The importance of positive and negative well-being in older people; associations with psychosocial factors, cortisol and cognitive performance

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ABSTRACT

During the past decades, studies have attempted to define predictive factors that are associated with successful ageing. The extent to which positive and negative well-being, as two independent dimensions (Huppert and Whittington, 2003), are related to ageing is examined in this research. The first aim was to confirm the independence of positive and negative well-being, secondly, to establish if demographic and psychosocial factors, a biomarker of health (cortisol) and cognitive functioning are associated with positive and negative well-being and thirdly, to determine if associations found would remain stable or change over a three-year period.

Fifty older adults (aged 59-91, mean=74, SD±7, 34 females) participated at Time 1 and 75% of the participants (n=37, aged 63-87, mean=74, SD±6, 25 females) participated at Time 2. Demographical and psychosocial data were collected at an initial home visit, followed by two diurnal cycles of cortisol collections (8 samples per day) and cognitive assessment at a second visit.

Four well-being quadrants (LowPos/LowNeg, LowPos/HighNeg, HighPos/LowNeg and HighPos/HighNeg) were found, supporting the theory that positive and negative well-being are two relatively independent domains. There was a significant main effect of negative well-being on health, quality of life and social support while positive well-being had no effect. There was also a main effect of positive well-being on successful ageing and spirituality while negative well-being had no effect. Results of the overall cortisol concentrations revealed an interaction between dimensions of well-being. The HighPos/LowNeg participants had significantly lower post-awakening cortisol compared to the rest of the group. Cognitive performance was inversely correlated with age for those who scored low on positive well-being and on those who scored high on the negative well-being, suggesting that those who reported high positive well-being and low negative well-being were likely to experience better age-related cognitive function. There was no change in positive and negative well-being over a three-year period. Despite this, participants reported worse health and less social support. The results from the cortisol data indicated a reduced

dynamic of the awakening cortisol response over the 3-year period but suggested that patterns of cortisol secretion remained largely consistent over time, regardless of changes in psychosocial factors.

This work has replicated and extended previous findings on positive and negative well-being, as measured by the GHQ-30, and developed our understanding of how and to what extent positive and negative well-being can be said to function as two relatively independent domains. This thesis has further demonstrated the utility of including a variety of factors, such as psychosocial, cortisol and cognitive performance in order to measure determinants of successful ageing.

Declaration

The work presented in this thesis is the work of the author.

The data arose from a collaborative project and benefited from the advice and experience of some of its WestFocus partners (Denise Forte and Liz Aitchenson, Faculty of Health and Social Care, St. Georges, University of London and Catherine Jacobs, Department of Health and Social Care, Royal Holloway, University of London). Despite this initial project, the research presented in this thesis is the original work of the author.

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Abbreviations

PosWB	Positive Well-being
NegWB	Negative Well-being
POS-GHQ	Positive General Health Questionnaire
CGHQ	Corrected General Health Questionnaire
GHQ-30	General Health Questionnaire 30 items
PANAS	Positive Affect and Negative Affect Scale
VAS	Visual Analogue Scale
SES	Socioeconomic Status
MOS	Medical Outcome Study Social Support
LSIA	Life Satisfaction Index A
PWS	Perceived Wellness Scale
CASP-19	Control Autonomy Self-realization Pleasure Scale
SF-36	The Short-Form 36 Health Survey
LowPos/HighNeg	Low Positive and High Negative well-being
HighPos/HighNeg	High Positive and High Negative well-being
LowPos/LowNeg	Low Positive and Low Negative well-being
HighPos/LowNeg	High Positive and Low Negative well-being
CAR	Cortisol Awakening Response
CRD	Cortisol Response during Day
AUC	Area Under the Curve
AUCg	Area Under the Curve with reference to Ground
AUCi	Area Under the Curve with respect to Increase
MnInc	Mean Increase
ANOVA	Analysis of Variance
OCP	Overall Cognitive Performance
NART	National Adult Reading Test
T1	Time 1
T2	Time 2

List of published articles and conference presentations

Peer-reviewed Papers (see appendix 9)

Evans P, **Fredhoi C**, Loveday C, Hucklebridge F, Aitchison E, Forte D, Clow A. (2011) The diurnal cortisol cycle and cognitive performance in the healthy old. International Journal of Psychophysiology, 79(3), 371-377

Evans P, Forte D, Jacobs C, **Fredhoi C**, Aitchison E, Hucklebridge F and Clow A, (2007) Cortisol secretory activity in older people in relation to positive and negative well-being, Psychoneuroendocrinology, 32, 922–930

Conference Presentations

Fredhoi, C., Towell, Clow, A., Evans, P. Associations of Positive and Negative Well-being in Older People, UniResearch collaborative conference, University of Bergen, Norway, October 2013

Clow A, **Fredhoi C**, Hucklebridge F, Forte D, Jacobs C, Aitchison E, Evans P. Gender differences in the diurnal pattern of cortisol secretion in older adults. 6th World Congress on Stress, Vienna, October 2007

Fredhoi, C., Towell, T., Maguire, M. and Clow, A. Predictors of Positive and Negative Well-being in Older People, 1st Applied Positive Psychology Conference, University of Warwick, April 2007

Evans P., Clow A., Hucklebridge F., **Fredhoi C**., Forte, D. and Aitchison, E. Post-Awakening Cortisol as a marker of Positive and Negative Well-being in Active Seniors, American Psychosomatic Society conference, Budapest Hungary, March 2007

Clow A, Forte D, Aitcheson E, Jacobs C, Hucklebridge F, **Fredhoi C**, Loveday C, Evans P. The diurnal pattern of cortisol secretion in relation to well-being, life satisfaction and health of older people. 3rd European Conference on Positive Psychology, Braga Portugal, July 2006

Fredhoi, C, Maguire, M, Towell, T and Clow, Positive and Negative well-being in Older People. Psychology Cluster Research Forum, King's Fund, London, May 2006

Forte, D, Jacobs, Catherine, Clow, A and **Fredhoi, C** Well-being in seniors: the meaning of the measure. Ageing Societies Conference, Keele University May 2005.

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Chapter 1 Well-being in context

Overview

This chapter begins with a general introduction to the science of well-being. It briefly explores the history of positive psychology and well-being before it moves on to present the two main philosophical paradigms of hedonic and eudaimonic well-being. The chapter presents the independence versus the bipolar view on well-being and further defines the two concepts of positive well-being and negative well-being. The significance of positive well-being in relation to evolutionary and developmental benefits will be discussed. The chapter finally moves on to argue why well-being is particularly relevant to older people, defines the related term successful ageing and presents relevant research within the area of well-being in older people.

1.1 Introduction

In recent years the area of psychology has witnessed an interesting shift from focusing on disorder and dysfunction to emphasising well-being and positive mental health. This burgeoning focus on well-being has not only had a big impact on psychology but also in other areas such as the economy, politics and social science in general (Marmot, Banks, Blundell, Lessof, & Nazroo, 2003; Lupien & Wan, 2004; Huppert, 2005; Layard, 2010; McKee & Schüz, 2015). As a high sense of well-being has been seen as a good indicator of progress and human flourishing, governments around the world increasingly recognise the importance of finding accurate ways of measuring the phenomenon. For example, in July 2012 the United Kingdom Office for National Statistics (2012) published the first national well-being report in order to measure the 'national well-being'. This recent focus on well-being has led to exciting new areas of research which attempt to understand, test and enhance the beneficial and potentially protective effects of well-being on both physical and mental health.

The importance of well-being in relation to health has long been acknowledged for example by the World Health Organisation (WHO) who declare that "health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 1948). A more recent definition on mental health from WHO defines positive mental health as a "state of well-being in which every individual realises his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to her or his community." (WHO, 2006). It is evident from these two definitions that well-being is important to both physical and mental health and is central to all people, across all cultures and of all ages. However, the link between well-being and health may be particularly relevant to the older population, as the ageing process usually leads to the accumulation of risk factors in relation to deteriorating health. Health psychology, as the core scientific discipline concerned with human behaviour related to health, can contribute considerably to the concept of healthy ageing as health psychology has a solid foundation in theory and evidence (McKee & Schüz, 2015). Hence, one of the main objectives of this thesis is to explore the importance of well-being in older people by applying a health psychology perspective.

Within the field of psychology, this relatively recent shift in focus to well-being follows the traditional view that psychology, since its beginning, has devoted too much attention to human psychopathology and dysfunction (Diener & Emmons, 1984; Huppert, 2009). However, as far back as the Greek philosophers there have always been a few scholars who were more interested in human thriving, such as what makes people feel good and function well (e.g. Aristotle and Epicurus). In particular, over the last 30 years, there has been an increasing trend to look at the possibility of improving the lives of ordinary people, and not just of those with disorder or dysfunction. It was Martin Seligman who brought the significance of positive characteristics and human flourishing to the focus of psychology when he launched the Positive Psychology Movement in 1998, after being elected as the president of the American Psychological Association. In his work, Seligman recognised the importance of getting answers to questions such as; why are some people happier or more resilient than others? Why do some

people age more successfully than others? And what are the psychosocial or biological processes associated with these positive emotional states? (Seligman & Csikszentmihalyi, 2000; Huppert, 2009).

1.1 Hedonic and eudaimonic well-being

The concept of well-being is not easy to define as it can seem that the number of definitions of the phenomenon has increased in accordance with the ever expanding research literature. The term well-being has in the literature been used synonymously with happiness, psychological well-being, mental well-being, positive emotional states, subjective well-being and positive well-being (e.g. Cheng & Furnham, 2003). However there is a vast literature which has tried to define the various differences between these terms. Two relatively distinct, yet overlapping, perspectives and paradigms for empirical enquiry into well-being seem to be the most prominent. These revolve around the two distinct philosophies, hedonism and eudaimonism.

The first of these, hedonism, reflects the view that well-being consists of pleasure or happiness. The field of hedonic psychology is often defined as the scientific study of what makes experiences and life in general pleasant and unpleasant (Kahneman, Diener, & Schwarz, 1999). Ryff et al. (2004) suggest that most empirical research with an hedonistic approach falls under the common term of subjective well-being. Subjective well-being is typically described by Diener (2000) as including life satisfaction, the presence of positive affect and the absence of negative affect. He argues that people experience subjective well-being when they "feel many pleasant and few unpleasant emotions, when they are engaged in interesting activities, when they experience many pleasures and few pains, and when they are satisfied with their lives" (Diener, 2000, pp. 34). In other words, hedonic well-being, also known as subjective well-being, commonly measures affects or emotions such as happiness over a limited time period.

The second view, both as ancient and in many ways as current as the hedonic view, is that well-being consists of more than just happiness. Well-being instead lies in the actualisation of human potentials. This view was first termed by Aristotle as eudaimonia and holds the belief that well-being consists of fulfilling or realising one's daimon or true nature. It further conveys the idea that individuals are forever engaging in new life challenges that contributes to greater self-knowledge, maturity and effectiveness (Ryff, et al., 2004). Ryff (1989) proposes that the structure of eudaimonic well-being, or what she calls psychological well-being, comprises six distinct components; levels of self-acceptance, purpose in life, personal growth, positive relations with others, environmental mastery and autonomy. In contrast to the hedonic view, eudaimonic well-being seems more appropriate to be measured over time. It also takes a multidimensional approach which includes psychological, social and demographic factors. Hence, the eudaimonic approach seems to provide a much broader definition of well-being than the more affect associated hedonic approach.

Most authors within the field of positive psychology seem to use a definition of well-being that combines these two distinct philosophies. For example, Huppert (2009) defines well-being as a positive outcome that is meaningful for people and for many sectors of society because it tells us that people perceive that their lives are going well. It combines feeling good and functioning effectively. This definition of well-being combines emotion, such as feeling good, with the more holistic approach of functioning effectively. Huppert (2009) further argues that sustainable well-being does not require individuals to feel good all the time. The experience of painful emotions, such as failure, grief and disappointment, is a normal part of life, and being able to manage these negative or painful emotions is essential for long-term well-being. Hence, that the concept of feeling good incorporates not only the positive emotions of happiness and contentment, but also such emotions as interest, engagement, confidence and affection. To function effectively and have a sense of positive well-being also involves the development of one's potential, having some control over one's life, having a sense of purpose and experiencing positive relationships (Huppert,

2009). Following these definitions, and for the purpose of this thesis the term well-being is defined as encompassing both hedonic and eudaimonic aspects of well-being.

1.2 Bipolar versus independent view

The view that sustainable well-being does not require individuals to feel good all the time suggests a shift in the definition of well-being. In the past, measures of well-being tended to focus upon the presence of positive statements such as happy, content, meaningful life and the absence of negative symptoms such as sadness, anxiety or low self-esteem. This view has suggested that well-being exists on a 'bipolar' or 'mirrored' continuum where positive well-being is at one end and negative well-being, also commonly referred to in the literature as 'ill-being', is at the other end. This theory thereby assumes that what has been learned about psychological maladjustment and disorders at one end of the continuum is also definitive for positive well-being at the other end. Typically, those with high levels of negative well-being would be expected to show low levels of positive well-being and vice versa (Ryff, Love, Urry, Muller, Rosenkranz, Friedman, Davidson, & Singer, 2006).

This distinction between positive and negative well-being has increasingly been studied by researchers and evidence is now accumulating that positive well-being is more than the mere absence of negative psychological symptoms (Russell & Carroll, 1999; Huppert & Whittington, 2003; Ryff, et al., 2006). While it is likely that positive feelings will be low when negative feelings are high, there is growing evidence that positive well-being and negative well-being tend to function relatively independently (Diener & Emmons, 1984; Watson, Clark, & Carey, 1988b; Russell & Carroll, 1999; Huppert & Whittington, 2003; Ryff, et al., 2006).

This 'independence' view, in contrast, asserts that positive well-being and negative well-being are largely distinct domains of mental functioning, where

knowledge about the cause, consequences and correlates of one does not extrapolate to the other (Ryff, et al., 2006). It was Bradburn and Caplovitz (1965) who first reported this relative independence between positive and negative well-being by taking the hedonic approach in examining affects. In their research the authors studied a cross section of more than 2000 adults in four small towns in Illinois, America. The survey asked whether the respondents had experienced several feelings during the previous week. Questions the respondents received included “during the past week have you felt lonely or remote from other people”, “on top of the world”, “bored” or “particularly excited or interested in something”. The findings showed that individuals varied along two dimensions, namely positive affect and negative affect. The results further revealed that these two dimensions were independent of one another, making it impossible to predict an individual’s scores on the negative affect dimension from any knowledge of the person’s scores on the positive affect dimension and vice versa. However, when respondents were asked about their overall self-ratings of happiness or subjective well-being both dimensions were related in the expected direction. What these findings further showed was that the best predictor of the overall self-rating was the discrepancy between the two scores on the dimensions. The greater the score of positive over negative affect, the higher the overall rating in subjective well-being. The analysis from this study also showed that not only were variations in positive and negative affect relatively independent of one another but the two dimensions were correlated with different factors. It was found that factors which were related to the presence or absence of positive affect had no relationship to the presence or absence of negative affect, while the factors which were related to the presence or absence of negative affect had a similar lack of relationship to positive affect (Bradburn, 1969).

Accordingly, it has been argued that just as positive affect is not the opposite of negative affect (Cacioppo & Berntson, 1999), positive well-being is not the opposite of negative well-being (Ryan & Deci, 2001). In a meta-analysis of 35 prospective studies, Chida & Steptoe (2008) found that positive well-being was linked to a reduced risk of mortality both in healthy populations and those

already ill at baseline. The analysis also showed that the survival benefit associated with positive well-being was particularly marked in people aged 60 and over. In all of the studies used in the meta-analysis, the protective effect of positive well-being persisted after adjustment for negative well-being. In other words, the effect was not due merely to the absence of negative psychological symptoms as one would predict by taking solely the bipolar view.

1.3 The importance of positive well-being

There are several arguments as to why in particular positive well-being may be important to human beings and a remarkable body of cross-sectional research in the area has emerged (for review see Huppert, 2009). In general these studies suggest that people with high levels of positive well-being tend to function better in life than those with low levels of positive well-being. Happy people are reported to be more productive, more socially engaged, and tend to have higher incomes (Diener & Lucas, 2000). Researchers also argue that people with high positive well-being are more likely to engage in social relationships (Ryff & Singer, 1996) successfully cope with stressful situations (Steptoe & Wardle, 2005) and feel more in control of their lives (Ryff & Singer, 1996). For example, Ryan and Deci (2001) point out that people high in happiness or subjective well-being tend to have attributional styles that are more self-enhancing and more enabling than those low in subjective well-being, suggesting that happiness can lead to positive cognition which in turn can contribute to further happiness (Huppert, 2009).

In accordance with the positive attributional styles it has been suggested that positive well-being has evolutionary benefits. One such argument suggests that by pursuing opportunities and signalling that it is safe to approach, individuals who display positive well-being become more attractive to other members of the species and thereby increase their reproductive success (Fredrickson, 2005). Another evolutionary theory by Cacioppo and Berntson (1999) claims that, following the habituation of an initial fear response, an individual who has a high

sense of positive well-being would be motivated to engage in exploratory behaviour by facing unfamiliar or new stimuli. This tendency may have an important survival value, at least for the species, if not for the individual.

Evidence is increasingly showing that there are individual differences in relation to levels of positive well-being and one explanation to this can be found within the field of developmental psychology. Positive well-being and cognitive functioning in later life appears to be profoundly influenced by early social environment. The importance of the closeness of the bond between mother and infant seems, in particular, to play a major part (Ryan & Deci, 2001; Bifulco, Mahon, Kwon, Moran, & Jacob, 2003; Huppert, 2005). Pioneering studies in the 1970s of mother-infant bonding showed that infants with secure attachment were more confident in exploring their environment and respond to strangers than infants with insecure attachment (Ainsworth & Bell, 1970). This body of research from Ainsworth and later investigators (e.g. Simpson, Collins, Tran, & Haydon, 2007) provides evidence that even in infancy, positive well-being is associated with positive cognitive and social behaviour that may provide a basis for resilience throughout life.

That high levels of positive well-being can improve resilience later in life is particularly relevant to older people. Recent studies have found that in older people, positive well-being is associated with a lower probability of becoming physically frail (Ostir, Ottenbacher, & Markides, 2004; Gale, Cooper, Deary, & Sayer, 2014) and to develop problems with mobility (Ostir, Markides, Black, & Goodwin, 2000; Collins, Goldman, & Rodríguez, 2008; Boyle, Buchman, Barnes, & Bennett, 2010). Hence, accumulating evidence suggests that maintaining a positive outlook in life, and particularly in later life, may be a potential resource for ageing well (Huppert & Baylis, 2004; Pitkala, Tilvis, Laakkonen, & Strandberg, 2004).

