-loss paradox: Brandtstädter & Greve, 1994; Filipp, 1996), evidence indicates that well-being is a sensitive indicator of adaptation to age-associated changes, particularly in advanced old age (Kunzmann, Little, & Smith, 2000; Mroczek & Spiro, 2001). With regard to survival, function-oriented research suggest a number of psychosocial factors to relate to mortality: Cognition (e.g., Bosworth, Schaie, & Willis, 1999; Maier & Smith, 1999; Small & Bäckman, 1999; White & Cunningham, 1988), personality characteristics such as absence of neuroticism (Wilson et al., 2003), and social integration (for review, see House, Landis, & Umberson, 1988; Schwarzer & Leppin, 1991). However, only very few research projects have gone beyond using mean level information from single constructs to predict survival (e.g., short-term variability in control beliefs: Eizenman, Nesselrode, Featherman, & Rowe, 1997).

What were the central findings about the correlates of heterogeneity reported by Smith and Baltes (1997)? The subgroups were found to show meaningful relations to demographic characteristics, measures of physical functioning and life history, and successful aging outcomes. With regard to the Third Age-Fourth Age separation, the relative risk of a less desirable profile was 2.5 times higher for participants older than age 85 than for people between the ages of 70–84 years. For example, 84% of the members in Subgroup 9 were older than age 85 ( $n = 27$  out of  $n = 32$ ), whereas the ratio was only 10% among Subgroup 1 members ( $n = 5$  out of  $n = 50$ ). Despite substantive variability (e.g., none of the groups exclusively contained the young old or the oldest old), this pattern suggests that particularly at the ex-

treme ends of the functioning rank-order, the effects of chronological age are strongest, be it as protective factor for the young old or as risk factor for the oldest old.

With regard to gender, the relative risk of a less desirable profile was 1.25 times higher for women than for men suggesting that different life circumstances for men and women (in old age) have critical implications for late-life adjustment. In addition, subgroup differences on measures of physical functioning, education, well-being, and three-year survival essentially paralleled those found on the psychological profiles, which suggests systemic processes at work. For example, members of the psychologically best-functioning Subgroup 1 were also in the best health, had most years of education and the best sensory functioning.<sup>8</sup>

The present dissertation study extends the above cross-sectional study of differential aging from a broad and systemic perspective into a longitudinal context. The following sections present in some detail the rationale underlying the present dissertation study, some methodological issues to be considered in the context of this extension, and the specific research questions investigated. Special attention is paid to the implications that arise from this previous work and from lifespan scripts about differential developmental over time.

## **2.2 Rationale for the Present Study**

The present dissertation study uses a systemic-wholistic approach (e.g., Magnusson, 1996) to study differential development in old age. Research questions about differential development are derived from lifespan scripts about the contexts of developmental change at the macro-level, the evolutionary and ontogenetic foundations of change, and the complex nature of these changes (for overview, see P. B. Baltes et al., 1998). Previous cross-sectional work from a systemic-wholistic perspective in the Berlin Aging Study (Smith & Baltes, 1997) is extended into a longitudinal context. The three objectives, which were used to organize research on differential development are addressed in the present study: Identification and description of heterogeneity and its correlates, examination of differential development over time and its underlying mechanisms, and investigation of potential outcomes of differential development (see Section 1.2.3). In this way, this dissertation focuses on differences in profiles of psychological functioning, long-term changes therein as well as the underlying mechanisms and outcomes. Among the questions asked are the following: Can subgroups be

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<sup>8</sup> Cluster analyzing 23 cross-disciplinary variables that covered the domains of psychological functioning, life conditions, and health revealed similar results. The 11 groups found substantively differed from each other, and women were over-represented in less desirable subgroups (e.g., depressive, lonely, frail, and cognitively impaired; Mayer, Baltes et al., 1999; Smith & Baltes, 1998).



identified in a sample of old age individuals? Do the subgroups differ as a function of age-graded, history-graded, and idiosyncratic factors (e.g., what is their contribution)? Do subgroups change differentially over time? How is differential development linked to outcomes of successful aging such as well-being and longevity?

The systemic-wholistic perspective on issues of differential patterns of change appears to constitute a fertile tool to shed some light on specific aspects of the broad concept of differential development in old age. Because the state of the field of aging is less strong as compared to earlier phases of life regarding the explanatory mechanisms of differential development (e.g., developmental psychopathology: Cicchetti & Cohen, 1995), the present study leans towards the descriptive identification of the general existence and potential fertility of the differential profile approach. It opens a conceptual and methodological door at a high level of aggregation rather than testing highly specific hypotheses.

