Physical Activity and Alzheimer's Disease

Measurements, Observations and Subjective Experiences

YLVA CEDERVALL
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**Abstract**


Gait disturbances such as slow walking speed and step-to-step variability have been reported among people with mild Alzheimer’s disease (AD) and as risk factors for functional decline, dependency, and falls. Additionally, AD-related emotional reactions and decreased initiative can lead to physical inactivity. The aims of this thesis, therefore, were to explore how the ability to be physically active is affected in the early years of AD, and how people with mild AD and their cohabitants reason about physical activity as part of their everyday life.

To meet the aims, an approach inspired by mixed methods research was used, covering measurements, observations and subjective experiences. Data were collected from different sources in parallel. Participants with mild AD were recruited at the Memory Clinic, Uppsala University Hospital. In **Study I**, a case study with two couples in which one member had AD, in-depth interviews and participating interviews were performed. Physical activity such as walking was viewed as a meaningful routine improving well-being. Participants were positive about making adjustments to enable physical activity. In **Study II**, the 25 participants with AD showed a significant lower walking capacity (10 m comfortable walk test, 6-minute walk test, Timed-up-and-Go test) at baseline compared to controls. The decline continued during the subsequent two years. The influence of a cognitive task on walking was distinct, despite this, participants maintained a health-promoting level of physical activity during the two-year study-period. In **Study III**, gait testing in the motor laboratory of 21 participants with AD showed a marked impact on gait parameters (e.g. slowed speed, decreased step length) by a cognitive task. Additionally, specific dual-task gait disturbances were frequent. In **Study IV**, in-depth interviews with 14 participants with AD indicated that physical activity was viewed as a meaningful activity, used as a means to maintain well-being and selfhood, and contributed to continuity in life.

In conclusion, walking capacity deteriorates and declines in the early stages of AD. A simple cognitive task can have a substantially negative impact on walking already in mild AD. In contrast, people with AD can also gain “self-promoting benefits” from physical activity beyond the common health-promoting benefits.

**Keywords:** Caregiver, continuity theory, dementia, dual-task, gait analysis, in-depth interview, mixed methods research, participant observation, physical capacity, qualitative, selfhood, walking

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Att röra sig är en nödvändig ingrediens i tillvaron

En deltagare
List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals (I-IV).


IV Cedervall Y, Torres S, Åberg AC. Maintained well-being and selfhood through physical activity: the meanings that people with Alzheimer’s disease attach to being active. Submitted

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Preface

This thesis has its origin in my experiences as a physiotherapist at the Memory Clinic at the Uppsala University Hospital. Many of the patients and relatives I met asked me for advice about physical activity because they had the intention to face the symptoms and consequences of the cognitive impairments with, to some extent, physical activity and exercises. I asked myself; why do they strive to continue being physically active? Does physical activity have a certain meaning for them that I do not fully understand?

At that time, research had just started to draw attention to the fact that individuals with mild Alzheimer’s disease, in addition to cognitive impairments, show gait impairments and have a lower physical activity level than cognitively healthy individuals (Camicioi et al., 1997; Pettersson et al., 2002). These findings were new and particularly interesting from a physiotherapist’s point of view. Would it be possible to prevent gait impairments that occurred early in the course of Alzheimer’s disease by physiotherapy interventions? I realized that I needed to learn more about the individuals’ personal experiences of physical activity, and the challenges they had to deal with in their daily life to remain physically active. What could I, as a physiotherapist, do to support them? These very first thoughts provided the basis for the qualitative case study and later on for the longitudinal project from which this thesis has emerged. My driving force was a wish to examine if physical activity can reinforce well-being and health for people living with Alzheimer’s disease. I do hope that this piece of research will improve the understanding of their prerequisites and challenges, and contribute to a better everyday life for those living with Alzheimer’s disease.
Abbreviations and definitions

AD  Alzheimer’s disease
FAST  Functional Assessment Staging
ICF  International Classification of Functioning Disability and Health
MCI  Mild Cognitive Impairments
MMSE  Mini-Mental State Examination
TUG  Timed Up-and-Go test
WHO  World Health Organization

The concepts used in this thesis are based on the terminology outlined in the International Classification of Functioning Disability and Health (ICF) (WHO, 2008). The definitions displayed below are based on the ICF if not otherwise stated.

The overall aim of the ICF is “to provide a unified and standard language and framework for the description of health and health-related states” (WHO, 2008). It also provides a general thought model to organize thoughts and important information about the individuals’ physical, psychological, and social functioning in the environment (Pless et al., 2011).

According to the ICF, functioning and disability include components of body function and body structure, activity and participating, as well as environmental and personal factors (Figure 1). A individual’s functioning stands for the positive aspects of the interaction between a person (with specific health conditions) and environmental and personal factors. Disability describes the negative aspects (loss of functioning).
Figure 1. Interactions between the components of ICF

Definitions of concepts

Activity The execution of a task or an action, for example walking.

Aerobic activity Type of physical activity in which large muscles move in a rhythmic manner for a sustained period of time. Maintain/improves cardiorespiratory fitness (Nelson et al., 2007; WHO, 2010).

Attention functions The cognitive function of being able to focus during a required period of time, also includes the ability divide attention between two tasks. Part of “Specific mental functions” in ICF.

Capacity The highest level of functioning that a person can reach in a domain in the Activities and Participating list in the ICF at a given moment. Capacity is measured in a uniform or standard environment.

Cognitive functions The ability to process thoughts (e.g. memory, language, calculation, executive function) (APA, 2000; McKhann et al., 2011). Part of “Specific mental
<table>
<thead>
<tr>
<th><strong>Disability</strong></th>
<th>An umbrella term for impairments, activity limitations and participation restrictions.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dual-task cost</strong></td>
<td>The percentage time difference between only walking and walking when simultaneously performing a concurrent cognitive task (i.e. naming animals).</td>
</tr>
<tr>
<td><strong>Dual-tasking</strong></td>
<td>Performance of two tasks simultaneously. In this thesis, walking was considered the primary task and the cognitive tasks (i.e. naming animals) were the secondary tasks.</td>
</tr>
<tr>
<td><strong>Environmental factors</strong></td>
<td>Constitute the physical, social, and attitudinal environments in which people live.</td>
</tr>
<tr>
<td><strong>Executive functions</strong></td>
<td>The cognitive function of decision making, abstract thinking, mental flexibility, planning and carrying out plans (i.e. higher-level cognitive functions), Part of “Specific mental functions” in ICF.</td>
</tr>
<tr>
<td><strong>Exercise</strong></td>
<td>A subcategory of physical activity that is planned, structured, repetitive and has the purpose to maintain or improve physical fitness (Caspersen et al., 1985; WHO, 2010).</td>
</tr>
<tr>
<td><strong>Functioning</strong></td>
<td>An umbrella term for body function and body structures, activities and participation.</td>
</tr>
<tr>
<td><strong>Gait</strong></td>
<td>Any method of locomotion characterized by periods of loading and unloading the lower limbs (Kirtley, 2009). Here used to describe gait patterns and components that make up gait in the motor laboratory setting (Study III).</td>
</tr>
<tr>
<td><strong>Mental functions</strong></td>
<td>A body function domain in ICF, which includes the functions of the brain, both global mental functions (e.g. consciousness) and specific mental functions (i.e. cognitive functions).</td>
</tr>
<tr>
<td><strong>Mild Cognitive Impairment</strong></td>
<td>A decline in memory and/or other cognitive function, which is notable for the patient and evident on testing, but not severe enough to interfere with activities in daily life (Winblad et al., 2004).</td>
</tr>
<tr>
<td><strong>Participating</strong></td>
<td>Involvement in a life situation.</td>
</tr>
<tr>
<td><strong>Performance</strong></td>
<td>Activities performed in a person’s ordinary environment.</td>
</tr>
<tr>
<td><strong>Personhood</strong></td>
<td>Defined by Kitwood (1997) as “The standard or status that is bestowed upon a human being, by others, in the context of relationship and social being”. The concept of Personhood is the base of person-</td>
</tr>
</tbody>
</table>
centred research and care in the area of dementia (O'Connor et al., 2007; SBU, 2008a). According to Harré (1998) the concept “person” describes the physical existence of a human being.

| Physical activity | Any bodily movement produced by skeletal muscles that result in energy expenditure (Caspersen et al., 1985; WHO, 2010). Here mainly used when referring to gait/walking and health promoting physical activity, in which a certain intensity and duration is central (i.e. health-enhancing physical activity, leisure time physical activity, recreational time physical activity, habitual physical activity, aerobic activity). |
| Selfhood | According to Harré (1998), selfhood is not an entity, rather a “site”, which is viewed to comprise three aspects of self (the self of personal identity, the self of physical and mental attributes, and the self of social roles). |
| Single-tasking | In this thesis, used to describe a walking task performed without a simultaneously cognitive task. |
| Walking | Gait when one foot is always on the ground, put into context and purposeful action. |
| Walking capacity | Performance during clinical measurements of walking. |
| Well-being | A general term encompassing the total universe of human life, including physical, mental and social aspects. |
Introduction

In recent years research has demonstrated that individuals in the early stages of Alzheimer’s Disease (AD), in addition to cognitive impairments, have gait disturbances such as greater step-to-step variability (Eggermont et al., 2010; Wittwer et al., 2008), which increases the risk of future falls and dependence (Gleason et al., 2009; Hausdorff, 2005). A suggested explanation for the gait disturbances is that walking in real life requires well-functioning executive and attention functions (Sheridan et al., 2007; Shumway-Cook et al., 2012). These cognitive functions are often affected in AD (Hausdorff et al., 2005; Snijders et al., 2007; Yogev-Seligmann et al., 2008). In addition, decreased initiation of activities, and emotional reactions, for example social withdrawal and anxiety, are common (Cook et al., 2008). This can complicate participation in organized exercises, as well as the maintenance of a health-promoting level of physical activity (SoS, 2012).

A low physical activity level has been reported among people with mild AD (Burns et al., 2008; Pettersson et al., 2002), which may affect body function, as well as mood, behaviour, cognitive function, and dependency (Blankevoort et al., 2010; Heyn et al., 2004). It is, however, unclear which factors individuals with AD perceive as barriers towards physical activity, and what meaning physical activity plays in everyday life for them and for their cohabitants (Lautenschlager et al., 2010).

It is therefore essential to explore these aspects of physical activity among people in the early stages of AD. By using clinical and laboratory measurements and observations of walking under different circumstances it may be possible to identify relevant early changes in walking ability. Moreover, complementing such data with the subjective experiences of individuals with AD and their cohabitants, adds an important understanding of which factors that limits, and facilitates people with AD to maintain physical activity.

Alzheimer’s disease

Alzheimer’s disease is a progressive neurodegenerative disease and accounts for about 60% of dementia cases. The prevalence of AD is expected to rise because of the growing number of older people in the population. The main risk factors for AD are old age and genetic factors. The general age of onset is 65 or older, but the neurodegenerative process starts many years before the
An individual is able to notice any cognitive impairment (Basun et al., 2013; SBU, 2008b).

The dementia syndrome is defined as a decline of cognitive function from a previously higher level, severe enough to interfere with activities of daily living, and persisting for more than six months. Worsening of memory is a core symptom along with decline of at least one more cognitive function, such as thinking, orientation, comprehension, calculation, learning capacity, language, and judgement. (APA, 2000; McKhann et al., 2011). In addition, executive and attention functions are commonly affected. There is, however, a wide individual variation in symptoms and progression, and survival time from diagnosis varies from 2 to 20 years (Basun et al., 2013; SBU, 2008b).

During the initial years following the onset of AD, symptoms are commonly mild. This stage of the disease is therefore often referred to as mild AD. At this early stage, individuals have trouble with instrumental activities of daily living such as paying bills and handling medication. The need for assistance in everyday life increases gradually when the disease progresses. At the moderate stage of AD, memory loss has worsened and the person requires help to cope with personal care. At the severe stage, the person gradually loses their gait ability, communication, and needs help with all personal care including feeding (Basun et al., 2013; SBU, 2008b).

Physical activity

**Physical activity as health promotion**

Regularly performed physical activity is an important factor to promote health in the population (FYSS, 2008). The American College of Sports Medicine, the American Heart Association (Nelson et al., 2007), and the World Health Organization (WHO) (2010) have published specific public health recommendations in relation to physical activity. The recommendations in focus comprise physical activity recommendations for adults older than 65 years and recommendations for people aged 50-64, with clinically significant chronic conditions or functional limitations that affect movement abilities. These health recommendations include aerobic-, muscle strength-, flexibility- and balance activities, but here we will focus on the aerobic activity recommendations.

In order to improve health, a minimum of 30 minutes aerobic activity of moderate intensity in bouts of at least 10 minutes are recommended to occur five days a week. This is in addition to the light intensity routine activities performed in daily life. Moderate intensity aerobic activities raise the heart-beat to 55-70% of maximum heart rate and leaves the person feeling warm and slightly out of breath. Among older individuals, the intensity level should be relative to a person’s aerobic fitness (Nelson et al., 2007).
In health promotion a range of concepts related to physical activity is used (see Abbreviations and definitions). They all describe activities that are not essential for daily living, but produce health benefits for individuals when performed at a moderate intensity (e.g. walking, bicycling, swimming and gardening) (FYSS, 2008; Nelson et al., 2007).

Walking is the most common habitual physical activity among the Swedish population. Factors which contribute to higher physical activity levels are a high education level and a distance of less than one kilometre from the housing to green spaces (FHI, 2010). Recreational physical activities in natural surroundings are appreciated among the Swedish population and it has been proposed that the reason for the positive experiences of being in nature (e.g. when going for a walk in the woods) is that it provides relaxation (Daun et al., 1996), restorative experiences (Kaplan, 1995; Korpela et al., 2001), and improves well-being (Bowler et al., 2010).