1.4 Well-being in older people

As a result of negative outcomes associated with increasing age, one could assume that there would be lower levels of happiness among older people, yet well-being seems to be unaffected by the adverse context brought on by the ageing process. Some researchers even suggest that well-being may improve with age (Fung & Carstensen, 2003; Helmuth, 2003). A review by Mather and Carstensen (2005) found that as people move through adulthood, they shift their orientation towards the future. Younger people see the future as being largely open, whereas older people see the future as being more bounded. This causes older people to gear their lives, especially their social lives, towards maximizing positive and minimising negative affect. A review by Helmut (2003) also found that with age, individuals tend to become happier, have better mental health, are better at managing interpersonal relationships and present fewer negative emotions.

Taking the eudaimonic perspective, Ryff et al. (2004) found that aspects of well-being, such as self-acceptance, showed little variation by age from young adulthood through midlife to old age, while environmental mastery increased with age. Both purpose in life and personal growth showed a dramatic decrease with age. There is no clear conclusion in the literature on why psychosocial predictors of well-being change across the lifespan. Some authors have argued that psychological well-being is U-shaped through the life cycle, where positive well-being is high amongst young and old people while lower in middle age (Blanchflower & Oswald, 2008). Other authors argue there is a positive linear correlation between age and positive well-being, where mean levels of well-being tend to remain relatively stable or to increase from young adulthood at least up until late midlife or young-old adulthood (Mather & Carstensen, 2005; Windsor & Anstey, 2010). Windsor and Anstey (2010) examined age group differences with positive and negative affect in young, midlife and older people. They found that positive affect was highest among the younger adults, however, the magnitude of the age group differences were small. More substantial age

differences were evident for negative affect, which was lowest among older people.

Maintaining positive psychological well-being in the face of the changes and losses of later life is generally considered a crucial part of ageing successfully (Rowe & Kahn, 1997; Rowe & Kahn, 2000; Allerhand, Gale, & Deary, 2014). The importance of positive well-being in older age is commonly associated with this theory of 'successful ageing'. Although the concept of successful ageing goes back over 60 years (Baker, 1958) the term received only minimal attention until it was introduced in 1987 by Rowe and Kahn. In the article they argued that what many viewed as effects of ageing were, in fact, effects of disease. Rowe and Kahn (1997) defined successful ageing as being multidimensional, encompassing the avoidance of disease and disability, maintaining high physical and cognitive functioning and actively engaging in life. This view of successful ageing seems to give more evidence for the bipolar approach to well-being by emphasising the two ends of one continuum, with the negative well-being at one end (avoidance disease and disability) and positive well-being at the other end (high physical and cognitive functioning). Rowe and Kahn (1997) described the conditions of 'successful' or 'unsuccessful' ageing as not fixed but transitional, as people can move in and out of success. For example, studies have shown that this move can be possible when people who are recovering from negative health events can be facilitated by psychological resources such as resilience (Hicks & Conner, 2014).

However, this definition of successful ageing, although widely used in current research on well-being in older people, has also been criticised (for review see Lowry et al., 2012). As pointed out by McKee and Schüz (2015), the problem of a lack of consensual definition of successful ageing is made more significant by the fact that a number of other terms appear to occupy the same conceptual territory, such as active ageing, productive ageing, healthy ageing, optimal ageing etc. To have a sense of self-perceived successful ageing has been shown to be much more common than Rowe and Kahn might suggest. A study by Strawbridge et al. (2002) found in a population of older adults aged 65-99

years, that about 50% self-reported that they were ageing successfully in contrast to 19% classified according to the classification proposed by Rowe and Kahn's criteria. This self-reported successful ageing was nonetheless still related to health and function. Strawbridge et al. (2002) also found that the proportion who stated they were ageing successfully declined as the number of prevalent medical conditions increased.

The importance of a biomedical model on well-being has been pointed out by Lowry et al. (2012). They argue that a biomedical model separates the effects of disease and disability from the ageing process, but it is limited in the way it excludes older people with any degree of illness or inability. They further claim that this model focuses on a "a smaller elite segment of the older population that may result in less interest in secondary and tertiary lines of prevention" (Lowry, et al., 2012, pp. 6). By suggesting that successfully ageing is possible even in the presence of disabilities or diseases they thereby suggest that the definition of successful ageing should consider a more independence approach to well-being.

Another support for this relative independence view in relation to successful ageing comes from Baltes and Baltes (1990). In their book "Successful aging: perspectives from the behavioural sciences" they define successful ageing from an ecological perspective. Baltes and Baltes (1990) viewed successful ageing as the ability to function across physical, cognitive, emotional, and social domains. They acknowledge that ageing often leads to losses or limitation in several domains and propose that successful ageing includes the ability to optimise adaption regardless of these losses and limitations. Accordingly, Baltes and Baltes (1990) define successful ageing as being able to make the most of one's remaining capacities and compensating for losses and limitations. Again, this definition suggests that positive and negative well-being exist as two independent concepts, with for example the possibility of being high on both scales such as feeling happy and satisfied with life while at the same time having a disorder or a dysfunction.

It is evident from the definitions and research presented in this first chapter that well-being is a complex concept. It has been a topic of concern since the Greek philosophers, but it was not until the Positive Psychology movement in the 1980's that it first became a hot topic of research within the area of psychology. This switch from emphasising mainly disorder and dysfunction to looking at human flourishing and satisfaction has had great impact on psychology. There is currently no single agreement to the definition of the term well-being and several authors argued that it can include both the hedonic and the eudaimonic perspective. It has also been argued that positive well-being and negative well-being either exist as separate domains or as opposite poles on the same domain. The importance of well-being in older age has been shown to be particularly interesting as positive well-being and satisfaction with life have been shown to act as protective factors against the ageing process.

The next chapter will present various ways of measuring well-being and in particular explore an in-depth way of measuring positive and negative well-being with the use of the GHQ-30 questionnaire (Huppert & Whittington, 2003). It will also consider the importance of looking at associations with positive and negative well-being on psychosocial factors, the biomarker cortisol and on cognitive performance in older people. The aims and hypotheses of this thesis will be presented at the end of the following chapter (Chapter 2, Section 8).

Chapter 2 Rationale, aims and hypotheses

Overview

This chapter will discuss the importance of measuring well-being and consider some of the most common measures used within this area of research. In particular, one novel method of measuring both positive and negative well-being with the use of the GHQ-30 questionnaire, as proposed by Huppert and Whittington (2003) will be discussed. Arguments for investigating associations between older people's positive and negative well-being in relation to demographical and psychosocial factors, the biomarker cortisol and cognitive performance will be put forward. The importance of including longitudinal data in research on well-being will also be highlighted. Finally, the main aims and hypotheses of the thesis, as well as the four studies included in this research, will be presented.

2.1 Measuring well-being

It is apparent from the previous chapter that well-being is a complex concept and accordingly there is currently no single agreed formula for its measurement. Despite the lack of agreed measurements, there is little doubt that there is an increasing need to assess the concept. The importance of measuring well-being was emphasised by the British labour economist Lord Layard when he claimed that all studies in social science should include measures of well-being. In his article he argues that "sound measurement will only become possible if social science (including psychology) takes as a prime objective the quantitative study of the determinants of well-being. Every survey of individuals should automatically measure their well-being, so that in time we can really say what matters to people and by how much. When we do, it will produce very different priorities for our society" (Layard, 2010 pp. 535).

The literature is increasingly suggesting that in order to measure well-being one needs to apply a multidimensional approach and include measures which include both objective and subjective elements of well-being (McKee & Schüz, 2015). For example, Rowe and Khan's model of successful ageing, as described in the previous chapter, has been criticised for lacking subjective components. This is, according to McKee and Schüz (2015), of particular concern as subjective health has been shown to strongly influence morbidity and mortality (Benyamini, 2011). McKee and Schüz (2015) therefore emphasise the importance of adding subjective measures of both physical and psychological health into research on well-being. They further suggest that a model of well-being in older people should include measures of objective and subjective physical functioning, psychological morbidity, life satisfaction, health-related quality of life, objective and subjective measures of cognitive functioning and measures of positive and negative affects. Importantly, the authors emphasise that the list of indicators is not meant to be exhaustive but selective, with factors chosen on the grounds that general agreement exists as to their meaning and reliable instruments exist by which they can be measured.

Accordingly, in order to increase positive aspects of life and to reduce negative factors there is a need to find suitable measures and surveys. The ever increasing field of well-being research has led to a vast number of scales which aim to capture this notion of well-being and human flourishing. A number of these scales take either a hedonistic approach or a eudaimonic approach. However, in some scales there is overlap between the two approaches. One frequently used questionnaire within the area of well-being research that takes a hedonic approach is the Positive and Negative affect Schedule (PANAS) by Watson et al. (1988b). PANAS consists of two 10-item mood scales, where one scale contains positive loaded emotions (e.g. attentive, interested and alert) and the other scale contains negative loaded emotions (e.g. afraid, guilty and scared). These two mood scales have found to be relatively independent from each other, making it almost impossible to predict an individual's scores on the negative affect scale from any knowledge of the persons scores on the positive affect scale and vice versa. In addition to low internal correlation on the two

scales, PANAS has been shown to be cross-culturally reliable, well validated and stable over time (Watson & Clark, 1997).

Taking a more eudaimonic approach to measuring well-being other authors have emphasised the need to include positive functioning, human potential and perceived health in measuring well-being (Ryff & Keyes, 1995). One such measure which assesses the psychological aspect of well-being is Ryff's scale of psychological well-being. This scale assesses many aspects of well-being, which include six dimensions of well-being; autonomy, self-acceptance, environmental mastery, personal growth, positive relations with others and purpose in life (Ryff, 1989). This measurement has also shown to be cross-culturally reliable, well validated and stable over time (Ryff & Keyes, 1995; Clarke, Marshall, Ryff, & Wheaton, 2001). However, some authors have criticised the scale, and in particular the six dimensions for not being internally consistent enough (e.g. van Dierendonck, 2004; Abbott, Ploubidis, Huppert, Kuh, Wadsworth, & Croudace, 2006). As opposed to the PANAS, Ryff's questionnaire does not include a negative well-being scale and it is therefore common in studies which use this scale to include separate negative well-being scales, such as depression and anxiety scales in order to assess both positive and negative well-being in the same sample of participants (e.g. Ruini, Ottolini, Rafanelli, Tossani, Ryff, & Fava, 2003)

The PANAS and Ryff's questionnaire are just two examples of a vast number of scales that aim to capture the phenomena of well-being. It is apparent that most of the well-being scales available in the literature take either the hedonic approach, such as the Oxford Happiness Questionnaire (Hills & Argyle, 2002) and the Subjective Happiness Scale (Lyubomirsky & Lepper, 1999) or the eudaimonic approach, such as the Questionnaire for Eudaimonic well-being (Waterman, Schwartz, Zamboanga, Ravert, Williams, Bede Agocha, Yeong Kim, & Brent Donnellan, 2010). Other scales again, seem to focus entirely on positive functioning and positive feelings and ignoring negative well-being, e.g. the Satisfaction with Life Scale (Diener, Emmons, Larsen, & Griffin, 1985). There are also scales that measure well-being in different age groups, for

example the Warwick-Edinburgh Mental Wellbeing Scale (Tennant, Hiller, Fishwick, Platt, Joseph, Weich, Parkinson, Secker, & Stewart-Brown, 2007) and scales that particularly explore well-being in older people, such as the Life Satisfaction Index (Hoyt & Creech, 1983).

However, there seems to be a lack of measurements that are able to capture both the hedonic and the eudaimonic phenomena as well as both positive well-being and negative well-being in the same scale. This was also pointed out in a review by Haywood et al. (2005) where they looked at the measurement properties of well-being and self-assessed health questionnaires in relation to older people. After analysing 46 articles relating to 18 different scales they were not able to recommend one questionnaire over the other, but rather highlighted the importance of assessing each scale for relevance before application. They further pointed out that studies should include widely used generic instruments for the analysis of well-being and health in older people (see Haywood et al., 2005 for a review).

2.2 Theoretical framework for the thesis

One interesting psychometric approach to the measurement of well-being that has particularly examined the independence between positive and negative well-being is seen in the work of Huppert and Whittington (2003). By combining the hedonic and eudaimonic approach, they examined if there were important differences between the demographic, health and social factors associated with positive versus negative well-being.

From the widely used General Health Questionnaire (GHQ) they developed an additional scale from the positively worded items on the GHQ-30 scale. A particular benefit of using the GHQ-30 in this way derives from its extremely widespread and global use of self-reported instruments in research. The GHQ in its various forms is one of the best validated self-report measures of psychiatric symptoms (Goldberg & Williams, 1988). Something that is reflected

in the fact that the GHQ-30 is still used in clinical settings today after more than 40 years since it was first published.

The GHQ questionnaire was developed by Goldberg (1972) and is a self-administered screening device for identifying minor psychiatric disorders in the general population and within community or non-psychiatric clinical settings such as primary care or general medical out-patients. The GHQ was designed to identify two main classes of problems, which are the inability to carry out one's normal 'healthy' functions and the appearance of new phenomena of a distressing nature (Goldberg & Hillier, 1979). It was meant to be a first-stage screening instrument for psychiatric illnesses that could be verified and diagnosed. It focuses on breaks in normal functioning rather than on lifelong traits and therefore only covers personality disorders or patterns of adjustment where these are associated with distress. The GHQ was not intended to detect severe illness such as schizophrenia or psychotic depression (Goldberg, 1978)

The scale is available in four different versions, GHQ-60, GHQ-30, GHQ-28 and GHQ-12. The most common version used in social science research is the GHQ-30, as it focuses more on psychological rather than somatic symptoms (Goldberg, Gater, Sartorius, Ustun, Piccinelli, Gureje, & Rutter, 1997). The GHQ-30 combines both questions related to hedonic well-being, such as the emotionally loaded item "have you recently been able to feel warmth and affection for those near you", as well as questions related to eudaimonic well-being such as "have you recently felt on the whole you were doing things well"? (For more information on the various versions of the GHQ and details on the scoring see Chapter 3, Section 4).

Based on the original GHQ-30, where half the questions are negatively loaded and half the questions are positively loaded, Huppert and Whittington (2003) developed a new measurement of positive well-being formed only from the 15 positive loaded items. They argued that a great deal of potentially valuable information was lost by ignoring positive responses to positive items and therefore wanted to establish a meaningful measure to assess positive well-being. Accordingly, the authors used all the items from the original GHQ-30 to

gain a negative well-being score and the sum of the positive loaded to gain a positive well-being score. The authors named the positive well-being scale as POS-GHQ and the negative well-being as CGHQ. For the purpose of this thesis the positive well-being scale (POS-GHQ) will be abbreviated to PosWB scale and the negative well-being scale (CGHQ) will be abbreviated to the NegWB scale.

In the longitudinal study by Huppert and Whittington (2003) data was collected from around 6000 people at Time 1 and from around 4000 people at Time 2 (7 years later). The sample consisted of participants form the Health and Lifestyle Survey (HALS). The original aim of HALS was to provide national data on a wide range of health measures, lifestyle variables, attitudes, beliefs and cognitive functions within one single survey. Participants first underwent an interview where physiological function, body measurements and cognitive function were measured. They were then given a self-completion questionnaire, which included the GHQ-30, to be returned by mail. The first survey at Time 1 was carried out between 1984 and 1985 and the follow-up study at Time 2 was carried our 7 years later, between 1991 and 1992.

The result from the frequency distribution that Huppert and Whittington (2003) obtained from the negative (CGHQ) and the positive (POS-GHQ) well-being scales at Time 1 and Time 2 are presented in Figure 2-1 and Figure 2-2.