The present study is unique in several ways. A first unique aspect of the present dissertation is that it combines a systemic-wholistic approach with a lifespan perspective on differential development to examine longitudinal data. Longitudinal observations from the 3-wave sample of the Berlin Aging Study provide a window on change in old age over a period of six years.<sup>9</sup> Longitudinal investigations from a person-oriented perspective are rare and typically restricted to epidemiological survey data (e.g., Manton & Land, 2000). In contrast, data from BASE provides the advantage that multiple domains of functioning were thoroughly and intensively assessed in a sample of persons in old and advanced old age. The initial cross-sectional evidence provided by Smith and Baltes (1997) suggests that a systemic-wholistic perspective on functioning in old age offers insights into lifespan proposals about heterogeneity and differential development in old age. Cross-sectional differences between individuals and subgroups, for example, can be interpreted as reflecting the conjoint outcomes of biogenetics of aging and different lifestyles and pathways *into* old age. Adding a longitudinal perspective to this earlier work allows questions about change over time to be examined that may reveal insights into whether these (groups of) individuals continue to age differently *during* old age (Aldwin et al., 2001; Liang et al., 2003; Smith, 2003a).

A second unique aspect of the present dissertation study is the consideration of differential patterns of change in the transition phase between the Third Age and the Fourth Age (P. B. Baltes, 1997; Laslett, 1991; Neugarten, 1974). Lifespan scripts about the incomplete architecture of the life course (P. B. Baltes et al., 1998) as well as empirical findings (Crim-

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<sup>9</sup> The 6-year longitudinal BASE sample was measured three times. In the following, the terms 6-year longitudinal BASE sample and 3-wave longitudinal BASE sample are used interchangeably.

mins et al., 1996; Jorm et al., 1998; Suzman, Manton et al., 1992) suggest that the causal system of aging in the Fourth Age is altered. As a consequence of the incomplete biocultural orchestration of the life course, individuals in the Fourth Age can be expected to be more vulnerable to functional decline, and losses are more pronounced, cross-dimensional, and less modifiable than in earlier phases of life. In this vein, notions about qualitative transitions in old age such as the classic threshold hypothesis (Birren, 1959) can be considered as one instantiation of different life phases and associated differences in aging processes.<sup>10</sup>

A third unique aspect about the present dissertation study is that the functional status of the cross-disciplinary factors selected by Smith and Baltes (1997) can be examined more thoroughly: Did these factors act as antecedents, correlates, or consequences of differential development in old age as manifested in subgroup differences in psychological profiles and change over time? The questions addressed are derived from lifespan scripts about developmental contextualism and the incomplete lifespan architecture (P. B. Baltes et al., 1998) as well as from the successful aging literature (P. B. Baltes & Baltes, 1990; Rowe & Kahn, 1997; Ryff & Singer, 1998). For example, are age-graded biological factors more important than environmental factors in accounting for variation in change trajectories over time? Is heterogeneity in psychological profiles and change over time linked to central outcomes of successful aging that were examined several years later? In contrast to most of the previous literature, information based on profiles of functioning rather than mean-level status on single measures is used to answer these questions.

In sum, the objective of this study is to find some answers to key questions about differential development in old age by continuing earlier systemic-wholistic work from the Berlin Aging Study. Demonstrating that the subgroups identified relate to cross-disciplinary factors that may causally be linked to their profile differences and examining questions about subgroup differences in stability and change over time adds to the credibility of the approach chosen.

The earlier work offers a solid starting point for this endeavor, but also constraints the present study to some extent. These constraints primarily relate to the fact that the subgroup-defining procedure as well as the subgroup-defining measures are determined by the Smith and Baltes study (1997). To assure comparability of the present dissertation to this previous

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<sup>10</sup> So far, evidence for discontinuous development in old age primarily comes from research on pathological processes such as accelerated aging trajectories among persons suffering from dementia or mild cognitive impairment (for review, see Bäckman et al., 2000). For example, Hall and colleagues (2001) demonstrated that participants who subsequently developed dementia showed accelerated decline on memory much earlier than accelerated decline on measures of perceptual speed.

work hence precludes using a different approach to define the subgroups (e.g., top-down approaches) or selecting a different set of subgroup-defining measures (e.g., cross-disciplinary variables).

