Handbook of the CLINICAL PSYCHOLOGY OF AGEING

SECOND EDITION

Editors
ROBERT WOODS
AND
LINDA CLARE

Handbook of the Clinical Psychology of Ageing

Second Edition

Edited by

Bob Woods and Linda Clare
University of Wales Bangor, UK

2008
WILEY
John Wiley & Sons, Ltd

3

Memory and cognition in ageing

Boo Johansson
Göteborg University, Göteborg, Sweden

INTRODUCTION

Memory and other cognitive abilities are often the focus of a clinical psychological assessment of older adults. Older people may experience changes in these abilities and family members may observe a compromised cognitive capacity that affects coping with everyday life demands. Although we perhaps tend to accept that memory and thinking abilities become worse with age, we all hope that we will experience good enough memory and cognition to be able to cope with our daily lives and maintain our preferred interests and activities. Whereas different types of dementia produce substantial change, we may ask ourselves whether self-experienced and observed changes represent significant changes within the 'range of normal ageing' or whether experienced or observed decline is indeed indicative of neuropsychological changes in early stages of dementia or other health-related conditions that produce compromised memory and cognition. The question that typically emerges is: 'What should I expect of memory and cognition in later life?' The same question is, in fact, often asked by the clinical psychologist working with older people in a professional clinical assessment.

Understanding is therefore needed of age-related changes in the complex higher order brain processes, which are involved in how we remember and use various types of acquired information in problem solving, decision making, communication and other activities that require reflection and coping with internal and external demands. An objective assessment of memory and cognitive functioning requires clinical expertise directed by evidence-based theoretical guidelines in the composition of a valid test battery, in the evaluation of testing outcomes and in the gathering of supplementary information by interview of older people themselves and potential informants. The clinical psychologist needs to consider strengths as well as weaknesses, in memory and cognitive abilities, current performance relative to previous functioning and the cognitive demands imposed in everyday life (see Green, 2000; Johansson & Wahlin, 1998).

This chapter provides a brief overview of both continuity and age-related changes in memory and cognitive functioning, including integrated theoretical models that guide

Handbook of the Clinical Psychology of Ageing.
Edited by Bob Woods and Linda Clare.

clinical psychology with older people. For more detailed information on current cognitive ageing research including the neurobiological and psychosocial context of cognitive functioning, the reader is directed to recent articles in scientific journals, textbooks (e.g. Craik & Salthouse, 2000; Dixon, Bäckman & Nilsson, 2004; Hofer & Alwin, in press; Park, 2000) and to chapters in the *Handbook of the Psychology of Aging* series edited by Birren and Schaie.

COGNITIVE CHANGE AND CONTINUITY – A LIFESPAN DEVELOPMENTAL MODEL

Age-related differences and changes in memory and other cognitive abilities should be considered in the context of a lifespan developmental model. Baltes and Nesselroade (1979) identify three major sources of influences that characterize the dynamic interaction between the individual and the context: normative age-graded influences, normative history-graded influences, and non-normative life events. The relationship between these influences is in a continuous state of change because of their continuous interaction.

Normative Age-graded Influences

Normative age-graded influences refer to biological ageing as well as to influences imposed from the external environment that are highly correlated with chronological age – for example, puberty, menopause or retirement. These influences means that we can expect a largely similar pattern of change among individuals with the same age exposed to the same environment – the same basic education, socioeconomic status, occupation, and standard of living.

Cross-sectional studies based on age differences typically provide a pattern confirming the public view of ageing as reflecting general decline in most cognitive abilities (see for example data from Schaie, 2005, demonstrating age differences in various cognitive abilities from age 25 to 81). However, data indicate that certain abilities seem to be less associated with chronological age. The finding of this 'classical ageing pattern' (Botwinick, 1978) of 'hold' versus 'not-hold' tests provided support for the broad distinction between fluid and crystallized abilities (Horn, 1982), a distinction assumed to reflect two developmental trends. Fluid abilities (Gf) were ascribed to cognitive processes involved in identifying complex relations among stimulus patterns and the drawing of inferences on the basis of comprehension of more complex relationships. Tests of logical reasoning, figural, and spatial relations are typically used to measure fluid ability. Crystallized abilities (Cc) refer to the lifelong cumulative product of information acquired mainly through interactions with the environment. These experience-based abilities include tests of vocabulary, general world knowledge and comprehension. Interestingly, the distinction leads to expectations of preserved function, or even improvements with age, in crystallized abilities.

In contrast to data from cross-sectional studies, longitudinal findings on memory and cognitive performance typically tend to demonstrate less negative age effects. In the same way as in a clinical assessment, the individual acts as his or her own control in these studies. The origin of intra-individual change is sought within the historical context of

the individual and in the unique mix of exposures across the lifespan; the origin may be sociocultural or refer to primary biological ageing processes that decrease the overall integrity of the nervous system and reserve capacity of older adults. Although selective survival and other factors causing attrition, the loss of participants at follow-up assessments, may bias the results of longitudinal studies, the longitudinal design represents the best available approach for developmental studies. Such studies allow intra-individual changes to be observed and disentangled from differences between individuals in trajectories of change (Hofer & Sliwinski, 2006).

Normative History-graded Influences

Normative history-graded influences refer to influences that are correlated with historical time and experienced in a similar way by most members of a birth cohort in a certain culture. History-graded influences become manifest in cohort and period effects. The historical context imprints individuals in a certain manner and forms cohorts and generations that share experiences and values that differ from previous and later cohorts and generations. For example, years of basic education and the historical introduction and use of technologies like the computer differ across cohorts and generations in the same way as experiences of epidemics and war are likely to affect members of a certain culture in a similar way. In an assessment context the clinical psychologist needs to consider whether available norms are cohort-adjusted to permit an accurate evaluation of performance across ages.

In a comparison of population-based samples of 70-year-old individuals born at various times it was found that later cohorts generally demonstrate better performance than earlier birth cohorts (Steen, Berg & Steen, 1998). Table 3.1 demonstrates these cohort effects, which may well be present in clinical psychological assessment of older people.

Although positive cohort effects might be the general expectation, for certain abilities we may expect the opposite due to less exposure and training in certain mental activities; for instance, later cohorts may perform worse at numerical calculations because today we largely rely on electronic calculators or other technical devices even for simple computations. For example, in the Seattle Study it was convincingly shown that this ability was worse in later birth cohorts (Schaie, 2005).

Findings of cohort differences provide clear evidence that memory and cognitive abilities are influenced by the experiences we gain over the life course as well as by the way in which various cognitive abilities are used, reinforced, and valued. Besides education, which is highly associated with generation and cohort, overall health is typically better in later cohorts, manifested also in an increasing life expectancy at the population level. One important lesson to be learned from cohort differences, sometimes referred to as the 'Flynn-effect' (Flynn, 1987), is that reference values and norms for cognitive tests need to be continuously updated to be valid for the normative age-related change of a certain birth cohort.

Non-normative Influences

Non-normative influences demonstrate weak associations with chronological age and refer to the events and exposures which affect certain, but not all, individuals. These might include

Table 3.1 A comparison between 70-year-old men and women born 1906–7 and 1922, respectively. Mean performance for each group. Adapted from Steen *et al.* (1998)

	Women		Men	
Cognitive test	1906/07	1922	1906/07	1922
Mental speed				
Perceptual speed (Ps^{if} test)	19.6	23.2	18.5	20.7
Verbal ability				
Synonyms (SRB 1)	18.1	20.9	19.1	21.1
Reasoning				
Figure logic (SRB 2)	13.8	15.2	14.1	16.5
Spatial ability				
Block design (SRB 3)	14.6	17.7	16.6	18.3
Primary/working memory				
Digit span forward	5.4	5.8	5.5	6.1
Digit span backward	4.1	4.3	4.2	4.3
Long-term memory – episodic				
Thurstone's picture recognition	18.9	21.3	18.3	20.1

traumatic life events, physical disease and disability, and dementia. From a lifespan developmental perspective, normative age-graded influences are likely to be more pronounced early in life due to biological maturity and in later life due to primary ageing changes – 'normal ageing'– that affect all of us to some extent, although with different magnitude at various ages. Non-normative life events are perhaps more significant in midlife i.e. during the period between maturity and ageing where biological changes are relatively less pronounced. The lifespan model largely suggests an increase of inter-individual differences across the lifespan. In the context of a clinical psychology assessment this means that multiple influences, besides primary ageing, always need to be considered in the evaluation of everyday life performance as well as of the outcomes of formal testing. A chronological time structure often assumes that development and ageing produce invariant trajectories. However, the passage of time is only one differential variable to consider, although it may be seen as the 'elephant in the room', dwarfing all other factors in its apparent explanatory power (Brayne, 2007). Other types of ageing effects are often more important and informative in the clinical psychology of late life.