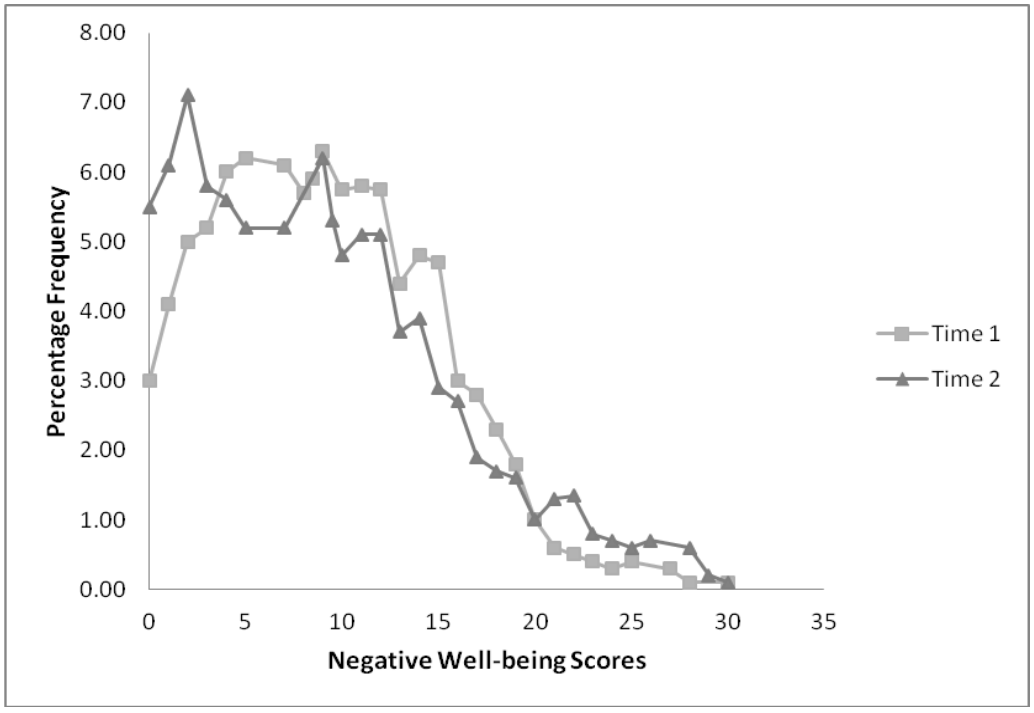

Figure 2-1 Frequency distribution of negative well-being at Time 1 and Time 2 (adapted from data reported in Huppert and Whittington, 2003)

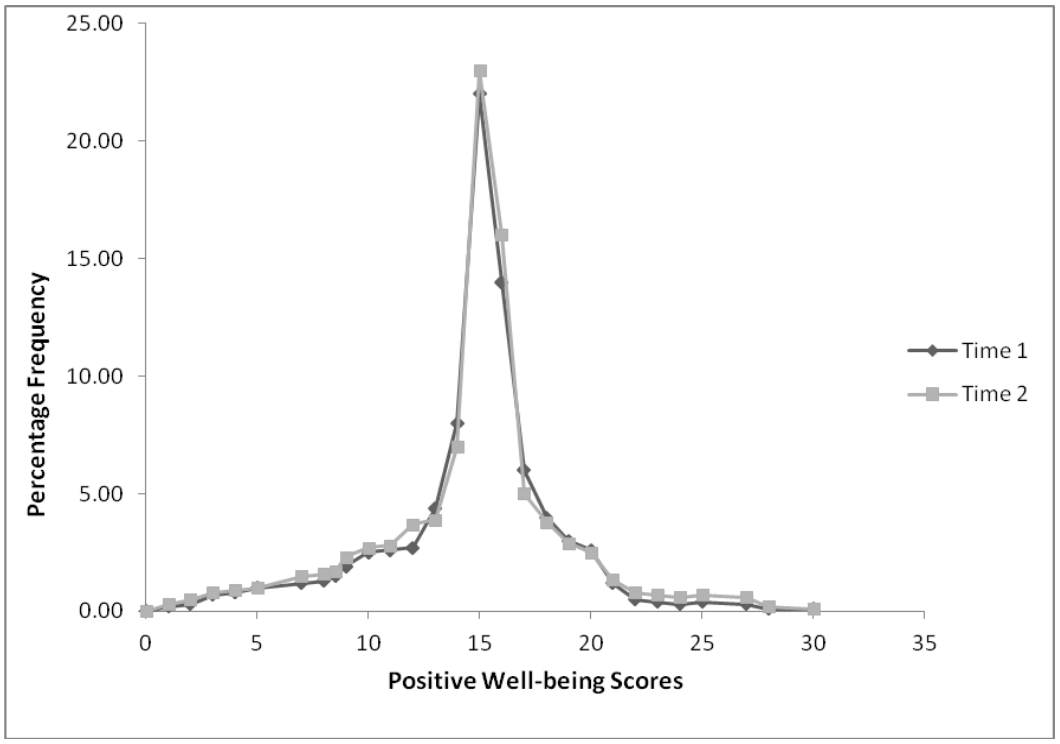

Figure 2-2 Frequency distribution of positive well-being at Time 1 and Time 2 (adapted from data reported in Huppert and Whittington, 2003)

The NegWB scores showed a marked skew in the direction of low numbers of symptoms. The skew was greater at Time 2 than in Time 1. The PosWB scores were more centrally distributed. In their article, Huppert and Whittington (2003) argue that it is apparent from these graphs that PosWB is capturing more than the mere absence of symptoms, as measured by NegWB, since PosWB scores were not the inverse of NegWB. However, their results revealed a significant correlation between the positive well-being and negative well-being measures with a Spearman's correlation coefficient between the PosWB and the NegWB of r=.62 at Time 1 and r=.67 at Time 2.

In order to compare the scores on the two scales Huppert and Whittington (2003) analysed the data by making a cut point (also known as a median split) between high and low scores on each scale. This median split generated four possible combinations of quadrants the participants could be categorised into: low positive/low negative, low positive/high negative, high positive/low negative and high positive/high negative. The result from the PosWB scale combined with the NegWB scale at Time 1 found that around 35.3% of the respondents scored high on the negative scale and low on the positive scale, 29.6% scored low on the negative scale and high on the positive scale, 17% scored high on both scales and 18.1% scored low on both scales (see Table 2.1).

Table 2.1 Percentage of respondents at Time 1 with four combinations of positive scores and negative scores

	Low Positive	High Positive
Low Negative	**18.1 %**	**29.6 %**
High Negative	**35.3 %**	**17.0 %**

Huppert and Whittington (2003) argued that these results, which showed that one third of the respondents fell within either the low positive/low negative quadrant or the high positive/high negative quadrant, provided confirmation of the relative independence of positive and negative well-being. Those

participants with low scores on both scales had few psychological symptoms, but also lacked positive well-being, while those with high scores on both scales combined symptoms with some degree of positive well-being. However, Huppert and Whittington (2003) emphasised that the results did not support the extreme hypothesis of either a clear cut bipolar or a completely independent approach. If positive well-being and negative well-being were entirely opposite domains, one would expect zero people to end up in the quadrant low positive/low negative and high positive/high negative. On the other hand, if positive well-being and negative well-being were entirely independent, one could assume roughly 25% of the samples in each of the four quadrants. These results therefore, together with additional chi-squares analysis, made Huppert and Whittington (2003) reach the conclusion that PosWB and NegWB showed a moderate degree of independence. See Figure 2-3 for a graphical illustration of the four well-being quadrants.

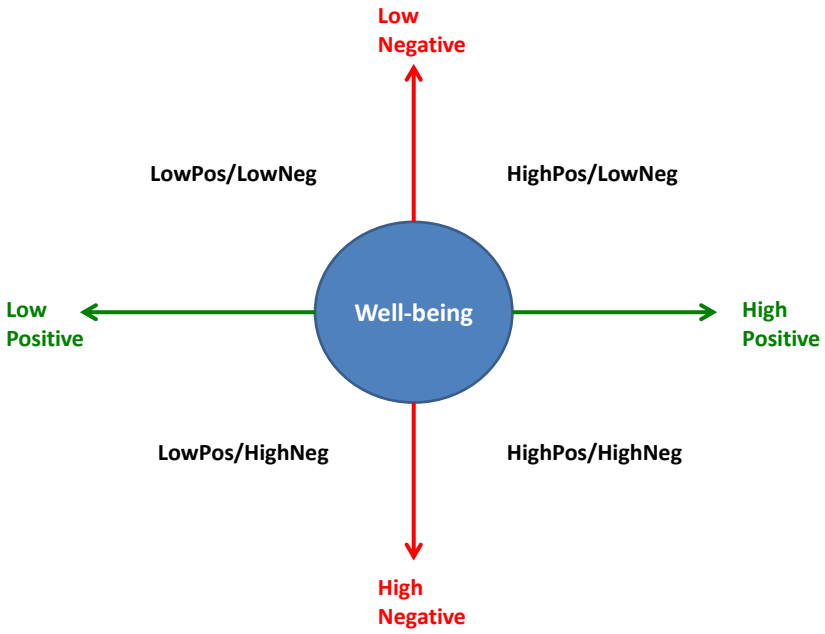

Figure 2-3 Graphical illustration of the four well-being categories; low positive/low negative (LowPos/LowNeg), high positive/low negative (HighPos/LowNeg), low positive/high negative (LowPos/HighNeg) and high positive/low negative (HighPos/LowNeg)

To find out which factors were associated with the positive and the negative well-being scales the authors carried out a factor analysis. They also applied a discrimination analysis on the data. The factors they examined were illness symptoms, disability, work status, social support, social roles, socioeconomic status, age, disease and marital status. The results from the analysis found different effects of positive well-being and negative well-being on a number of health and social factors. Disability and lack of social roles were important determinants of negative well-being, but had less influence on positive well-being. Being in paid work was an important determinant of positive well-being and lack of paid employment was more strongly associated with a reduction in positive feelings than with an increase in psychological symptoms. The presence of chronic disease made little contribution to either the positive or negative well-being score, neither did socioeconomic status or marital status. At Time 2, life events and stress were included as additional factors and both were revealed as useful discriminators in relation to negative well-being.

Huppert and Whittington (2003) reported that older women were underrepresented in the data, but they still found that positive and negative well-being changed with age (see Figure 2-3 and Figure 2-4). For women, negative well-being increased and positive well-being fell with age. For men too, positive well-being declined steadily with age but negative well-being was higher in middle age and lowest in old age. In other words, older men seemed to score low on both the positive and the negative well-being scale.

Interestingly, Huppert and Whittington (2003) also found that 7-year mortality was predicted more strongly by the absence of positive well-being than by the presence of negative well-being. This suggests that, by applying this relatively independent approach to well-being, the dimension of positive well-being seems to be more important to older people than the dimension of negative well-being. In other words, participants had a higher risk of dying if they reported lack of positive well-being than if they reported high levels of negative well-being.

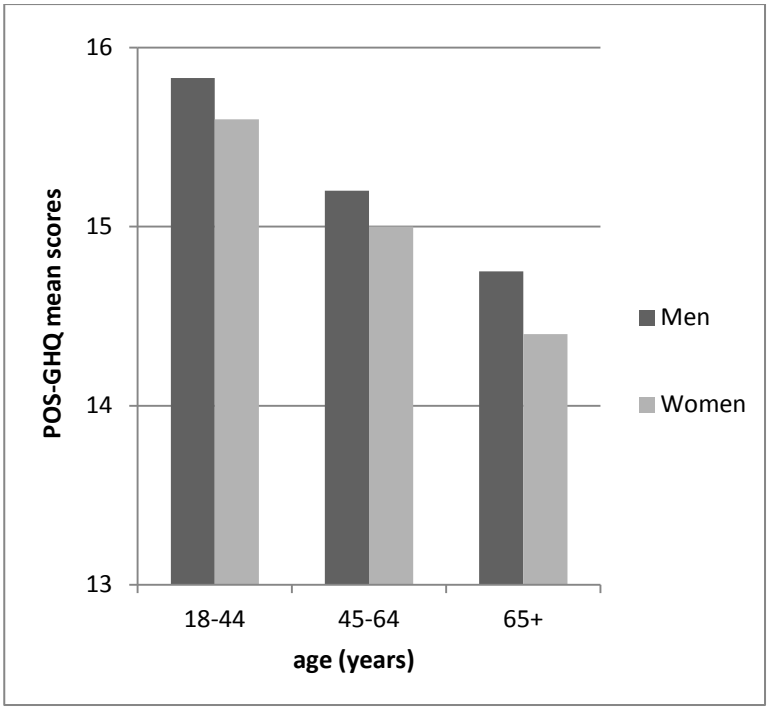

Figure 2-4 Positive well-being scores and age (adapted from data reported in Huppert and Whittington, 2003)

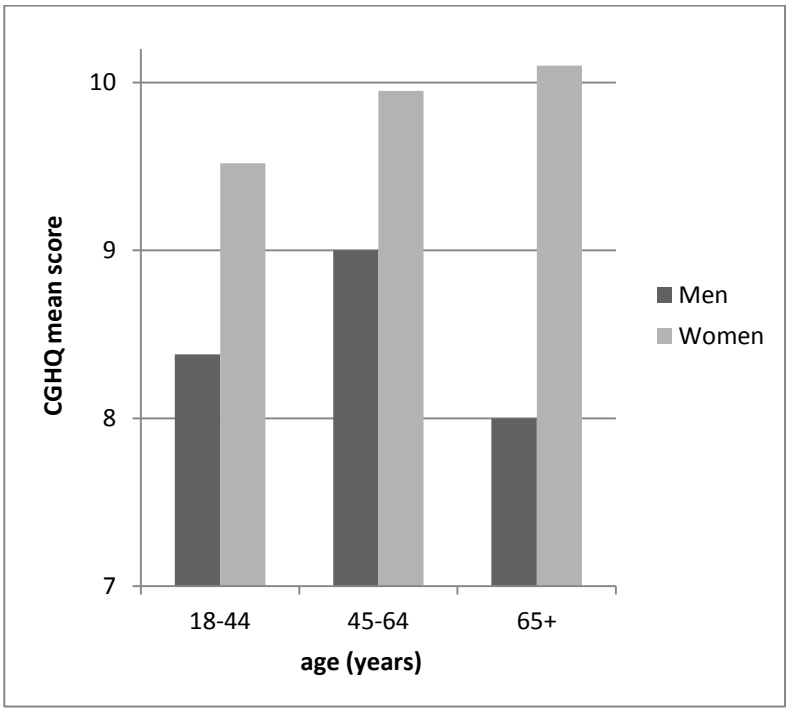

Figure 2-5 Negative well-being scores and age (adapted from data reported in Huppert and Whittington, 2003)

In sum, this interesting research by Huppert and Whittington (2003) provided confirmation of the relative independence of positive and negative well-being. The evidence is based on the very different distributional properties of the positive and negative well-being scales, the different pattern of positive and negative well-being scores for men (but not for women) across the three age groups, and the finding that participants were represented in all of the four quadrants. The authors pointed out that positive well-being, which was strongly associated with sociability and feelings of life satisfaction, was commonly expressed in the presence of disability. In other words, the fact that a participant can score high on both the positive well-being scale and the negative well-being scale can have important implications for future quality of life assessments and hence, both measures of well-being should be included.

The findings presented in the introduction (Chapter 1) together with the findings from this research by Huppert and Whittington (2003) demonstrate the importance of looking at different variables in relation to positive and negative well-being. However, since positive and negative well-being, while clearly related to each other, do not always relate to other variables in the same way, a more detailed examination of associations between positive and negative dimensions of well-being in relation to demographical, psychosocial, objective measures of health and cognitive functioning need to be assessed.

2.3 Well-being, demographical and psychosocial factors

Age is an important demographic variable that is considered in most studies on well-being. A number of relatively recent studies have shown that older people do not have a higher level of negative well-being than middle-aged or younger people. These findings have been found despite the decline in physical health and the deaths of peers and spouses and other objective factors that accompany old age (Mroczek & Kolarz, 1998; Blanchflower & Oswald, 2008; Windsor & Anstey, 2010). In other words, as a result of the negative outcomes associated with increasing age, one could assume that there would be lower

levels of happiness among older people, yet well-being seems to be unaffected by the adverse context brought on by the ageing process. Some researchers even suggest that well-being may improve with age (Fung & Carstensen, 2003; Helmuth, 2003; Mather & Carstensen, 2005). This was also supported by the findings from Huppert and Whittington (2003) where they reported that positive and negative well-being changed with age. For women, positive well-being fell and negative well-being increased with age. Also for men positive well-being declined with age but negative well-being was highest in middle age and lowest in old age. Hence, older men seemed to score low on both the positive and the negative well-being scale.

The findings from Huppert and Whittington (2003) further demonstrate the importance of looking at sex in relation to well-being. However, there are mixed findings in the literature on the importance of sex differences in relation to positive and negative well-being. A meta-analysis of 96 studies which looked at sex differences and well-being revealed that overall females report greater happiness and life satisfaction than males (Wood, Rhodes, & Whelan, 1989). However, this research did not take into account whether the studies took a hedonic or an eudaimonic approach to well-being, nor did it consider the independent versus bipolar view on well-being. Applying a hedonic approach, Mroczek and Kolarz (1998) found that among women, age was related to positive affect but was unrelated to negative affect. Among men, age interacted with both extraversion and marital status in predicting positive and negative affect. Huppert and Whittington (2003) reported that older women were underrepresented in the data, but still found sex differences in the negative well-being scale in that women scored high and men scored low. No difference in sex on the positive well-being scale was apparent.

Socioeconomic status is another variable that has been studied in great detail in relation to well-being but without giving a conclusive answer to its importance in relation to positive and negative well-being. Huppert and Whittington (2003) found that in the middle age group being in paid work was an important determinant of positive well-being and lack of paid employment was more

strongly associated with a reduction in positive feelings than with an increase in psychological symptoms. However, the authors found that neither socioeconomic status nor marital status made a contribution to positive and negative well-being. Another study that looked at socioeconomic status, by Barresi and colleagues (1983), found that housing satisfaction contributed to well-being among the elderly. Interestingly, home ownership was not found to affect well-being positively. For men who owned their own homes, lower scores on positive well-being were reported. In another study Headey and Wooden (2004) reported that income had little effect on either positive or negative well-being and objective circumstances of all kinds, such as sex, age and employment status, had only modest effects on well-being. Findings from the same study found that positive well-being turned out to be much more related to personality traits, personal relationships and social participation, and negative well-being was more related to personality problems, marital problems, job problems (including unemployment) and self assessed health. The authors concluded that psychosocial factors can have a bigger impact on well-being than demographical factors.

Social relationships and social support are psychosocial factors that seem to have an effect on well-being and levels of social interaction have been shown to be associated with self-rated health (Ichida, Hirai, Kondo, Kawachi, Takeda, & Endo, 2013) and well-being (Yip, Leung, & Huang, 2013). A recent study found that changes in social engagement predicted changes in life satisfaction, positive affect, and physical and subjective health, whereas, changes in emotional support predicted changes in negative affect (Huxhold, Fiori, & Windsor, 2013). A study by Brown et al. (2003) found that mortality was significantly reduced for individuals who reported providing instrumental support to friends, relatives and neighbours, and individuals who provided emotional support to their spouse. Receiving support had no effect on mortality once giving support was taken into consideration. Barresi et al. (1983) also found evidence for the importance of social relationships with others on well-being but with a slight sex difference. In their study on well-being they applied a multidimensional approach and looked at environmental satisfaction, sociability

and person characteristics. While the quantity of neighbour interaction benefited the well-being of men, women benefited more from the positive emotions of sociability in the neighbourhood. However, as pointed out by McKee and Schüz (2015) to measure social support is complicated, with the consequence that it is difficult to determine what forms of social interaction might be most important for older people. For example, measures can relate to frequency, quality, quantity, and who the contact is with. A recent study demonstrated that spending time with friends increased positive affect and decreased negative affect, whilst spending time with family increased both positive and negative affect. The findings from Huppert and Whittington (2003) also support the importance of social support on well-being. In their research they found that social support had little impact on positive well-being while lack of social roles was an important determinant of negative well-being. The evidence from the studies presented above suggests that both positive and negative well-being are important in relation to social support.

It is clear from the literature that demographical and psychosocial data such as age, sex, socioeconomic and social support are essential to include in research on well-being. This association between positive and negative well-being in relation to demographical and psychosocial factors will be examined and presented in greater details in Chapter 4 of this thesis.