The present extension to longitudinal data involves additional consideration of methodological issues such as differential sample attrition and longitudinal design issues related to the Berlin Aging Study (e.g., time in study, number of occasions). Such issues also have to be taken into account in the examination of questions about differential development in old age. Because of this, these methodological issues are also central to this dissertation and are reviewed in the next sections in more detail.

### **2.3 Methodological Considerations**

The ensuing section addresses methodological issues that can be expected to play a major role in whether or not researchers are sufficiently equipped to determine individual and subgroups differences in change over time in old age. Studying old age provides a context to explicitly address some of the methodological difficulties and open questions associated with research on heterogeneity. Specifically, issues of differential sample attrition and the design of longitudinal data collection play a strong role in research on old age and are perhaps more critical in the interpretation of findings than is the case in research on earlier life phases. Before considering these issues, a brief introduction into the method of cluster analysis is provided.

#### **2.3.1 A Brief Introduction to Cluster Analysis**

In analogy to the Smith and Baltes study (1997), the present study uses cluster analysis as a statistical method to identify subgroups of individuals in a given data set. There are a number of different methods available, which allow researchers to preserve the theoretical notion that each individual configuration in the variables of interest is unique. Cluster analysis is among the most prominent of such methods. Cluster analysis groups individuals into homogeneous subgroups, in which members of one group show similar patterns of scores across the variables selected, but differ from members of other groups (Gustafson & Magnusson, 1991; Nesselroade & Ghisletta, 2000). More specifically, this technique allows the identification of groups of individuals by using information about individual communalities and differences in profile elevation (overall level), dispersion (degree of variability of the ele-

ments around the profile average), and shape (pattern of high and low scores across elements in a profile; Green, 1990).

Several reasons have been repeatedly put forward for the usefulness of cluster analysis (for review, see Hair & Black, 2000). First, the person-oriented and multidimensional approach of cluster analysis is a statistical method of taxonomy or classification that can be used to name, number, and sort persons based on shared characteristics, and so to organize, structure, and summarize the heterogeneity in the data. Second, by using cluster analysis, the variety of dimensions examined are allowed to contribute uniquely and equally to the grouping of individuals. Cluster analysis can be regarded an ‘unbiased’ method that groups individuals based on similarities across a range of (psychological) variables.

Some notes of caution have been raised in the literature regarding the appropriate use of cluster analysis. First, groups identified by cluster analysis may not be unique because the cluster algorithm always generates subgroups irrespective of the ‘true’ existence of any structure in the data (Hair & Black, 2000). Given this, the question that remains to be answered is how meaningful and useful the subgroups in fact are. To demonstrate the significance of the subgroups, many researchers opt for external criteria that were not used in defining the subgroups. For example, Maxson et al. (1996) determined the predictive validity of their subgroups for outcomes of successful aging (e.g., dementia incidence, survival; see Section 1.3.4 for Table 1). An additional, but so far rarely applied strategy in the literature involves showing the integrity and stability of the subgroups over time (e.g., in terms of membership). This strategy, of course, requires the availability of longitudinal data.

A second concern relates to the fact that cluster analysis is not a statistical technique of inference. That is, cluster analysis quantifies the structural characteristics in a given data set, but it does not allow the researcher to examine the degree to which sample parameters represent population parameters (Hair & Black, 2000). Accordingly, statistical assumptions required in applying other multivariate techniques (e.g., multivariate normality, linearity) play a minor role as opposed to two other central issues: Sample representativeness and multicollinearity. Previous analyses from BASE demonstrated that the total cross-sectional sample was locally representative for the population of Berlin/West (Lindenberger et al., 1999). This constitutes one central argument why the subgroups extracted from the 6-year longitudinal BASE sample, which is used in the present study, are embedded into those previously identified in the total cross-sectional BASE sample (Smith & Baltes, 1997). This is even more

important when one considers the positive selection of the different longitudinal BASE samples.

Multicollinearity among the constructs entered into the analyses represents a third concern. This might obscure or distort cluster solutions because cluster analysis assigns the same relative weight to each clustering variable. The entry of highly correlated variables into the analyses inadvertently weights the generation of clusters in favor of these dimensions. Although distance measures are available that adjust for multicollinearity (e.g., factor scores based on Mahalanobis distance), the use of such corrections has also been cautioned. To begin with, it is unclear how many similar (i.e., highly correlated) measures would be needed to disrupt an optimal cluster solution (Milligan & Cooper, 1987). Furthermore, if the indicators of one domain are more similar than those of another domain, the costs and benefits of including similar indicators should be counterbalanced against the concern that an unequal number of indicators for the different domains may also lead to ambiguous results. Deriving cluster solutions from factor scores may protect against multicollinearity, but may also result in a poor representation of the structure in the data because truly discriminating variables may not be well represented by those factor scores (see Hair & Black, 2000). Multicollinearity thus requires a careful consideration of intercorrelations among the subgroup-defining measures.