TYPES OF AGEING AND COGNITIVE OUTCOMES

The cascade model proposed by Birren and Cunningham (1985) (see Figure 3.1) represents a useful model, relevant for a clinical psychology assessment of memory and cognitive abilities in older people. The model is based on a separation of primary, secondary and tertiary ageing effects. Primary ageing refers to the irreversible maturation changes characterizing the normal ageing trajectory, produced by intrinsic sources. Secondary ageing

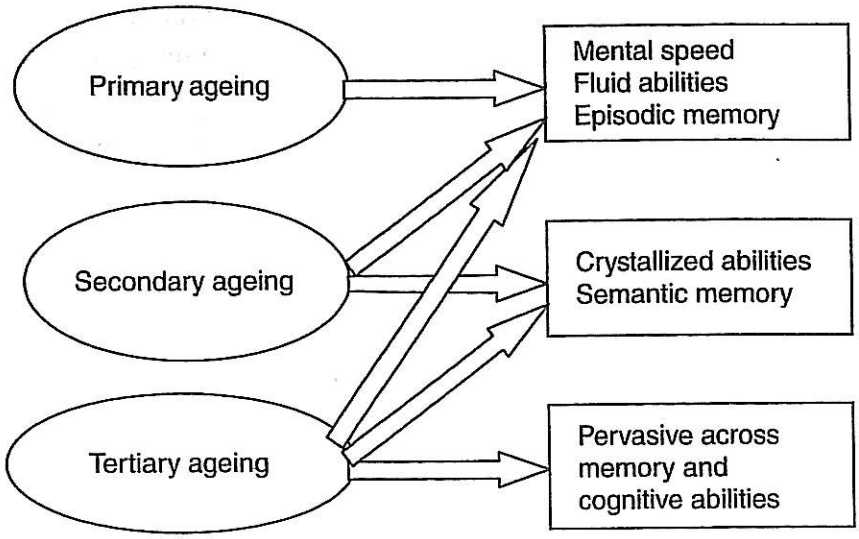

Figure 3.1 Types of ageing and cognitive outcomes. The modified cascade model (adapted from Birren & Cunningham, 1985).

refers to changes due to illnesses or pathology, on top of inevitable changes accompanying primary ageing. Tertiary ageing refers to decremental influences, including subclinical disease processes, which elevate the risk of mortality and produce a decline in memory and cognitive abilities. This decline may become manifest some years before death and is therefore referred to as terminal change, and more specifically as terminal decline in the case of the linear decline observed at the population level and terminal drop for the curvilinear decline pattern observed in single individuals (see Berg, 1996; Bosworth & Siegler, 2002).

The three types of ageing are unfortunately impossible to fully disentangle in a clinical assessment. Not only does the critical issue of 'normality' become more problematic with age but a full evaluation according to the model also includes longitudinal follow-ups until the death of the individual; the identification of terminal change requires a retrospective analysis based on information about performance level and change across occasions relative to time of death. In a clinical assessment, however, the psychologist typically needs to conclude whether the person's functioning is to be seen as impaired or whether the person's overall functioning may be considered as relatively normal – within the range of 'normal ageing'. In this sense the model directs attention to major categories of influence on memory and cognition, including overall vitality, indexed by health status and the likelihood of subsequent survival.

Primary Ageing

Primary ageing is principally produced by inevitable age-related changes – changes associated with chronological age or distance from birth. Primary ageing effects on cognition are basically observed in the decline of mental speed. This slowing may in turn affect other cognitive processes where speed of behaviour is an essential component, for example in problem solving and executive functioning (see Hartley, 2006). Primary ageing effects are also observed in working memory, episodic memory and in fluid abilities. In most tests,

time limits are more disadvantageous for older people. The likelihood of primary ageing effects occurring in isolation, empirically defined as lack of manifest or subclinical illnesses, decreases substantially with age.

Secondary Ageing

Secondary ageing or disease-related ageing becomes significantly more important with age. For example, in a population-based sample of individuals aged 80 and older, only five individuals (0.7%) among 702 were found with no evidence of any diagnosis from medical records, self-reports or use of medications. The mean number of diagnoses in this sample was 6.7 (range 0–18). Notably, less than 10% had two or fewer diagnoses (Nilsson *et al.*, 2002).

Numerous studies have shown that specific diseases and comorbidity may affect memory and cognitive abilities. For example, comorbid hypertension and diabetes produced more pronounced decline in the above sample compared with those who had hypertension or diabetes alone (Hassing *et al.*, 2004). Recent studies on memory and cognitive ageing tend to include aspects of physical health as covariates in analysing performance. In the clinical setting, the clinical psychologist should always consider the potential effects of specific diseases and of overall health status in evaluating test performance, in the same way as more obvious impairments in sensory and motor functioning would be considered. The distinction between primary ageing effects and pathology, however, becomes increasingly difficult with age. Besides the substantial prevalence of comorbidities, multiple coexisting conditions, the symptoms of diseases may change and often tend to be become more diffuse in later life. In addition, any particular disease is often accompanied by specific treatments, which may have potential side effects on memory and cognitive functioning, as seen, for example, with psychotropic medications (see Berg & Dellasega, 1996; Gray, Lai & Larson, 1999; O'Keeffe & Moore, 1999).

The detection of cognitive deficits in a clinical psychology assessment is likely to be indicative of early disease processes (secondary ageing), whether reflecting early stage dementia or other diseases affecting neuropsychological functioning. Dementia represents a diagnostic category of particular relevance and demonstrates the principal difficulty in distinguishing between primary and secondary ageing, especially in the early stages of the disease. The insidious onset of diseases like Alzheimer's presents a special diagnostic challenge as well as a problem in the interpretation of research findings. There is current intense research interest in understanding the mild cognitive impairment (MCI) complex (Winblad, *et al.*, 2004) and in distinguishing individuals who will subsequently develop dementia from those who will remain nondemented, although perhaps at a low-performance level. This concern is shared by the clinical psychologist who identifies compromised memory and cognitive functioning in an older person, not fully meeting ICD or DSM-criteria for dementia (e.g. Artero & Ritchie, 2003). The diagnostic criteria for dementia emphasize the centrality of cognitive changes and therefore it is clinically diagnosed on the basis of certain patterns of memory and cognitive impairments, supplemented with an examination of health status that may rule out other origins for compromised function.

The dementias have increasingly become a major public health concern in all countries with a greying population, but especially for ageing persons themselves. The high prevalence

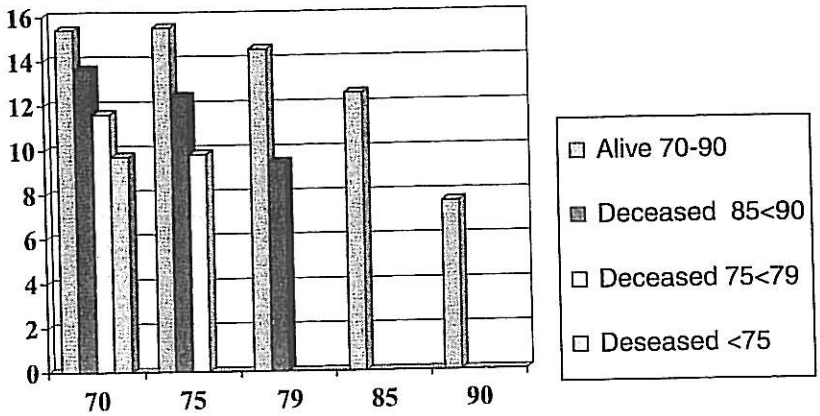

Figure 3.2 Test performance in the Block Design Test relative to subsequent survival (Author's own data from the H70 Study in Göteborg).

and incidence rates (Ferri, *et al.* 2005), coupled with personal experiences of dementia among friends and relatives and an increasing public awareness that dementia represents a disease entity that should be distinguished from 'normal ageing' are well understood and lead increasing numbers of older people to seek a professional assessment.

Tertiary Ageing

Tertiary ageing effects become more pronounced with age simply due to a greater likelihood of a shorter 'distance-from-death' period. Primary ageing and secondary ageing are often considered with reference to chronological age while tertiary ageing raises the more complex issue of the effects on memory and cognitive performance arising from the overall biological devitalization that typically occurs prior to death.

The original cross-sectional finding by Kleemeier (1962) of a relationship between performance levels and subsequent survival is largely supported by more recent longitudinal data (Bäckman & MacDonald, 2006; Bosworth & Siegler, 2002). Individuals who are closer to death typically perform worse on various tests of memory and cognition compared to those of the same age who survive for longer. Although this may seem obvious, as survival is closely related to overall health, subclinical neurobehavioral change may present long before clinical manifestations of disease (Hassing, 2002). Figure 3.2 shows a typical pattern of terminal change in which a population-based sample is separated into groups according to their subsequent survival. Individuals with a longer survival also show superior performance at previous time-points.

In a recent longitudinal study of individuals aged 70-100, multilevel analysis was used to simultaneously model the effects of distance to death-related change, controlling for age-related change, and vice versa. The outcome showed a more pronounced time-to-death decline compared with the time-from-birth pattern in which time-to-death was controlled for as shown in Figure 3.3 (Thorvaldsson, Hofer & Johansson, 2006).