Additionally, aerobic activity on a health promoting level has been highlighted in recent years as a non-pharmacological treatment that can have a positive effect on the brain structure and function in older adults (Tseng et al., 2011). This was shown for example by Colcombe et al. (2006) who conducted a randomized clinical trial in which sedentary elderly people participated in an aerobic training group for a one-hour period, three times a week, while the control group was engaged in stretching. After six months of aerobic exercise, the participants had improved cardiorespiratory fitness, and the brain volume had increased, mainly in the prefrontal and the temporal cortices. In line with these results Erickson et al. (2011) reported that after six months of aerobic exercise on a moderate level hippocampal size increased, and spatial memory improved. These results suggest a biological base for the role of aerobic fitness in enhancing brain health and cognitive function in elderly people. Thus, these results imply that aerobic exercise is a promising non-pharmacological treatment in preventing age-related cognitive decline.

Similarly, physical activity may be beneficial for brain health in individuals with mild cognitive impairment (MCI) (Ten Brinke et al., 2014) and dementia (Bherer et al., 2013; Intlekofer et al., 2012), and for enhancing emotional function in older people (Erickson et al., 2013). However, it is unclear what types of exercises, and the intensity and duration that are most effective in improving cognitive and emotional functions in elderly individuals (Lautenschlager et al., 2010).

**Physical activity and Alzheimer’s disease**

People with AD are covered by the same public health recommendations as the rest of the population and it is plausible that individuals with AD achieve health benefits from physical activity (SoS, 2010). Previously, improvements in ability to perform daily activities (Forbes et al., 2013), physical functioning (Blankevoort et al., 2010; Heyn et al., 2004), possibly also
cognitive function (Forbes et al., 2013) and a reduction in the number of falls have been reported among people with AD (Pitkala et al., 2013). Additionally, a higher level of physical activity has been reported to be associated with prolonged survival in AD (Scarmeas et al., 2011).

However, individuals with AD may have difficulties to remain physically active even in the early stages of the disease (Burns et al., 2008; Pettersson et al., 2002). There are several factors related to the dementia diagnosis which may affect the performance of physical activities, for example a decreased ability to take initiative (Cook et al., 2008), deteriorated attention-, executive- and perceptual functions (including visuospatial perception), and ability to find the way (Basun et al., 2013). Similarly, feelings of anxiety and unease can lead to social withdrawal and increase the risk of inactivity (Beard et al., 2009; Husband, 2000; Phinney, 1998). Each one of these factors mentioned may individually lead to a decline in physical functioning and independence.

Gait disturbances and dual-tasking in Alzheimer’s disease

Until the 1990s, AD was perceived as a disease that mainly affected cognitive functions, and spared motor functions to its later stages. However, it was known then, that individuals with AD had an increased risk of falls and fractures, but the causes were unclear (Buchner et al., 1987). In 1995, Alexander et al. showed that individuals with AD differed from healthy individuals by walking slower and crossing obstacles in their path with less safety. Moreover, Nakamura et al. (1996) reported that gait disturbances increased with the severity of dementia and that a decrease of step length appeared to be a predictor for falls. It was hypothesized that an impaired ability to perform two tasks simultaneously (i.e. dual-tasking) could explain why people with AD fell under certain circumstances. Therefore, Camicioli et al. (1997) conducted a study in which they combined a cognitive task (i.e. naming names) with walking five metres back and forth (the “Talking-While-Walking” test). They found that people with AD slowed more than cognitively intact people during the dual-task walk. This study was followed by others that confirmed these early findings, e.g. Pettersson et al. (2005, 2007).

A corner stone in understanding the relation between cognition and gait was the findings reported by Lundin et al. in 1997. They found that an inability to hold an informal conversation when walking (“Stops-walking-while-talking”) was a predictor for future falls among elderly people. These findings underscored that cognitive function and ability to walk is interrelated and indicated that impaired cognitive function can increase the risk of falls (Gleason et al. 2009).

Today, it is established that people with mild AD have an impaired walking capacity, such as slower gait speed, shorter step length and increased step-to-step variability compared to cognitively healthy individuals (e.g.
Wittwer et al., 2008). Walking capacity continues to deteriorate as the dementia progresses and a significant decline has been reported during a period of only one year (Tangen et al., 2012; Wittwer et al., 2010). In addition, the described gait disturbances are accentuated during dual-task conditions among individuals with mild AD (Allali et al., 2008; Ijmker et al., 2011; Maquet et al., 2010; Muir et al., 2011), but longitudinal studies investigating dual-task ability in the early stages of AD have not been found in the literature.

Executive and attention functions have been found to play a central role in the ability to walk safely and stably in everyday life (Allali et al., 2008; Hausdorff et al., 2005; Sheridan et al., 2007; Yogev-Seligmann et al., 2008). In agreement with this a lower executive function performance on the pen-and-paper test was reported to be associated with slow usual gait speed in people with MCI (McGough et al., 2011). When walking in real life, there is a constant need to adapt to environmental factors such as curbs, uneven surfaces, and rapidly evolving situations (e.g. cars, busses, and other people). These environmental factors altogether put high demands on the ability to make quick decisions, carry out plans, and divide and shift attention etc. As executive and attention functions are often affected in the early stages of AD, impairments of these functions have been suggested to explain reported instability and the increased fall risk among people with AD. In addition, recent research indicates that people with AD have problems to merge details into a meaningful whole. They may therefore receive a slightly fragmentary picture of their environment (Mårdh, 2013). There are, however, conflicting findings as to whether an impaired dual-task ability when walking, is associated with falling or not among older people (Beauchet et al., 2009).

Research over recent years has therefore been focused on investigating dual-task ability when walking. Different methods have been used to measure the impact of a concurrent cognitive task on walking. As mentioned before, Camicioli et al. (1997) combined walking back and forth with a quite simple cognitive task (naming names). In laboratory settings, walking straight has often been used in combination with a more complex cognitive task such as counting backwards (Allali et al., 2008). Accordingly, the combination of a more complex motor task, such as the Timed Up-and-Go-Test, with a cognitive task has also been suggested (Horak et al., 2009).

The Timed Up-and-Go test (TUG) (Podsiadlo et al., 1991) is a well-established test for measuring basic mobility. Time is recorded when an individual completes the following sequence: starts from a seated position, stands up, walks three metres, turns around, walks back, and sits down. The mobility sequence is often performed at a comfortable (usual) walking speed. The TUG test combined with either a manual task (carrying a cup of water) or a cognitive task (subtractions), were equal in predicting older peo-
ple who were prone to fall (Shumway-Cook et al., 2000), but the manual task has been more frequently used in the clinical setting. Appealing factors about using the TUG test for assessing dual-tasking are that it is well known, easy to administer and requires little time, and is reliable for individuals with AD (Ries et al., 2009). Additionally, as the mobility component is complex the cognitive task may not have to be too challenging for a person with cognitive impairments to expose dual-task impairments.

**Physical activity in daily living with AD**

The cohabitants of community-dwelling people at a mild stage of AD are often responsible for a large portion of informal care (Gruffydd et al., 2006; SoS, 2010; WHO, 2012). This often includes support and prompting of habitual physical activities such as walks (Cook et al., 2008; Jansson et al., 2001; McCurry et al., 2011). One would presume that assistance of this kind would increase the caregiver burden. However, there are indications that informal caregivers view regular physical activity for their partner with AD as a meaningful and important activity (Jansson et al., 2001; Pitkala et al., 2010). Informal caregivers whose partners participated in a six-month exercise programme reduced their caregiver burden in comparison to a control group (Canonici et al., 2012). In the same way, caregivers of a partner with AD participating in a four-month home-based exercise programme reported less stress, despite the fact that the caregivers supervised the daily exercises (Vreugdenhil et al., 2012). Thus, involvement in structured physical activities may be beneficial not only for the person with AD, but also for the informal caregiver (Yu et al., 2013).

Subjective experiences of physical activity from the perspective of individuals with AD and cohabitants have rarely been evaluated in research. In an interview study, Malthouse et al. (2013) found that community-dwelling individuals with AD appreciated exercises, but preferred to perform activities in their home environments, indicating that individual tailored physical exercises might be preferable for this group. In that study, caregivers acted as facilitators of activities, but also as gatekeepers to protect the partner from activities that might be experienced as too stressful. In other studies, preferences for outdoor activities (e.g. walks and gardening), have been emphasized, not only for individuals’ needs, but also for interactions between people with dementia and their informal caregivers (Gibson, 2007). Being physically active outdoors was reported to be appreciated for confirming the ability to maintain desired activities (Olsson et al., 2013), enjoyment, exercise, fresh air and emotional well-being (Duggan et al., 2008). Interactions with neighbours were another positive factor that participants in both these studies mentioned in association with being outdoors.
Currently, there is insufficient knowledge about the impact of AD on the ability to remain physically active in everyday life and we also do not fully know the views of physical activity of those concerned.
Aims

This thesis has for its focus physical activity among individuals in the early stages of Alzheimer’s disease. The overall aims were to explore how the ability to be physically active is affected in the early stages of AD, and how people with mild AD and their cohabitants reason about physical activity as part of everyday life.

Specific aims of the Studies I, II, III and IV were to:

I. Improve the understanding of experiences regarding ability to be physically active from the perspective of individuals with mild AD and their cohabitants.

II. Investigate and describe changes in walking capacity and physical activity levels during a period of two years among individuals who initially had mild AD.

III. Investigate and describe longitudinal changes in gait parameters under single- and dual-task conditions, during a period of two years among individuals who initially had mild AD.

IV. Further the understanding of how people with mild AD reason about physical activity, focusing on their ability to be active, and the meaning they attach to physical activity.
This thesis has an exploratory approach, inspired by mixed methods research. The first study conducted (Study I), was a qualitative case study including two couples (Figure 2). In each couple, one party had mild AD. The findings from this first study constituted the basis for planning and conducting a longitudinal project in which measurements, observation data, and data on subjective experiences were collected from individuals with mild AD, and from their cohabitants.

This thesis, comprises the case study (Study I), two longitudinal studies presenting results from measuring and observing aspects of physical activity (Studies II and III), and findings from the baseline interviews with the participants with mild AD (Study IV) (Figure 2). In the following sections the theoretical perspectives used will be presented.
Figure 2. A flow chart of data collection in Studies I, II, III, and IV. AD=participants with Alzheimer’s disease, HC=healthy controls, Coh=cohabitants
Theoretical perspectives

The theoretical base for mixed methods research

In order to meet the overall aims focusing on measurements, observations and the participants’ subjective experiences of physical activity in the early stages of AD, an approach inspired by mixed methods research was used in the present work (Johnson et al., 2004). Mixed methods research has been emphasized in recent years as it enables the conduct of research that provides a holistic and multifaceted interpretation of the subject addressed in a research project (Bryman, 2004; Creswell, 2009). Mixed methods research is viewed as both a method (“a doing tool”) and a methodology (“a thinking tool”) and is not committed to any one system of philosophy (Andrew et al., 2009). Epistemologically, mixed methods research has its roots in pragmatism and, as such it is not bound to traditional viewpoints that research should be performed in the paradigms of either empirical-holistic research traditions or natural sciences (positivism) (Bryman, 2004; Creswell, 2007; Johnson et al., 2004), instead, researchers in mixed methods research believe that epistemological and ontological issues are of minor importance for the research findings and interpretations. They emphasise the research questions and use available methods and procedures to understand the problem under study (Creswell, 2009). In line with this thinking is the viewpoint among some philosophers of sciences that the differences between the two paradigms should not be exaggerated, because traits from one of the paradigms are often used in the other and vice versa (Bryman, 2004; Föllesdal, 1994).

In this thesis, the decision to use an approach inspired by mixed methods research was based on the complexity of the research questions addressed in the project (Andrew et al., 2009; Creswell, 2009; Polit et al., 2008). Thus, to meet the aims of this work, which covered measurements, observations, and subjective experiences of aspects of physical activity, data from different sources were collected separately, but in parallel. The findings and results from Studies I, II, III, and IV are separately reported in the Results section, but interpreted and discussed in an integral manner in the General discussion section (Andrew et al., 2009; Creswell, 2009).

In research, the concept understanding is fundamental, but it has fairly different meanings in the empirical-holistic compared with the positivistic paradigms. Therefore, some clarification is necessary. Within the empirical-holistic paradigm, the concept understand is defined as an insight into the meaning of something (Grön et al., 1988; Trost et al., 2011). The researcher tries to understand the problem from an inner perspective, i.e. from the perspective of those being studied. Understand in this context comprises a scientific interpretation and analysis that is more theoretical than only understanding something in everyday life. Thus, the concept understand used in
the empirical-holistic paradigm is close to the concepts of empathy and meaning.

Understand in the natural sciences, on the other hand, has a slightly different meaning. The researcher in the natural science paradigm aims to study the world “objectively”, from an outer perspective. In this context, the concept *understand* is often used to explain an event. Thus, an event is explained (understood) if it is proven to be a consequence of a certain cause (Persson et al., 2012). By explaining a result, the potential cause is described.

When advocating mixed methods research in a project such as the present one, the results from one of the methods can contribute to understanding the research problem and provide plausible explanations to the findings from the other method (and vice versa) (Bryman, 2004). Additionally, a theoretical framework used to guide the analysis of text data (e.g. from interviews) can help to understand and interpret findings on a more abstract level and may, therefore, contribute to a potential explanation of the findings. Here we have used the Continuity theory (Atchley, 1989; 1999) and Harré’s framework of Selfhood (1998) to interpret the results. These theories will be introduced in the following section.

**Selfhood and continuity in dementia**

Harré’s theoretical framework of Selfhood (1998) has its origin in social constructionism and has been used in several studies involving people with dementia to illuminate manifestations of selfhood (Hedman et al., 2013; Kelly, 2010; Olsson et al., 2013; Sabat, 2002; Sabat et al., 1999). According to this framework, individuals interact with others to construct meaning in life. Selfhood is constructed and reconstructed in an on-going process and, therefore, has implications for how people cope with illness (Caddell et al., 2010).