A fourth concern is one that cluster analysis shares with factor analysis, namely the caution of many researchers that its application is much more of an art than a science (Aldenderfer & Blashfield, 1984; Hair & Black, 2000). In analogy to factor analysis, many steps in the cluster analytical procedure require subjective decisions. This begins with decisions regarding the number and scope of variables to include in the analysis and extends to decisions about the interpretation of extracted subgroups. For example, the subgroups identified depend upon the clustering variables selected and minimal alterations through adding or deleting single variables may lead to more or less substantially different subgroups. The most critical difference between cluster analysis and factor analysis is that cluster analysis attempts to provide structure and dimensions to persons rather than to variables. As opposed to other multivariate techniques, cluster analysis also does not estimate the variables empirically, but compares persons based on the variables specified by the researcher.

Despite these methodological concerns, cluster analysis is a powerful tool that has the potential to detect non-linear structures within a given data set that might not be detected using other statistical means (e.g., in a linear-relationships framework; Hair & Black, 2000).

The current methodological literature recommends a sequential combination of hierarchical methods (e.g., Ward, 1963) and non-hierarchical methods (e.g., *k*-means) to be the ‘gold standard’ in applying cluster analysis (Hair & Black, 2000; Milligan & Cooper, 1987; SAS, 1997). Such procedure assures that the limitations of one approach can be compensated by the strengths of the other approach. For example, hierarchical methods are sensitive to early random combinations of observations, (multivariate) outliers, and irrelevant variables, whereas non-hierarchical methods usually reveal optimal cluster solutions only in case of pre-specified (i.e., non-random) seed points. Consequently, hierarchical methods such as Ward’s method (1963) are used to evaluate the optimal number of clusters in a given data set and to produce the initial seed points for the subsequent non-hierarchical methods such as *k*-means, which determine the final case location in the separate subgroups. Hence, the present study opted for the 2-step procedure to identify subgroups of individuals at baseline assessment of the 6-year longitudinal BASE sample.

### 2.3.2 Sample Selection and Differential Attrition Over Time

Sample selection and attrition refer to the fact that in most studies not all individuals asked to participate agree to do so (Riegel, Riegel, & Meyer, 1967; Hertzog & Nesselroade, 2003). Although selection effects were found in comparisons between the total cross-sectional sample in BASE ( $n = 516$ ) and all individuals who were eligible for participation ( $n = 1908$ ), these effects were of relatively minor size (0.5 *SD* at maximum) and still allowed the total sample to be characterized as locally representative (Lindenberger et al., 1999). However, this picture has changed longitudinally. Several articles have demonstrated that (a) the longitudinal samples of BASE are positively selected across a number of different factors, (b) mortality-associated attrition was much stronger than experimental attrition, and (c) mortality-associated attrition increased with age (4-year sample: Lindenberger et al., 2002; six-year sample: T. Singer et al., 2003; eight-year sample: Smith & Delius, 2003).<sup>11</sup>

Nonrandom sample attrition could magnify or diminish observations of heterogeneity and differential development in old age. Hence, researchers have to take into account implications that arise from differential sample attrition. There is a substantive body of literature on the issue (for reviews, see P. B. Baltes, Reese, & Nesselroade, 1977; Rabbitt et al., 2004),

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<sup>11</sup> Mortality-associated attrition refers to differences between individuals who survived and those who died and as such reflects a (natural) population process that usually does not compromise the validity of observations. Experimental attrition, in contrast, relates to differences among individuals who survived: Study participants versus those who declined participation due to unwillingness or incapability. Such attrition processes result in a nonrandom subsample of the surviving population, which limits generalization of research findings.