Findings like this support the notion that proximity to death may be more important for observed decline than distance from birth or chronological age. This was recently confirmed in a study using change-point analysis to identify the inflection point or the typical start of accelerated change related to mortality. Longitudinal data from age 70 until mortality after

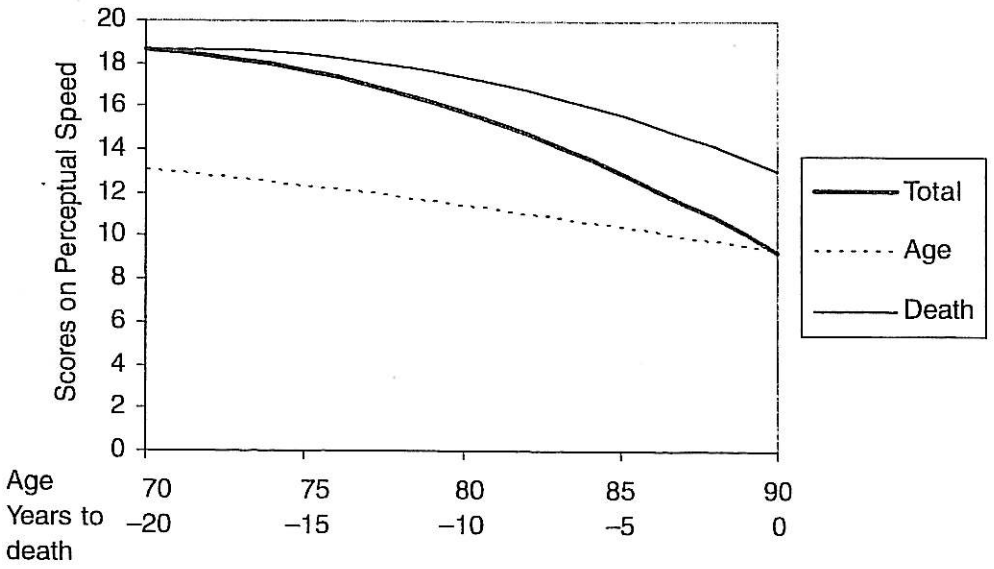

Figure 3.3 Perceptual speed performance relative to age and time to death. The age based trajectory is less pronounced compared to the time-to-death based. (from Thorvaldsson, Hofer & Johansson, 2006)

100, with up to 12 measurement occasions, demonstrated that the onset of terminal decline was identified as long as six to eight years prior to death for verbal and spatial ability, and for more than 14 years for perceptual speed (Thorvaldsson, *et al.*, submitted). Change in neuropsychological functioning in later life may be indicative of an increased mortality risk, which is shown in studies among individuals with compromised memory and cognition as well as among those who develop a dementia (see Johansson & Zarit, 1997).

AGEING – A MIXTURE OF GENETIC AND ENVIRONMENTAL INFLUENCES

The challenge of separating primary, secondary and tertiary ageing effects on memory and cognition is reflected in the claim by K. Warner Schaie that 'we have begun to recognize that the passage of time and getting older cannot have any causal property for any observed behaviour change' (Schaie, 2005, p. 6). Thus, the origin of cognitive ageing needs to be identified in the underlying neurobiological mechanisms that become more evident in later life and that operate in all three types of ageing (primary, secondary, and tertiary), as well as in the physical and socio-cultural influences that operate throughout life on our unique genetic configuration (Brayne, 2007).

Stress models provide a biobehavioural framework to incorporate the complex interaction between the outer and inner environment of the ageing individual (Sapolsky, 1999). A significant age-related increase is found in the activation of the HPA (hypothalamic-pituitary-adrenal) axis, especially where cognition is compromised. Levels of stress hormones, such as cortisol, are found to be higher in older people, providing evidence for the notion that older individuals are more prone to stress (e.g. Magri *et al.*, 2006). In fact, the definition of ageing once suggested by Nathan Shock (1983) was that of 'a progressive loss of the organism's ability to adapt to stress'. From a psychological perspective, this notion includes not only mechanisms associated with biological ageing but also our coping with

various stressors, whether they reflect changes in the inner biological environment or in the outer world. Feelings of control and autonomy are important and may further account for individual differences in various ageing outcomes (Baltes & Baltes, 1986). These feelings are highly associated with our appraisal of the person-environment relationship (Lazarus & Folkman, 1984). Although self-appraisals seem to be rather stable from midlife to old age, net change may even favour a more positive appraisal in ageing in individuals experiencing more successful ageing (Holahan, 2003) (see Chapter 2, this volume, for a more detailed discussion).

Recent studies of the relative importance of genetic and environmental influences in memory and cognitive outcomes demonstrate that a substantial heritability, 60% for general cognitive ability, may remain into very late life among nondemented individuals (McClearn *et al.*, 1997). The heritability is typically lower for memory (Johansson *et al.*, 1999). Although genetic influences are important for cognitive decline in later life and a substantial risk factor for compromised cognition (Gatz *et al.*, 2005) and dementia (Gatz *et al.*, 2006), recent studies also confirm the old notion of 'use it or lose it' as an important differential factor (Gatz, 2005). Engaged life styles, including physical exercise, social interactions, cognitively stimulating activities at work and in leisure may buffer cognitive decline and perhaps even have a neuro-protective role for dementia (Andel *et al.*, 2005; Bennet *et al.*, 2006; Crowe *et al.*, 2003; Hultsch *et al.*, 1999, Kramer, Erickson & Colcombe, 2006). The lesson to be learned is that although we may blame our genes, various influences from the physical and sociocultural context operate throughout the lifespan, sometimes adding to the risk of cognitive deterioration in later life, sometimes acting protectively.

Disuse is sometimes identified as a source of age decline in abilities that require continuous use to be preserved. Support for the disuse hypothesis is provided by studies and interventions demonstrating considerably plasticity or modifiability in primary ageing. The gap between capacity and performance may become greater with age due to disuse. Reviews of memory and cognitive training studies suggest that older adults are able to 'learn new tricks' but that the acquisition of new techniques to improve performance produce specific, rather than generalized effects with low spontaneous use in everyday life. Notably, the magnitude of improvements are generally less in older people compared with younger individuals (Derwinger, 2005; Verhaeghen, Marcoen & Goosens, 1992). Training as well as observation studies are encouraging and provide support for the 'use it or lose it' idea implicated in a healthy lifestyle. More research, however, is needed to understand the limits and neurobehavioral restrictions of the ageing nervous system as well as about the mechanisms involved in late life brain plasticity (Kramer *et al.*, 2004).

It is evident that the physical changes in the ageing brain cannot fully account for all the changes observed with age in memory and cognition. Apart from cohort effects observed at the population level, lifelong learning experiences change individual brains by the new interconnections that are established. This positive brain plasticity makes the function of the brain more locally and globally adapted to perform various tasks. However, reduced schedules of cognitively demanding activities ('brain disuse'), 'noisy' processing due to a deterioration in peripheral sensory systems and slower information processing, weakened neuromodulatory control by changed levels of neurotransmitters and negative learning or adaptation of behaviours that reinforce cognitive disuse, interact to produce diversely degraded memory and cognitive abilities in later life (Mahncke, Bronstone & Merzenich, 2006).

Examination of individual life histories and individual differences in ageing is therefore as important as the identification of normative age changes, especially in the context of

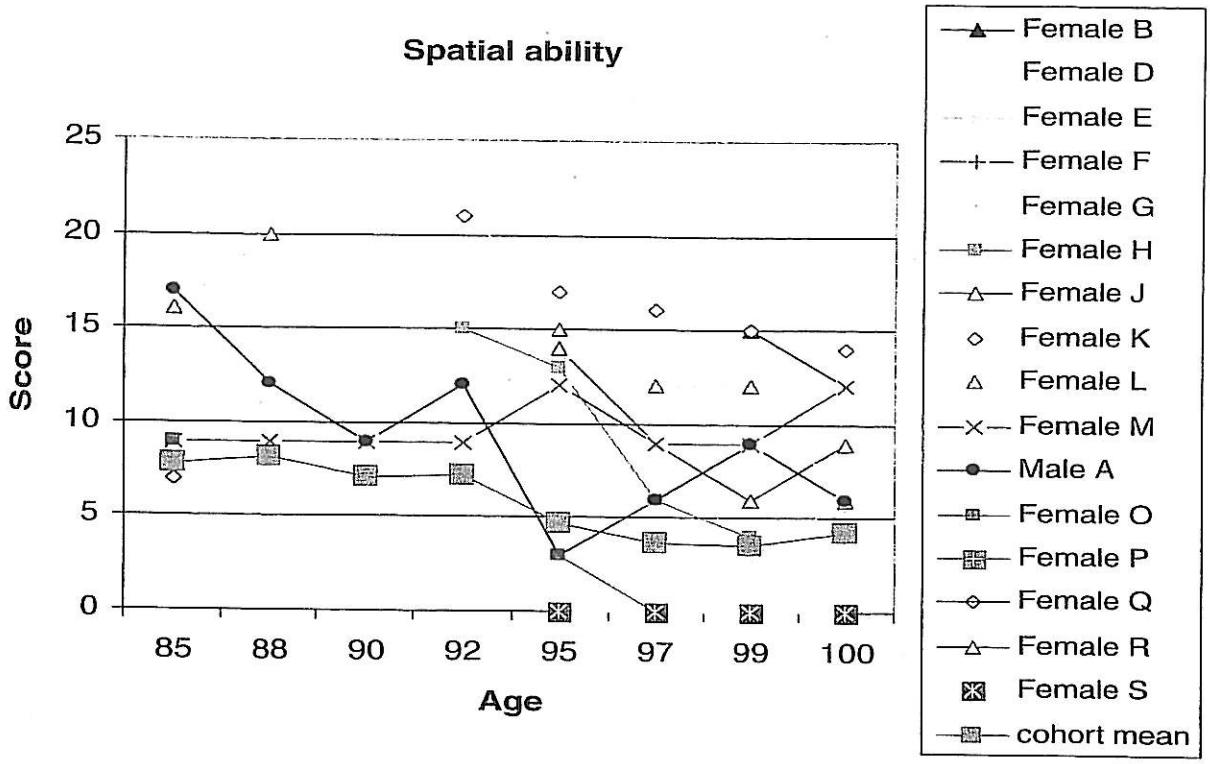

Figure 3.4 Longitudinal test scores from age 85 to age 100. (Author's own data from the H70 Study).