In this framework, the selfhood is regarded as comprising three aspects of self. To have a sense of self is to be able to express these three aspects of self with its own characteristics. The first form is the self of personal identity, which in speech can be manifested by the use of “I”, “me”, “mine”, “ours” etc. and constitutes the subjective experience of being a person. From this point, individuals can relate to themselves and to others. This form of self has been shown to persist even in the moderate-severe stages of dementia (Caddell et al., 2010). The second form is the self of individuals’ physical and mental attributes and their beliefs about these characteristics (e.g. traits, skills). In contrast to the first form of self, the attributes attached to a person, for example, an ability to do certain activities, and beliefs in those abilities, undergo changes during the course of dementia (Hedman et al., 2013; Olsson et al., 2013). The third form of selfhood is the self of social roles (i.e. social persona) that we construct in varying situations during our lifetimes. It comprises the different ways people display themselves to others and the way in
which others perceive a person. This aspect of selfhood is severely threatened when a person is diagnosed with dementia, primarily because of the reactions and behaviour of others (Clare, 2003; Harré, 1998).

Dementia can hence pose a threat to individuals’ different aspects of selfhood (Steeman et al., 2006). People in the early stages of AD have described attempts to balance a wish to maintain a prior (healthy) self, with a need to construct a new (adapted) self because of the impact of dementia (Pearce et al., 2002). The first strategy older adults use when trying to adapt to changing circumstances in life, is often to strive to achieve continuity. According to the Continuity theory developed by Achtley, people adapt by preserving a sense of continuity in internal and external structures (Atchley, 1989; 1999). Continuity of both ideas and lifestyle is hence of key importance. According to this theory, older adults strive to establish an external life situation that supports continuity of their internal ideas of their self and life, despite changes in health and social circumstances. Thus, they can experience continuity and change of selfhood simultaneously (Caddell et al., 2011; Hedman et al., 2013; Åberg et al., 2005).

The framework of Selfhood and the Continuity theory are closely related, as the selfhood of a person provides continuity with the former life at the same time as it is under constantly revision through interactions with others. In the present work, Harré’s framework of Selfhood, was mainly used in the analysis and interpretation of interview findings in Study IV, but also for conducting a comprehensive interpretation of results from all four studies in this thesis in the General discussion and the Clinical reflections sections. The Continuity theory was used to illuminate interview and observation findings as a complement to the framework of Selfhood, and both were adopted for the comprehensive interpretation displayed in the General discussion and the Clinical reflections sections.

**Ethical considerations**

The Regional Ethical Review Board in Uppsala approved the studies in this thesis.

There are ethical issues in research involving people with dementia which have to be considered. One main issue is that an individual with cognitive impairments may have difficulties to give his/her consent to participate based on the given information. Therefore, a range of precautions were taken to ensure that participating would not be experienced as harmful. These will be described in the following paragraph.

In Study I, the physicians at the Memory Clinic at the Uppsala University Hospital identified two potential couples according to the inclusion criteria. Both couples accepted to participate and gave their oral informed consent. During the inclusion process in Studies II and III, a consecutive inclusion was made from patients with AD at the Memory Clinic. Potential partici-
pants were identified by a review of the records. The physicians gave their
clearance before patients were contacted. At the first phone contact, the po-
tential participant and the spouse were briefly informed about the longitu-
dinal project. If they accepted, written information was sent to them. A week
after the phone contact, they were approached again, additional information
was given and a time for inclusion assessment was booked if they accepted.
Both participants and spouses were questioned and gave their informed oral
and written consent that the person with AD would participate in the study.
This was made in order to ensure that participating in the longitudinal study
would not increase the caregiver burden or expose the participants to harm.

A purposive selection of participants in Studies II and III was made for
inclusion to the interview study (Study IV). Potential participants were con-
tacted by phone or in person, and a similar procedure as described above was
performed. The participants chose whether the interview would take place in
their homes or at the Uppsala University Hospital. All interviews were per-
formed in privacy, without the partner being present.

During all test procedures and interviewing, efforts were made to make
sure that the participants felt comfortable and relaxed. Before each yearly
follow-up, the participants and the spouses were contacted by phone. They
were reminded that participation was voluntary and that they could terminate
it (if they wished to) without explaining why. If they accepted to continue, a
visit time was booked.

Participants

All participants with AD were recruited at the Memory Clinic at the Uppsala
University Hospital. The AD diagnosis fulfilled the current research criteria
of probable AD according to DSM-IV-TR (APA, 2000), and NINCDS-
ADRDA (McKhann et al., 1984). The inclusion criteria for the participants
with AD were: Mini-Mental State Examination (MMSE) score of 20-30
(Folstein et al., 1975), Functional Assessment Staging (FAST) stage 3 or 4
(indicate “early dementia” and “mild dementia”, respectively) (Reisberg,
1988), age 80 years or younger, and community dwelling with a cohabitant.
All participants were capable to walk without a walking aid (Åberg et al.,
2003), and had no other illnesses, injuries or pain that substantially affected
mobility. An overview of the participants’ characteristics is displayed in
Table 1, and an overview over the Studies I, II, III, and IV is displayed in
Table 2.
<table>
<thead>
<tr>
<th>Study</th>
<th>Main focus</th>
<th>Approach</th>
<th>Participants</th>
<th>MMSE score Md (range)</th>
<th>Data collection methods</th>
<th>Data analysis methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Subjective experiences of people with AD and cohabitants</td>
<td>Qualitative case study and cross sectional</td>
<td>Two men with AD, age 74 and 63 and their two female spouses</td>
<td>AD: 21 p and 22 p</td>
<td>Individual in-depth interviews</td>
<td>Thematic analysis</td>
</tr>
<tr>
<td>II</td>
<td>Cross sectional differences, and longitudinal changes of walking capacity and physical activity levels</td>
<td>Quantitative, cross sectional, and longitudinal</td>
<td>25 people with AD, age 73 (55-79), 14 male/11 female* 25 healthy controls, age 70 (56-79), 14 male/11 female</td>
<td>AD: 25 (21-30) p Healthy controls: 30 (28-30) p</td>
<td>Measurements of walking capacity, physical activity level, cognitive function Observations of dual-task walking performance Reports of falls</td>
<td>Descriptive statistics Non-parametric statistics Between and within subjects comparison</td>
</tr>
<tr>
<td>III</td>
<td>Longitudinal changes in gait function during single and dual-tasking</td>
<td>Quantitative and longitudinal</td>
<td>21 people with AD, age 72 (55-78), 10 male/11 female</td>
<td>AD: 25 (21-30) p</td>
<td>Laboratory based gait analysis by a motion capture system</td>
<td>Descriptive statistics Parametric statistics Non-parametric statistics (double support, correlations) Within subjects comparison Visual examinations of motion capture files</td>
</tr>
<tr>
<td>IV</td>
<td>Subjective experiences of people with AD</td>
<td>Qualitative and cross sectional</td>
<td>14 people with AD: age 72 (59-79), 6 male/8 female</td>
<td>AD: 23.5 (21-30) p</td>
<td>Individual in-depth interviews</td>
<td>Qualitative content analysis</td>
</tr>
</tbody>
</table>

AD= Alzheimer’s Disease, MMSE=Mini-Mental State Examination, * Drop outs in the 2-year follow-up: n=3
Table 2. Performance based test of walking capacity and cognitive function.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Reported in Study</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 m comfortable walking test (m/s)</td>
<td>II, IV</td>
<td>The participant starts from a standing position and walks 10 m at comfortable walking speed. Timing starts when one foot moves in order to take a step, and stops when the finishing line is touched or crossed by the leading foot.</td>
</tr>
<tr>
<td>6-minute walking test (m)</td>
<td>II</td>
<td>The participant is instructed to walk back and forth along a 30 m hallway as far as possible during 6 minutes. Information is given when half-time has elapsed, when one minute is left, and when six minutes have elapsed. Encouragement is given once, after one minute of walking.</td>
</tr>
<tr>
<td>Timed Up-and-Go test (s)</td>
<td>II, IV</td>
<td>The participant sits on a chair with arm rests, and is instructed to walk at her/his comfortable speed for 3 metres, passes a tape marker on the floor, turns around, walks back and sits down. Timing starts when the subject’s back leaves the back of the chair and stops when the bottom touches the seat.</td>
</tr>
<tr>
<td>Timed Up-and-Go dual-task test (s)</td>
<td>II, IV</td>
<td>The participant performs the TUG test (see above) and simultaneously performs a cognitive task at a self-selected pace (i.e. recited names or animals). Here only the naming animal task will be presented. They are instructed to prioritize the walking task.</td>
</tr>
<tr>
<td>Clock Drawing test (score)</td>
<td>II, III</td>
<td>Assesses visuospatial function, semantic memory, and planning. The participant set numbers and hands showing “ten minutes to two” on a clock face.</td>
</tr>
<tr>
<td>Verbal Fluency test (number)</td>
<td>II, III</td>
<td>Assesses semantic memory and language. The participant names as many animal words as possible during 60 s.</td>
</tr>
<tr>
<td>Trail Making Test A (s)</td>
<td>II, III</td>
<td>Assesses executive function; visual attention, executive and psychomotor speed. On a paper with 25 numbered circles, the participant draws a line from 1 to 25 as fast as possible.</td>
</tr>
</tbody>
</table>
Participating couples in Study I
Two community-dwelling men with mild AD were recruited to participate in a qualitative case study along with their spouses. In addition to the criteria mentioned above, the men and their spouses were considered to have relevant contributions to make regarding the questions addressed in the study, and regarded as capable of holding a conversation for at least half an hour. Based on these criteria the physicians at the Memory Clinic suggested two couples. They were subsequently invited and both agreed to participate.

Participants in Studies II – IV
The participants in Studies II, III, and IV were based on a sample of 25 individuals with AD (Table 1). They were recruited consecutively during 20 months from the Memory Clinic at the Uppsala University Hospital. Of the 48 individuals with AD who fulfilled the inclusion criteria according to the medical records, 19 declined participation because of lack of time, long travelling distance to the hospital, or other reasons not mentioned. The remaining 29 eligible individuals underwent a brief examination, and it was found that three of them no longer fulfilled the inclusion criteria, and another one withdrew consent to participate. Thus, 25 individuals with AD were included to participate in the longitudinal project (Studies II and III).

At baseline, the 25 participants with AD were compared with 25 cognitively healthy age and group-matched controls to reflect the baseline status of the participants with AD. Nineteen of the healthy controls were recruited from a register of cognitively healthy people 65 years of age or older. They had previously consented to participate in clinical research at the Memory Clinic. The six cognitively healthy controls, younger than 65 years of age, were recruited from the staff at a Geriatric Clinic. The healthy controls scored 28-30 points on the MMSE (Folstein et al., 1975), and 1 or 2 on the FAST (indicate “normal adult” and “normal older adult”, respectively) (Reisberg, 1988).

Twenty-two of the 25 participants with AD completed the two-year period including clinical measurements of walking capacity and physical activity levels (Study II), and 21 of the 25 participants with AD completed the two-year study period including gait analysis in the motor laboratory (Study III). Twenty one of the 22 participants were still community-dwelling at the two-year follow-up. Reasons for discontinuation were severe illness other than AD (n=2), cohabitant’s occupation (n=1) or severity of dementia (n=1).

A purposive sample (Bryman, 2002) of 14 people with AD was selected from participants included in Studies II and III, to participate in individual in-depth interviews. These 14 individuals were selected with the intention to achieve a wide variation with regards to age, gender, physical activity level, dependency in activities, residence, and education level.
Data collection and analysis

Study I – A qualitative case study

Data on the four participants’ experiences and perceptions related to different aspects of physical activity were collected by individual in-depth interviews. An interview guide with open-ended questions was used. The areas of questioning dealt with how the participants felt that the AD had influenced the men’s ability to be physically active and the participants’ thoughts about the importance of physical activity. Two interviews and two participant observations were made with each man with AD. Their spouses were interviewed once each. Each interview lasted for 45-60 minutes. The interviews were carried out in privacy without the spouse being present. Data collection for each couple lasted for about a month. The interviews were tape recorded and then transcribed verbatim. The participant observations were carried out in their home environment during physical activities they normally did several times a week. Suitable times were chosen in agreement with the participants and the observations lasted 45-120 minutes. During the participant observations, the men’s ability to perform physical activities in everyday life was observed. Field notes were taken during the observations, and immediately afterwards summarized into a written text.

The written text material from in-depth interviews and participant observations was analysed according to the thematic analysis guidelines described by Braun and Clarke (2006). However, in the following, the terms of the identified patterns will follow the terminology outlined by Graneheim & Lundman (2004, 2008), which was the analysis method applied in Study IV. Thereby, comparisons and relations between the findings in Studies I and IV can be carried out more easily. Thus, the analysis concept category is composed of codes with a similar content and refers to analysis patterns of text data on a descriptive and low abstraction level (manifest content). A category answers the question “What?”. Accordingly, the concept theme reflects the connection thread in two or more categories and links the underlying meaning together on an interpretive level, i.e. an analysis of the latent content. A theme answers the question “How?”