primarily in the context of function- or variable oriented research. A systemic-wholistic perspective suggests additional questions about attrition effects at the person-oriented level. At the level of the subgroups, for example, it can be determined to what extent less desirable subgroups from the total BASE sample (Smith & Baltes, 1997) were more vulnerable to drop out over time than were desirable profile subgroups. At the level of the subgroup-defining measures, research on psychological factors that affect sample attrition has primarily focused on mean level and covariance differences in cognitive variables. From a systemic-wholistic perspective, attrition effects can be determined across multiple domains of psychological functioning including measures of personality and self-related functioning, and social integration. One further question relates to the effects of differential attrition on change trajectories over time. It appears reasonable to assume that functional decline is a risk factor for attrition and that the same amount of decline affects the initially disadvantaged more than the initially advantaged (e.g., cognitive capacity). Despite inconclusive results on this from variable-oriented research (Schaie, 1996; Sliwinski & Buschke 1999; Zelinski & Burnight, 1997), implications of differential attrition at the ‘person-level’ warrant caution in interpreting change trajectories found among select samples of surviving longitudinal study participants.

### 2. 3. 3 Longitudinal Study Design Issues

Characteristics of the study design play a major role in whether or not researchers are sufficiently equipped to examine questions about differential stability and change over time in old age. Two central characteristics in this regard are the *time in study* and the *number of occasions* over which change can be observed. Time in study refers to both the length of the time interval between occasions and the overall duration of a study. Issues of time and timing play a major role in lifespan development theory. Developmental processes are suggested to be multidirectional (P. B. Baltes, 1987; Birren & Cunningham, 1985; Busse, 1969; Schaie, 1996; Lehr & Thoma, 1987), which implies relative independence of the various developmental states and trajectories that characterize different domains of functioning. From this follows that different time schedules may be required to detect change at different levels of organization, within different domains of functioning as well as at different points in development (for discussion, see Lerner, 1986). Because little is known about the various ‘time schedules’ that underlie change in old age, it is an open question whether the BASE longitudinal design is appropriate to determine (differential) change over time.

In the present study, BASE data are available from three measurement occasions spread out over a study period of six years in total with a 4-year and a 2-year interval between the waves, respectively. In analogy to many longitudinal panel data, decisions about the number of occasions and the time intervals in-between were primarily based on practical and economic aspects such as funding rather than theoretical arguments. Given the age distribution of the sample (70 to 100 years), it is reasonable to assume that the available longitudinal data over six years is sufficient to detect intraindividual long-term changes and interindividual differences therein. This line of reasoning may particularly apply to oldest-old participants who can be expected to be at risk for functional decline at the end of life on measures that are relatively stable throughout most phases of the lifespan (Colsher & Wallace, 1991; Giambra, Arenberg, Zonderman, Kawas, & Costa, 1995; Smith & Baltes, 1997).

The above issues highlight the necessity of considering methodological aspects in studies aimed at gathering insights into individual and group differences in functional status and change over time in old age. This provides the background to the specific research questions and hypotheses to be tested in the present dissertation.

#### **2.4 Research Questions and Hypotheses of the Present Study**

The key objective of the current study is to apply a systemic-wholistic approach as a research tool to generate and test questions about heterogeneity of functioning in old age and differential development over time. To implement the systemic-wholistic approach, the present study examines subgroups of individuals, which are identified by cluster analysis of scores across multiple domains of psychological functioning: Cognition, personality and self-related functioning, and social integration. The cluster analytic technique ensures that members of the subgroups share communalities in their psychological profiles, but also that the subgroups differ from one another in their profiles.

The dissertation is embedded into theoretical notions about differential development in old age and its underlying mechanisms as suggested by lifespan scripts about developmental contextualism and co-constructivism (for overview, see P. B. Baltes et al., 1998), and successful versus less successful aging (P. B. Baltes & Baltes, 1990; Rowe & Kahn, 1997; Ryff & Singer, 1998). Based on these concepts, this dissertation asks questions about profiles of psychological functioning in old age, enduring changes in these profiles over time as well as about underlying mechanisms and outcomes. The prospect is that the systemic-wholistic perspective can be used as a tool to capture facets of differential development in old age and



thus complements variable-oriented approaches that are more function-, element-, and domain-specific.

The research questions and hypotheses of this study are structured around three objectives central to research on heterogeneity and differential development: (a) Identification and description of heterogeneity and its correlates, (b) examination of differential development and its underlying mechanisms, and (c) examination of outcomes of heterogeneity and differential development. In the following sections, these questions are outlined in more detail (for an overview, see Table 3). Because the interpretation of results from analyses aimed at investigating the above research questions is conditioned by methodological considerations, analyses in a preliminary step determine the effects of differential sample attrition in BASE over six years. In a preliminary step of data preparation, however, issues of differential sample attrition are to be considered.