2.4 Well-being, health and the biomarker cortisol

The possibility that a high level of well-being has favourable effects on physical health outcomes have increasingly been reported in the literature. In particular, research into how positive well-being can reduce the rate of various physical illnesses and premature mortality has been investigated (Huppert, Baylis, & Keverne, 2004; Ryff, et al., 2004). In a review of older people in relation to well-being, positive affect was found to be associated with lower mortality, reduced morbidity and pain, and increased self-reported health (Cohen & Pressman, 2006). There is also increasing evidence that physical activity has a major role

in determining healthy ageing and increasing positive well-being in older people (McKee & Schüz, 2015). Reviews also provide strong evidence that physical activity is related to well-being (Windle, Hughes, Linck, Russell, & Woods, 2010) and results from the English Longitudinal Study of Ageing show that a construct of healthy ageing, indicated by an absence of chronic disease, depression and impairment, is predicted by physical activity (Hamer, Lavoie, & Bacon, 2013).

This association between positive well-being and health was not confirmed in the study by Huppert and Whittington (2003). However, they found evidence for the independent view when they reported that disability was an important determinant of negative well-being, but had less influence on positive well-being.

One commonly used way to assess physical health outcomes in experiments is to look at various biomarkers (e.g. salivary cortisol, ephinephrine, waist-hip ratio and high-density lipoprotein cholesterol). Biomarkers can provide further opportunities for assessing if negative and positive well-being function as separate and independent domains. This was shown in a study where Steptoe and Wardle (2005) found support for the association between well-being and physical health in men (but not for women). The results revealed that greater happiness was associated with lower salivary cortisol, reduced fibrinogen stress responses, and lower ambulatory heart rate. These effects were independent of age, socioeconomic status, smoking status, body mass and psychological distress. The authors further pointed out that these findings can be particularly relevant in old age, since the accumulation of risk factors can lead to increased risk of chronic disease.

One important research study that has particularly examined if positive and negative well-being exists independently or on a bipolar continuum (what they called mirrored view) in relation to biological correlates was published by Ryff et al. (2006). In this study the researchers examined well-being in relation to ten different biomarkers. They found that the outcomes for seven biomarkers supported the independent hypothesis, while findings for only two biomarkers supported the bipolar hypothesis. One of the biomarkers which was particularly

found to support the independence view between positive and negative well-being was the hormone cortisol (Ryff, et al., 2006).

Several studies have demonstrated that a healthy cortisol profile, typically recognised by a marked increase in the morning followed by a steady decline throughout the day (Clow, 2004), is associated with high scores on PosWB, such as optimism and positive affect, but not with scores on NegWB, such as anxiety and negative affect (Lai, Chong, Ho, Siu, Evans, Ng, Chan, Chan, & Ho, 2005; Steptoe & Wardle, 2005; Ryff, et al., 2006; Steptoe, Gibson, Hamer, & Wardle, 2007). Research has also shown that individual differences in well-being, such as self-esteem and emotional style, can change the increase in cortisol (Smyth, Ockenfels, Porter, Kirschbaum, Hellhammer, & Stone, 1998; Pruessner, Hellhammer, & Kirschbaum, 1999; Polk, Skoner, Kirschbaum, Cohen, & Doyle, 2005; Jacobs, Delespaul, Derom, van Os, Myin-Germeys, & Nicolson, 2007). In other words, both positive well-being and negative well-being have been shown to be associated with the cortisol profile. This was further demonstrated in a study by Lindfors and Lundberg (2002). With the use of Ryff's Psychological Well-being scale they found that individuals with positive well-being had a significantly lower cortisol response than individuals with negative well-being, as measured by physical symptoms.

It is evident from these studies that cortisol is a particularly relevant biomarker to use in order to determine if there is a relative independence between positive well-being and negative well-being. Associations between positive and negative well-being and cortisol will be explored in Chapter 5 of this thesis.

2.5 Well-being and cognitive functioning

The association between cognitive functioning and well-being has been hypothesised to be reciprocal, and, in particular, in relation to old age (Llewellyn, Lang, Langa, & Huppert, 2008; Wilson, Boyle, Segawa, Yu, Begeny, Anagnos, & Bennett, 2013). It is therefore essential to include cognitive

functioning as a variable in the analysis of well-being in older people. For example, in a recent study, Allerhand et al. (2014) found that although most variations in cognitive functioning could be explained by age, and most variation in well-being was explained by symptoms of depression, a significant association between cognition and positive well-being remained after variation in age and depression was controlled for.

Growing evidence suggests that positive well-being together with good cognitive functioning may be a potential component for ageing well, and higher levels of positive well-being have been associated with less cognitive decline (Isaacowitz & Smith, 2003; Pitkala, et al., 2004; Boyle, Wilson, Aggarwal, Tang, & Bennett, 2006; Gale, Cooper, Craig, Elliott, Kuh, Richards, Starr, Whalley, Deary, Gale, Cooper, Craig, Elliott, Kuh, Richards, Starr, Whalley, & Deary, 2012; Allerhand, et al., 2014). However, the findings are mixed in relation to the associations between cognitive functioning and the hedonic versus eudaimonic approaches to well-being. Some studies show that cognitive decline does not seem to have an impact on the hedonic dimension of positive and negative affects (e.g. Amieva, Le Goff, Millet, Orgogozo, Pérès, Barberger-Gateau, Jacqmin-Gadda, & Dartigues, 2008; Wilson, Hoganson, Rajan, Barnes, Mendes de Leon, & Evans, 2010) while other studies suggest that cognitive functioning can have an effect on the eudaimonic dimension such as 'purpose in life' (e.g. Wilson, et al., 2013). For example, Wilson et al. (2013) found that decline in cognitive function, and especially in relation to executive functioning and memory, was associated with loss of positive well-being. These findings suggest that positive and negative affects does not seem to have a great impact on cognitive functioning and well-being, while psychological dimensions such as 'purpose in life' does have an influence on cognition in later life. They further suggest that cognitive decline might have a greater adverse impact on eudaimonic aspects of well-being than on the hedonic aspects.

Accordingly, there is a need to explore the association between positive and negative well-being and cognitive functioning. In addition, as age has been shown to have a great impact on cognitive functioning it is important to include

age as a variable in the equation (Mather & Carstensen, 2005; Wilson, et al., 2013). This association between positive and negative well-being and cognitive functioning in relation to age and older people will be explored and presented in Chapter 6 of this thesis.

2.6 Well-being and longitudinal data

In order to measure the association between well-being and health outcomes several studies take a longitudinal approach (e.g. Huppert & Whittington, 2003; Windsor & Anstey, 2010; Wood & Joseph, 2010; Allerhand, et al., 2014). As mentioned above, Huppert and Whittington's (2003) longitudinal study found that after a 7 year period between Time 1 and Time 2, mortality was predicted more strongly by the absence of positive well-being than by the presence of negative well-being. Another study which particularly highlights the importance of well-being over time was carried out by Danner et al. (2001). The autobiographies of 180 Catholic nuns, which were written when the participants were young (mean age 22), were analysed and scored around 60 years later for emotional content. The results, which were related to survival at the ages of 75 and 95 years old, revealed that there was a strong inverse association between positive and emotional content and risk of mortality later in life. In other words, the nuns who reported high on positive well-being at a young age lived longer than those who did not report the same high positive well-being at a young age (Danner, et al., 2001).

Steptoe and Wardle (2005) also found support for the association between well-being and physical health in their longitudinal study. A 3-year follow-up study confirmed the associations with biological measures and happiness found at Time 1. In addition, Steptoe and Wardle (2005) found that happiness was inversely related to ambulatory systolic blood pressure at the follow-up study, and again this was independent of potential confounders including negative affect. The overall findings suggested that positive affective states were linked

to favourable health outcomes as shown by the longitudinal nature of the research.

An additional study that emphasises the importance of longitudinal studies in relation to well-being was carried out by Wood and Joseph (2010) who found that the absence of positive well-being formed a sustainable risk factor for depression as measured in a 10-year cohort study. These results were found to be independent of the presence of negative functioning and impaired physical health. Older people with low positive well-being were more likely to become depressed over a 10 years period

Other studies have also demonstrated the importance between physical health and well-being. Recent studies employing longitudinal designs have, for example, demonstrated that cognitive performance predicts self-reported activities of daily life (Yam & Marsiske, 2013), There is an association between physical functioning, mental health and life satisfaction in later life (Hsu, 2009), High levels of baseline physical ability have been shown to predict well-being at five and ten years follow-up (Cooper, Stafford, Hardy, Sayer, Ben-Shlomo, Cooper, Craig, Deary, Gallacher, & McNeill, 2014) and better memory predicts less functional limitations in both young-old and old-old people (Infurna, Gerstorf, Ryan, & Smith, 2011). Interestingly, this last study also showed evidence for the independence view, as worse memory did not predict more functional limitations.

Accordingly, the findings from these studies suggest that when considering well-being it is important to find out if individual's positive and negative well-being changes over time. If this is the case then longitudinal research on well-being can result in preventative interventions by monitoring individuals at risk over time. The effect of a longitudinal approach to the measure of positive and negative well-being in older people will be examined and presented in Chapter 7 of this thesis.

2.7 Problems of causality

Research within psychology, and, in particular, research related to well-being needs to consider and address problems of causality. As one gets older, reduced social interaction, cognitive decline, reduced mobility and increasing health concerns may lead to a decrease in positive well-being and an increase in negative well-being. On the other hand, a person low in positive well-being and high in negative well-being may avoid social interactions, refrain from physical exercise and avoid cognitively challenging activities.

Similar to the problems of causality, Ryan and Deci (2001) point out that people high in happiness or subjective well-being tend to have attributional styles that are more self-enhancing and more enabling than those low in subjective well-being. This suggest that happiness can lead to positive cognition which in turn can contribute to further happiness (Huppert, 2009). Pitkala et al. (2004) found that taking into consideration various aspects of declining health, age and sex, positive life orientation remained a significant protector both against mortality and against institutional care in long-term follow-up studies.

It is also possible that the relationship between positive well-being and cognitive functioning, as reported earlier, is bidirectional. As one gets older, reduced cognitive functioning may limit the ability to manage usual activities of daily life, and as a result this can again cause decline in positive well-being. Whether factors are causally related, and in which direction, or whether other unknown mediating factors exist, are considered throughout this thesis.

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2.8 Aims and hypotheses

The overall aim of this thesis is to explore positive and negative well-being in an older population. Firstly, this is done by further developing our understanding on how positive and negative well-being can be said to function as two relatively separate and independent domains. Secondly, it will apply the independence

framework and use the two well-being scales (Huppert and Whittington, 2003) to examine which factors are associated with positive and/or negative well-being in older age. As illustrated in Figure 2-6 the factors included are demographic factors (e.g. age, sex and socioeconomic status), psychosocial factors (e.g. life satisfaction, social support and subjective health), an objective biomarker of health (cortisol) and measures of cognitive functioning (memory and executive functioning). Thirdly, it will determine if the factors that are found to be associated with positive and negative well-being will remain stable or change over a three-year period.

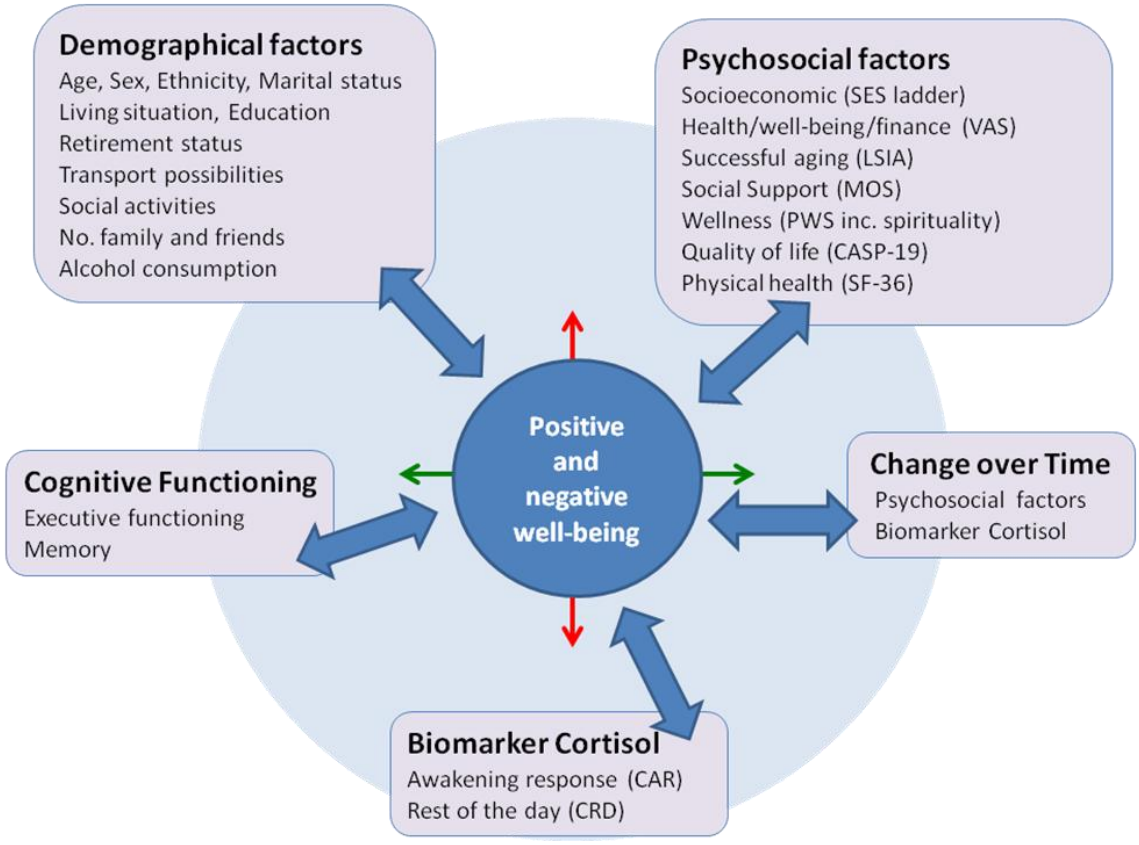

Figure 2-6 Illustration of the theoretical framework and the factors measured in relation to well-being in older people.

Chapter 4 - Aims and hypothesis

The aim of this chapter was firstly to determine if positive and negative well-being can be defined as two relatively separate and independent domains as suggested by Huppert and Whittington (2003). The second aim was to establish which demographical and self-reported psychosocial factors were associated with positive well-being and negative well-being in an older population.

It was hypothesised that positive and negative well-being are relatively separate domains and that these two domains are associated with different demographical and psychosocial factors.

Chapter 5 - Aim and hypothesis

The aim of this chapter was to find further evidence for the independence view on well-being as proposed by Huppert and Whittington (2003) with the use of an objective biomarker of health, namely cortisol.

It was hypothesised that, in accordance with the relative independence theory, the hormone cortisol would provide further evidence for the distinct associations between positive and negative well-being.

Chapter 6 - Aims and hypothesis

The aim of this chapter was to examine if positive and negative well-being was associated with cognitive performance, and in particular in relation to the cognitive domains of memory and executive functioning. The aim was also to establish the associations between increasing age on cognitive performance in relation to positive and negative well-being.

It was hypothesised that cognitive performance would be negatively associated with age and that both positive and negative well-being would be related to cognitive performance as a result of ageing.

Chapter 7 - Aims and hypothesis

The aim of this follow-up study was to find out if participants' positive and negative well-being would change over a three-year period. The data from the psychosocial measures at Time 1 (as reported in Chapter 4) were used to compare the data from this follow-up study, at Time 2, to find out if the associations with health and social support in relation to positive and negative well-being had changed. Since the Cortisol Awakening Response (CAR) was found to be a reliable biomarker of both positive and negative well-being at Time 1 (with the combination HighPos/LowNeg, as described in Chapter 5) the aim was also to find out if these findings in relation to the CAR would remain stable over a three-years period.

It was hypothesised that as a result of increasing age, the associations between positive and negative well-being on health, social support and cortisol secretion would change over a three-year period.

In sum, this chapter on measuring well-being has presented the main aims and hypotheses of the thesis, as well as the overall aims of the chapters. The importance of including longitudinal data in research on well-being has been highlighted and arguments for the need to investigate associations between older people's positive and negative well-being in relation to demographical and psychosocial factors, the biomarker cortisol and cognitive performance has been discussed. A novel way of using the GHQ-30 to create two subscales of positive and negative well-being has been presented, and the evidence for the relative independence between these two scales has been highlighted. Finally, this chapter has pointed out the importance of using valid and reliable ways of measuring both hedonic and eudaimonic well-being.

Chapter 3 General methods

Overview

This chapter will first explain the ethical considerations related to the research and describe the participants who took part. A brief description of the demographical measures and a detailed account of the psychosocial questionnaires will be presented. In particular, the methods of scoring the GHQ-30 to create two measures of positive well-being (PosWB) and negative well-being (NegWB) will be considered. Additional psychosocial measures used in the research will also be described. The biomarker cortisol will be explained in detail, and, in particular, information regarding the collection and the analysis of the saliva cortisol profile. The chapter will then give a summary of the cognitive tests used before it finally moves on to explain the statistical approaches to the analysis of the data.

3.1 Ethical considerations

The research presented in this thesis was conducted in accordance with the Ethical Guidelines for Research with Human Participants as laid down in the British Psychological Society Code of Conduct, Ethical Principles and Guidelines. The University of Westminster's Code of Practice governing the Ethical Conduct of Investigations, Demonstrations, Research and Experiments was also consulted. The proposed programme of research for this thesis was submitted to the University of Westminster's Ethical Committee for consideration and approval gained.

In this research ethical implications and the psychological consequences for the participants were considered from the standpoint of the participants. Every effort was made to ensure there was a mutual respect and confidence between the researcher and participants. The study was carried out with the informed,

written consent of all volunteers (see Appendix 1). Due to the nature of the studies presented in this thesis any deception or withholding of information was unnecessary. The participants were fully briefed regarding all aspects of the research including the procedure, aims and rationale for each investigation.

Participants were healthy older adults that were screened for impairments in either communication or understanding through an initial phone interview. During recruitment, participants were informed of their right to withdraw from the research at any point, including the right to withdraw consent retrospectively and to require that their own data be destroyed.

The participants were visited in their home twice. At the first visit, all reasonable steps were taken to ensure that participants understood the nature of the investigation and both verbal and written information was provided. Other aspects of the research about which the participants enquired were fully explained. For the studies that comprise this thesis the risk of harm in participation was not greater than in ordinary life. Apart from potentially experiencing saliva sampling as distasteful, wearing a wrist-watch and being required to refrain from brushing their teeth or smoking during the post-awakening collection period, participants were not subject to any physical discomfort. Emotional discomfort to participants in the investigations could potentially have arisen from completing questionnaires regarding psychosocial factors including mental health. However, participants were assured that they were not obliged to disclose any information they did not wish to. During the course of this programme of research there was no evidence that any participant was experiencing psychological problems of which they were apparently unaware, and no participant solicited advice concerning mental health issues. In all cases, participants were given the researcher's email address and phone number to enable them to ask questions or express anxieties following participation.