a clinical psychological assessment (e.g. Rabbitt, 1993). The notion of substantial inter-individual differences in intra-individual change is largely supported by observational and longitudinal data depicting individual trajectories. Figure 3.4 shows various trajectories across ages 85–100 years for individuals who survived to become centenarians.

The cross-sectional cohort mean is considerably lower than for the longitudinal sample's results. An important lesson for the clinical psychologist is that a sample cohort mean is uninformative for longitudinal trajectories. Interestingly, even in studies of genetically related individuals, observed trajectories may also differ considerably within twin pairs. In a study of cognitive change and continuity over six years in monozygotic and dizygotic twin pairs aged 80 and older, weak but often negative correlations were found among rates of change between individuals within twin pairs. The results suggest greater differential change within pairs compared with average change across twin pairs (Johansson *et al.*, 2004).

In everyday life we may encounter individuals of advanced age who actually show improved performance at an older age. Recovery from disease, and successful treatment of disease, is also possible in advanced age and should reinforce the need to consider individual patterns of change that potentially may become manifest as improvements (see Johansson, Zarit & Berg, 1992).

MEMORY – ACQUISITION AND STORAGE OF INFORMATION

The capacity to acquire and store various types of information involves multiple memory systems and processes that operate in parallel to support individuals' coping ability.

A taxonomy of memory systems, based on neurobiological and behavioural data, was proposed by Squire (2004), which, together with more specific insights drawn from cognitive psychology, provides an overall guideline in the clinical setting. A major distinction can be made between explicit or declarative memory and implicit or nondeclarative memory. The former refers to memories of facts and events that can be consciously reported or declared – episodic and semantic memory. Nondeclarative memory includes a heterogeneous set of acquired learning, not directly available to our conscious experience – procedural memory, priming, simple classical conditioning and nonassociative learning.

Studies have shown that the nondeclarative procedural memory system remains fairly robust throughout life, whereas declarative memory is more affected (Hoyer & Verhaeghen, 2006). For example, in a study of visuomotor procedural memory in healthy individuals aged 18 to 95 it was found that motor learning was slower with age but that memory for the motor performance was well retained across ages over a two-year period without further training or rehearsal (Smith *et al.*, 2005). Further evidence for the robustness of procedural memory in primary ageing is provided by animal studies (e.g. Churchill *et al.*, 2003).

Longitudinal, as well as cross-sectional, data provide evidence for negative age effects in many memory tasks, the exception being short-term memory and in some cases semantic memory (e.g. Park *et al.*, 2002). The magnitude of the age effects are, however, consistently smaller in longitudinal studies (Rönnlund, 2005). Thus, we may expect memory to decline with age, but the magnitude of this decline differs considerably across tests measuring various memory systems and processes involved in the acquisition and storage of information.

Short-term Memory

Short-term memory includes the primary memory component of a temporary passive storage system, as well as the working memory component that requires temporary holding of information at the same time as this information is being elaborated or processed in some way. Test of the former, such as the forwards Digit-Span test, show less age-related decline (Gregoire & Van der Linden, 1997), whereas tests of working memory produce more pronounced deficits in older individuals (Verhagen, Marcoen & Goossens, 1993).

Semantic and Episodic Memory

In a clinical assessment, the focus is typically directed towards declarative memory and especially to the episodic long-term memory system of remembered events defined by time and place. Although the episodic memory system represents a storage system for discrete events that we retrieve in retrospect upon testing or in the course of normal everyday activities, it also includes a prospective component of memory for future acts, i.e. the remembering of intentions of what to do, where, and when. The prospective memory component has a significant role in executive functioning.

Evidence show that our memory for facts – semantic memory – changes less in later life, compared with the more vulnerable episodic system. Tests of free recall and tasks providing limited support at testing are typically more difficult, whereas cued recall and recognition often show fewer age-related effects (e.g. Bäckman, Small & Wahlin, 2001; Hoyer & Verhaeghen, 2006).

Semantic memory deficits are likely to indicate secondary ageing, whereas a decline in episodic memory is also observed in primary ageing. In a psychological assessment it is important to differentiate between memory systems that are more-or-less impaired and to identify specific memory processes that are more-or-less preserved. To advance our understanding of memory functioning and the mechanisms involved in change we need explicitly to anchor and report our findings and observations from specific tests in explicit models. For example, comparisons of free recall and recognition performance in an episodic task may provide insights about the extent of encoding as well as the capacity to mobilize retrieval cues at testing. Although it is difficult to control fully for level of difficulty, comparisons of performance on verbal and nonverbal memory tasks may provide more detailed information about an individual's capacity to remember and cope with everyday life.

An issue often overlooked in memory testing is whether the to-be-remembered material is actually encoded. Word lists, varying in item length and with items that sometimes can be organized into aggregate categories, are often used to examine episodic memory. Following a single presentation trial the individual is asked for free recall, sometimes followed by selective cued recall for those items not retrieved. A problem with this test paradigm is that initial acquisition or learning is, in fact, uncontrolled. A subsequent test performance may falsely be interpreted as a retrieval memory problem although it might well be the case that the individual never learned or encoded the to-be-remembered material. This problem highlights the difficulty of distinguishing between difficulties in learning and the ability to store acquired information and the capacity for retrieval of encoded information, whether in a free recall, cued recall, or recognition condition. A test procedure explicitly examining the acquisition of the to-be-remembered material is often more informative, such as the Buschke selective reminding procedure (Buschke, 1973). Even the brief MMSE screening device includes learning to criterion before free recall of three items (Folstein *et al.*, 1975). Chapter 22 (this volume) provides a detailed account of memory assessment.

OTHER COGNITIVE ABILITIES

Cognition in a broad sense includes processes involved in the integration and reorganization of acquired information for the sake of matching behaviour to the environment in an appropriate manner – intelligent behaviour. The outcome of matching cognitive resources and task demands is demonstrated in terms of relative success, or failure, in performing a certain task, whether observed in everyday activities or measured by specific cognitive tests. Certain tasks are novel and therefore require the execution of new behaviour whereas others may be practised and therefore require less processing effort.

Fluid and Crystallized Abilities

Fluid and crystallized abilities are largely associated with the study of psychometric intelligence. Various cognitive abilities are operationalized into specific tests assumed to measure differential cognitive processes as well as the more aggregate components of fluid and crystallized intelligence. Test batteries like the WAIS (Wechsler Adult Intelligence Scale)

provide a set of specific tests for mental speed, verbal abilities, spatial orientation, and various aspects of reasoning.

In a recent study of performance on the Block Design test (a test of visuo-spatial constructional ability) across the age range of 35 to 85, the estimated age-related change showed similar slopes for cross-sectional and longitudinal data. Longitudinal data, however, demonstrated a decline only after age 60–65 whereas the cross-sectional data indicated a deterioration from age 35. Notably, when the cross-sectional data was adjusted for education, the pattern became similar to that of the longitudinal data; this provides further evidence for cohort effects when comparing performance across ages groups (Rönnlund & Nilsson, 2006).

Results, based on seven-year intra-individual change for the six abilities measured in the Seattle Longitudinal Study by the Primary Mental Ability (PMA) test battery, show that the earliest reliable decline was observed from age 60 for perceptual speed and numerical ability (Schaie, 2005). Inductive reasoning and spatial orientation showed decline after age 67, whereas verbal ability remained fairly stable and declined only after age 80.