The analysis involved repeated reading of the text material and coding of important features into potential categories. This stage was followed by a preliminary identification of categories and sub-categories based on analysis and interpretation of the entire data set. The main supervisor (AC Åberg) and Y Cedervall held repeated peer debriefings to explore various aspects of the preliminary findings, and to refine the interpretations and definition of categories. The analysis and interpretations were performed both on a descriptive and on a more comprehensive level. Finally, categories and sub-categories relevant to the aim of the study were confirmed, named, and then considered
in relation to theoretical perspectives and findings from other studies. Multiple triangulations (i.e. method-, time-, space-, and person-triangulation) (Polit et al., 2008), were used to enable a thick description and provided a basis for establishing trustworthiness

**Study II – Clinical measurements and observations**

The data was collected on three occasions; at baseline, and after one and two years (Figure 2). The participants with AD and the healthy controls completed five walking capacity tests (Table 2): the 10 m comfortable walk test (Watson, 2002), the 6-minute walk test (Bean et al., 2002; Steffen et al., 2002), and three different types of the TUG test (Podsiadlo et al., 1991; Shumway-Cook et al., 2000). The TUG tests were performed in the following order: one TUG single-task and two types of TUG dual-task (naming names and naming animals). We will here present results only from the TUG dual-tasks naming animals because this dual-task type had the greatest impact on walking capacity. The participants’ need for verbal cueing during TUG-testing was recorded as present or not present. Verbal cueing was recorded as present if the participant needed instructions to turn around, to sit down, or if he/she asked questions about how to perform the test during testing. No verbal cueing was given to encourage the participants to walk faster, to continue to walk if they hesitated, or if they made occasional stops during walking. The 10 m walk test was chosen to assess general physical function, the 6-minute walk test to assess endurance and walking capacity, and the TUG tests to assess basic mobility and capacity to divide attention when walking. These are reliable measures for use on individuals with AD (Ries et al., 2009; Suttanon et al., 2011).

In addition, measurements of aerobic activity level (Ainsworth et al., 1993, 2000; Nelson et al., 2007) were applied in the AD- and in the control group. Physical activity level was assessed by diary registrations of aerobic activities (Bryman, 2004; Nelson et al., 2007; WHO, 2010). In the AD group, the cohabitants performed or supervised the registrations. The recorded activities were then classified according to the coding scheme proposed by Ainsworth et al. (1993, 2000) as a basis, related to public health recommendations, and then quantified by calculating estimated minutes of aerobic activity/week (moderate intensity or higher) and number of days/week with 30 minutes of aerobic activity (moderate intensity or higher).

Falls the previous year were registered. A fall was defined as an event which results in a person coming to rest inadvertently on the ground or floor or other lower level (Lamb et al., 2005). In the AD group, cohabitants reported participants’ falls.

The AD group completed four cognitive tests (Table 2): the MMSE (Folstein et al., 1975), the Clock Drawing test (Freedman et al., 1994), the Verbal Fluency test (Solomon et al., 1998), and the Trail-Making Test A (Lezak, 1995). The control group completed the MMSE.
**Statistical analysis**

Non-parametric statistics were applied because of the small sample size and data on ordinal levels. Cross-sectional differences at baseline between the AD group and the control group were calculated by the Mann-Whitney U-test (continuous variables), and Fisher’s test (categorical variables). Longitudinal differences in the AD-group in walking capacity, aerobic activity level and cognitive function were calculated using Friedman’s test. The Wilcoxon signed-rank test was used for post hoc pair wise analyses on differences during the follow-up period. Correlations between walking capacity and cognitive function were assessed by Spearman’s rank correlation coefficient. All tests were two-tailed. The level of significance was set at p<0.05, except for post hoc pair wise comparisons, where significance was p<0.025 to adjust for multiple comparisons. The percentage time differences (dual-task cost) between mean time of TUG single- and dual-task were calculated.

**Study III – Gait parameter measurements and gait observations**

The data collection was conducted on three occasions, at baseline, and one and two years (Figure 2). A Qualisys® motion capture system, which is a three-dimensional optical gait analysis system, was used. The standard marker set-up at the motor laboratory of the Uppsala University Hospital included 18 reflecting markers applied on defined anatomical landmarks (Figure 3). The marker set up was developed at the Lundberg Motion Analysis Laboratory at Sahlgrenska University Hospital, Sweden. A six camera Pro Reflex® system recorded the position of the markers at a sampling frequency of 240 Hz and low-pass-filtered with a cut off frequency of 6 Hz. At each gait occasion, the following gait parameters were computed: gait speed (m/s), step width (m), step length (m), step height (m), and double support (seconds spent with both feet on the ground). The participant walked barefoot a distance of approximately 7 metres. Data on gait parameters were collected from the middle part (approximately 3 metres). All gait parameters were examined at the participant’s comfortable gait speed during three different conditions in the following order: five single-task trials, three dual-task trials naming names, and three dual-task trials naming animals. Here only the dual-task test, naming animals will be presented because this dual-task type had the greatest impact on gait.

A brief explanation of the test procedure and instructions on how to walk during the tests were initially given to the participants in a narrative way. Thereafter, standardized instructions were given before each of the trials. If necessary, repeated instructions were given. The participants were instructed to prioritize the motor task during the dual-task trials (i.e. continue walking even if they did not come up with any words).
Figure 3. The marker set-up during gait testing in the motor laboratory (the person is not a participant in the study, and he has given us his permission to use the photo).

The marker placement
Shoulder
Thoracic vertebrae 12
Sacrum
Anterior superior iliac spine
Superior part of the patella
Knee joint line
Tuberosity of the tibia
Lateral malleolus
Toe
Heel

Data processing
The data was processed using the software Visual 3D (C-Motion Inc., Germantown, DM, USA) and gait parameters were computed according to the developed Qualisys® motion capture system. The first single-task trial was considered a practice round and therefore excluded from the statistical analysis. Thus, the statistical results presented here are based on mean values of 3-4 steps in the middle part of each trial of four single-task trials and three dual-task trials naming animals. The visual examinations are based on all available motion capture files for each participant.

Statistical analysis
All parameters were normally distributed except double support. Therefore, parametric statistics were applied for calculating longitudinal differences in gait speed, step width, step length and step height (repeated measures ANOVA). Non-parametric statistics were applied for longitudinal differences in double support (Friedman’s test). For cross-sectional analysis of differences between single- and dual-task gait parameters, the paired samples t-test was used for normally distributed gait parameters, and the Wilcoxon signed-rank test for double-support. The Spearman’s rank correlation coefficient was
used to assess correlations between gait parameters and cognitive function. All tests were two-tailed. The levels of significance were set to p<0.05 for cross-sectional and longitudinal differences. The cross-sectional dual-task cost percent was calculated between single-task gait parameters and dual-task gait parameters (see Abbreviations and definitions). The Bonferroni method was used to correct for multiple comparisons of normally distributed gait parameters, and the Wilcoxon signed-rank test for post hoc tests of double support time (p<0.025 to adjust for multiple comparisons). To minimize the risk of type 1-error, the significance for correlations was set at p<0.01.

**Systematic visual examination**

A systematic visual examination of all motion capture files was performed, with the intention of comparing gait patterns at single- and dual-tasking. The visual examination comprised scrutinizing all the motion capture files (i.e. each gait trail) several times from different angles and at different gait speeds. A preliminary classification of the characteristics of the different dual-task gait disturbances was performed. Thereafter, the different types of gait disturbances were compared with each other, and the preliminary classification was refined. During the analysis process, repeated peer debriefings were held between the main supervisor (AC Åberg) and Y Cedervall. Finally, a classification of dual-task gait disturbances was determined.

**Study IV – Subjective experiences of people with AD**

Data collection consisted of two individual in-depth interviews within a month with each of the 14 participants. The interviews were performed in private. The informants decided if the interviews would take place in their homes or at the Uppsala University hospital. An interview guide with open-ended questions was used as a basis. The guide covered questions regarding the participants’ experiences about how the ability to be physically active had been influenced by the dementia and their thoughts related to physical activity. A free narration was encouraged and the initial questions were followed by probing questions. At the second interview in the set, focus was on obtaining clarifications and deepening the understanding of the experiences and thoughts expressed in the first interview, and to touch areas that were not commented upon or only briefly mentioned during the first interview. Each interview lasted 30-60 minutes. The interviews were tape recorded and thereafter transcribed into written text. A qualitative content analysis was used to analyse and interpret the manifest and latent content (Graneheim et al., 2004; Lundman et al., 2008).

The qualitative content analysis started with repeated readings of all the transcribed text data. Preliminary thoughts and analysis ideas were noted and used as a starting point for the analysis and interpretation. Meaning units (one or two sentences) related to the aim were identified and coded (short
description of the content). Codes with a similar content were grouped into preliminary descriptive sub-categories. They were checked and compared against the text of origin in an on-going process and finally grouped into four descriptive categories. Thereafter, an analysis of the latent content was conducted. During this phase of the analysis process, the data was interpreted at a higher abstraction level to identify underlying connecting thoughts in two or more categories. Preliminary interpretations were checked and compared with the text of origin several times and finally three sub themes and one overarching theme were identified, which constituted a plausible interpretation of the role physical activity plays for individuals with AD. In order to establish trustworthiness, repeated peer debriefing sessions were conducted during the analysis process. The co-authors (S Torres and AC Åberg) acted as peers to Y. Cedervall, who was the primary coder.
Results

In the following, the main results from Studies I, II, III, and IV will be presented. They all reflect different perspectives on how the ability to be physically active is affected in the early stages of AD. To explore the diverse aspects and further understanding, three main strategies were used, namely, exploring by measurements (Studies II and III), observation (Studies I, II, and III), and sharing the participants’ subjective experiences (Studies I and IV). In Studies I and IV descriptive statistics on the participants’ cognitive function were reported, and in Study IV the text data were complemented by data on walking capacity, gait function, and aerobic activity levels (see Table 1 and 2 for an overview).

Study I - A qualitative case study

Three central categories that described the participants’ experiences related to physical activity and their perceptions of the importance of physical activity were identified: 1) Physical activity as health reinforcement; 2) Barriers to physical activity; 3) Adaptation strategies (Figure 4).

![Figure 4](image-url)  
*Figure 4.* Three categories describing experiences related to the ability to be physically active and the perceived importance of such activity.
Physical activity such as walking was described as an important routine in everyday life for the two men with AD. Important driving forces for them were enjoyment of nature and body movement, and positive attitudes towards physical activity in general. The spouses said that their husbands benefited from taking walks, in particular by gaining increased well-being but they also expressed opinions on the importance of being physically active in general. Despite the positive experiences and perceptions regarding physical activity, all four participants mentioned several barriers to it, caused by the dementia. However, the men with AD did not appear to dwell on these barriers to the same extent as their spouses.

One main barrier was tiredness, which restricted the activity level of both men during the day. Along with tiredness, difficulties in finding the way seemed to be a significant barrier. The picture, however, was contradictory. On the one hand, both spouses talked about the difficulties their husbands had in finding the way, and on the other hand, both men took outdoor walks on their own almost daily. None of the men showed any difficulties to find the way on their routine walks during the participant observations. The spouses and one of the men additionally spoke about “peculiar behaviour” among the men that was considered incomprehensible. This “peculiar behaviour” referred difficulties in adjusting the body to the environment (e.g. walking straight into objects, standing in the way). Impaired walking ability was mentioned by one of the two couples as a barrier and included a deterioration of balance and endurance, but this was only partly confirmed during the observations.

The spouses expressed their opinion that their men benefited from outdoor walks and that the walks contributed in making their day meaningful. Therefore, the spouses made considerable practical and mental adjustments in everyday life to enable their husbands to stay physically active. Practical adaptation strategies consisted of, for example, security routines to overcome risks for the men getting lost, and mental strategies to take things one day at a time and not to worry in advance.

Study II – Clinical measurements and observations

Cross-sectional results
At baseline, the AD group had a significantly lower walking capacity and cognitive function than the healthy control group (e.g. Md. walking speed 1.11 vs. 1.32 m/s, MMSE 25 p vs. 30 p, p<0.001), but comparable levels of aerobic activity (Md. 335 vs. 340 minutes/week, p=0.564). In both groups, 20 out of 24 (missing data n=1) (83%) reached the public health recommendations of aerobic activity. The TUG dual-task cost was 89% in the AD group and 11% in the control group. However, there were no significant correlations between walking capacity tests and cognitive function tests at
baseline in the AD-group. Eight participants with AD needed verbal cueing to complete the TUG test but only one in the control group. For the TUG dual-task, 12 participants in the AD group needed verbal cueing but none in the control group. In the AD group, three participants had experienced one fall during the last year. In the control group, 10 participants had fallen once or twice during the same period.

Longitudinal results
Twenty-two of the 25 participants with AD completed the two-year study period and their results were included in the longitudinal calculations (Table 3). During the two-year follow-up period, walking capacity declined in the AD group when assessed by the 10 m walk test, 6-minute walk test, and TUG single-task. Additionally, cognitive function declined significantly, but aerobic activity levels did not change significantly. Thirteen out of 21 needed verbal cueing during the TUG single-task test (without a cognitive task). No significant difference was observed in the TUG dual-task, but five participants with AD were not able to perform the test despite verbal cueing regarding performance (i.e. “turn around”, “sit down”). The difficulties were due to cognitive impairments. Of the 17 participants completing the TUG dual-task on all three occasions, 10 individuals required verbal cueing to complete the task. In comparison, moderately significant correlations were detected only between the TUG dual-task and the MMSE (\(r_s=-0.567, p=0.014\)) and the clock drawing test (\(r_s=-0.579, p=0.019\)), but not between any other of the walking capacity and cognitive tests.

The rate of falls in the AD group did not change significantly during the follow-up period.

Study III – Laboratory-based gait measures and observations
There was a significant decline in gait speed and step length during single- and dual-tasking (Table 3). Dual-task cost was marked at baseline, but appeared to remain on a stable level during the study period. However, the cross-sectional differences between single- and dual-tasks gait parameters were significant for all comparisons, except the one-year follow-up values for step width (see Figure 5 for gait speed).
Figure 5. The cross-sectional differences between gait speed single-task and dual-task (m/s). The differences are significant for comparisons between single-task and dual-task on all three occasions.

Systematic visual examination of the motion capture files revealed three different characteristics of gait disturbances that only occurred during dual-tasking (see Appendix): 1) Temporal disturbance, 2) Spatial disturbance, and 3) Instability in single stance. Temporal disturbance consisted of occasional stops in single or double stance, Spatial disturbance comprised variable step length, step width or deviating direction, and Instability in single stance correction of the stance foot position in single stance. Twelve participants showed at least one specific type of gait disturbance at baseline, but the number did not increase during the study period (n=10, n=10). However, there was a tendency of an increase in showed gait disturbances during the study period (16/15/18). It is to be noted that the prevalence of a specific type of gait disturbance was not consistent, but occurred irregularly. The most common types of gait disturbances were occasional stops in double stance, variable step width/deviation direction, and variable step length.
Table 3. Longitudinal differences in participants with Alzheimer’s disease concerning walking capacity, aerobic activity levels, and gait parameters (Study II and III).