On the second visit, when the participants returned the saliva samples and the questionnaire pack they were debriefed and given the opportunity to discuss their experience with the researcher. This was done in order to monitor any

unforeseen negative effects or misconceptions. Participants were encouraged to give feedback regarding how they felt about doing the study.

All participants were assured that any data would be treated confidentially. They were informed that only collective data would be used in any subsequent publication and that no individual would be identifiable. Steps were taken to preserve the confidentiality of information acquired through the research conducted in this research. Participant names were separately coded rendering written and computerised records identifiable only by researcher. Files of questionnaire data were stored in a locked room in Regent Street Campus at the University of Westminster.

Computerised data were stored on the University of Westminster's server and could be accessed only by password, known only by the researcher. Anonymous computer data files were shared, only with the supervisory team, all of whom were aware of confidentiality issues. As the studies involved the collection of saliva samples participants were assured that samples would be tested for cortisol only.

3.2 Participants

Twenty six participants were recruited via the 'University of the Third Age', which is a learning co-operative for older people. Sixteen were recruited from a local agency of 'Age Concern' in the Sutton area of London. Eight participants were recruited as a convenience sample through colleagues and friends

Following an expression of interest, each participant received an initial general information letter describing the project. This was followed up with a standardised informal telephone call in which the researcher checked for exclusion criteria, including a list of corticosteroid medications, and signs of acute and chronic illnesses. No participants were taking any medication

(notably corticosteroids) known to effect cortisol status and none of the participants smoked cigarettes

A cognitive screening test, based on the 'Mini Mental State Examination' (Folstein, Folstein, & McHugh, 1975) was also carried out during this telephone call in order to eliminate participants with signs of reduced cognitive functioning, such as dementia (see Appendix 2 for interview schedule). Three people who were initially approached were excluded because they were on steroid medication, and a fourth person who had recently been diagnosed by their medical practitioner as suffering from an anxiety order. Unknown to the participants in advance they were given a £25 voucher from Marks & Spencer after completion.

In total, 50 older adults aged 59-91 years (mean=74, SD±7, 34 females and 16 males) participated at Time 1 (presented in Chapter 4, 5 and 6). All the 50 participants in the first study were invited back to a research meeting three years after the initial study at Time 2 (presented in Chapter 7). Of the 50 participants in the first study 37 participants took part in this follow-up study (74%). The age range of this study was 63-87 years old (mean=75, SD±6, 25 females and 12 males).

3.3 General Procedure

At the first visit the participants were asked to sign a consent form. Each participant was given a detailed instruction sheet which explained exactly what was required of them and how to contact the researcher in case they had any queries. A semi-structured interview was used to assess demographic and other factors such as living arrangements, family background, education and retirement status (see Appendix 2). They were also given a questionnaire booklet, which they could complete at any time before the researcher returned (see Appendix 3). The researcher showed the participants how to use the special wrist-worn actimeter (see Chapter 3, Section 6), and the procedure for

collecting their own saliva samples at the appropriate times (see Chapter 3, Section 5). At the second home visit, which was usually within 2 days of the first visit, the researcher collected the wrist-watch device, saliva samples and the completed questionnaire booklet. In addition, at the second visit, the researcher carried out a set of cognitive tests on the participants (results of which will be presented in Chapter 6) and the researcher carried out a debriefing interview to explore participants' experience of the study.

3.4 Demographical measure

Demographical data was collected at the initial phone interview (date of birth, current medications) and at the first home visit (see Appendix 2 for interview schedule). Data collected from the semi-structured interview included retirement status (working or years since retired), job status (last job title), educational status (years at school and attendance at college or university), family and social network (number of siblings, children, grandchildren, number of friends), social activities and hobbies (number of hours a week) and other social commitments (times a week).

3.5 Psychosocial Measures of Well-being

A questionnaire booklet which combined measures that have a track record of being reliable, well validated and stable over time was compiled for the purpose of this research (see Appendix 3). The main aim of this booklet was to collect the self-reported psychosocial data. Each of the questionnaires included in the booklet is described in detail below.

The General Health Questionnaire (GHQ-30)

The General Health Questionnaire (GHQ) was developed by Goldberg (1972) and is a screening instrument designed to detect current, diagnosable psychiatric disorders. As described in the introduction (Chapter 2), the questionnaire is a well-known instrument for measuring psychological distress and has the advantage that no items are related to physical illness and it is therefore specific to psychological state. The GHQ-30 has also been shown to be a particularly relevant psychometric measure to use in research with older people living in their own homes, since it includes areas such as social relationships, coping with daily life activities, depressive moods and anxiety inclusive sleep pattern (Dale, Söderhamn, & Söderhamn, 2012)

The GHQ was designed to use in general population surveys, in primary medical care settings and among medical outpatients (Goldberg, 1978). The full scale version GHQ-60 contains 60 items, and Goldberg recommended using this version where possible because of its superior validity. However, he proposed alternative shorter versions for use where all 60 questions could not be asked. The GHQ therefore is available in four different versions, enabling researchers and clinicians to select the version most appropriate to their individual requirements. GHQ-60 is the fully detailed original 60-item questionnaire, the GHQ-28 assesses somatic symptoms, anxiety and insomnia, social dysfunction and severe depression, the GHQ-12 is a quick, reliable and sensitive short form and the GHQ-30 focuses on psychological rather than somatic symptoms.

The GHQ-30, which is used in this research, contains 30 items derived from the full scale version. It is balanced in terms of positive and negative loaded items. Half of the questions are worded to indicate illness if answered in a positive way (e.g. have you recently been finding life a struggle all the time?) and half indicate illness if answered in a negative way (e.g. have you recently been feeling hopeful about your future?). Responses are conventionally scored on a four point (0-3) Likert Scale (not at all, no more than usual, rather more than usual, much more than usual). However, Goodchild and Duncan-Jones (1985)

suggested an alternative scoring system for the GHQ-30, termed the Corrected CHQ, or CGHQ. While Goldberg originally rated only changes in conditions, Goodchild and Duncan-Jones argued that ratings should cover changes from what is normal in the population rather than what is normal for each respondent. The CGHQ treats the response “no more than usual” on negative items as an indicator of health problems (score of 1) and the same response “no more than usual” on positive items an indication of healthy psychological state (score of 0). The negative loaded items are scored 0-1-1-1 and the positive loaded items are scored 0-0-1-1 suggesting the higher the score the more psychological disturbance. The suggested cut off point for the probability of being a psychiatric case for the CHQ-30 is a score of 5 (McDowell & Newell, 1996). Several authors, including Huppert et al. (1988), have found this way of scoring the GHQ-30 an improvement as it provides less skewed responses. The validity of the GHQ is a very well documented (e.g. Tennant, 1977; Hobbs, Ballinger, & Smith, 1983; Vieweg & Hedlund, 1983) and the reliability has been tested in several studies, for example Chan and Chan (1983) reported an alpha of .85 and Vieweg and Hedlund (1983) an alpha of .92 for the GHQ-30 (see McDowell & Newell, 1996, page 231 for a summary). For the purpose of this thesis this traditional way of scoring the GHQ-30 as CGHQ will be given the abbreviation NegWB (negative well-being).

Positive General Health Questionnaire (POS-GHQ)

Both positive and negative well-being was measured using Goldberg’s (1972) GHQ-30 (see above) and scored in the manner described by Huppert and Whittington (2003). They developed a method of dividing the scores into two separate well-being scores; positive well-being (POS-GHQ) and negative well-being (CGHQ). According to this, CGHQ is scored as described above (under the General Health Questionnaire heading). The POS-GHQ score is derived from only the 15 positive loaded items of the GHQ-30 (items 1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 20, 26 and 27). If the response to the positive item is “not at all” the score yield is 2, if the response is “no more than usual” the score yield is

1 and both “rather more than usual” and “much more than usual” yield zero in scores. Both CGHQ and POS-GHQ produce a total score in the range of 0-30. In the paper by Huppert and Whittington (2003) the items for each well-being measure achieved a high Cronbach alpha reliability coefficient, for POS-GHQ the alpha was .87 and for CGHQ the alpha was .91. A particular benefit of using the GHQ-30 for measures of positive and negative well-being in this way derives from its extremely widespread and global use as self-report instrument in medical research. Using this approach it has been shown that although positive and negative well-being are quite strongly and significantly negatively correlated, there is also evidence of some degree of independence. Approximately, 40% of variance is shared, but just over a third of over 6000 participants in a large survey were either above average on both positive and negative well-being or below average on both. For the purpose of this current research this new way of scoring the GHQ-30, which the authors named POS-GHQ, will be given the abbreviation PosWB (positive well-being)

Visual Analogue Scale (VAS)

Three single item Visual Analogue Scales (VAS) were used to measure perceived health, perceived well-being and perceived financial situation. The VAS is a measurement instrument that attempts to measure a characteristic or attitude that is believed to range across a continuum of values which cannot easily be directly measured (Wewers & Lowe, 1990). It is usually a horizontal line, 100 mm in length, with word descriptors anchored at each end. The participant marks on the line the point that they feel represents their perception of their current state. The VAS score is determined by measuring in millimetres from the left end of the line to the point that the participant marks. In this research, participants were asked to rate their current state of health, well-being and financial status by placing a cross on the three lines, with the word descriptions of ‘poor’ at one end and ‘perfect’ at the other end. Crichton (2001) points out that since this assessment is clearly highly subjective, these scales are of most value when looking at change within individuals, and are of less

value for comparing across a group of individuals at one time point. As such, these scales were included in order to assess individual differences between perceived health, perceived well-being and perceived financial situation from Time 1 and Time 2.

The MacArthur Scale of Subjective Social Status

The MacArthur Scale of Subjective Social Status was developed by Adler and colleagues (2000) in order to capture subjective sense of social status. They argue that it is not the absolute levels of socioeconomic status (SES) that are important for health, but rather inequality resulting from relative standing. There are two versions of the ladder, one linked to traditional SES indicators ("SES ladder"), which is used in this thesis, and the second linked to standing in one's community ("community ladder"). Participants are given a drawing of a ladder with 10 rungs and are asked to place an "X" on the rung on which they feel they stand. It is described as follows: "Think of this ladder as representing where people stand in our society. At the top of the ladder are the people who are the best off, those who have the most money, most education and best jobs. At the bottom are the people who are the worst off, those who have the least money, least education, and worst jobs or no jobs". Each rung is rated from 1-10 where 1 is the lowest subjective SES and 10 is the highest subjective SES. The SES scale has been shown to have a good test-retest reliability and good validity (Operario, Adler, & Williams, 2004).

The Life Satisfaction Index (LSIA)

The Life Satisfaction Index A (LSIA) was developed by Neugarten and colleagues (1961) to measure general feelings of well-being among older people and to identify 'successful' ageing. The concept of life satisfaction is closely related to morale, adjustment and psychological well-being. From a review of previous instruments Neugarten et al. (1961) identified five

components of life satisfaction which the LSIA was intended to measure. These include zest (as opposed to apathy), resolution and fortitude, congruence between desired and achieved goals, positive self-concept and mood tone. Positive well-being is indicated by the individual taking pleasure in his/her daily activities, finding life meaningful, reporting a feeling of success in achieving major goals, a positive self-image and optimism. There are several versions of the Life Satisfaction Index. The original, the Life Satisfaction Index A (LSIA) is used in this thesis. It comprises 20 items of which 12 are positively and 8 are negatively loaded (negative loaded items are 3, 5, 7, 10, 14, 17, 18, 20). The questionnaire is scored by using a three point scale, rating a satisfied response as 2, an uncertain response as 1, and a dissatisfied response as 0. Neugarten et al. (1961) obtained a mean score of 12.4 (SD=4.4), where higher scores indicate higher general feelings of well-being and successful ageing. However these scores were calculated based on a range of scores from 2-20, re-calculating this mean score into the current LISA index would indicate a mean score of 22.4. The questionnaire has been tested and has satisfactory reliability and validity, with the alpha internal consistency ranging from .79 to .90 (Hoyt & Creech, 1983).

Perceived Wellness Scale (PWS)

The Perceived Wellness Scale (PWS) was developed by Adams et al. (1997) to assess the degree to which participants perceive themselves to be functioning across six life dimensions; physical, spiritual, intellectual, psychological, social and emotional. Physical wellness is defined as a positive perception and expectation of physical health, i.e. “my body resists physical illness very well”. Spiritual wellness is defined as a positive perception of meaning and purpose in life, i.e. “I understand what life is about”. Intellectual wellness is defined as being internally energised by and experiencing an optimal amount of intellectually stimulating activity, i.e. “I seek out activities that challenge me to think and reason”. Psychological wellness is defined as a general perception that one will experience positive outcomes to the events and circumstances of

life, i.e. “I am optimistic about my future”. Social wellness is defined as the perception of having support available from family and friends in times of need and the perception of being a valued provider of support, i.e. “Members of my family come to me for support”. Emotional wellness is defined as possession of a secure self-identity or a high self-esteem, i.e. “I feel confident about my abilities”. The items are scored on a Likert Scale ranging from 1 (very strongly disagree) to 6 (very strongly agree). Each dimension is covered by six questions and higher scores indicate greater perceived wellness. Items 2, 4, 11, 12, 14, 29 and 34 are negatively loaded and should be reversed when scoring. In addition to providing scores on the six life dimensions, scoring includes an overall wellness composite score derived from the mean of the six dimensions (magnitude score) and a dimensional standard deviation, or the balance score. Obtaining the magnitude, balance, and wellness composite scores is accomplished by a mathematical algorithm (see Adams et al., 1997). The magnitude score is computed by summing the six items on each subscale score and adding the average of these six scores together. The balance score is derived from computing the square root of the variance among the six magnitude scale scores. The wellness composite score is derived by dividing the magnitude score by the balance score (plus a constant value, 1.25, to prevent the denominator from being zero, and therefore invalid). The rationale for the mathematical algorithm is to produce a composite score that integrates magnitude and balance into the equation (Harari, Waehler, & Rogers, 2005). There is good evidence of internal consistency with alpha scores ranging from .88 to .93 (Adams, et al., 1997).

Control Autonomy Self-realization Pleasure Scale (CASP-19)

The control, autonomy, self-realisation and pleasure questionnaire (CASP-19) was developed by Hyde et al. (2003) to measure quality of life in older people. In developing the CASP-19 measure, the initial idea was that any quality of life measure should be distinct from the factors that influence it. This idea was derived from a theory of human need that recognises the social and biological

components as equal (Doyal & Gough, 1991). This 'needs satisfaction' approach assumes that quality of life should be measured as the degree to which human needs are satisfied. Based on the range of human needs, four domains of the quality of life are included: control, autonomy, self-realisation and pleasure. Control measures the ability to actively intervene on one's environment. Autonomy measures the right of an individual to be free from unwanted interference of others. Self-realisation and pleasure captures the active and reflective process of being human. Each domain consists of five Likert-scaled agreement items (except Control which consists of four) and there are 19 items in total, which are summed to form the overall score. The range of the scale is from zero, which represents a complete absence of quality of life, to 57, which represents total satisfaction across the four domains. Internal-consistency analysis reveals a reliable overall measure with a Cronbach's alpha between .6 and .8 (Hyde, et al., 2003). CASP-19 has been adopted by several important studies, notably the English Longitudinal Study of Ageing (Marmot, et al., 2003) and the retirement module in wave 11 of the British Household Panel Survey (Taylor, Brice, Buck, & Prentice-Lane, 2003)

The Medical Outcome Study Social Support Survey (MOS)

Social Support was measured with the use of the Medical Outcome Study (MOS) by Sherbourne and Stewart (1991). It was originally developed for patients in the Medical Outcomes Study, which was a two-year study of patients with chronic conditions, but the authors suggest the questionnaire can be used with other populations. The questionnaire consists of five subscales that are derived to measure social support; tangible support, affectionate support, positive social interaction, emotional support and informational support. Tangible support is defined as the provision of material aid or behavioural assistance (4 items), i.e. "someone to help you if you were confined to bed". Affectionate support is defined as involving expressions of love and affection (3 items), i.e. "someone who shows you love and affection". Positive social interaction is defined as the availability of other persons to do fun things to you

(4 items), i.e. “someone to have a good time with”. Emotional support is defined as the expression of positive affect, empathetic understanding, and the encouragement of expressions of feelings positive (4 items), i.e. “someone you can count on to listen to you when you need to talk”. Informational support is defined as the offering of advice, information, guidance and feedback (4 items), someone to give you good advice about a crisis”. One structural support item asks about the respondent’s number of close friends and family. The scale does not ask about who provides the support, rather each question asks about how often each form of support is available to them. The instrument uses a five-point Likert scale (none of the time, a little of the time, some of the time, most of the time, all of the time). Empirical analyses indicated that the emotional and informational support items should be scored together so four dimensions are derived (McDowell & Newell, 1996). The scores are rescaled to 0-to-100 range (0-25-50-75-100) with high scores indicating more support. A total score is calculated from the mean of the subscale scores. The questionnaire has been tested and has satisfactory reliability and validity, with a Cronbach’s alpha of .97 (Sherbourne & Stewart, 1991).

The Short-Form-36 Health Survey (SF-36)

The Short-Form-36 Health Survey (SF-36) was developed by the Rand corporation and John E. Ware (Ware & Sherbourne, 1992). It was designed as a generic indicator of health status in population surveys. The SF-36 covers both physical and mental concepts of health and measures each concept in several contrasting ways. The questionnaire asks about health situations during the last four weeks and it consists of eight dimensions; physical functioning (10 items), role limitations due to physical health problems (4 items), bodily pain (2 items), social functioning (2 items), general mental health, covering psychological distress and well-being (5 items), role limitations due to emotional problems (4 items), vitality, energy and fatigue (4 items) and general health perceptions (5 items). In addition, question 2 covers change in health status over the past year. The scoring of the items varies from dichotomous scales

(yes/no) to six point ordinal scales where a high score indicates better health (all of the time, most of the time, a good bit of the time, some of the time, a little of the time, none of the time). The Rand method of scoring the questionnaire recodes the answers of each question into a 0 to 100 score, where high values represent more positive states. Questions with three-category responses are coded as 0-50-100. Five category responses are coded in steps of 25, and six-point scales are coded in steps of 20. The scores for items in the same health dimensions are then averaged to create the eight scale scores ranging from 0-100. Items not answered are ignored when calculating the scale scores. The questionnaire has been tested and has satisfactory reliability and validity (Kurtin, Davies, Meyer, DeGiacomo, & Kantz, 1992). In Table 3.1 the abbreviations for the dimensions of SF-36 which will be used in this current research are presented.