*Effects of Differential Sample Attrition.* At the level of interindividual differences in functioning, substantial heterogeneity is expected in old age. This expectation is based on theoretical arguments such as lifespan scripts about the biological-environmental co-construction of the life course and the influence of age-graded, history-graded, and non-normative factors (P. B. Baltes et al., 1998; for discussion from a bio-medical perspective, see Finch, 1996; Olshansky et al., 2001) as well as on empirical findings (e.g., Lövdén, Bergman et al., submitted; Maxson et al., 1996). At the subgroup level, the foundational study for the present dissertation (Smith & Baltes, 1997) identified nine different profiles of psychological functioning in the cross-sectional BASE sample ( $N = 516$ ; see Section 2.1). These profiles reflected different cross-domain relationships and more and less desirable functioning.

The present study extends this previous work into a longitudinal context and is restricted to those BASE participants who were longitudinal survivors after six years, on average ( $n = 132$ ). Even though this sample size is smaller than that used previously and more select in terms of mortality, it is nevertheless expected that heterogeneity in functioning will prevail.

However, given sample attrition, it is expected that the range of heterogeneity will be reduced. From previous examinations of selectivity and attrition effects in BASE (e.g., Lindenberger et al., 2002; T. Singer et al., 2003; Smith & Delius, 2003; for reports of attrition effects in other large-scale longitudinal studies, see Cooney et al., 1988; Rabbitt et al., 2004; Siegler & Botwinick, 1979; Sliwinski & Buschke 1999; Zelinski & Burnight, 1997), it is

known that the 6-year longitudinal BASE sample reflected a positive selection of the total cross-sectional sample. They were younger, healthier, and, in general, functioning at higher levels in terms of cognition and well-being at baseline assessment. Investigating attrition effects apparent in this longitudinal sample from a systemic-wholistic perspective adds to previous selectivity results from BASE. In particular, attrition effects are examined at the subgroup level and across multiple domains of psychological functioning.

At the level of the subgroups, the positive selection of the longitudinal BASE sample leads to the expectation that attrition over time is stronger for the less desirable profile subgroups from the Smith and Baltes study (1997; subgroups 5 through 9) than for the desirable profile groups (subgroups 1 through 4). At the level of the subgroup-defining measures, it is expected that mean-level attrition effects are present in all three domains of psychological functioning (i.e., cognition, personality and self-related functioning, and social integration). In addition, it is predicted that the covariance structure (i.e., age correlations, construct inter-correlations) is more differentiated in the longitudinal BASE sample at baseline assessment as compared to the total cross-sectional sample. Acknowledging that chronological age plays a role in determining differences between continuers and non-continuers in longitudinal samples of older individuals (Lindenberger et al., 2002; McArdle, Hamagami, Elias, & Robbins, 2001; Rabbitt et al., 2004), adjustments for age are also considered. The research questions specified in the following are to some extent conditional upon the outcome of these attrition analyses carried out in a preliminary step of data preparation.

#### 2. 4. 1 Identification and Description of Heterogeneity and Its Correlates:

##### Subgroup Differences in Psychological Profiles and External Correlates at Baseline

If preliminary analyses of differential sample attrition in BASE reveal that heterogeneity is still present but reduced, then these differences in measurement space have important implications for the present dissertation study. One major implication relates to a comparison of profile similarities between subgroups extracted from the 6-year longitudinal BASE sample and those from the total BASE sample. Profile subgroups from the longitudinal sample will most likely represent various profiles of desirable psychological functioning rather than less desirable functioning ( $Q_{1a}$ ). In other words, the longitudinal sample is mainly restricted to different patterns of successful aging, at least at baseline assessment. Follow-up analyses will examine the range of heterogeneity of the subgroups. That is, the extent to which subgroups

extracted from the sample of longitudinal survivors are distinctly different from one another in their psychological profiles of functioning.

Having identified heterogeneous subgroups using psychological profile information, it is expected that the subgroups can be differentiated by a set of cross-disciplinary factors ( $Q_{1b}$ ). These factors signify past and current developmental contexts that may have acted as antecedents and correlates as suggested by lifespan scripts about the mechanisms underlying differential development (P. B. Baltes et al., 1998). The potential correlates examined were not part of the group-defining procedure and can thus be used to demonstrate the validity and meaningfulness of the subgroups. Two sets of cross-disciplinary measures are specifically examined, demographic characteristics as well as biological and environmental factors.