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Baseline Md (range)</th>
<th>One-year follow-up Md (range)</th>
<th>Two-year follow-up Md (range)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mini-Mental State Examination score (0-30), Md (range)</strong></td>
<td>21</td>
<td>25 (21-30)</td>
<td>22 (16-29)</td>
<td>20 (9-28)</td>
<td>&lt;0.001a,b</td>
</tr>
<tr>
<td><strong>Walking capacity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 m comfortable walk test (m/s)</td>
<td>22</td>
<td>1.11 (0.83-2.0)</td>
<td>1.11 (0.5-1.43)</td>
<td>1.08 (0.48-1.43)</td>
<td>0.022c</td>
</tr>
<tr>
<td>6-minute walk test (m)</td>
<td>22</td>
<td>494 (344-712)</td>
<td>445 (174-703)</td>
<td>430 (160-616)</td>
<td>&lt;0.001a,b</td>
</tr>
<tr>
<td>TUG single-task (s)</td>
<td>21</td>
<td>11 (8-14)</td>
<td>12 (9-30)</td>
<td>12.5 (9-27)</td>
<td>0.020a,b</td>
</tr>
<tr>
<td>TUG dual-task (s)</td>
<td>17</td>
<td>17 (12-39)</td>
<td>17 (12-70)</td>
<td>22 (12-83)</td>
<td>0.137</td>
</tr>
<tr>
<td>TUG difference</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>dual-task – single-task (s)</td>
<td>17</td>
<td>7 (-1-25)</td>
<td>6 (81-53)</td>
<td>11 (-1-57)</td>
<td>0.459</td>
</tr>
<tr>
<td>dual-task cost (%)</td>
<td>17</td>
<td>79</td>
<td>84</td>
<td>96</td>
<td></td>
</tr>
<tr>
<td><strong>Aerobic activity level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>minutes/week (minutes)</td>
<td>21</td>
<td>332 (8-945)</td>
<td>285 (10-670)</td>
<td>270 (10-600)</td>
<td>0.711</td>
</tr>
<tr>
<td>days/week with aerobic activity ≥ 30 minutes (days)</td>
<td>21</td>
<td>5 (0-7)</td>
<td>4.5 (0-7)</td>
<td>4 (0-6.5)</td>
<td>0.308</td>
</tr>
</tbody>
</table>

Table 3 continued on page 43.
Table 3 continued from page 42.

<table>
<thead>
<tr>
<th>Gait parameters</th>
<th>n</th>
<th>mean±SD</th>
<th>mean±SD</th>
<th>mean±SD</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Single-task</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gait speed (m/s)</td>
<td>21</td>
<td>1.14 ± 0.14</td>
<td>1.10 ± 0.15</td>
<td>1.01 ± 0.20</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Step length (m)</td>
<td>21</td>
<td>0.62 ± 0.07</td>
<td>0.60 ± 0.07</td>
<td>0.57 ± 0.09</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Step width (m)</td>
<td>21</td>
<td>0.08 ± 0.02</td>
<td>0.08 ± 0.02</td>
<td>0.09 ± 0.02</td>
<td>0.801</td>
</tr>
<tr>
<td>Double support (s)</td>
<td>21</td>
<td>0.27 ± 0.06</td>
<td>0.26 ± 0.07</td>
<td>0.29 ± 0.08</td>
<td>0.008</td>
</tr>
<tr>
<td>Step height (m)</td>
<td>21</td>
<td>0.22 ± 0.02</td>
<td>0.21 ± 0.02</td>
<td>0.21 ± 0.02</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Dual-task</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gait speed (m/s)</td>
<td>21</td>
<td>0.74 ± 0.22</td>
<td>0.76 ± 0.27</td>
<td>0.64 ± 0.22</td>
<td>0.007</td>
</tr>
<tr>
<td>Step length (m)</td>
<td>21</td>
<td>0.57 ± 0.09</td>
<td>0.55 ± 0.09</td>
<td>0.51 ± 0.11</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Step width (m)</td>
<td>21</td>
<td>0.09 ± 0.03</td>
<td>0.09 ± 0.04</td>
<td>0.10 ± 0.03</td>
<td>0.117</td>
</tr>
<tr>
<td>Double support (s)</td>
<td>21</td>
<td>0.50 ± 0.32</td>
<td>0.43 ± 0.19</td>
<td>0.49 ± 0.18</td>
<td>0.012</td>
</tr>
<tr>
<td>Step height (m)</td>
<td>21</td>
<td>0.21 ± 0.002</td>
<td>0.20 ± 0.02</td>
<td>0.20 ± 0.03</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Friedman’s test was used to calculate differences in walking capacity, aerobic activity level, and double support. Post hoc pairwise differences were calculated by the Wilcoxon signed-rank test. Repeated measures ANOVA was used to calculate differences for all other gait parameters (corrected for multiple comparisons by Bonferroni). *Significant differences between baseline and 2-year follow-up. †Significant differences between baseline and 1-year follow-up. ‡Significant differences between 1-year follow-up and 2-year follow-up.
Study IV - Subjective experiences of physical activity in individuals with AD

The analysis of the interview data from the 14 participants with AD revealed three sub-themes that reflected interrelated perspectives on how people with mild AD reason about physical activity as part of everyday life (Figure 6). Specific focus was put on their ability to be physically active, and the meaning they attached to physical activity: Sub theme 1) *Striving to be physically active*, mirrors the participants’ approaches to cope with dementia-related barriers to physical activity by different strategies; Sub-theme 2) *Understanding in favour of physical activity*, reflects how their thoughts and beliefs regarding written and tacit norms encouraged them to remain physically active, and Sub-theme 3) *Physical activity as a means to well-being*, refers to how emotions and feelings related to the performance of physical activity inspired them to remain physically active. These emotions and feelings seemed to be achieved by movements in themselves and also by being outdoors while performing them.

![Figure 6](image)

*Figure 6.* The three sub-themes illustrating interrelated perspectives on how people with mild Alzheimer’s disease reason about physical activity, and one overarching theme that mirrors the common thread in the sub-themes interpreted against Harré’s framework of selfhood: Physical activity as a means of selfhood maintenance.

An analysis of the underlying meaning in the sub-themes revealed one overarching theme that tied these three sub-themes together. This main theme emerged when the sub-themes were interpreted against Harré’s framework on selfhood: Physical activity as a means of selfhood maintenance. This main theme indicated that people with AD use physical activity as a means
to shift the focus from attributes and social roles associated with the dementia diagnosis to activities and behaviours that could be considered associated with a healthy life. One of the participants described her views on this matter.

“No, I think that keeping going is good for my whole mental state. I can tell. I feel so alive when I walk outside and manage on my own. So it’s, well, it feels really good, and then I don’t have that feeling that I’m ill.”

This quote can be interpreted as a statement that her ability to take walks independently gave her a sense of continuity in her selfhood. Thus, the findings suggest that physical activity may be highly valued in AD as it puts the focus on continuity in aspects linked to a healthy life, and that physical activity can constitute a means of sustaining well-being and selfhood in mild AD.
Methodological considerations

Sampling

One main concern in this work is the study sample. The participants with AD were recruited to participate in a longitudinal study exploring different aspects of physical activity. The participants, and their cohabitants, may therefore have been specifically engaged in physical activity. Thus, it is possible that the participants were systematically different from other individuals with AD. However, the inclusion criteria did not comprise any specific claims about physical activity levels, or interest in physical activity. Still, a specific interest for physical activity may have influenced the positive attitude towards physical activity reported in Studies I and IV. On the other hand, the numeric data on aerobic activity levels (Study II) enabled a purposive selection of informants for Study IV with a wide variety of physical activity levels ranging from less than 10 minutes a week to 10 hours a week. Therefore, the findings in Study IV are based on interviews with both physically inactive and active participants.

The high level of education in the AD and in the control group was another factor that might have influenced the participants’ physical activity level and cognitive function. The level of education may explain why the participants in both groups reported higher aerobic activity levels than the general population (FHI, 2010).

Additionally, all participants with AD were community-dwelling with a cohabitant, and may therefore have been more active in everyday life than individuals with AD dwelling alone. It would not have been possible, however, to have conducted the research project without a supporting cohabitant. It is to be noted that, despite the relatively high reported aerobic activity level in the AD group, they had a significantly lower cognitive function and walking capacity than the healthy controls. Moreover, the deteriorated cognitive function and walking capacity continued to decline during the study period.

The small sample sizes in Studies II and III is a limitation, which restricts the possibility of generalizing the results from these studies to a larger population. The study group was, however, comparable to previous cross-sectional studies that have demonstrated significant differences in walking capacity and gait function between people with mild AD and healthy controls (Ijmker et al., 2012; Maquet et al., 2010; Muir et al., 2012; Pettersson et
al., 2007), and significant changes of gait function during a one-year period among people with mild to moderate AD (Wittwer et al., 2010). It is likely that the lack of significant correlations between cognitive functions, gait parameters, and walking capacity could be due to the small sample size, in addition to the drop out of participants unable to perform some of the cognitive tests and the TUG tests at the two-year follow-up.

Data collection

Aerobic activity level

Our decision to use diary registration to measure aerobic activity levels was based on previous studies in which the questionnaires Physical Activity Scale for the Elderly (Burns et al., 2008) and the Frenchay Activity Index (Pettersson et al., 2002) were used. Both scales showed a decreased level of physical activity among people in the early stages of AD, but at the same time indicated a reasonable level of physical activities such as walking. A suggested explanation for the contradictory picture could be that questionnaires such as those mentioned above commonly reward regular performance of a wide variety of physical activities. There is hence a risk that the habitual aerobic activity level of people with AD is underestimated, as individuals with dementia tend to cease complicated activities early in the course of the disease. We therefore wanted to explore if people in the early stages of AD may still be physically active, but with a limited range of activities.

A limitation with diary registrations, and questionnaires, is that it is not possible to obtain the exact intensity, duration and frequency of physical activities. A strength is that an overall picture of the different types of performed physical activities can be attained. A complementation with an objective measurement of physical activity, e.g. accelerometer, might have added interesting data to the diary registrations although accelerometers are insensitive to physical activities performed with the upper body, bicycling and swimming (FYSS, 2008). In order to ensure the validity of the diary registrations, careful instructions were given to the participants and the caregivers. The instructions included that the participants would continue with their habitual physical activities during the two-week registration period. Moreover, they were informed about what types of activities they would register, with regard to intensity and duration, i.e. activities of moderate intensity of bouts of at least 10 minutes. In addition, clarifications of recorded activities were obtained in direct dialogue with the caregivers and participants. The recorded activities were finally classified according to the coding scheme proposed by Ainsworth (1993, 2000) to estimate the intensity of the recorded physical activities and thereby validate data.
Ability to divide attention

Our intention regarding the dual-task tests (Studies II and III) was to examine how walking capacity and gait function are influenced by a relatively simple cognitive task, and what changes can occur over an extended period of time, i.e. two years. Longitudinal changes in dual-tasking have to our knowledge, not been previously explored in people with AD. Assessing dual-task ability might be a potential measurement to identify individuals who are at risk of falls during dual-task conditions. The participants were instructed to name animals at their self-selected pace and prioritize the walking task if they did not come up with any words. We used the self-selected pace when wording to minimize the stress on the participants, but still distract their gait. This method has previously been used in cross-sectional studies including individuals with mild AD (Camicioli et al 1997; Pettersson et al. 2005; Muir et al 2012). The same method was used during both the TUG dual-task test (Study II) and the gait testing in the motor laboratory (Study III). A structured recording of whether verbal cueing was given or not was performed during TUG testing to validate data (Study II), i.e. no cueing was given to encourage the participant to keep on walking if he/she hesitated or made occasional stops as this would have made it impossible to measure the “true” dual-task effect on the performance.

It is to be noted that even though the participants could choose the severity of the cognitive task (i.e. naming animals at a self-selected pace), and were instructed to prioritize the walking task, we noticed that the participants made occasional stops when they did not come up with any words. This was likely due to their impaired working memory, which made them forget to prioritize the walking task, and also due to an impaired ability to divide attention between a motor task and a cognitive task. Our experiences are in accordance with Suttanon et al. (2011) who found that 4 out of 14 individuals with mild-moderate AD in their study were unable to perform TUG cognitive, despite cueing.

During gait testing in the motor laboratory (Study III), no cueing was given because the motor task consisted of a straight walk (i.e. no turning or sitting down as in the TUG test). However, we frequently observed dual-task gait disturbances that only occurred during dual-tasking. Therefore, the numeric data obtained from the gait testing were complemented by a systematic visual examination of all motion capture files. Because of the observed dual-task gait disturbances during testing the purpose was to identify different characteristics of gait disturbances. During this procedure, all motion capture files were scrutinized several times, at different speeds and from different angles, which is an advantage in comparison to observing gait in “a real life situation”. A clear strength by complementing statistically calculated gait variability with a visual examination of motion capture files (including a descriptive classification and video illustrations of dual-task gait dis-
turbances), is that it provides a potential explanation to calculated dual-task gait variability in early-stage AD. Moreover, the characteristics of such disturbances can easily be communicated to health care professionals, researchers, caregivers and individuals with AD if illustrations are shown.

Comparison of the AD group’s gait function measured in the motor laboratory to a healthy control group might have been of benefit. However, in Study II the healthy controls did not demonstrate any signs of walking disturbances while performing the TUG dual-task test, even if the TUG dual-task seemed to be more challenging than dual-tasking in the motor laboratory. This was shown by higher dual-task costs in TUG tests and more participants in the AD-group unable to perform the TUG dual-task test at the two-year follow-up, in comparison to performance during gait testing in the motor laboratory.