Table 3.1 Abbreviations of dimensions in SF-36 for this thesis

Dimensions in SF-36	**Abbreviations used**
Physical functioning	Physical functioning
Role limitations due to physical health problems	Physical health
Bodily pain	Pain
Social functioning	Social functioning
General mental health, covering psychological distress and well-being	Emotional well-being
Role limitations due to emotional problems	Emotional health
Vitality, energy and fatigue	Vitality and fatigue
General health perceptions	Health Perception
Change in health status over the past year	Health Change

3.6 Biomarker cortisol

Cortisol is usually referred to as a “stress hormone” as it is involved in the response to stress and anxiety. It is also important in the regulation of the day-night cycles. Cortisol secretion from the adrenal glands is controlled by the suprachiasmatic nucleus in the brain, which entrains a marked circadian cycle. A healthy pattern of cortisol secretion is characterised by high levels in the morning followed by a steeply declining profile to late levels in the evening (Edwards, Clow, Evans, & Hucklebridge, 2001a).

As cortisol is a steroid, its chemical structure permits passage through all membranes of the body; it can be measured in any body fluid. Measurement in blood, and sometimes urine, is the clinical norm. More recently, cortisol has been measured in saliva, which has numerous advantages over blood and urine sampling. The validity of salivary cortisol measures is evidenced by high correlations between salivary and circulating free cortisol, with most investigators reporting correlation coefficients of at least 0.90 (reviewed in Kirschbaum & Hellhammer, 1989). As such, salivary cortisol is the ideal assessment for both laboratory and naturalistic field studies as it enables self-collection of samples within the participant’s domestic setting (Smyth, Hucklebridge, Thorn, Evans, & Clow, 2013).

The two distinct phases of cortisol secretion

Data from studies on healthy adults has shown that salivary cortisol secretion over the day can be divided into two distinct phases; the Cortisol Awakening Response (CAR) and the Cortisol Response during the rest of the Day (CRD) (Edwards, Clow, Evans, & Hucklebridge, 2001b). CAR is the typically 50-100% increase in cortisol levels following awakening in the morning. It usually peaks at 30-45 minutes post-awakening (see Figure 3-1). Pruessner and colleagues (1997) were the first researchers to demonstrate the importance of the CAR in healthy participants. They concluded that CAR is a reliable estimation of the

hypothalamic-pituitary-adrenal axis activity when measured with strict reference to the individual time of awakening.

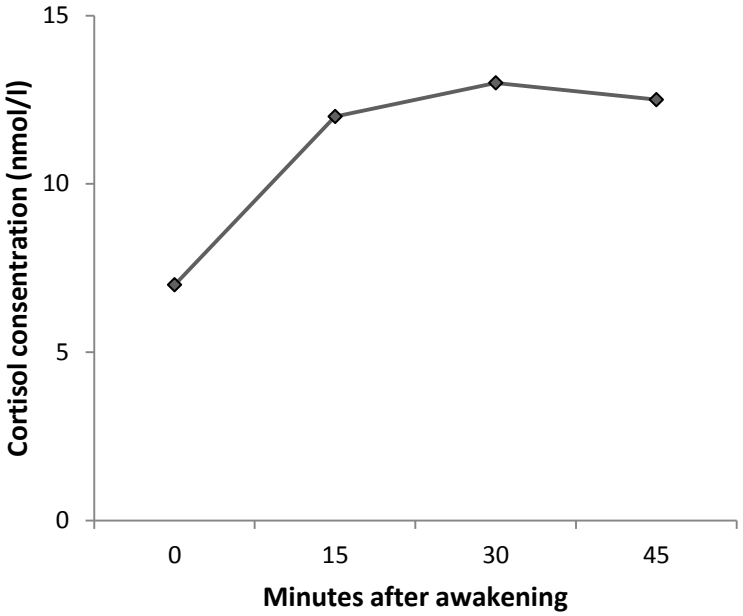

Figure 3-1 Mean salivary free cortisol levels after morning awakening in healthy young adults (N=42) (adapted from Edwards et al. (2001))

CAR and CRD magnitude should be measured with the composite measures of the Area Under the post-awakening Curve with reference to Ground/Zero (AUCg) with the formula s1+s2+s3 + ((s4_s1)/2) (s=sample), as the mean increase (MnInc) with the formula (s2 + s3 + s4)/3 – s1 (s=sample) or the near equivalent of area under the curve with respect to increase (AUC_i) with the formula s2 + s3 + ((s4 – s1)/2) - 2s1 (s=sample). These three measurements are illustrated in Figure 3-2 (see Smith et al. (2013) for a full review on methodological issues related to salivary cortisol as a biomarker in social science research).

More simply it is possible to calculate the CAR as the difference between the awakening level and a single later 'peak' measure at a set time (typically 30 minutes post awakening). This approach is commonly used in large scale epidemiological-type studies but is not ideal as the actual peak may be missed. Problems related to the peak may be particularly relevant in studies of males

and females, as males typically peak at 30 min post-awakening whereas females peak at 45 min post-awakening (Pruessner, et al., 1997; Oskis, Loveday, Hucklebridge, Thorn, & Clow, 2009).

Cortisol response over the day (CRD) is commonly measured in terms if AUCg and in terms of the slope. This is firstly because the direction of the day is down and not up (as in the CAR) and secondly, because the slope can tell how much cortisol falls per time over the day. As with the CAR, diurnal cortisol sample points should also be synchronised to awakening time rather than clock time (Edwards et al., 2001). A steeper cortisol diurnal decline has consistently been associated with better psychosocial and physical health outcomes (Adam & Gunnar, 2001; Adam, Hawkley, Kudielka, & Cacioppo, 2006; Cohen, Schwartz, Epel, Kirschbaum, Sidney, & Seeman, 2006). For measurement of the cortisol slope, nearly all methods use an evening measure (prior to sleep or 12 hours after awakening). However, there is no consensus about the best morning time point from which to anchor the diurnal decline.

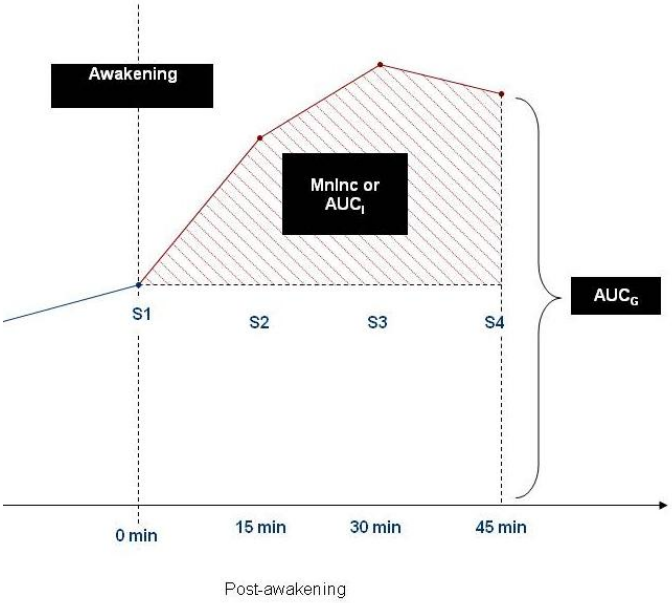

Figure 3-2 Illustration of the composite measures of the Area Under the post-awakening Curve with reference to Ground/Zero (AUCg), the mean increase (MnInc) and the area under the curve with respect to increase (AUCi)

Cortisol Saliva Sampling Protocol

As the cortisol awakening response represents a dynamic change in cortisol levels, repeated saliva samples need to be collected over time. In the present research, the cortisol response was assessed on weekdays, as the cortisol response has previously been found to be different at the weekend in comparison to weekdays (Kunz-Ebrecht, Kirschbaum, Marmot, & Steptoe, 2004). Saliva sampling was also carried out over two study days, which enabled examination of the consistency of the cortisol response for each individual across the two days. However, it has been emphasised that the impact of repeated sampling on participants should be considered as it adds to the demands placed on participants and can potentially reduce adherence to protocol (Broderick, Arnold, Kudielka, & Kirschbaum, 2004).

The daily collection protocol used in the studies of this thesis was designed to capture, in eight measures, the crucial aspects of the cortisol awakening response and the overall decline over the day (see Figure 3-3). Clearly, any measurement of the free cortisol response, and particularly the cortisol awakening response, must be done with strict reference to awakening time and requires the collection of a saliva sample immediately on awakening. Samples were collected at awakening 0, 15, 30 and 45 minutes post awakening and 3, 6, 9 and 12 hours post awakening on each study day.

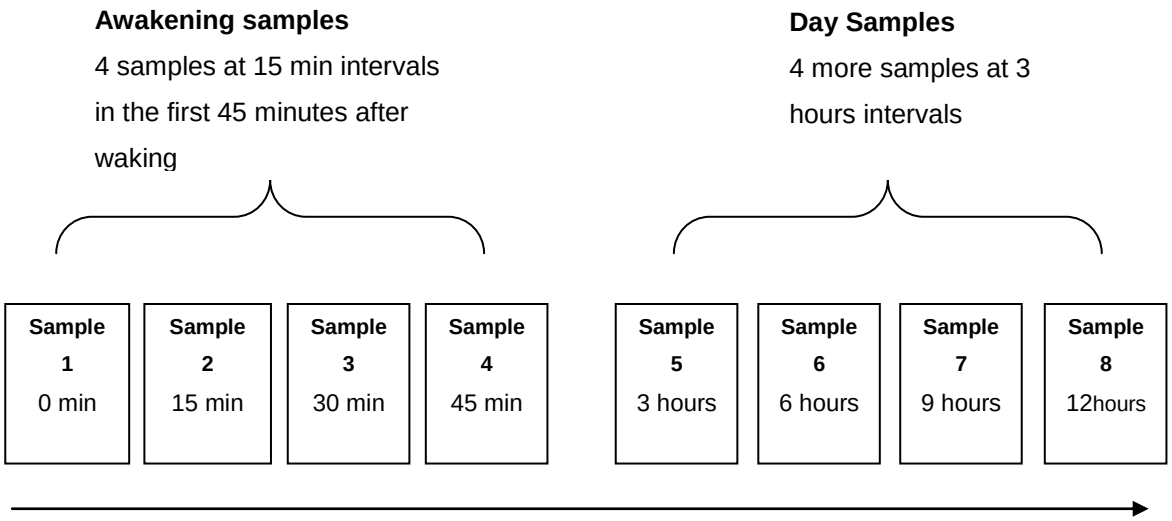

Figure 3-3 Schedule of cortisol saliva sampling

To assist participants in collecting saliva samples at the correct times they were asked to complete a recording table on each study day with details regarding their awakening time and actual time of collection of samples (see Appendix 5). The participant also wore a wrist actimeter to monitor the compliance in regard to the reported timings of self-collected saliva samples, and, in particular, in regard to the first awakening sample (see Section 1.7 Wrist Actimeter).

Although there is some evidence that unexpected awakening can influence the awakening cortisol response (Born, Spath-Schwalbe, Schwakenhofer, Kern, & Fehm, 1989), studies have found, in general, that awakening cortisol response appears to be largely independent of mode of awakening (Pruessner, et al., 1997; Wüst, Wolf, Hellhammer, Federenko, Schommer, & Kirschbaum, 2000). Therefore, for the studies presented in this thesis, participants were instructed to awaken in their habitual way, either naturally or by alarm clock.

Participants were instructed to take nil by mouth except water to avoid diet-induced stimulation in cortisol during the awakening saliva collection period, i.e. for the first 45 minutes following awakening and 30 minutes prior to taking the day samples. They were also asked to refrain from brushing their teeth in order to avoid abrasion and subsequently micro-vascular leakage, as contamination of the saliva samples with plasma cortisol would not accurately reflect salivary free cortisol levels. Participants were also instructed to avoid smoking, as smoking has been shown to elevate cortisol levels (Steptoe & Ussher, 2006), but since none of the participants smoked this was not issue.

It has been shown that cortisol is stable for at least seven days at room temperature, and for at least nine months at -20 degrees centigrade (Aardal & Holm, 1995). However, to be on the safe side, participants were instructed to place the samples in sealed bags in their home freezer as soon as possible after they had collected all eight samples of the day. The use of salivettes in sealed plastic bags allowed for hygienic storage of the samples. Participants were provided with insulated bags in which to return their frozen samples to the investigator, by post. Samples were stored at -20˚C in a laboratory freezer until they were assayed.

Cortisol saliva sampling device

Saliva was sampled by means of the salivette sampling device, which is an optimal method for obtaining full saliva samples, manufactured and sold by Sarstedt (Sarstedt Ltd., Leicester, England). A diagram of a Salivette adapted from the Sarstedt website (www.sarstedt.com) is shown in Figure 3-4. It consists of a small cotton swab inside a suspended insert, a capped plastic tube. The swab is removed from the tube, placed in the mouth and gently chewed to stimulate saliva flow rate for a period of up to two minutes. A saliva sample of 0.5-1 ml in volume can usually be obtained in approximately one minute. The swab is then returned to the insert in the tube and the cap firmly resealed. Recovery of the saliva sample from the cotton swab is achieved by centrifuging the salivette. The suspended insert has a hole in it and clear saliva escapes into the centrifuge vessel.

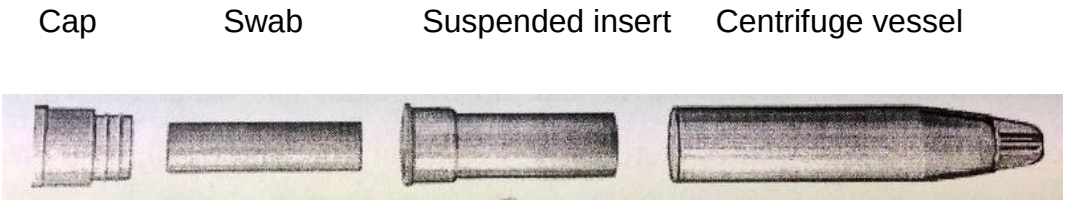

Figure 3-4 Illustration of the salivette saliva sampling device (Sarstedt Ltd)

Eight salivettes were provided for each participant per sampling day. Each salivette was clearly labelled with the participant code, sampling day and time. Participants were given a practical demonstration in the use of the salivette, and they were given the opportunity for a practical trial if they so wished, so that home collection of saliva samples could be achieved. As well as oral instructions, detailed written instructions were provided regarding the sampling protocol and the correct use of the salivettes (see Appendix 6 for the written instructions).

Cortisol Assay

Saliva samples were thawed and centrifuged at 3,500 rpm for 10 minutes allowing clear saliva to flow from the cotton swab into the centrifuge vessel. Samples were assayed by the researcher (author of thesis) at the University of Westminster salivary assay laboratory using the Cortisol Enzyme Linked Immuno-Sorbent Assay developed by Salimetrics, which exploits immunological processes in the measurement of cortisol. This is a commercially available system, which has been designed specially for the quantitative measurement of salivary cortisol. It is sensitive to the low levels of cortisol in saliva, being able to detect cortisol levels as low as 0.19 nmol/l. Salimetrics state that the results of this salivary cortisol assay correlate highly with those from a serum cortisol assay ($r=0.960$, $p<0.0001$, $n=19$ samples, see www.salimetrics.com). A further advantage of this system is that it requires only a small amount of saliva (25 µl) per test.

Salimetrics provide a microtitre plate with wells coated with monoclonal antibodies to cortisol and cortisol standards, which are known cortisol concentrations (values in nmol/l: 82.77, 27.59, 9.19, 3.06, 1.02, 0.33). Standards and unknowns (saliva samples from participants) were pipetted in to the wells in the microtitre plate and an enzyme conjugate added. The test principle is that cortisol in standards and unknowns compete with an enzyme conjugate (cortisol labelled with horseradish peroxidase) for antibody binding sites in the wells on the microtitre plate. After incubation for one hour unbound components are washed away using a phosphate buffered solution containing detergents. Bound cortisol peroxidase is measured by reaction with tetramethylbenzidine solution producing a blue colour after incubation in the dark for half an hour. Reaction is stopped using a sulphuric acid stop solution, which changes the colour to yellow and optical density is read on a plate reader at 450 nanometres within 10 minutes of adding the stop solution. The amount of cortisol peroxidase present is inversely proportional to the amount of cortisol present. In visual terms, the more yellow the solution in each well the less cortisol in the sample.

The procedure detailed by Salimetrics was followed carefully for all the salivary cortisol assays performed. In addition to this, samples from individual participants were assayed on the same plate and each sample was assayed in duplicate. On the rare occasion that the percentage variation between the duplicates was greater than 10% the assay was repeated for that sample. In this way intra-assay variation was less than 10% for the studies. Other known concentrations of cortisol, the high and the low controls, were treated like unknowns and used to determine inter-assay variability, which was below 10% for the studies. On average both intra and inter assay coefficients of variation were comfortably below 10%.

3.7 Wrist-worn actimeter

Physical movement of wrist activity was continuously monitored on the participants during the study period by an actimeter device (WristCare, Vivatec Ltd., UK). The choice of device was based solely on the assessment of how easy and convenient it would be for participants to use and prior demonstration of its prime function to provide an objective check on reported awakening times. The device consisted of a special wrist-worn apparatus (see Figure 3-5), the signals from which were sent to a base unit connected to the telephone point in the participant's home, and then transmitted to the Vivatec centre. The raw data output was minute-by-minute level of wrist activity. The technology is widely used by UK health authorities to monitor the activity of vulnerable people living alone and can be used to send alarms when suspicious periods of inactivity are recorded. To be fit for such purpose, its algorithms had to be well-proven, and it was thus well able to discriminate periods of sleep and wakefulness. The primary interest in the actimeter for this research was to make use of its algorithm-derived outputs to check self-reported awakening times. In particular, the aim was to use the actimeter data as an objective check on compliance in regard to the reported timings of self-collected saliva samples, especially in the period immediately after wakening. Participants were instructed to put on the wrist device prior to going to bed on the day of the first visit and to keep it on

until the last saliva sample was collected. The wrist activity was continuously monitored in 42 of the participants during the study period by an actimeter device. Eight base units of the wrist-watch device could not be installed in the participants' homes because of prior installation of an alarm system which had its own base unit.