Findings of normative patterns of age-related change, like the above, typically confirm that crystallized abilities remain relatively unaffected in later life compared to fluid abilities. Although normative age-related patterns are important for our general understanding of cognitive ageing, it is equally important for the psychologist to consider the unique trajectory of the individual and consider whether similar patterns can be revealed among individuals sharing certain experiences or affected by conditions such as Alzheimer's. Changes in the overall mean score may otherwise obscure an understanding of why certain individuals present preserved memory and cognitive abilities in very late life. For example, in the Seattle Study examinations were also made of the proportion of persons in various age segments (53–60, 60–67, 67–74 and 74–81) who maintained their level of cognitive performance over a seven-year period. Interestingly, it was shown that more than 60% across all age groups showed no significant decline in tests of verbal meaning, spatial orientation, inductive reasoning, numerical ability or word fluency. The proportion with stable performance at age 74 was 70% and at 81 years of age 60% (Schaie, 1989).

There are problems inherent in all higher-order approaches. Their greatest value is as a heuristic framework. Findings generally support the fluid-crystallized dichotomy but the trend in recent cognitive research is rather to examine various components and processes separately. This is in line with the task of the clinical psychologist seeking to evaluate a set of test scores from an older person.

Mental Speed

Mental speed is a crucial ingredient in many memory and cognitive tasks because of time constraints. This is the case in everyday life as well as in clinical testing. It could be argued that time is less important than accuracy and that speeded tasks therefore are unfair to older people. On the other hand, speed of behaviour per se is an important marker of adaptation and intelligent behaviour. The former position assumes that the reduced rate of processing was extrinsic or peripheral to primary ageing of the nervous system. However, studies have demonstrated that slowing in fact represents an intrinsic phenomena accompanying primary ageing and that slowing reflects central rather than peripheral processes. In a meta-analysis of studies on the association between age and mental speed, the overall correlation was

0.52, a figure that suggests the magnitude of normative slowing with age (Verhaeghen & Salthouse, 1997). Cognitive ageing researchers nowadays accept that speed of behaviour represents an informative component in tests of memory and intelligent behaviour.

Executive Functioning

Executive functioning refers to the composite aspect of intelligent behaviour that enables us to engage in independent, purposive, self-serving behaviour. Executive functioning is consequently an important component in the cognitive processing of many tasks (see Lamar *et al.*, 2002). Various tests of executive performance, including the components of planning, inhibition and flexibility typically demonstrate a decline with age (Salthouse, Atkinson & Berish, 2003; Wecker *et al.*, 2005). In primary ageing, the executive capacity may, however, be maintained at the 'good-enough' level for many everyday activities. The exception may be activities that require high mental speed, for example, psychomotor behaviour and in verbal communications that parallel a verbal fluency test. The lack of alternative behaviours necessary to overcome and compensate for deficits in certain cognitive domains may be an indicator of executive dysfunction. This lack of flexibility may manifest as rigidity in both tests and in everyday tasks requiring a switching strategy.

Cognitive Processing Strategies

Studies in cognitive neuroscience using functional brain imaging, have identified differences in brain activity suggesting that cognitive tasks may be processed differently in younger and older adults. The hemispheric encoding/retrieval asymmetry – the HERA pattern – which was found showed that the left frontal lobe was more active at encoding whereas the right frontal hemisphere was specifically involved in the retrieval of episodic memory, both verbal and nonverbal (Habib, Nyberg & Tulving, 2003; Tulving *et al.*, 1994). Older adults were typically found to present a more diffuse activity pattern in which more regions were involved compared with younger individuals (Cabeza *et al.*, 1997; Cabeza, 2002). This cross-sectional finding may indicate a compensatory strategy in older individuals (Cabeza *et al.*, 2004) or perhaps a more integrated experience-based cognitive style in later life. Whether age differences in cognitive processing strategies reflect normative age changes remains to be examined. The way we perceive and cope with cognitive tasks may differ across ages due to familiarity and differential experiences associated with gender, education, and sociocultural influences that produce cohort differences.

Cognitive processing strategies may differ considerably between individuals and across tasks. Evaluations of most memory and cognitive tests are based on performance scores, typically measured in terms of accuracy. Individuals are instructed to respond to a certain set of stimuli and performance is typically rated only in quantitative terms. However, a certain score may be obtained in various ways by the use of various strategies. For example, in the MIR (Memory-in-Reality) Test (Johansson, 1988/89) participants are instructed to first identify 10 common everyday objects by multimodal encoding and then to place these objects into various rooms in an apartment model, according to their own preferences. Participants are instructed to 'think aloud' while performing the task as well as at later free recall (Fiske & Gatz, 2007). The procedure enables observation of the way in which an

individual organizes the to-be-remembered material at encoding and the potential use of a strategy to facilitate retrieval. Healthy older people often retrieve the objects by spontaneously using the ancient 'method of loci' of associating a specific object with a certain room ('where did I put it?'). Interestingly, individuals with dementia and those with mild cognitive impairment are less able to use visuo-spatial imagery to facilitate their performance.

Common daily life tasks, like handwriting, may also provide a window into cognitive processing. Older participants were asked to perform five functional writing tasks, including copying of a phone number, a grocery list with five items, details of a cheque into appropriate places, the alphabet sequence and a paragraph of about 100 characters (Werner, *et al.*, 2006). In performing these tasks, kinematic measures of temporal, spatial and pressure characteristics were obtained. The results provide support for an association between handwriting performance and overall cognitive functioning. Normal older people and people with mild Alzheimer's were clearly distinguished but the performance of individuals with MCI showed greater heterogeneity; presumably because some individuals may later convert to dementia, others will remain low functioning and others may in fact be showing terminal change.

EVALUATIONS OF CURRENT FUNCTIONING RELATIVE TO PREVIOUS FUNCTIONING

Cognitive ageing research has recently become more focused on underlying mechanisms and factors that may contribute to age-related change as well as stability in memory and cognitive functioning. The research largely parallels the search requirements of the clinical psychologist who tries to understand current functioning in a single individual based on available information and assumptions about previous functioning. Using professional expertise and evidence-based evaluation methods the main question to be answered following an evaluation is: 'How does current memory and cognitive functioning relate to what it was earlier in life and what may account for decline, whether compromised functioning is identified in tests, by self-report or informant observed behaviour change?' (see Green, 2000; Johansson & Wahlin, 1998; Zarit & Zarit, 1999).

This question corresponds with the longitudinal research design in which individuals are followed over time to identify evidence for continuity or change from a previous level, independently of the actual level relative to others. Uncertainty about how to evaluate an individual's cognitive performance in clinical practice is likely to be resolved by re-evaluations at appropriate intervals.

The lack of historical memory and cognitive performance data for a person makes the inter-individual perspective an essential, but second best, approach for the clinical psychologist working with older people. At best, using cohort-, gender-, and education-adjusted norms provides more valid interindividual comparisons (McCarthy *et al.*, 2003). An adequate understanding of the individual always requires information regarding previous cognitive functioning. Lack of this information makes it necessary for the psychologist to rely on assumptions about 'previous performance' combining information from life history, medical history, informant reports and self-evaluations. Information about professional accomplishments, leisure interests and activities that indicate intellectual ability or markers of the requirements associated with certain professions should also be considered.

Informants, like spouses and family members can often contribute with significant information about change and functional consequences of impaired memory and cognition (Pearlin *et al.*, 2001). Detailed reports from informants are therefore obligatory to evaluate the daily life implications of compromised cognition.

Estimation of previous or pre-morbid functioning presents numerous pitfalls (see also Chapter 22, this volume). Previously high-functioning individuals often present a challenge in the clinical setting. For example, in the case of high-functioning individuals the clinician may ascribe self-reported problems, not convincingly shown in impaired test performance relative to norms, to non-cognitive factors like depression and compromised wellbeing rather than to actual cognitive decline (e.g. Tuokko *et al.*, 2003).

Another dimension to consider in a psychological assessment refers to ecological validity or the congruence between everyday life tasks and clinical memory and cognitive tests (Marsiske & Margrett, 2006). Although administered tests typically cover multiple domains and dimensions, it is important to remember that they only represent a sample of markers across domains of cognitive functioning. For example, in everyday life individuals may compensate for weaknesses in certain abilities by using strengths in other areas of functioning. This ecological aspect needs to be considered in an evaluation and may account for a discrepancy between self-reported problems and those identified in memory and cognitive tests where the individual is usually inhibited from using compensatory strategies to overcome weaknesses (Cockburn & Smith, 1991; Goodman & Zarit, 1995). The 'lab-life dimension' is especially relevant to consider in individuals showing impaired test performance, but relatively intact daily life functioning.

Self-evaluations

Although a clinical psychological evaluation of memory and cognition is largely based on systematic testing, the clinical interview is still an important source of information. Self-reports may provide valuable insights about how people perceive their own cognitive functioning and the coping behaviours used to handle everyday life. An interview can be informative about how cognitive problems have evolved over time and should allow the person to address affective reactions and social consequences of compromised function. Self-reports and 'self-diagnosis' may in this respect uncover the impact of depression and negative affect on cognitive performance.