**Fall registrations**

Falls were not a main focus of this project even though they are closely related to physical activity among people with AD (Beauchet et al., 2009; Gleason et al., 2009). The intention with the fall registrations was to reflect the number of falls in the study groups and relate them to aerobic activity levels, walking capacity, gait function and subjective experiences to achieve a comprehensive descriptive picture of the participants’ functioning. Unfortunately, it proved difficult to draw any conclusions from the fall data. The main reason was the problems involved in fall registration by self-reports (i.e. cohabitants) of community-dwelling people with early-stage AD as they often spend time alone during the days and may not remember if they have fallen or not. Therefore, the fact that participants in the control group reported more falls than were reported among the participants in the AD group raises some questions (Study II). Did the participants with AD fall more often than was reported? Did the healthy controls engage in more risky types of activities and were therefore exposed to situations where one might fall (although not captured by the diary registration of aerobic activity)? Or was the high fall frequency in the control group just a coincidence? Another explanation may be that the number of falls increases until later on in the course of AD. This was suggested by Wittwer et al. (2010) who investigated gait function and falls in people with mild-moderate AD and found an almost identical number of falls in the AD and control-group. However, Pitkälä et al. (2013) could demonstrate that physical exercises reduced the number of falls among community-living people with mild-moderate AD in comparison to a control group, by use of reports from informal participants/cohabitants.

As mentioned previously, there may be validity problems involved in the self-reporting of falls from community-dwelling people with dementia. Therefore, studies are warranted using technical devices (e.g. body-worn sensors) (Schwickert et al., 2013), which can capture falls in everyday life,
indoor as well as outdoor to enable the accurate evaluation of fall interventions among community-dwelling individuals with dementia.

Analyses
A qualitative approach was considered appropriate in Studies I and IV to answer the research questions furthering the understanding of experiences regarding the ability to be physically active from the perspective of individuals with mild AD and their cohabitants, and the meaning they attach to physical activity as part of their everyday life. Individual in-depth interviews are a feasible method of exploring the perspectives of people with mild AD (Clare, 2003; Hellström et al., 2007; Nygård, 2006). This method has become more common during the last decade and previous studies have shown that people with mild dementia are able to respond reliably to questions concerning, e.g. preferences, choices, feelings and other subjects related to quality of life (Feinberg, 2001; Mozley et al., 1999; Öhman et al., 2008; Trigg et al., 2007). The benefits for a person with dementia to participate in an interview usually outweigh the risks if the interviewee has experience of people with cognitive impairments (Hellström et al., 2007; Nygård, 2006). This involves taking into account the specific problems a person with dementia might have (e.g. related to language and memory), and creating a safe context. In this project these precautions were made, and the fact that the internal dropout was low in the longitudinal project indicates that participation was not experienced to be stressful by the participants.

Participant observation was used in Study I to collect data on walking performance (i.e. walking in the ordinary environment), and is a method that has previously been used in research involving people with dementia (Brorsson et al., 2011; Nygård, 2006). A benefit of this method is that the researcher can observe the individuals’ behaviour and abilities in their ordinary environment. The observations provided valuable data on the participants’ daily routines, and performance in different familiar contexts, which had not been possible to obtain otherwise. During the observations, it was necessary as an observer to be part of the activities, as the participants normally did not have any company on their activities that was of interest for observation, e.g. daily walks. The participants were also informed of the aims of the study. To minimize the impact of the presence of the observer (Y. Cedervall), no initiative was taken, or interference made with the participants’ actions, but efforts were made to adopt a cautious approach and act in a casual manner.

Qualitative content analysis, as well as thematic analysis, is not philosophically bound to any specific philosophical tradition such as grounded theory or phenomenology (Braun et al., 2006; Danielsson, 2012). Qualitative content analysis and thematic analysis are described as suitable methods for the analysis and interpretation of text data grounded in the empirical-holistic
paradigm. Both methods have been widely used in health care research and have many similarities, even though the terminology of analysis patterns differs. The quality and richness of collected data is the main determining factor for whether it is possible to perform an analysis of the manifest (descriptive) or the latent (interpretive) content in the data (Braun et al., 2006; Danielsson, 2012; Hsieh et al., 2005). In Study I, the data was composed of written text from four interviews and four participant observations with the men with AD, and two interviews with their spouses. This enabled an analysis mainly of the manifest content of text and resulted in three separate categories (Figure 4). In Study IV, the richness of data obtained from 28 individual in-depth interviews made it possible to analyse the latent content and interpret the underlying meanings on a higher abstraction level, which resulted in three interrelated sub-themes and one overarching theme (Figure 6).

Trustworthiness
To achieve trustworthiness of Studies I and IV a detailed description of the data collection and analysis procedures has been made (Graneheim et al., 2004; Lundman et al., 2008; Polit et al., 2008). The findings are illustrated by quotes from the interviews and observation notes enabling the readers to determine that the interpretations are based on data. We also used different kinds of triangulation to validate data (Polit et al., 2008). For example, in both Studies I and IV an informal member’s check was carried out by doing two individual interviews during a period of one to four weeks with the participant with AD. This method enabled the interviewer to obtain clarifications of statements made in the first interview and probe deeper to ensure understanding of the participants’ statements and meanings. The two interconnected interviews were also a way to achieve time triangulation, i.e. to ask similar questions at different time points to achieve a picture of consistence or inconsistence in the answers and statements made. Moreover, in Study I, data were collected by different methods and from different sources (participant observations of participants with AD, and interviews with them and their spouses), enabling a method, space and person triangulation and by that a multifaceted picture of the research question. In Study IV, text data from the interviews were complemented with numeric data from tests of walking capacity, cognitive function, and aerobic activity level to achieve a description of the participants with a focus on physical activity. Furthermore, the longitudinal design in the project as a whole, in combination with a person (Y. Cedervall) collecting all the data, enabled a prolonged engagement and possibilities to build trust with the participants. During the analysis and interpretation phase in Study IV, repeated peer debriefing sessions were held between the co-authors (S Torres and AC Åberg) and Y. Cedervall, in which preliminary analysis and interpretations were discussed and refined in an on-
going process. The co-authors are skilled researchers with long experience in performing qualitative research.

Mixed methods

A clear strength of this thesis is the comprehensive approach involving data from diverse data sources, and that part of the data is collected under an extended period of time. This design provided new perspectives on physical activity among people in the early stages of AD, and is in line with the proposed framework for organizing and identifying future directions for research in the area of dementia (O’Connor et al., 2007). The research framework proposed by O’Connor et al. is based on Kitwood’s definition of personhood (see Abbreviations and definition section) and is the base for a person-centered care (Basun et al., 2013; SBU, 2008a; SoS, 2010). Research within this area encompasses three interrelated domains, namely subjective experiences of the person with dementia, the interactional environment and the broader socio-cultural context. The multi-perspectives used to investigate aspects of physical activity and AD in this thesis are in line with this research direction (O’Connor et al., 2007). The four studies included in this work involved a clinical-based picture of the prerequisites for being physically active, habitual physical activity levels, and observations of being physically active in everyday life. In addition, subjective experiences related to these aspects and to physical activity in general were achieved. Thus, a comprehensive picture of the research problem was obtained. Moreover, data collected by one of these methods could compensate for weaknesses of, and add strengths to, the other methods used (Andrew, 2009; Creswell, 2009).

For example, the approach in this thesis, inspired by mixed methods research was probably decisive for the decision to perform a visual examination of motion capture files when dual-task gait disturbances in the motor laboratory were observed. Thereby, we could identify specific characteristics of dual-task gait disturbances in AD. Statistically calculated gait variability has previously been reported (Allali et al., 2008; Sheridan et al., 2003; Wittwer et al., 2008) and clinical dual-task gait disturbances indicated (Camicia et al., 1997), but to our knowledge specific types of gait irregularities related to dual-tasking have not been described or illustrated previously. Moreover, the interview and observation data complemented by numeric data on walking, aerobic activity levels and dual-task performance enabled understanding and explanations that we believe would not have been possible with data from either of the sources alone.
General discussion

People in the early stages of AD have an impaired and declining walking capacity. A simple cognitive task can have a distinct impact on their walking performance. Their ability to walk can therefore vary substantially depending on differing cognitive and environmental demands. Despite this, people with AD seem motivated and capable of maintaining a health-promoting level of physical activity. This could be understood as if physical activity provides them with “self-promoting benefits”, in addition to the common health-promoting benefits. In fact, in our study, being physically active was interpreted as a way to strengthen the participants’ sense of self associated with their lives before the dementia diagnosis. Physical activity hence contributed to reduce the sense of having dementia, and provided continuity and meaning to life.

Physical activity capacity and performance

One of our main findings was that a simultaneously performed cognitive task, i.e. naming animals, appears to have a distinct impact on walking even in mild AD. This was shown by clinical (Study II) as well as laboratory-based measures (Study III). In Study II, the participants demonstrated difficulties in remembering the instructions for how to perform the mobility sequence during the TUG test, and to prioritize the motor task. This resulted in the dual-task cost during the TUG test being significantly higher for the participants with AD than for the controls’ at baseline (89% vs 11%), and larger than in studies using only walking as the motor task (27%) (Muir et al., 2012). Similarly, in the motor laboratory setting (Study III), the dual-task cost for gait speed in our study was increased, but on a lower level than shown by the TUG test (35%). Thus, the lower dual-task cost shown in the laboratory setting most likely reflected the lower complexity of the motor task (only walking in comparison to the TUG test), however the dual-task cost in the motor laboratory setting was increased in comparison to healthy reference values (9%) (Muir et al., 2012). Previously, an increase of the complexity of the cognitive task (e.g. subtracting serials of 7s from 100) has been shown to raise the dual-task cost (Montero-Odesso et al., 2012a). Our findings suggest that even a more complex motor task, i.e. the TUG test, results in an increased dual-task cost. These observations demonstrate, that, cognitive function and gait are closely interrelated which is in line with an
emerging, alternative view on the relation between cognitive function and gait presented by Monter-Odasso et al. (2012b). They suggest that gait and cognitive function interact since cognitive impairments predict mobility decline and falls and, conversely, slow gait velocity and instability predict cognitive deterioration. Traditionally, cognitive function and gait have been viewed as separated geriatric entities related to dementia and falls, respectively. According to Montero-Odasso et al. (2012b) these two phenomena occur not in parallel, separated from each other, but in a concurrent manner.

In addition to the high dual-task cost for the TUG test described above (Study II), we also observed a clear effect on performance of the mobility sequence when a cognitive task was added. During baseline testing of the TUG dual-task test almost half of the participants with AD (12/25) needed verbal cueing such as “turn around” and/or “sit down”, but none in the healthy control group needed this. At the two-year follow-up, the proportion of participants in need for verbal cueing had increased (10/17). In addition, 5 of the 22 participants who completed the two-year study-period were unable to perform the TUG dual-task due to cognitive impairments, despite verbal cueing. Moreover, during gait testing in the laboratory setting (Study III), the participants presented irregular gait that only was observed during dual-tasking. The observed irregularities occurred occasionally and did not follow any consistent pattern. Thus, a participant could exhibit one distinct type of dual-task gait disturbance at just one of the dual-task trials, or two different types of gait disturbances at different dual-task trials. More than half of the participants exhibited at least one distinct type of dual-task gait disturbance at baseline (12/21), and there was a tendency of increased dual-task gait disturbances during the study period. Such descriptions and illustrations can provide a clarifying picture of the clinical characteristics of dual-task gait variability among people with AD, and constitute a valuable complement to previously reported statistically calculated gait variability (Allali et al., 2008; Sheridan et al., 2003; Wittwer et al., 2008). The dual-task conditions hence exposed clinically observable dual-task gait disturbances, which may be predictors of future falls (Bruce-Keller et al., 2012; Yogev-Seligmann et al., 2008). Longitudinal studies investigating the association between the prevalence of these types of dual-task gait disturbances for the prediction of functional decline and falls are, therefore, warranted.

Moreover, we found that the walking capacity and gait function in terms of e.g. gait speed and step length, were deteriorated already in mild AD and continued to decline in the following two years. These findings are in line with previous cross-sectional studies including people with MCI and AD at different stages of dementia (Eggermont et al., 2010; Maquet et al., 2010; Pettersson et al., 2005; Wittwer et al., 2008), and with a longitudinal laboratory-based study involving people with mild and moderate AD (Wittwer et al., 2010). In our study group, the dual-task costs for gait speed did not increase, but remained on a stable level during the two-year follow-up period,
even though the gait speed during both conditions declined significantly (Study III). One may speculate if this could reflect a “walking-too-fast-strategy”, indicating a lack of insight in declining cognitive functions and resulting in an inability to adapt walking to a cognitively demanding situation, i.e. walking slower, but still too fast in relation to their capacity. Such a strategy has been reported among frail older people with dementia who showed a tendency to walk too fast in relation to their capacity and environmental factors (van Iersel et al., 2006). When we used the TUG tests (Study II), the dual-task cost appeared to remain relatively stable during the two-year study-period, but it is to be noted that 5 out of 22 were not able to perform the test due to cognitive impairments, despite cueing. However, a comparison of dual-task costs between healthy controls, people with MCI and those with mild AD shows inconsistent results. One study reported a gradual increase of dual-task costs as the cognitive function deteriorated (Pettersson et al., 2007), while another demonstrated equal dual-task costs among people with MCI and mild AD (Muir et al., 2012). Longitudinal studies evaluating dual-task costs in people with cognitive impairments are scarce, but are needed to clarify the relation between ability to divide attention when walking and falls.