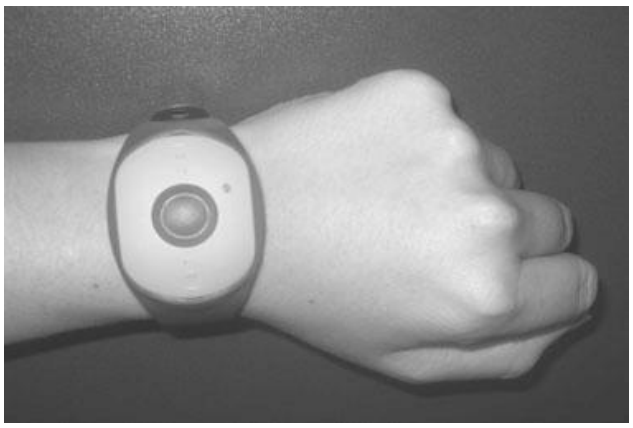

Figure 3-5 Illustration of the wrist-worn actimeter by WristCare, Vivatec Ltd

3.8 Cognitive performance

Cognitive functioning was assessed at Time 1 with the use of a battery of tests, selected on the basis that they would provide a comprehensive assessment of overall cognitive performance. They were also selected to cover specific domains of declarative memory and executive function (see Appendix 4 for example of the cognitive tests).

During the standardised telephone call the participants were asked a range of questions in an attempt to screen for, and exclude, participants with cognitive impairment. The first sets of questions were asked to get general feedback on the participant's perception of their own well-being, as well as their levels of daily social activities. Questions asked were: "What do you think are the main

things that affect how you are and how well you feel at the moment?" and "What would you say are your main social activities or hobbies?" Following this, a set of questions to screen for cognitive impairment and dementia were asked. These questions were adapted from the Mini-Mental State Examination (Folstein, et al., 1975). The questions included: "Do you keep up with the news and do you read newspapers?": "Is there anything that has happened over the last week that has particularly caught your eye?" and "Do you have any problems with your memory or concentration?" The volunteers were given an opportunity to say if they, for example, had problems forgetting names or had to write things down more than usual. None of the volunteers were excluded based on signs of cognitive decline.

National Adult Reading Test (NART)

The National Adult Reading Test (NART) was originally developed by Nelson (Nelson, 1982) to assess premorbid intelligence in patients with dementia. Several studies have shown that NART correlates highly with cognitive performance and it is therefore often used as a proxy for premorbid intelligence (Crawford, Stewart, Cochrane, Parker, & Besson, 1989; McGurn, Starr, Topfer, Pattie, Whiteman, Lemmon, Whalley, & Deary, 2004). Participants were given a list of 50 words with atypical phonemic pronunciation and asked to read the words out loud. They were informed that many of the words would be difficult and were encouraged to guess if they did not recognise them. At the end of the task, if wanted, participants were given the correct pronunciation and the meaning of each word. No time limit was imposed. An overall estimated IQ score was derived from the number of errors (using the formula Estimated IQ = 127.7 – 0.826 x NART error scores).

Verbal and Semantic Fluency Test

To test for verbal and semantic fluency performance the controlled oral word association test was carried out (Benton, Hamsher, & Sivan, 1983). Verbal fluency was assessed by asking participants to recall as many words as they could, starting with a certain letter within a minute. This was repeated three times with different letters (F, A and S). To test for semantic fluency participants were asked to recall the name of as many animals they could within a minute. The verbal fluency test was scored by adding the three scores together and the semantic test was scored by simply counting the number of animals recalled.

The Hopkins Verbal Learning Test

The Hopkins Verbal Learning Test is a test of memory and was developed by (Frank & Byrne, 2000). It contains 12 nouns, four words each from one of three semantic categories (places to live, items of clothing and food). Participants were given the list and asked to remember the words over the course of three learning trials. Unknown to the participants in advance, a delayed recall trial was carried out approximately 25 minutes later. The delayed recall required free recall of any words remembered. Finally a recognition trial was carried out. The recognition trial was composed of 24 words, including the 12 original words and 12 new words. Participants were asked to remember which words were included in the original list. A score for immediate recall was calculated by combining the total number of recalled words. The delayed recall score included the number of recalled words remembered after 25 minutes. The recognition score was the number of correct answers to whether the word was part of the original list or not.

Trail Making Test

The Trail Making Test is a test of attention and task switching originally developed during the 2nd World War to assess general intelligence in the army. It is now commonly used as a diagnostic tool in clinical settings (Arnett & Labovitz, 1995) and it has been shown to be sensitive to detecting cognitive impartment such as Alzheimer's disease and dementia (Tombaugh, 2004). The trail making test consists of two parts, A and B. Part A is used primarily to examine cognitive processing speed while part B is used to examine executive functioning (Tombaugh, 2004). In part A, the participants were instructed to connect twenty five dots as fast as possible while still maintaining accuracy (1, 2, 3, 4, 5, 6 etc.). In part B, the participants were asked to join alternates between numbers and letters (1, A, 2, B, 3, C etc.). The time of completion of each test was recorded.

3.9 Approach to statistical analysis

In order to examine if positive and negative well-being were separate, relatively independent dimensions of well-being a Spearman's rho correlation was first carried out to analyse the relationship between the PosWB and NegWB scales. Following this, a median split was performed on both scales in order to analyse the data according to the four well-being quadrants as suggested by Whittington and Huppert (1998). As a result of the median split the data was categorised into the four different well-being quadrants; LowPos/LowNeg, LowPos/HighNeg, HighPos/LowNeg, HighPos/HighNeg. Chi-square analysis and Analysis of Variance (ANOVAs) were used to analyse the demographic data. The psychosocial data was analysed by two-way between subjects ANOVAs with factors well-being and psychosocial variables, to establish which psychosocial factors were associated with positive and negative well-being in an older population.

The cortisol data was, as expected, significantly skewed. Square root transformation optimally reduced the skew statistic and all inferential analyses were done on these transformed scores. The CAR cortisol was analysed according to the AUCg and AUCi formulas described above (Section 3.5). For descriptive purposes, mean data in figures and tables were re-transformed to original units (nmol/l). Two separate ANOVAs were carried out because of the two distinct periods of cortisol measurements. The first four samples constituted the period of the CAR (time 0, 15, 30, 45 min post-awakening) and the last four samples measured the normal diurnal decline in cortisol (time 3, 6, 9 and 12 hours after awakening). Mixed ANOVAs were performed in order to examine the cortisol profile, including mean values and dynamic changes across sampling points. Interactive as well as main effects on both positive and negative well-being were explored. Significance probabilities where appropriate were corrected for sphericity violation by using the Greenhouse-Geisser method.

Because the scoring of each individual cognitive test varied, test scores were standardised to give a mean of 0 and a standard deviation of 1 (*z*-scores), where high scores represent high levels of cognitive performance. The Overall Cognitive Performance (OCP) score was obtained by standardising the summed *z*-scores on all tests. One-way ANOVAs and Spearman's rank correlations were carried out to find out if OCP was associated with demographical and psychosocial factors. Correlation analyses were carried out to find associations between OCP and age on each of the two well-being scales, since age was hypothesised to have a great effect on OCP.

In the follow-up study (n=37) Spearman's rank correlations were carried out to analyse the relationship between the PosWB and the NegWB scales. Chi-square analysis was used to analyse the demographic data and paired t-tests were used to find out if PosWB, NegWB, psychosocial factors and cortisol levels had changed from Time 1 (T1) to Time 2 (T2). As in the three first studies, a median split was performed on both well-being scales in order to see if the participants were represented in all of the four well-being quadrants.

However, since only two people had scores which classified them into the quadrant, HighPos/HighNeg, these participants were excluded from the analysis. The data was subsequently analysed with one-way between ANOVAs with three levels (LowPos/LowNeg, LowPos/HighNeg, HighPos/LowNeg) followed by Bonferroni Post Hoc tests.

The data collection

The data in this research arose from information collected for a large collaborative project with support from WestFocus, which was a partnership between several universities whose projects were supported by the Higher Education Funding Council of England (HEFCE) between 2004 and 2009. The WestFocus consortium was initially established as part of a government-funded knowledge exchange project. This research was conducted with the aim of identifying needs and research questions concerned with the well-being of older people in the region of south-west London area. This research benefited from the advice and experience of some of its WestFocus partners (Denise Forte and Liz Aitchenson, Faculty of Health and Social Care, St. Georges, University of London and Catherine Jacobs, Department of Health and Social Care, Royal Holloway, University of London). Despite this initial project, the research presented in this thesis is the original work of the author.

In sum, this chapter gave an overview of the statistical approaches to the analysis of the data, as well as a comprehensive account of the cognitive test battery used in the research. A detailed explanation of the psychosocial questionnaires was presented together with a brief description of the demographical data. Extra weight was given to the method of scoring the GHQ-30 to create the two measures of positive and negative well-being. The chapter also considered ethical issues and presented the participants who took part in the research.

Chapter 4 Demographical and psychosocial factors

Overview

This chapter aims to establish if the GHQ-30 can be used to create two relatively independent scales of positive and negative well-being. The chapter will move on to investigate which demographical and psychosocial factors are associated with positive and negative well-being in an older population. The main findings will be presented and the discussion will summarise the results and evaluate the findings.

4.1 Introduction

Few would disagree that part of what it means to age well is to live a long life while maintaining a positive outlook. However, it is clear from the literature that factors which encourage successful ageing are not fully understood. Negative well-being, such as depression and feelings of loneliness, have been found to be significant predictors of declining health status in old age (Everson, Roberts, Goldberg, & Kaplan, 1998; Mitchell & Subramaniam, 2005). However, much less attention has been given to the impact of positive well-being in later life (Ostir, et al., 2000; Penninx, Guralnik, Bandeen-Roche, Kasper, Simonsick, Ferrucci, & Fried, 2000). The various research presented in the introduction of this thesis (Chapter 1), together with the findings from the study by Huppert and Whittington (2003) (Chapter 2, Section 2), highlights the importance of looking at both positive and negative well-being in relation to successful ageing.

In Huppert and Whittington's (2003) paper they used the well-known General Health Questionnaire (GHQ) to create two well-being scores, namely positive well-being (PosWB) and negative well-being (NegWB). They proposed a novel and interesting way of measuring positive and negative well-being by deriving both well-being dimensions from the same scale. These measures also

contained items which covered both the eudaimonic and hedonic perspective on well-being. Their findings demonstrated evidence for the relevant independence theory, as opposite to the bipolar theory, both theories which are described in greater details in the introduction (Chapter 1). Huppert and Whittington (2003) further found that positive and negative well-being, while clearly related to each other, did not always relate to other factors in the same way. In particular age, sex, work, social roles, perceived stress and physical health were factors that had different effects on the positive and negative well-being dimensions.

These two scales of PosWB and NegWB as presented by Huppert and Whittington (2003) do not seem to have been fully explored in other population studies to see if they are measuring well-being in the way suggested by the authors. Hence, there is little evidence in the research literature which uses the GHQ-30 in the way suggested by Huppert and Whittington. One study that comes close to Huppert and Whittington's (2003) scoring was carried out by Bobowik and colleagues (2011). In their study they applied the GHQ-12 and scored the 6 positive loaded items and the 6 negative items as suggested by Huppert and Whittington (2003) to examine relationships between personal value and well-being. However, as they used the GHQ-12 and not the GHQ-30 some of the dimensions of well-being were evidently unaccounted for. In addition, according to the author of the original scale, Goldberg (1972), the GHQ-30 is better at detecting psychological symptoms than the shorter version of the GHQ-12. Apart from this study there is little evidence of studies which have used the GHQ-30 to create one PosWB scale and a separate NegWB scale as suggested by Huppert and Whittington (2003). It is therefore interesting to examine if these findings can be replicated and to explore how these two scales are associated with demographical and psychosocial factors. It is particularly interesting to see how the scales are related to older people as the focus on successful ageing has traditionally emphasised reduction of negative well-being, and ignored the importance of increasing positive well-being,

For many years social scientists have attempted to explain why people differ in their level of well-being by looking at demographic factors such as age, sex, marital status and income (McKenzie & Campbell, 1987; Mookherjee, 1998; Pinquart & Sorensen, 2000). This has been known as the “social indicators movement” in well-being research (Mroczek & Kolarz, 1998). The idea was that some sociodemographically defined groups, for example, married people, those with higher incomes and younger people had more positive well-being than others because of better availability of psychological, physical and material resources. As a result, individual differences in well-being were thought to be by-products of these group differences (Mroczek & Kolarz, 1998).

A study that investigated the association between age and well-being, and more specifically in relation to hedonic well-being, was carried out by Mroczek and Kolarz (1998). In the study they gave 2,727 participants (age range 25-74 years old) two 6-item scales, one for each positive and negative affect. The results showed that the second oldest participants (range 68-77) and the oldest participant (79-89 years old) had the highest level of positive well-being compared to any other age group in the sample. Interestingly, the youngest people (18-27 years old) reported the most negative affect and the oldest the least. They further found that for women, age was related to positive affect but was unrelated to negative affect. In men, age interacted with the variables extraversion and martial status in predicting affect.

As presented in the introduction of this thesis (Chapter 2, Section 2) Huppert and Whittington (2003) also found evidence that positive and negative well-being changed with age. For women, negative well-being increased and positive well-being fell with age. For men too, positive well-being declined steadily with age but negative well-being was higher in middle age and lowest in old age. In other words, older men seemed to score low on both the positive and the negative well-being scale. This difference in age, as presented by Huppert and Whittington (2003) highlights the importance of looking at well-being in relation to age since it implies that well-being has a different effect on different age groups. Well-being is also an important factor in relation to the

concept of successful ageing, which is presented and discussed in greater detail in the introduction of this thesis (Chapter 1).

The importance of socioeconomic status in relation to positive and negative well-being is another variable that should be examined. However, when it comes to socioeconomic and well-being, there is currently no agreed association between the variables. A study by Headey and Wooden (2004) found that in a sample of 7934 participants in prime working age (25-59 years) economic variables, notably income, appeared to have little effect on either positive or negative well-being. Mookherjee (1998), on the other hand, found evidence for the importance of financial status in relation to both positive and negative well-being. Wright and Steptoe (2005) further note that in older adults, subjective social status may be particular useful in providing an aggregate estimate of lifetime social experience, which is not so effectively captured by objective markers of socioeconomic status.

Psychosocial measures, such as social relations, social roles and social support, have been shown to be important factors in relation to positive and negative well-being (Barresi, et al., 1983; Brown, et al., 2003). In a study by Pitkala et al. (2004) they found that positive well-being correlated inversely with having few social relations. Demographic indicators such as income, education and sex accounted for very little variation in well-being. McAuley and colleagues (2000) also reported from their study that social relations were related to increased satisfaction with life and reduction in loneliness.

Additional studies have demonstrated the impact of positive well-being on health. For example, in a review of prospective and empirical studies of older people, positive affect was found to be associated with lower mortality, reduced morbidity and pain, and increased self-reported health (Cohen & Pressman, 2006). The possibility that a high level of well-being has favourable effects on physical health outcomes have been increasingly reported in the literature. Recently research into how positive well-being can reduce the rate of various physical illnesses and premature mortality has been investigated (Huppert, et al., 2004; Ryff, et al., 2004). Subjective measures of health can be very useful

to measure in order to establish how participants perceived their own health situation, and subjective health is therefore important to include as a psychosocial variable in relation to the analysis of positive and negative well-being.

Aims and hypothesis

The aim of this chapter was firstly to determine if positive and negative well-being can be defined as two relatively separate and independent domains as suggested by Huppert and Whittington (2003). The second aim was to establish which demographical and self-reported psychosocial factors were associated with positive well-being and negative well-being in an older population.

It was hypothesised that positive and negative well-being are relative separate domains and that these two domains are associated with different demographical and psychosocial factors.

4.2 Analysis of the demographical data

Analysis of the demographical data revealed that the mean age of participants was 74 years (SD±7) with a range from 59 to 91 years old. Forty-seven participants classified themselves as white-British, one as white-Irish and two as 'others'. Demographical factors linked to social interaction and social support revealed that 23 participants were married or cohabiting, 11 participants were divorced or single and 16 participants were widowed. Twenty seven people lived alone and 23 lived with a partner or family members. Forty-three were retired and 7 semi-retired (defined as working one day or more a week). Thirty-six people reported that they had a driving license and 35 participants had a freedom pass for public transport. On the question related to social activities and social commitments, participants reported an average of 8.2 (SD±3.1) hours a week being occupied with social activities. The mean number of close

family participants reported to have was 6.1 (SD±3.7) and number of close friends was 4.8 (SD±4.3).

Additional demographical information related to socioeconomic status showed that the mean age of leaving school was 16.5 years old (SD±1.2) and over 60% (n=30) attended college or university after school. The mean number of years since the participants retired was 14 years (SD±11) and on answer to the question how long participants had lived in the area the mean number was 37 years (SD±16.4).

More than half of the participants (N=26) reported that they had health concerns at the moment and 80% (N=40) answered that they drank alcohol, with mean units of 10.4 (SD±8.1) a week. None of the participants smoked.

Positive and negative well-being as independent dimensions

The questionnaires related to psychosocial factors were scored according to the procedure described in Chapter 3, Section 4. The independent factors in the analysis were the GHQ-30 scores. Data was scored according to the two ways suggested by Huppert and Whittington (2003), where the sum of the items on the GHQ-30 added up to one overall positive well-being score (PosWB) and one overall negative well-being score (NegWB).

As illustrated in Figure 4-1, PosWB scores were centrally distributed with most of the answers around the middle value of 15 (mean=15.1, SD±4.0). The NegWB scores on the other hand, as illustrated in Figure 4-2, showed a skew in the direction of low scores, suggesting fewer negative symptoms (mean=8.4, SD±6.3).