In a study of performance predictions, people aged 50 to 79 were asked to predict how they would perform on four memory tasks. Besides, fluid ability scores the results also showed that self-confidence was an important predictor (Rabbitt & Abson, 1991). The authors conclude that accuracy of individuals' assessment of their own abilities alters with age-related changes in fluid IQ but probably more radically with age-related changes in self-regard and in life style. Most studies of meta-memory, the knowledge of one's own memory functioning, show weak associations between test performance and self-reports (see Burt, Zembar & Niederehe, 1995; Frerichs & Tuokko, 2006; Johansson, Allen-Burge & Zarit, 1997). Psychological wellbeing, depression, neuroticism, and feelings of self-control often contribute to self-evaluations and memory complaints (e.g., Derouesne *et al.*, 1999; Kliegel, Zimprich & Eschen, 2005; Verhaeghen, Geraerts & Marcoen, 2000). A recent study, however, suggests that subjective memory may be a better indicator among individuals with possible incipient cognitive impairment, perhaps because persons who experience mild

cognitive impairment may have heightened insight into their own memory functioning (Cook & Marsiske, 2006). Experiences of compromised memory and cognition often represent a major change in overall health.

Functional Health, Compromised Cognition and Clinical Priorities

Older people are distributed between the extremes of those who experience early physical and cognitive impairments and the successful agers who maintain their performance throughout life. This notion provides the basic frame of reference for a clinical assessment, as well as for an accurate portrayal of differential ageing. An assessment of memory and cognition is often an essential component in a comprehensive health examination of older people.

A general finding in studies of the association between subjective health and markers of 'objective' health is that of a weak relationship. Subjective health correlates with self-evaluations of general subjective wellbeing, including life satisfaction, anxiety, and depression, with sense of coherence but not substantially with objective health-related variables (Berg, 2006; Schneider *et al.*, 2004). Studies of overall perceived health show that individuals generally report a slight worsening with age. Self-evaluations may also indicate slightly better subjective health in individuals who have survived into advanced ages (Johnsson & Barer, 1997). The major patterns of temporal health changes typically found in later life include those reporting constant good health, those with an early onset of perceived health decline, individuals with late onset of perceived health decline and those experiencing a course of recovery from poor self-assessed health (Liang *et al.*, 2005).

Self-evaluations of health can be contrasted with the research literature on memory and other cognitive functions that convey the general conclusion that memory and other cognitive performances decline with age due to primary, secondary and tertiary ageing. At the same time we often find that many older people maintain independence and successful functioning in everyday life with activities that require preserved memory and cognitive abilities. These observations seem contradictory and address the question of the practical or ecological significance of research based findings.

Reduced speed of behaviour, less efficient episodic memory and deficits in fluid abilities may compromise various everyday life activities and remind the individual about compromised functioning. These primary ageing effects, largely associated with an overall reduced reserve capacity in the old nervous system, tend to lead the ageing individual to gradually adapt to a more restricted life and produce a negative spiral that leads to more and more decline (Mahncke, Bronstone & Merzenich, 2006). By the use of more-or-less conscious compensatory strategies and by deliberate selection of life arenas with lower exposure of cognitive demanding tasks, individuals may experience memory and thinking that is 'good enough' for daily life. The selective optimization with compensation model is relevant here (Baltes, 1991; 1993; see also Jopp & Smith, 2006; Riedeger, Li & Lindenberger, 2006 and Chapter 2 of this volume).

A clinical psychological assessment of memory and cognition is unlikely in individuals experiencing only primary ageing. An unbiased evaluation approach of older individuals could therefore largely be based on the general assumption and expectation of relatively preserved memory and cognitive abilities relative to ordinary everyday demands (see Figure 3.5). Individuals who present more pronounced decline in tests and who are brought

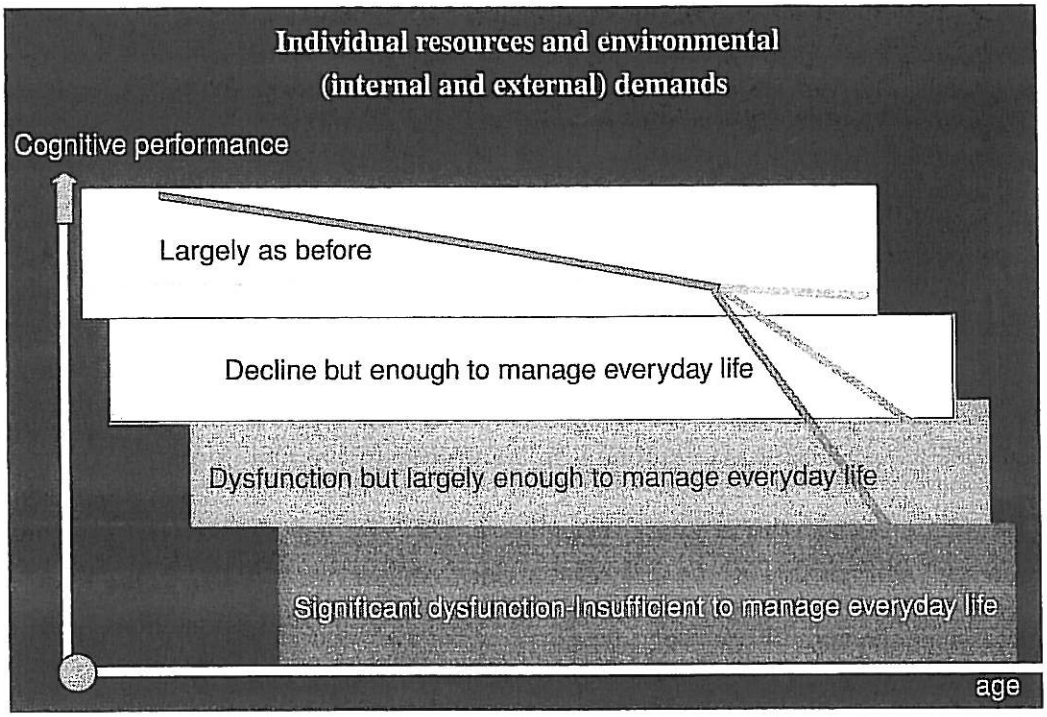

Figure 3.5 Differential trajectories of memory and cognitive change in later life in relation to everyday life task demands.

to the clinic by their family members or their own worries and experiences about compromised cognition should be offered an evaluation focusing on strengths as well as weaknesses across domains of memory and cognitive functioning taking into account potential effects of secondary and tertiary ageing processes. Compromised 'memory and thinking' experienced by older people themselves or recognized by others are always legitimate reasons for professional consultation and screening given the expectation that these abilities should be relatively preserved in primary ageing. Tentative findings from screening and interview should provide explicit arguments whether an in-depth psychological examination is indicated or not.

A comprehensive clinical psychological examination should (a) identify level of functioning across multiple cognitive domains, (b) determine the magnitude of change relative to previous performance levels, (c) relate findings to underlying cognitive systems and processes, (d) analyse weaknesses as well as strengths in relation to ecological functioning, (e) suggest diagnosis in the context of overall physical and mental health, (f) communicate findings with the person, spouse or family, and (g) suggest psychological treatment and psychosocial interventions tailored to the individual person.

The professional assessment can ultimately advance our understanding of cognitive change and the mechanisms involved in compromised memory and cognitive functioning also in later life.

REFERENCES

Andel, R., Crowe, M., Pedersen M. *et al.* (2005) Complexity of work and risk of Alzheimer's disease: a population-based study of Swedish twins. *Journal of Gerontology: Psychological Sciences*, **60**(5): P251–8.

Artero, S. & Ritchie, K. (2003) The detection of mild cognitive impairment in the general practice setting. *Aging and Mental Health*, **7**, 251–58.

Bäckman, L. & MacDonald, S.W.S. (2006) Death and cognition. synthesis and outlook. *European Psychologist*, **11**, 224–35.

Bäckman, L., Small, B.J. & Wahlin, Å. (2001) Aging and memory: cognitive and biological perspectives, in *Handbook of the Psychology of Aging*, 5th edn (eds J.E. Birren & K.W. Schaie). Academic Press, San Diego CA, pp. 349–77.

Baltes, M.M. & Baltes, P.B. (eds) (1986): *The Psychology of Control and Ageing*. Lawrence Erlbaum, Hillsdale NJ.

Baltes, P.B. (1991) The many faces of human ageing: toward a psychological culture of of old age. *Psychological Medicine*, **21**, 837–54.

Baltes, P.B. (1993) The ageing mind: potential and limits. *The Gerontologist*, **33**, 580–94.

Baltes, P.B. & Nesselroade, J. (1979) History and rationale of longitudinal research, in *Longitudinal Research in the Study of Behaviour and Development* (eds J.R. Nesselroade & P.B. Baltes). Academic Press, New York, pp. 1–39.

Bennet, D.A., Schneide, J.A., Tang, Y. *et al.* (2006) The effect of social networks on the relation between Alzheimer's disease pathology and level of cognitive function in old people: a longitudinal cohort study. *Lancet Neurology*, **5**, 406–12.

Berg, A.I. Hassing, L., McClearn, G.E., & Johansson, B. (2006) What matters for life satisfaction in the oldest-old? *Aging and Mental Health*, **10**, 257–64.