How did the participants perceive their impaired ability to walk? One may presume that they would restrict their physical activity levels in accordance to their deteriorated walking capacity. Rather surprisingly, their habitual aerobic activity levels by far exceeded the recommended health-promoting levels at baseline. Their activity levels additionally remained on a stable level during the study period, despite the decline of walking capacity and cognitive function. However, participating in structured exercises such as fitness and strength training in groups or individually was rare in the study group. The reason could be that these kinds of activities might be too challenging for people in the early stages of AD since they require well-functioning executive, attention, and visuospatial functions. Probably, it also reflects a lack of organized exercise activities adapted for people with cognitive impairments in the community. In line with this assumption participants revealed that they had stopped doing more complicated physical activities (e.g. swimming in public pools, playing tennis), in favour of outdoor walks (Studies I and IV). Similarly, people with dementia have previously reported a preference for relatively undemanding physical activities such as outdoor walks (Duggan et al., 2008; Malthouse et al., 2013; Olsson et al., 2013).

In contrast to the measured and observed walking deteriorations described previously (see Results Studies I, II, and III) participants did not dwell on impaired walking capacity. Instead, they talked about barriers to being physically active in a wider perspective. Frequently reported barriers were, for example, a decreased energy level, feelings of anxiety and impaired orientation ability (Studies I and IV), which are in accordance with findings reported by Duggan et al. (2008). The decreased energy level involved an overall
sense of tiredness and difficulty in taking the initiative to undertake activities which, in addition to anxiety was described as a major hindrance to being active. These descriptions reflect common dementia symptoms (APA, 2000; Basun et al., 2013). Moreover, the impaired orientation ability limited the life space of the participants and increased the risk of them getting lost. They described different strategies they used to handle these orientation disabilities, for example, the use of specific landmarks on walking routes, only walking in well-known places, avoidance of crowded places, and having company walking. In previous studies, the use of landmarks have been described by people with dementia as an important strategy to orienteers themselves in public places (Brorsson et al., 2011), along with the avoidance of specific problematic situations and the company of a caregiver (Duggan et al., 2008).

What was striking was that the participants with AD described and exposed a varying walking performance in daily life (Studies I). This was also reported by their spouses. The walking performance could differ markedly from one situation to another. One of the spouses described occasional incidences of “peculiar behaviour” in her husband (Study I). In certain situations, he did not seem to notice objects in the environment and, therefore, could walk straight into them (e.g. a lamp post), which probably illustrated his impaired attention, perceptual or visual-spatial functions. This description must be viewed in the light of this man’s routine to walk independently to the day-care centre several times a week. During the trip that he normally did on his own, he walked freely through public places and crossed crowded streets safely without any problems. During an observed walk, he gave the impression of being alert and to really enjoy walking. This kind of contradictory report concerning a person’s ability to move, mirror the different dual-task (or multiple-task) demands frequently involved in real life situations. Thus, the efficient and safe physical activity performance of people with AD is largely dependent on cognitive and environmental demands attached to a certain situation. A complicated activity that is well-known can function well, whereas a seemingly simple (unaccustomed) activity can imply significant difficulties. Additionally, a rapidly evolving distraction in a usual activity can severely interfere with a cognitively impaired person’s performance. This knowledge can be of great importance for health professionals in relation to the guidance and planning of interventions for people with AD.

Activity-promoting factors

It was apparent that the participants had a strong driving force to overcome barriers in favour of sustaining physically active. The question is why they strived to remain physically active in everyday life, and why they committed themselves to outdoor activities. The answer might be that outdoor walks and recreational activities in natural environments are one of the most com-
mon leisure time physical activities reported by the Swedish population (FHI, 2010). Additionally, older people undergoing geriatric rehabilitation have strongly emphasized the ability to go out of doors as a key activity for their life satisfaction, irrespective of their physical functioning (Åberg et al., 2005; Åberg, 2008). In line with this, the participants in our studies also had a strong driving force to maintain physically active despite impaired walking capacity, declining cognitive functions, and other perceived barriers (Studies I and IV). Some of the participants needed assistance to take the initiative to go out and needed company for security reasons.

It was evident that the two participating spouses in Study I had a wish to support their husbands to maintain their physical activity routines. The spouses’ positive attitudes were mainly based on their perceptions that their partners benefitted from being physically active, which are opinions that also have been reported previously (Jansson et al., 2001; Pitkala et al., 2013). The spouses’ willingness to support activities and the desire to remain active expressed by the participants with AD (Studies I and IV) can explain why the AD-group reported a relatively high, and stable habitual aerobic activity level during the entire study period, despite limitations and deteriorations of walking and cognition (Study II).

There are several potential explanations for the participants’ positive attitudes towards physical activities such as outdoor walks, which may be interrelated. Firstly, in recent years, numerous research reports have focused on the positive effects of aerobic activity on brain structures and, subsequently, on cognitive function and depressive symptoms in older people, people with MCI, and dementia (Bherer et al., 2013; Erickson et al., 2013; Forbes et al., 2013; Tseng et al., 2011). It has been suggested that underlying neurological mechanisms can explain the positive effects. These effects are relatively widespread in the brain even though the prefrontal and hippocampal areas appear to be more influenced (Erickson et al., 2013). One may speculate that the well-being associated with being physically active reported in our studies (I and IV) and previous investigations (Malthouse et al., 2013) are in part results of these physiological effects of aerobic activity of the brain. On the other hand, positive subjective experiences associated with muscle strength exercise interventions among older people depending in activities of daily living, some with a dementia diagnosis, have also been reported to improve quality of life (Lindelöf et al., 2012). However, the studies that have explored subjective experiences of different types of physical activities among people with dementia are scarce and include few participants. The importance of exploring these aspects has been highlighted not least to increase adherence to physical activity interventions aimed at maintaining independence and preventing falls without increasing the total cost of health and social services, and without increasing the informal caregivers’ burden (Bowes et al., 2013; Forbes, 2013; Lautenschlager et al., 2010).
Secondly, in addition to the potential positive effects of aerobic activity on brain health, it has been proposed that solitude in natural surroundings provides relaxation as well as relief from expectations and stress in cognitively healthy people (Daun et al., 1996; Korpela et al., 2001). Furthermore, exercising in natural environments has been associated with improvement in mental well-being compared to exercising indoors (Thompson Coon et al., 2011), and outdoor activities have been emphasised as being relatively undemanding and, therefore, appreciated by people with dementia (Duggan et al., 2008; Olsson et al., 2013). These findings are supported by our results showing that the participants frequently stressed the importance of going out of doors for achieving general well-being, and for reducing feelings of stress and unease (Studies I and IV). Another aspect related to the fact that AD is a lethal disease is that being in nature, listening to the sounds of nature, enjoying the scenery, and engaging in activities such as walking can be an effective coping strategy to deal with severe illness (Ahmadi et al., 2013; Annerstedt et al., 2011; Gibson, 2007). These examples are in line with what participants in our study expressed as motivating and inspiring factors for being physically active in natural surroundings (Studies I and IV). The data on habitual aerobic activity additionally indicated that outdoor activities were a priority for the participants with AD, as well as for the healthy controls (Study II).

Thirdly, in addition to the positive experiences related to movements and outdoor activities reported by the participants, they seemed to have the fundamental attitude that physical activity in general is good for the body and soul. Their perceptions regarding physical activity appeared to be based on their understanding of societal norms, both written and tacit (Studies I and IV). Additionally, they tended to compare themselves with others who were worse off or less active, which is a strategy described previously (Clare, 2002). We interpreted these attitudes as striving to sustain “normality”, when the dementia posed threats to their selfhood. Correspondingly, people with dementia have previously described how they actively strive to stay “normal” by doing activities they associate with their former (healthy) life (Beattie et al., 2004; Hedman et al., 2013; Phinney, 1998). If the participants’ statements in Study II are reflected in light of the data on aerobic activity levels, we can confirm that their efforts to maintain a physical activity level in accordance with “ordinary” healthy individuals were successful. On the other hand, a majority of the participants had marked walking capacity limitations, but seemed to regard them as minor, or overlooked them in everyday life. A similar attitude to minimize problems due to the dementia and instead focus on abilities that function quite well has been described in previous research (Caddell et al., 2011; Hedman et al., 2013; Kiyak et al., 1994). This attitude may reflect a deteriorated insight caused by cerebral neurodegeneration, but may also be understood as a strategy to handle the negative consequences of AD. We will discuss this in the next chapter.
Selfhood maintenance through physical activity

At first sight, one may draw the conclusion that the participants’ preferences for being physically active were driven by a desire to maintain physical functioning and prevent illnesses. Instead, the participants emphasized a general sense of well-being attached to being physically active as their main motivation for maintaining regular physical activity routines (Studies I and II). Their descriptions of well-being involved a positive experience of body movements, nature, and open air. Participants with AD additionally expressed general opinions that one should “keep moving” (Studies I and IV), as did the spouses (Study I). Thus, the maintenance of fitness and independence were not mentioned as specific motivating factors for sustaining a physically active lifestyle. How could we understand the well-being physical activity seemed to bring out in the participants? A significant finding emerged when we made a comprehensive interpretation of the results in the four studies against the backdrop of the theoretical perspectives chosen (Atchley, 1989, 1999; Harré, 1998). We found an underlying common thread, which indicated that, by being active, the participants were engaged in self-protective strategies to maintain normality and continuity in lifestyle and selfhood since AD posed a threat to their selfhood.

As suggested previously, the participants with AD had no difficulties in expressing their self of personal identity (Caddell et al., 2010). However, their self of physical and mental attributes, and their self of social roles had obviously undergone changes since the onset of dementia, which was in accordance with previous findings in the area (Caddell et al., 2010; Hedman et al., 2013). The participants acknowledged a range of alterations due to the dementia disease and told of actions they had taken, often with support from cohabitants, to overcome these barriers. In parallel, they appeared to be engaged in balancing self-maintenance with self-adjusting in order to achieve continuity in lifestyle and selfhood. Thus, they were involved in an on-going process of construction and re-construction of selfhood to give prominence to attributes and social roles associated with a past healthy life before they had AD. In this process of sustaining selfhood, physical activities such as outdoor walks appeared to be a significant and powerful tool.

Our interpretation identified several reasons why physical activity might be a specifically appropriate means to overcome the negative consequences on selfhood that AD might bring about. Firstly, physical activity was described as giving the participants well-being and joy (Studies I and IV), which corresponds with previous findings involving people with dementia (Duggan et al., 2008; Malthouse et al., 2013; Olsson et al., 2013). Secondly, physiological mechanisms that can enhance brain health and reduce stress may also play a part (Bowler et al., 2010; Erickson et al., 2013). Thirdly, regularly performed physical activity is stressed in societal norms as necessary for a healthy lifestyle. This was reflected in the participants’ positive
statements (Studies I and IV) and actions (Studies I and II) attached to being physically active. Altogether, these factors indicate that the participants perceived physical activity as a meaningful activity in daily life. This is in accordance with findings in previous studies involving people with dementia (Duggan et al., 2008; Malthouse et al., 2013), and mental ill-health (Mason et al., 2012). The relatively stable health promoting aerobic activity level in the AD group (Study II) supports this interpretation and can be regarded as the participants’ ambitions to retain continuity in selfhood and in health aspects linked to their past life. Corresponding findings demonstrating that people with dementia strive to maintain continuity in life have been previously reported (Menne, 2002; Phinney, 1998; Steeman et al., 2006). Thus, the theoretical perspectives chosen (Atchley, 1989, 1999; Harré, 1998) could help to understand their motivation to be physically active, despite numerous barriers towards physical activity, such as anxiety, decreased ability to take initiative, and impaired orientation ability. In addition, the theories of selfhood and continuity can explain their statements regarding the importance of adhering to physical activity norms, tendencies to compare themselves to others (who are less active), and prominences given to attributes of themselves related to a good capacity, e.g., “I swim really fast”, “I keep up well” (Studies I and IV).

However, strategies to handle threats to selfhood may be misinterpreted by others as unawareness of dementia-related impairments. Bettie et al. (2004) described this as a tension between a desire in the person with dementia to maintain independence, and the caregivers’ perceptions of risks associated with certain situations. In line with this, participants in our Studies (I and IV) stated that they sometimes weighted the risks and benefits in favour of doing an activity they used to do independently, but that now implied an element of risk taking. This tension described by Beattie et al. (2004) could also help to understand the contradiction found between the two spouses’ descriptions of their husbands’ abilities to find their way around and the men’s routines to take long walks on their own. The spouses’ conflicting approaches, which might be viewed as hazardous from an external perspective, could be interpreted as if they were engaged in actions that support their husbands to remain independent.

The participants were hence able to strengthen their self-image by being physically active and thereby probably minimize the sense of having dementia. We noted that the two spouses (Study I) correspondingly supported their husbands in the process of maintaining continuity in selfhood. Thus, it appeared that the two men’s physical activity routines had the potential to reinforce also the cohabitants’ health in terms of well-being (Study I). This is consistent with previous findings that supporting a partner with dementia in physical activities can reduce the burden on the caregiver (Söderhamn et al., 2013; Vreugdenhil et al., 2012). The participating spouses in Study I both said that they wanted to support their husbands to have a meaningful every-
day life and it was clear that physical activity was also viewed in a meaningful way by the cohabitants. It is possible that physical activity helped the two men with AD to hold on to a social role associated with their old familiar self by their spouses, which may also have been vital for their interrelationships (Åberg et al., 2004).

To sum up, being physically active can be a strategy for people in the early stages of AD to shift focus from the social persona, “a dementia patient”, to a (physically) capable person, although with some cognitive impairments. People with AD who remain physically active may thereby gain “self-promotion benefits” in addition to the common “health-promoting benefits”. This may be one of the most important potential benefits of physical activity, as dementia severely threatens continuity in a person’s selfhood and life. Therefore, health professionals and informal caregivers should take into account the self-protective strategies that individuals with AD may be involved in and assist them to maintain normality and continuity in selfhood by supporting them to engage in meaningful undemanding physical activities.
Main conclusions

- A relatively simple cognitive task, i.e. naming animals, can have a substantial impact on walking, even in mild AD. Additionally, specific dual-task gait disturbances during testing are frequent in this group. Such gait disturbances occur occasionally, are irregular, and possess different characteristics, i.e. temporal, spatial, and instable. Therefore, combining a cognitive task with a complex motor task such as the TUG test appears to be a sensitive test for detecting the early signs of cognitive impairment in clinical settings (Studies II and III).