Expecting that subgroups can be differentiated by chronological age is based on theoretical arguments such as lifespan scripts about developmental co-constructivism (P. B. Baltes, 1997) and bio-medical notions (Finch, 1996; Olshansky et al., 2001; Verbrugge, 1990). Similarly, life course sociological theories (Elder, 1998; Moen, 1996; Troll, 1994) suggest age- and gender-related differences in life conditions and functional profiles in old age. In the total cross-sectional BASE sample, the relative risk of a less desirable profile was highest among the oldest old and among women (Smith & Baltes, 1997). The question is whether subgroups identified in the 6-year longitudinal BASE sample will reveal similar trends. For example, do individuals in the Fourth Age (i.e., the oldest old), despite their positive selection for survival, show a less desirable profile of psychological functioning?

With regard to potential biological and environmental correlates of subgroup differences, lifespan scripts about developmental co-constructivism (P. B. Baltes et al., 1980) as well as empirical evidence (e.g., Salthouse et al., 1996) suggest that psychological functioning in advanced old age is primarily dependent upon the integrity of biological and physical-functioning factors. At the same time, supportive environmental factors such as high standing on desirable life history dimensions result in higher levels of entry-into-old-age functions (Christensen & Hendersen, 1991; Gribbin, Schaie, & Parham, 1980) suggesting that both biological and environmental factors have played a major role in determining subgroup differences in psychological profiles. Based on this line of reasoning, it is expected that subgroup membership can be differentiated by age, gender, biological, and environmental factors.

#### 2. 4. 2 Differential Development Over Time and Its Underlying Mechanisms:

##### Subgroup Differences in Change of Psychological Profiles Over Six Years and the Role of External Correlates

A unique feature of the present study is the use of the systemic-wholistic approach to examine questions about differential development over time and its underlying mechanisms in old and advanced old age. In a first step, it is asked whether subgroups extracted from the 6-year longitudinal BASE sample show differential development of their psychological profiles over six years. To find answers to this general question, analyses are carried out at the level of the subgroups as well as at the level of the profile-defining measures. Such an approach allows to (a) capture the dynamic and multivariate nature of human development, (b) examine interindividual as well as intraindividual differences, and (c) investigate the heterogeneity of developmental processes (Lövdèn, Bergman et al., submitted). It is expected that the subgroups are relatively stable over time in terms of subgroup membership, but the subgroups show differential stability and decline in the profile-defining measures ( $Q_{2a}$ ). In a second step, mechanisms underlying differential development are explored. It is expected that subgroups with less functional psychological profiles are most at risk for functional decline and age, gender, and biological factors predict subgroup change over time ( $Q_{2b}$ ).

At the level of the subgroups, membership stability of the subgroups over time is examined to demonstrate that the subgroups are relatively stable and persistent over the period of observation. It has long been acknowledged that findings of group or category membership largely are state- or episode-dependent (e.g., Nesselroade, 1991). Manton and Land (2000), for example, reported that a large proportion of individuals after the age of 65 years transit in and out of several states of disability. Thus, it is reasonable to assume that some people move in and out of different states of psychological functioning whereas others maintain their level over time. Hence, the objective is to demonstrate that subgroup membership is not a mere momentary, but a reasonably stable phenomenon. In other words, the majority of persons who were grouped together at baseline assessment are expected to remain in their subgroups rather than being re-assigned to a different subgroup at later measurement occasions. To test this question, subgroups that were identified by separate cluster analyses on data at baseline assessment, at the second wave, and at the third wave are linked over time. In follow-up analyses, more specific information than typically used is considered. This includes the comparisons of the profiles revealed at every occasion as well as the examination of variables that

distinguish participants who remained in their subgroups over time from those who showed subgroup transition.

Depending on the outcomes, new questions can arise regarding longitudinal change at the level of the profile-defining measures. For instance, if it were so that the subgroups were shown to be stable over time, it is possible to use subgroup membership at baseline assessment to compare the direction and the amount of change over time between the subgroups on those measures that defined their psychological profiles at baseline assessment. Such an approach would present a classification of change at the meso-level (i.e., level between the groups as a whole and the single individuals). The objective is to demonstrate that the subgroups are characterized by non-linearity not only in terms of mean-level differences at baseline assessment, but also in terms of differential change patterns over time across the different profile-defining measures. This would illustrate the argument that individuals and subgroups who developed differently into old age also continue to develop differently throughout old age. To guard against regression artifacts (for overview, see Campbell & Kenny, 1999; Rogosa, 1995), three different sets of methods are utilized and findings compared with one another for convergence. On the basis of the above considerations, it is expected that the subgroups are relatively stable over time in terms of subgroup membership, but the subgroups show differential stability and decline in the profile-defining measures.