Berg, S. (1996) Aging, behavior, and terminal decline, in *Handbook of the Psychology of Aging* (eds J.E. Birren & K.W. Schaie). Academic Press, New York.

Berg, S. & Dellasega, C. (1996) The use of psychoactive medications and cognitive function in older adults. *Journal of Aging and Health*, **8**, 136–49.

Birren, J.E. & Cunningham, W.R. (1985) Research on the psychology of ageing: principles, concepts and theory, in *Handbook of the Psychology of Aging* (eds J.E. Birren & K.W. Schaie). Van Nostrand Reinhold Company, New York.

Bosworth, H.B. & Siegler, I.C. (2002) Terminal change in cognitive function: an updated review of longitudinal studies. *Experimental Aging Research*, **28**, 299–315.

Botwinick, J. (1978) *Aging and Behavior*. Springer: New York.

Brayne, C. (2007) The elephant in the room – healthy brains in later life, epidemiology, and public health. *Nature Reviews – Neuroscience*, **8**, 233–39.

Burt, D.B., Zembar, M.J. & Niederehe, G. (1995) Depression and memory impairment:a meta-analysis of the association, its pattern, and specificity. *Psychological Bulletin*, **117**, 285–305.

Buschke, H. (1973) Selective reminding for analysis of memory and learning. *Journal of Verbal Learning and Verbal Behavior*, **12**, 543–50.

Cabeza, R. (2002) Hemispheric asymmetry reduction in old adults. The HAROLD model. *Psychology and Aging*, **17**, 85–100.

Cabeza, R., Anderson, N.D., Locantore, J.K., McInstosh, A (2004) Aging gracefully: compensatory brain activity in high performing older adults. *Neuroimage*, **17**, 1394–402.

Cabeza, R., Grady, C.L., Nyberg, L. *et al.* (1997) Age-related differences in neural activity during memory encoding and retrieval: a positron emission tomography study. *Journal of Neuroscience*, **17**(1): 391–400.

Churchill, J.D., Stanis, J.J., Press, C. *et al.* (2003) Is procedural memory relatively spared from age effects? *Neurobiology of Aging*, **24**, 883–92.

Cockburn, J. & Smith, P.T. (1991) The relative influence of intelligence and age on everyday memory. *Journal of Gerontology: Psychological Sciences*, **46**, 31–6.

Cook, S. & Marsiske, M. (2006) Subjective memory beliefs and cognitive performance in normal and mildy impaired older adults. *Aging and Mental Health*, **10**, 413–23.

Craik, F.I.M & Salthouse, T.A. (eds) (2000) *The Handbook of Aging and Cognition*, 2nd edn. Lawrence Erlbaum, Mahwah NJ.

Crowe, M., Andel, R., Pedersen, N.L. *et al.* (2003) Does participation in leisure activities lead to reduced risk of of Alzheimer's disease? A prospective study of Swedish twins. *Journal of Gerontology: Psychological Sciences*, **58**(5), 249–55.

Derousene, C., Lacomblez, Thibault, S. & LePoncin, M. (1999) Memory complaints in young and elderly subjects. *International Journal of Geriatric Psychiatry*, **14**, 291–301.

Derwinger, A. (2005) *Develop your Memory Strategies. Self-generated versus Mnemonic Training in Old Age: Maintance, Forgetting, Transfer, and Age Differences*. Doctoral dissertation. Karolinska Institute, Stockholm.

Dixon, R., Bäckman, L. & Nilsson, L.-G. (eds) (2004) *New Frontiers in Cognitive Ageing*. Oxford University Press, Oxford.

Ferri, C.P., Prince, M., Brayne, C. *et al.* (2005) Global prevalence of dementia: a Delphi consensus study. *Lancet*, **7; 366**(9503): 2112–7.

Fiske, A. & Gatz, M. (2007) The apartment test: validity of a memory measure. *Aging, Neuropsychology & Cognition*, **14**, 441–461.

Flynn, J.R. (1987) Massive gains in 14 nations: what IQ tests really measure. *Psychological Bulletin*, **101**, 171–91.

Folstein, M.F., Folstein, S.E. & McHugh, P.R. (1975) 'Mini-mental state': A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, **12**, 189–98.

Frerichs, R.J. & Tuokko, H.A. (2006) Reliable change scores and their relation to perceived change in memory: implications for the diagnosis of mild cognitive impairment. *Archives of Clinical Neuropsychology*, **21**, 109–15.

Gatz, M. (2005) Educating the brain to avoid dementia: can mental exercise prevent Alzheimer's disease? *PLoS Medicine*, **2**(1), e7 *doi: 10.1371/journal.pmed.0020007*.

Gatz, M., Fiske, A., Reynolds, C.A. *et al.* (2005) Performance on neurocognitive tests by co-twins to dementia cases compared to normal control twins. *Journal of Geriatric Psychiatry Neurology*, **18**, 202–7.

Gatz, M., Reynolds, C.A., Fratiglioni, L. *et al.* (2006) Role of genes and environments for explaining Alzheimer disease. *Archives of General Psychiatry*, **63**, 168–74.

Goodman, C.R. & Zarit, S.H. (1995) Ecological measures of cognitive functioning: a validation study. *International Psychogeriatrics*, **7**, 39–50.

Gray, S.L., Lai, K.V. & Larson, E.B. (1999) Drug-induced cognition disorders in the elderly: Incidence, prevention, and management. *Drug Saftey*, **21**, 101–22.

Green, J. (2000) *Neuropsychological Evaluation of the Older Adult. A Clinician's Guidebook*. Academic Press, San Diego.

Gregoire, J. & Van der Linden, M. (1997) Effects of age on forward and backward digit spans. *Aging, Neuropsychology, and Cognition*, **4**, 140–9.

Habib, R., Nyberg, L. & Tulving, E. (2003) Hemispheric assymmetries of memory: the HERA model revisited. *Trends in Cognitive Science*, **7**, 241–5.

Hartley, A. (2006) Changing role of the speed of processing construct in the cognitive psychology of human aging, in *Handbook of the Psychology of Aging* (eds J.E. Birren & K.W. Schaie). Elsevier Academic Press. San Diego.

Hassing, L.B., Hofer, S.M., Nilsson, S.E. *et al.* (2004) Comorbid hypertension and type 2 diabetes mellitus exacerbates cognitive decline: evidence from a longitudinal study. *Age and Ageing*, **33**, 355–61.

Hassing, L.B., Johansson, B., Berg, S. *et al.* (2002) Terminal decline and markers of cerebro- and cardiovascular disease: findings from a longitudinal study of the oldest old. *Journals of Gerontology: Series B: Psychological Sciences and Social Sciences*, **57B**(3), 268–76.

Hofer, S.M. & Alwin, D.F. (in press) *The Handbook on Cognitive Ageing: Interdisciplinary Perspectives*. Sage Publications, Thousand Oaks.

Hofer, S.M. & Sliwinski, M.J. (2006) Design and analysysis of longitudinal studies of aging. In *Handbook of the Psychology of Aging* (eds J.E. Birren & K.W. Schaie). Elsevier Academic Press. San Diego.

Holahan, C.K. (2003) Stability and change in positive self-appraisal from midlife to later aging. *International Journal of Aging and Human Devlelopment*, **56**, 247–67.

Horn, J.L. (1982) The theory of fluid and crystallized intelligence in relation to concepts of cognitive psychology and ageing in adulthood, in *Aging and Cognitive Processes*, (eds F.I.M. Craik & S. Trehub). Plenum Press, New York.

Hoyer, W.J. & Verhaeghen, P. (2006) Memory and ageing, in *Handbook of the Psychology of Aging* (eds J.E. Birren & K.W. Schaie). Elsevier Academic Press, San Diego.

Hultsch, D.F., Hertzog, C., Small, B.J. Dixon, R.A. (1999) Use it or lose it: engaged lifestyle as a buffer of cognitive decline in ageing? *Psychology and Aging*, **14**(2), 245–63.

Johansson, B. (1988/89) *The MIR test (Memory-in-Reality)*. Psykologiförlaget AB, Stockholm.

Johansson, B., Allen-Burge, R. & Zarit, S.H. (1997) Self-reports on memory functioning in a longitudinal study of the oldest old: relation to current, prospective, and retrospective performance. *Journal of Gerontology: Psychological Science*, **52**, P139–46.

Johansson, B., Hofer, S.M., Allaire, J.C. (2004) Change in cognitive cababilities in the old-old: the effects of proximity to death in genetically-related individuals over a six-year period. *Psychology and Aging*, **19**, 145–56.

Johansson, B. & Wahlin, Å. (1998) Cognition and geropsychological assessment, in *Comprehensive Clinical Psychology Volume 7: Clinical Geropsychology* (ed. B. Edelstein). Elsevier, New York.

Johansson, B., Whitfield, K., Pedersen, N.L. *et al.* (1999) Origins of individual differences in episodic memory in the oldest-old: a population- based study of identical and same-sex fraternal twins aged 80 and older. *Journal of Gerontology: Psychological Sciences*, **54**(3), P173–9.