- Physical activity can be a meaningful activity that contributes to a continuity of self and life for people with AD. The sense of meaning is supported by written and tacit common norms about physical activity as well as experiences of well-being related to being physically active. Physical activities, in particular, those performed outdoors can be used by people with AD as a means to sustain their well-being and selfhood, and informal caregivers appear positive towards supporting them in this. Thus, beyond the common health-promoting benefits, people with AD can also gain “self-promoting benefits” from physical activity (Studies I, II, and IV).

- Multi-perspective investigations by the use of mixed methods research can generate valuable knowledge about physical activity and AD; knowledge contributing to a holistic picture of difficulties and possibilities related to being physically active, despite a dementia diagnosis (Studies I, II, III, and IV).
Clinical reflections

Can we use performance-based tests?

The TUG test has been considered as a test of basic mobility, useful in the follow-up of clinical change over time (Podsiadlo et al., 1991), and for identifying community-dwelling adults who are at risk of falls (Shumway-Cook et al., 2000). However, our results (Studies II and III) highlight the need to clarify whether the results of walking capacity tests in the early stages of AD, primarily reflect cognitive impairments or not (Study II). Namely, our findings demonstrate that the use of verbal cueing is an issue even when testing people with mild dementia (MMSE score 21-30 p). For this reason, evaluating physical activity interventions by performance-based tests should be carried out with caution. Otherwise, there is a risk that the physical benefits achieved from a physical exercise intervention may not be captured because of the impact of the impaired cognitive function (Rockwood et al., 2000). However, if the intention is to evaluate dual-task ability specifically, the TUG might be feasible, but needs to be investigated in further studies.

The question to what extent verbal cueing is used in reality, and how this influences validity has been highlighted previously by Nordin et al. (2006), and should be considered in both the clinical setting and research. Van Iersel et al. (2007) and Ries et al. (2009) stressed that verbal cueing should be used when necessary in patients with dementia. In contrast, Hauer et al. (2008) stated that, when verbal cueing is needed, the patients’ results probably document the quality and quantity of the external cueing, not their walking capacity. Our experience is that it is specifically important to identify if verbal cueing is given to encourage individuals to “keep going” if they walk slowly, hesitate or make occasional stops. In these cases, the validity of the test can be severely jeopardized. Our experiences are in line with those reported by Rockwood et al. (2000) and Pitkälä et al. (2013). Pitkälä et al. used a performance-based test, the Short Physical Performance Battery (SPPB) (Guralnik et al., 1994) in an intervention study and the community-dwelling participants with AD had problems following the instructions properly. Therefore, the SPPB mobility test was proven to be infeasible for them.

On the other hand, the distinct impact of a cognitive task on the performance of the TUG test, indicates that the TUG test (including dual-task testing) can be a sensitive test for detecting the early signs of cognitive impairment (Studies II and III). These thoughts correspond with Yogev et al.
(2008) who suggest that assessment of dual-task walking abilities, and executive function should become a part of the routine examination among neurological patients to more fully evaluate gait disturbances and fall risk. In order to implement prevention strategies, the TUG test (including the dual-task test) may be a feasible screening test for physiotherapists in, for example, primary care and the community to identify individuals who are at increased risk of functional decline and falls. Based on our findings (Studies II and III), we suggest that in such testing focus should be placed on both the dual-task cost and the qualitative aspects, e.g. the need for verbal cueing and the prevalence of dual-task gait disturbances. However, further investigation is necessary to establish this.

One may speculate if it would be more accurate to evaluate exercise interventions designed for people with cognitive impairments with tests of body functions (e.g. cardiorespiratory fitness, muscle strength) in order to minimize the influence of their cognitive impairments on test results. We know from previous studies that people with dementia can manage to perform for example cardiorespiratory testing on a treadmill (Billinger et al., 2011; Burns et al., 2008), or on a stationary cycle (Yu et al., 2011), and test of leg muscle strength by one repetition maximum test in leg-press (Hauer et al., 2012; Rosendahl et al., 2006). These types of measurements do not require a large amount of cognitive ability, but reflect a general picture of fitness and physical capacity states, which are a prerequisite for physical functioning and independence.

Physical activity as a means to self-promotion

Our findings place emphasis on the fact that people with early-stage AD may strive to maintain a physically active state for reasons that have not been previously highlighted by health care professionals. Commonly articulated motives for older people to be physically active are, for example, maintained muscle strength, independence in daily life, and a reduced risk of illnesses such as heart diseases and diabetes. It was clear in our study group that maintenance of fitness was not a significant reason for being physically active, instead, sustained well-being and selfhood were interpreted to be the main motives for the participants with AD to stay physically active.

Furthermore, our findings show that physical activities such as walking are feasible and viewed as meaningful by individuals with early-stage AD. Our findings and research over recent years demonstrate, on the one hand, the importance of a well-functioning cognitive function (especially executive and attention functions) to walk safely, and on the other hand, the benefits of aerobic activity on brain health (specifically executive functions). Altogether, this shows that a new approach towards rehabilitation for individuals with AD, embracing aerobic activity is warranted.
A consequence of this reasoning is that physical activity should not be offered a limited period of time with the intention to improve fitness or reach a certain goal. Instead, health care professionals should support the person in being regularly active with physical activities they appreciate and attach to their past healthy life before they had AD. Thereby, the person might be able to maintain selfhood despite changes due to the dementia. This is in line with the common core principles for supporting people with dementia (e.g. to promote independence and encourage activity) proposed by WHO (2012).

An important aspect is the vast lack of structured activities in the community designed to meet people with impaired cognitive function who have the desire and capability for high intensity exercise. This will be a much larger problem in the future when people who are used to take part in, for example, fitness and muscle strength exercises for gaining general well-being, will reach the ages when the risk of dementia is a reality. Younger people with dementia have expressed an overwhelming need for activities appropriate for their age (Beattie et al., 2004). Have physiotherapists and other health professionals developed any strategies to meet their needs?

Is “self-promoting” by using physical activity an issue for physiotherapists? I would say “Yes”. According to the World Confederation for Physical Therapy (2011), physiotherapy is concerned with identifying and maximizing quality of life and movement potential in the fields of promotion and prevention, which comprises physical, psychological, emotional and social well-being. Moreover, rehabilitation, which is central for physiotherapists, is aimed at enabling people with disabilities to “maintain their optimal physical, sensory, intellectual, psychological and social functional levels” (WHO, 2014). Thus, physical activity as a means for people with dementia to sustain well-being and selfhood should indeed be an issue for physiotherapists and other health professionals and should be an interesting focus in future research.
Sammanfattning på svenska
(Summary in Swedish)

Bakgrund
Personer med Alzheimers sjukdom (AD) har redan tidigt i sjukdomsförloppet ett långsammare, instabilare gångmönster än kognitivt friska individer. Orsakerna är inte klarlagda, men på senare år har väl fungerande kognitiva funktioner uppmärksammats som avgörande för att förflytta sig säkert i vardagslivet. Exekutiva funktioner (att planera och genomföra en uppgift) och uppmärksamhetsfunktioner tros ha särskilt stor betydelse för att gå säkert och stabilt. Störningar i förmågan att dela uppmärksamheten mellan att gå och utföra en kognitiv uppgift (s.k dual-tasking) ökar risken för fallincidenter och har påvisats hos personer med mild AD.

Även nedsättning av andra kognitiva funktioner som förekommer vid AD kan inverka negativt på förmågan att vara fysiskt aktiv, till exempel försämrad förmåga att orientera sig geografiskt. Känslomässiga reaktioner till följd av AD kan även det påverka aktivitetsnivån negativt.

Personer med AD riskerar således att få en alltför låg fysisk aktivitetsnivå och därmed att fysiska funktioner försämras, beroende tidigareläggs och livslängden förkortas. Regelbunden fysisk aktivitet rekommenderas därför för personer med demenssjukdom, men många behöver redan tidigt i sjukdomsförloppet praktiskt stöd för att kunna utöva aktiviteter. Dessutom är det stor brist på träningsaktiviteter i samhället som är anpassade för personer med kognitiv nedsättning. För att möta deras behov av att träna och röra sig i vardagen behöver kunskapen öka om vilka begränsningar och förutsättningar de har för att vara fysiskt aktiva.

Det övergripande syftet med denna avhandling var därför att studera hur förmågan att vara fysiskt aktiv påverkas under två år i tidigt skede av AD. Dessutom var syftet att få förståelse för hur personer med AD och deras anhöriga resonerar kring fysisk aktivitet som en del i vardagen.

Metod och resultat
Forskningsansatsen var explorativ och inspirerad av flermetodsforskning (s.k. mixed methods research). Både texdata och numerisk data samlades därför in parallellt för att belysa olika aspekter av fysisk aktivitet vid AD. Deltagarna med AD rekryterades från Minnes- och geriatrikmottagningen på Akademiska sjukhuset. Alla deltagare med AD uppfyllde gällande forsk-
ningskriterier för trolig AD. De hade vid studiens start mild AD (Mini Mental Test (MMT) 21-30 poäng), var mellan 55-79 år gamla, sammanboende i eget boende, och kunde gå utan hjälpmedel. Ingen av deltagarna hade någon annan sjukdom eller skada som påtagligt påverkade gångförmågan negativt.


Studie II Vid baslinjen jämfördes 25 personer med AD med 25 kognitivt friska personer för att få en bild av AD-gruppens fysiska nivå. Personerna med AD följdes därefter under två år och data samlades in vid baslinje, efter ett och efter två år. 22 personer fullföljde den studien. Data avseende gångkapacitet samlades in med kliniska tester (10 m bekväm gånghastighet, 6-minuters gång, Timed Up-and-Go (TUG) single- och dual task), fysisk aktivitetsnivå med dagboksregistrering av anhöriga (eller under deras överinseende), och fallincidenter med rapport från anhöriga. Redan vid baslinjemätningen hade deltagarna med AD en nedsatt gångkapacitet jämfört med kontrollgruppen. Försämringen fortsatte under studiens två år. Särskilt framträdande var att gången påverkades påtagligt negativt av en samtidig kognitiv uppgift. Trots denna försämring var deltagarnas fysiska aktivitetsnivå jämförbar med kognitivt friska personer vid baslinjen, och förändrade inte nämnvärt under studietiden. Flertalet i AD-gruppen uppfyllde de gällande hälsorekommendationerna för aerob aktivitet (150 minuter/veckan).

Studie III Gånganalys i motoriklaboratorium genomfördes med deltagarna med AD för att identifiera skillnader i gångparametrar vid vanlig gång jämfört med gång då en kognitiv uppgift utfördes simultant (dual-tasking). Datainsamling utfördes vid baslinjen, efter ett och efter två år. 21 deltagare med AD fullföljde studien. Ett optiskt motion capture system (ProReflex, Qualisys AB, Göteborg) användes. Förutom insamling av numerisk data om gångparametrar, gjordes en systematisk visuell analys av rörelsefilerna för att identifiera eventuella störningar i gångmönster. Gånghastigheten vid gång med samtidig kognitiv uppgift var redan vid baslinjen signifikant långsammare än hastighet vid vanlig gång, men ingen säker förändring av hastighetsskillnaden (dual-task cost) kunde ses under tvåårsperioden. Specifika gång-
störningar som förekom oregelbundet och endast under ”dual-tasking” identifierades dessutom.

Studie IV Ett strategiskt urval av 14 personer gjordes från de 25 personerna inkludera i Studie II och III. En bred variation med avseende på bland annat aktivitetsnivå och självständighet eftersträvades i urvalet. Individuella djupintervjuer gjordes med var och en av deltagarna vid två tillfällen inom en månads tid. Analys av textdata utfördes med kvalitativ innehållsanalys.

Fysisk aktivitet i vardagen beskrevs som en meningsfull aktivitet som gav kontinuitet i livet. Personerna med AD tycktes använda fysisk aktivitet för att stödja sitt välbefinnande och sin ”jag-upplevelse” genom att fokusera på kapabla aspekter i sin person. Deras uppfattningar om normer och känsla av välbefinnade relaterade till fysisk aktivitet tolkades vara viktiga drivkrafter i denna process.

Slutsats
Resultaten visar att gångförmågan är nedsatt hos personer med mild AD och fortsätter att försämras de följande åren. En enkel kognitiv uppgift kan ha en betydande negativ påverkan på gången redan vid mild AD. Det indikerar att testning av ”dual-tasking” med TUG skulle kunna vara en metod för att i klinik identifiera personer med kognitiv svikt. Trots dessa försämringar av gångförmågan tyder våra resultat på att personer med AD kan bibehålla en hälsofrämjande nivå av fysisk aktivitet. Dessutom kan fysisk aktivitet, särskilt utomhusaktiviteter, användas av dem inte bara för att främja fysisk hälsa, utan även som ett medel för att stärka välbefinnandet och upplevelser av ”jaget” som förknippas med hälsa och kontinuitet i livet.
Ni är många personer som på olika sätt har bidragit till att jag har kunnat genomföra min doktorandutbildning. Jag känner en stor tacksamhet mot er alla. Framför allt vill jag rikta ett varmt tack till deltagare, och anhöriga, som så generöst delade med sig av sin tid, sina tankar och erfarenheter. Utan ert engagemang hade denna forskning inte kunnat genomföras.

Jag vill också rikta ett särskilt tack till:

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Uppsala, Maj 2014

Ylva Cedervall
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### Appendix

Overview of the 21 participants and their identified types of dual-task gait disturbances (Study III)

<table>
<thead>
<tr>
<th>Participants</th>
<th>MMSE score</th>
<th>Gait speed m/s</th>
<th>Double stance stop</th>
<th>Single stance stop</th>
<th>Variable step length</th>
<th>Variable Step width/ Deviating direction</th>
<th>Instability in single stance</th>
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MMSE = Mini Mental State Examination
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