To explore potential mechanisms underlying subgroup differences in change over six years, two questions are asked. The first question was selected to explore ideas about qualitative transitions in advanced old age such as those proposed by the threshold hypothesis (Birren, 1959). The classic threshold notion states that reaching critically low limits of functioning in one domain may trigger decline in other functional domains. In line with this idea, it is expected that subgroups with less desirable/functional psychological profiles at baseline assessment are more vulnerable to decline over time than desirable profile subgroups.

The second question explores the role of external correlates for subgroup differences in change of psychological profiles over time. In line with lifespan scripts about the decreasing robustness and adaptivity of the system in advanced old age (P. B. Baltes et al., 1998; Shock, 1977) as well as cross-sectional empirical findings (Crimmins et al., 1996; Jorm et al., 1998; Smith & Baltes, 1997), it is examined whether age, gender, and biological factors play a major role in subgroup change over time. It is expected that the risk of unstable membership over time is greater for the oldest old than for the young old and for women as compared with men. In a similar vein, biological factors rather than environmental factors are hypothesized

to be linked with profile change over time. In sum, it is expected that age, gender, and biological factors predict subgroup change over time.

2. 4. 3 Outcomes of Heterogeneity and Differential Development Over Time:  
Consequences of Subgroup Differences in Psychological Profiles and  
Change Over Six Years

The last set of questions explicitly examines how heterogeneity of functioning and differential development in old age are linked to successful aging outcomes. Well-being is selected to represent one subjective outcome of successful aging and survival to represent one objective outcome. Well-being involves affective as well as cognitive components (Diener et al., 1999) and can be considered to signify a person's capacity to adapt to age-associated challenges (e.g., Caspi & Elder, 1986). Because the examination of survival differences has often been restricted to studying single functions (e.g., cognition: Small & Bäckman, 1999; social integration: House et al., 1988; Schwarzer & Leppin, 1991), a consideration of profile information might result in added information and predictive power. It is expected that subgroups with more functional psychological profiles report higher well-being over time than less desirable profile subgroups ( $Q_{3a}$ ). Similarly, subgroups with more functional psychological profiles are expected to live longer than less desirable profile subgroups ( $Q_{3b}$ ). The usefulness of a systemic-wholistic approach would be clear if profile information were demonstrated to be predictive of key successful aging outcomes over time, even after the effects of other powerful covariates such as dementia, sensory functioning, and multimorbidity have been partialled out. Based on proposals about the power of self-related resilience (Brandtstädter & Greve, 1994; Staudinger et al., 1995), the association between the subgroups and subjective well-being can be expected to be existent, but to be weaker than that for survival.

Table 3  
*Overview of Central Research Questions of the Present Study*

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**Identification and Description of Heterogeneity and Its Correlates:**

*Subgroup Differences in Psychological Profiles and External Correlates at Baseline*

- Q<sub>1a</sub> Because of differential sample attrition, subgroups identified in the 6-year longitudinal BASE sample are expected to primarily represent various profiles of desirable psychological functioning rather than less desirable functioning.
- Q<sub>1b</sub> At baseline, subgroup membership is expected to be differentiated by age, gender, biological, and environmental factors.

**Differential Development Over Time and its Underlying Mechanisms:**

*Subgroup Differences in Change of Psychological Profiles Over Six Years and the Role of External Correlates*

- Q<sub>2a</sub> Relative stability in subgroup membership over time is expected, but the subgroups show differential stability and decline in the profile-defining measures.
- Q<sub>2b</sub> Over time, subgroups with less functional/desirable psychological profiles are expected to be most at risk for functional decline. In addition, age, gender, and biological factors are expected to predict subgroup change over time.

**Outcomes of Heterogeneity and Differential Development Over Time:**

*Consequences of Subgroup Differences in Psychological Profiles and Change Over Six Years*

- Q<sub>3a</sub> Subgroups with more functional/desirable psychological profiles are expected to report higher well-being over time than less desirable profile subgroups.
- Q<sub>3b</sub> Subgroups with more functional/desirable psychological profiles are expected to live longer than less desirable profile subgroups.
-