Johansson, B. & Zarit, S.H. (1997) Early cognitive markers of the incidence of dementia and mortality: a longitudinal population-based study of the oldest old. *International Journal of Geriatric Psychiatry*, **12**, 53–9.

Johansson, B., Zarit, SH. & Berg, S. (1992) Changes in cognitive functioning of the oldest old. *Journal of Gerontolology: Psychological Sciences*, **47**, P75–80.

Johnson, C.L. & Barer, B.M. (1997) *Life Beyond 85 years. The Aura of Survivorship*. Springer, New York.

Kleemeier, R.W. (1962) Intellectual changes in the senium. *Proceedings of the Social and Statistics Section of the American Statistical Association*, **1**, 290–295.

Jopp, D., & Smith, J. (2006) Resources and life-management strategies as determinants of successful ageing: on the protective effect of selection, optimization, and compensation. *Psychology and Aging*, **21**, 253–65.

Kliegel, M., Zimprich, D. & Eschen, A. (2005) What do subjective complaints in persons with ageing associated cognitive decline reflect? *International Psychogeriatrics*, **17**, 499–512.

Kramer, A., Bherer, L., Colcombe, S.J. *et al.* (2004) Environmental influences on cognitive and brain plasticity during ageing. *Journal of Gerontology: Medical Sciences*, **59**, M940–57.

Kramer, A., Erickson, K.I. & Colcombe, S.J. (2006) Exercise, cognition and the aging brain. *Journal of Applied Physiology*, **101**, 1237–42.

Lamar, M., Zonderman, A.B., & Resnick, S. (2002) Contribution of specific cognitive processes to executive functioning in an ageing population. *Neuropsychology*, **16**, 1576–162.

Lazarus, R.S. & Folkman, S. (1984) *Stress, Appraisal and Coping*. Oxford University Press, New York.

Liang, J., Shaw, B.A., Krause, N. *et al.* (2005) How does self-assessed health change with age? A study of older adults in Japan. *Journal of Gerontology: Social Sciences*, **60**, S224–32.

Magri, F., Cravello, L., Barili, L. *et al.* (2006) Stress and dementia: the role of the hypothalamic-pituitary-adrenal axis. *Aging Clinical Experimental Research*, **18**, 167–70.

Mahncke, H.W., Bronstone, A. & Merzenich, M.M. (2006) Brain plasticity and functional losses in the aged: scientific bases for a novel intervention. *Progress in Brain Research*, **157**, 81–109.

Marsiske, M. & Margrett, M. (2006) Everyday problem solving and decision making, in *Handbook of the Psychology of Aging* (eds J.E. Birren & K.W. Schaie). Elsevier Academic Press. San Diego.

McCarthy, F.M., Sellers, A.H., Burns, W.J. *et al.* (2003) Predicion of IQ in the Mayo older adult normative sample using multiple methods. *Journal of Clinical Psychology*, **59**, 457–63.

McClearn, G.E., Johansson, B., Berg, S. *et al.* (1997) Substantial genetic influence on cognitive abilities in twins 80 or more years old. *Science*, **276**(5318), 1560–3.

Nilsson, S.N., Johansson, B., Berg, S. *et al.* (2002) A comparison of diagnosis capture from medical records, self reports, and drug registrations: A study in individuals 80 years and older. *Aging Clinical and Experimental Research*, **14**, 178–84.

O'Keeffe, S.T. & Moore, A.R. (1999) Drug-induced cognitive impairment in the elderly. *Drugs and Aging*, **15**, 15–28.

Park, D.C. (eds) (2000) *Cognitive Ageing. A Primer*. Taylor & Francis, Philadelphia PA.

Park, D.C., Lautenschlager, G., Hedden, T. *et al.* (2002) Models of memory across the life span. *Psychology and Aging*, **17**, 299–320.

Pearlin, L.I., Harrington, C., Lawton, M.P. *et al.* (2001) An overview of the social and behavioural consequences of Alzheimer's disease. *Aging and Mental Health, Supplement*, 1, S3–6.

Rabbitt, P. (1993) Does it all go together when it goes? *Quarterly Journal of Experimental Psychology*, **46** A, 385–434.

Rabbitt, P. & Abson, V. (1991) Do older people know how good they are? *British Journal of Psychology*, **82**, 137–51.

Riediger, M., Li, S-C., Lindenberger, U. (2006) Selection, optimization, and compensation as developmental mechanisms of adaptive resource allocation: review and preview, in *Handbook of the Psychology of Aging* (eds .J.E. Birren & K.W. Schaie). Academic Press, London.

Rönnlund, M., Nyberg, L. , Bäckman, L. & Nilsson, L-G. (2005) Stability, growth, and decline in adult life span development of declarative memory: cross-sectional and longitudinal data from a population-based study. *Psychology and Aging*, **20**, 3–18.

Rönnlund, M. & Nilsson, L-G. (2006) Adult life-span patterns in WAIS-R Block Design performance: cross-sectional versus longitudinal age gradients and relations to demographic factors. *Intelligence*, **31**, 63–78.

Salthouse, T.A., Atkinson, T.M., & Berish, D.E. (2003) Executive functioning as a potential mediator of age-related decline in normal adults. *Journal of Experimental Psychology: General*, **132**, 566–94.

Sapolsky, R.M. (1999) Glucocoricoids, stress, and their adverse neurological effects: relevance to ageing. *Experimental Gerontology*, **34**, 721–32.

Schaie, K.W. (1989) The optimization of cognitive functioning in old age. Predictions based on cohort-sequential and longitudinal data, in P.B. Baltes & M.M. Baltes (eds) *Successful Ageing: Perspectives from the Behavioural Sciences*. Cambridge University Press, Cambridge.

Schaie, K.W. (2005) What can we learn from longitudinal studies of adult development? *Reearch in Human Development*, **2**, 133–158.

Schneider, G., Driesch, G., Kruse, A. *et al.* (2004) What influences self-perceptions of health in the elderly? The role of objective health condition, subjective well-being, and sense of coherence. *Archives of Gerontology and Geriatrics*, **39**, 227–37.

Shock, N.W. (1983) Aging of physiological systems. *Journal of Chronic Diseases*, **36**, 137–42.

Smith, C.D., Walton, A., Loveland, A.D. *et al.* (2005) Memories that last in old age: motor skill learning and memory preservation. *Neurobiology of Aging*, **26**, 883–90.

Squire, L.R. (2004) Memory systems of the brain: a brief history and current perspectives. *Neurobiology of Learning and Memory*, **82**, 171–7.

Steen, G., Berg, S. & Steen, B. (1998) Cognitive function in 70-year old men and women: a 16-year cohort difference population study. *Aging*, **10**, 120–6.

Thorvaldsson, V., Hofer, S.M. & Johansson, B. (2006) Aging and late life terminal decline: a comparison of alternative modeling approaches. *European Psychologist*, **11**, 196–203.

Thorvaldsson, V., Hofer, S.M., Berg, S. *et al.* (submitted) Onset of terminal decline in cognitive abilities in nondemented individuals.

Tulving, E., Kapur, S., Craik, F.I.M. *et al.* (1994) Hemispheric encoding/retrieval asymmetry in episodic memory: Positron emission tomography findings. *Proceedings of the National Academy of Science*, **91**, 2016–20.

Tuokko, H., Garett, D.D., McDowell, I. *et al.* (2003) Cognitive decline in high-functioning older adults. Reserve or ascertainment bias? *Aging and Mental Health*, **7**, 259–270.

Verhaeghen, P., Geraerts, N. & Marcoen, A. (2000) Memory complaints, coping, and well-being in old age: a systematic approach. *The Gerontologist*, **40**, 540–8.

Verhaeghen, P. & Marcoen, A. & Goossens, L. (1992) Improving memory performance in the aged through the use of mnemonic training: a meta-analytic study. *Psychology and Aging*, **7**, 242–51.

Verhaeghen, P., Marcoen, A., & Goossens, L. (1993) Facts and fiction about memory aging. *Journal of Gerontology: Psychological Sciences*, **48**, P157–171.

Verhaeghen, P. & Salthouse, T.A. (1997) Meta-analyses of age-cognition relations in adulthood: estimates of linear and nonlinear age effects and structural models. *Psychological Bulletin.* **122**, 231–49.

Wecker, N.S., Kramer, J.H., Hallam, B.J. & Dellis, D.C. (2005) Mental flexibility: age effects on switching. *Neuropsychology*, **19**, 345–52.

Werner, P., Rosenblum, S., Bar-On, G. *et al.* (2006) Handwriting process variables discriminating mild Alzheimer's disease and mild cognitive impairment. *Journal of Gerontology: Psychological Sciences*, **61B**, P228–236.

Winblad, B., Palmer, K., Kivipelto, M. *et al.* (2004) *Journal of Internal Medicine*, **256**, 3, special issue: mild cognitive impairment – beyond controversies, towards a consensus: report of the International Working Group on Mild Cognitive Impairment.

Zarit, S.H. & J.M. Zarit (1999), *Mental Disorders in Older Adults. Fundamentals of Assessment and Treatment.* Guilford Press, New York.