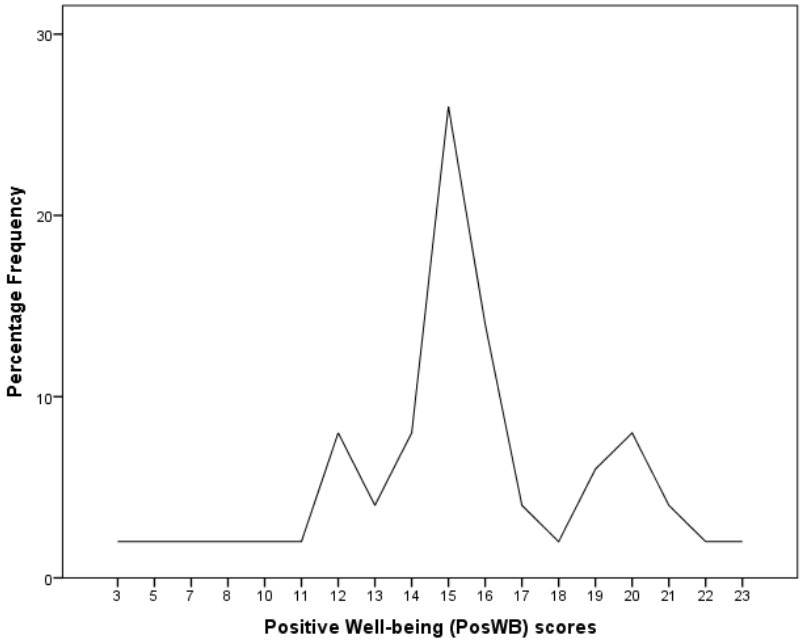

Figure 4-1 Frequency distribution of positive well-being (PosWB) scores

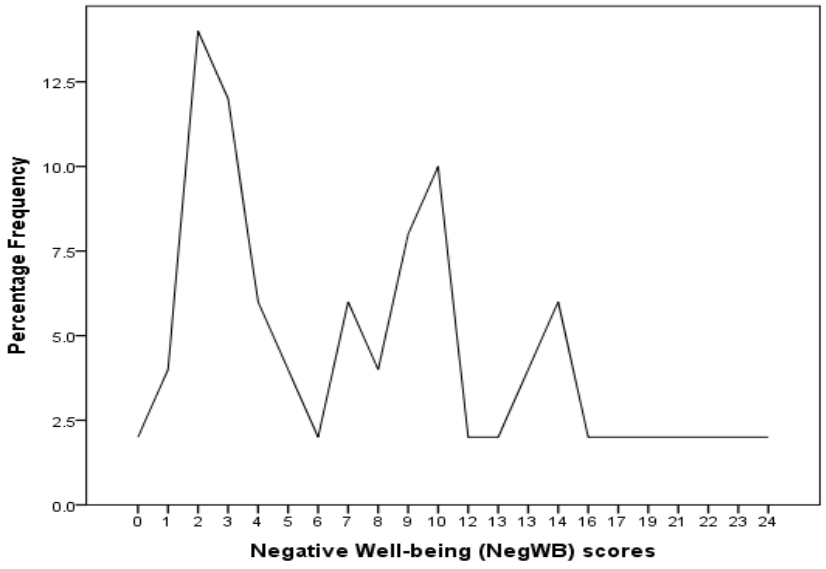

Figure 4-2 Frequency distribution of negative well-being (NegWB) scores

These findings are similar to the distributions obtained by Huppert and Whittington (2003) at Time 1 and Time 2, where they also reported that the PosWB scores were normally distributed and the NegWB were skewed with

more scores at the lower end of the scale, suggesting most participants report few psychological symptoms. This finding is also supportive of Huppert and Whittington's (2003) argument for the independent hypothesis in that PosWB is capturing more than the mere absence of symptoms since PosWB was not the inverse of the NegWB. However, in accordance with Huppert and Whittington's (2003) study these results also revealed a significant correlation between positive well-being and negative well-being. As demonstrated in the scatter diagram in Figure 4-3, the results from the Spearman's rho correlation showed that there was a significant negative relationship between PosWB and NegWB ($r=-.59$, $N = 50$, $p<.001$, two-tailed). Participants who scored high on the PosWB were more likely to score low on the NegWB scale and vice versa, the participants who scored low on PosWB scale were more likely to score high on the NegWB scale.

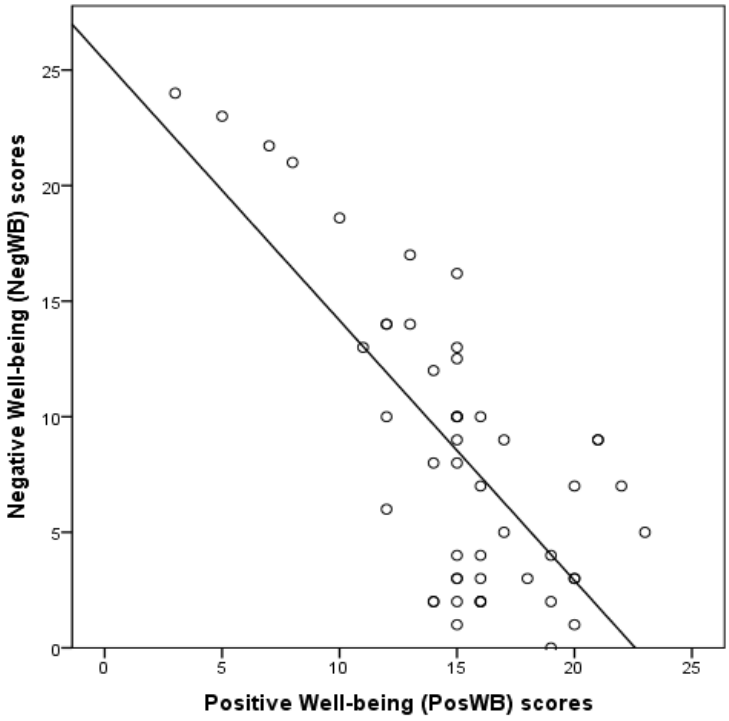

Figure 4-3 Scatter plot of correlation between positive well-being (PosWB) and negative well-being (NegWB) scales

Independent sample t-test analyses of the two well-being scales in relation to sex found no difference between men (n=16) and women (n=36) on the PosWB

scale (t=.728, df=48, p=.470) or the NegWB scale (t=.309, df=48, p=.758). This suggests that no sex difference in older people, in relation to the two well-being scales, was found.

Huppert & Whittington's (2003) strategy of applying cross-tabulating median splits of both the PosWB and the NegWB scales was carried out. Accordingly the combined response of the two scales were grouped and each participant allocated to one out of four quadrants; LowPos/LowNeg, LowPos/HighNeg, HighPos/LowNeg and HighPos/HighNeg. The results from the median split, which are presented in Table 4.1, revealed that the distributions in the four quadrants closely mirrored those given by Huppert & Whittington (2003). The comparative percentages of the results, as obtained by Huppert and Whittington, are presented in brackets.

Table 4.1 Percentage of respondents with four combinations of PosWB and NegWB scores with Huppert and Whittington's (2003) findings in brackets.

	LowPos	HighPos
LowNeg	**16% (18.1 %)**	**34% (29.6 %)**
HighNeg	**42% (35.3 %)**	**8% (17.0 %)**

The results from the four quadrants revealed that 16% (N=8) of the respondents to the GHQ-30 questionnaire indicated that they had low NegWB and low PosWB (compared to 18% in the Huppert and Whittington study). Forty-two percent (N=21) of the respondents answered that they experienced low PosWB and high NegWB (compared to 35% in the Huppert and Whittington study). Thirty-four percent (N=17) of the participants indicated that they had high PosWB and low NegWB (compared to 30% in the Huppert and Whittington study). Eight percent (N=4) of the participants scored high on both PosWB and on NegWB (compared to 17% in the Huppert and Whittington study).

Well-being and demographical factors

The demographical factors were analysed with two-way ANOVAs and chi-squares. The analysis of the demographical data revealed that there was no significant difference between the four well-being quadrants in relation to sex ($\chi^2_{(3,N=50)}$=2.77, p=.429), marital status ($\chi^2_{(12,N=50)}$=9.48, p=.661), living arrangements ($\chi^2_{(6,N=50)}$=3.31, p=.770), education ($\chi^2_{(3,N=50)}$=7.25, p=.064), retirement status ($\chi^2_{(3,N=50)}$=.95, p=.812), driving ($\chi^2_{(3,N=50)}$=2.20, p=.532) having a freedom pass ($\chi^2_{(3,N=50)}$=4.79 p=.188), drinking alcohol ($\chi^2_{(3,N=50)}$=2.03, p=.566) or reporting health concerns ($\chi^2_{(3,N=50)}$=3.30 p=.213).

The results from the between subject ANOVAs revealed no interaction between PosWB and NegWB in relation to age ($F_{(1, 46)}$ = .168, p=.685), no main effect of PosWB on age ($F_{(1, 46)}$ = 1.500, p=.227) and no main effect of NegWB on age ($F_{(1, 46)}$ =.385, p=.538). Likewise, there was no interaction between PosWB and NegWB on age when participants left school ($F_{(1, 46)}$ = 2.741, p=.105), no main effect of PosWB on age when participants left school ($F_{(1, 46)}$ = 4.032, p=0.61) and no main effect on NegWB and age when participants left school ($F_{(1, 46)}$ = 2.741, p=.105). No interaction between PosWB and NegWB in relation to years lived in the area ($F_{(1, 46)}$ = .010, p=.922) was found, likewise, no main effect of PosWB on years lived in the area ($F_{(1, 46)}$ = 1.897, p=.175) and no main effect of NegWB on years lived in the area ($F_{(1, 46)}$ = 3.194, p=.081) was found. The results revealed no interaction between PosWB and NegWB in relation to years since retirement ($F_{(1, 43)}$ = .299, p=.587), no main effect of PosWB on years since retirement ($F_{(1, 43)}$ = 1.816, p=.185) and no main effect of NegWB on years since retirement ($F_{(1, 43)}$ = .282, p=.598). Finally, the results revealed no interaction between PosWB and NegWB in relation to alcohol per week ($F_{(1, 33)}$ = .690 p=.412) no main effect of PosWB on alcohol per week ($F_{(1, 33)}$ = .074, p=.787) and no main effect of NegWB on alcohol per week ($F_{(1, 33)}$ = .005, p=.941). Accordingly, the demographical data did not reveal any significant differences between the four well-being quadrants.

Well-being and psychosocial factors

The mean score of the socioeconomic status, as measured by the SES Ladder (scale from 1 low to 10 high) was 7.0 (SD±1.8) The average score on the Visual Analogue Scales (scale from 1 low to 100 high) showed a mean of 67 (SD±14) on perceived health, a mean of 73 (SD±14) on perceived well-being and a mean of 66 (SD±23) on perceived financial status. The results from a two-way between subject ANOVA did not reveal any interaction between the PosWB and NegWB on the SES Ladder ($F_{(1, 46)}$ = .00, p=.947), there was no main effect of PosWB on the SES Ladder ($F_{(1, 46)}$ = .396, p.=532) and no main effect of NegWB on the SES Ladder scores ($F_{(1, 46)}$ = .692, p=.410). These findings suggest that participants' scores on the PosWB and the NegWB scales were not associated with socioeconomic status.

Two-way between subjects ANOVAs were also carried out to see if there were any differences between the VAS scores and the two well-being scales. There was no interaction between PosWB and NegWB on the perceived health ($F_{(1, 46)}$ = .074, p=..787), and no main effect on PosWB and perceived health ($F_{(1, 46)}$ = .100, p=.753) and no main effect on NegWB on perceived health ($F_{(1, 46)}$ = 3.752, p=.059) was found. Likewise, there was no interaction between PosWB and NegWB on the perceived wellness ($F_{(1, 46)}$ = .475, p=.494), and no main effect on PosWB and perceived wellness ($F_{(1, 46)}$ = 2.958, p=.092) and no main effect on NegWB on perceived wellness ($F_{(1, 46)}$ = .386, p=.537).

However, the results from the two-way ANOVA on perceived financial status showed a significant interaction between PosWB and NegWB and perceived financial status ($F_{(1, 46)}$ = 4.594, p=.037), as presented in Figure 4-4. Interestingly, a significant main effect on PosWB showed that people who scored high on PosWB rated their financial status as lower than participants who scored low on PosWB ($F_{(1, 46)}$ = 6.018, p=.018), there was also a main effect on NegWB where those who scored high on NegWB scored low on perceived financial rating and vice versa ($F_{(1, 46)}$ = 9.970, p=.003), see Figure 4-4. Looking closer at the mean in the four well-being quadrants, as presented in Table 4.3, it becomes apparent that the HighPos/HighNeg quadrant (mean=33,

SD=22) scored much lower on the perceived financial status than the remaining quadrants (LowPos/LowNeg (mean=74, SD=22), HighPos/LowNeg (mean=71, SD=16) and HighNeg/LowPos (mean=66, SD=24).

Table 4.2 Mean score in each of the well-being quadrants in relation to perceived financial status

	LowPos	HighPos	Total
LowNeg	**74 (SD=22)**	**71 (SD=16)**	**145**
HighNeg	**66 (SD=24)**	**33 (SD=21)**	**99**
Total	**140**	**104**	

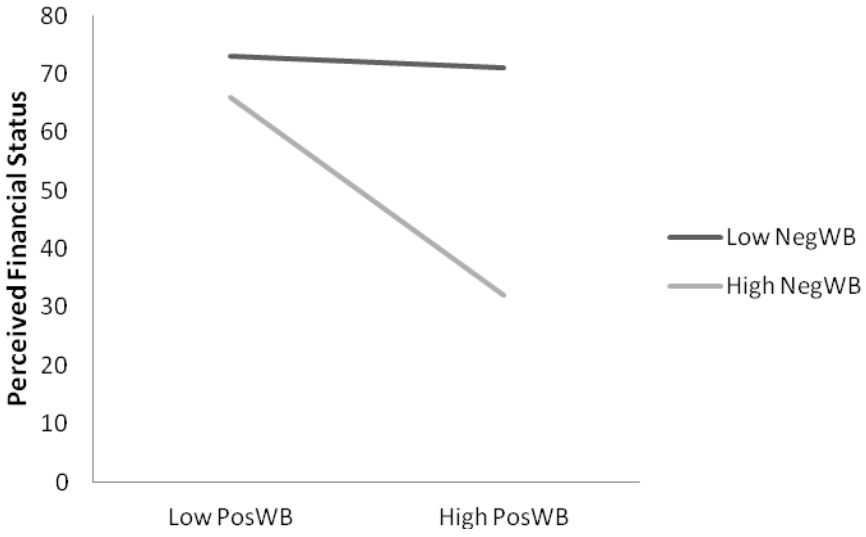

Figure 4-4 Positive Well-being (PosWB) and Negative Well-being (NegWB) scores in relation to perceived financial status score

The next stage in the analysis was to look at successful ageing as measured by the Life Satisfaction Index A (LISA). The mean score of this sample was 29.5 compare to the normative data which had a mean of 22.4, suggesting this

population had an above average rating of successful ageing. With the analysis of the LISA data in relation to the four quadrants no interaction between PosWB and NegWB was found in relation to successful ageing ($F_{(1, 46)}$ = .519, p=.475) and there was no main effect on NegWB on successful ageing ($F_{(1, 46)}$ = 2.941, p=.093). However, a significant main effect of PosWB on successful ageing was found ($F_{(1, 46)}$ = 12.980 p=.001), as presented in Figure 4-5. From the mean values of each quadrant in Table 4.3 it is apparent that participants in the two high PosWB quadrants (HighPos/LowNeg and HighPos/HighNeg) scored significantly higher (mean total=66) on the successful ageing scale than participants who reported LowPos (LowPos/LowNeg and LowPos/HighNeg) (mean total=55), suggesting that low levels of PosWB is associated with low levels of successful ageing and vice versa, high levels of successful ageing are associated with high levels of PosWB. No association was found between successful ageing and NegWB.

Table 4.3 Mean score in each of the well-being quadrants in relation to successful ageing

	LowPos	HighPos	Total
LowNeg	**29 (SD=4)**	**34 (SD=3)**	**63**
HighNeg	**26 (SD=5)**	**32 (SD=3)**	**58**
Total	**55**	**66**	

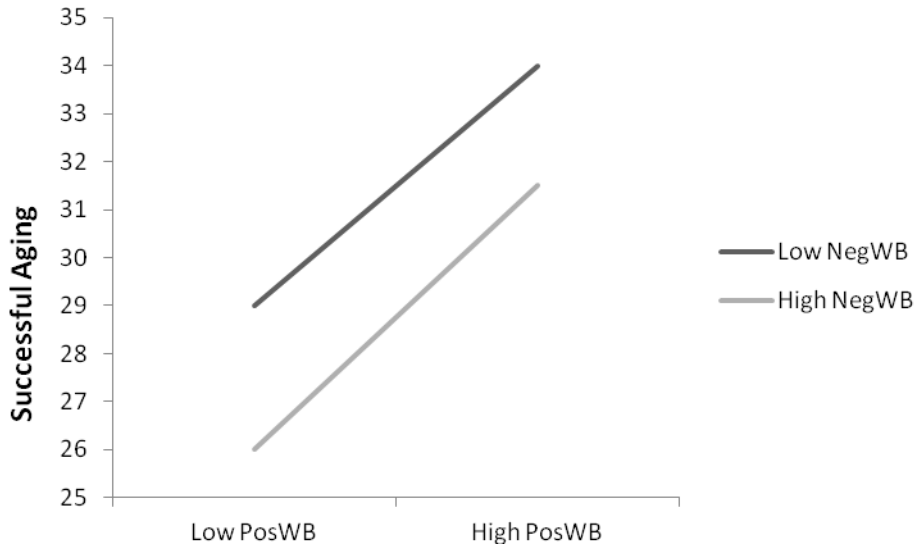

Figure 4-5 Positive wellbeing (PosWB) and negative well-being (NegWB) scores in relation to successful ageing score

Analysing the MOS social support questionnaire the two-way ANOVA revealed a significant main effect on NegWB on the MOS scores (F(1, 46) = 5.340, p=.025), as presented in Figure 4-6. The results indicate that participants in the low NegWB group scored high on social support in comparison to those in the high NegWB comparison group, which is supported by the mean scores of each quadrant, as presented in Table 4.5. No interaction was found between PosWB and NegWB on social support ($F_{(1, 46)}$ = 1.081, p=.304) and no main effect on the PosWB on social support was found ($F_{(1, 46)}$ = .031, p=.860). These findings suggest that social support is associated with NegWB but not PosWB.

Table 4.4 Mean score in each of the well-being quadrants in relation to social support score

	LowPos	HighPos	Total
LowNeg	**83 (SD=15)**	**77 (SD=18)**	**160**
HighNeg	**58 (SD=24)**	**67 (SD=34)**	**125**
Total	**141**	**144**	

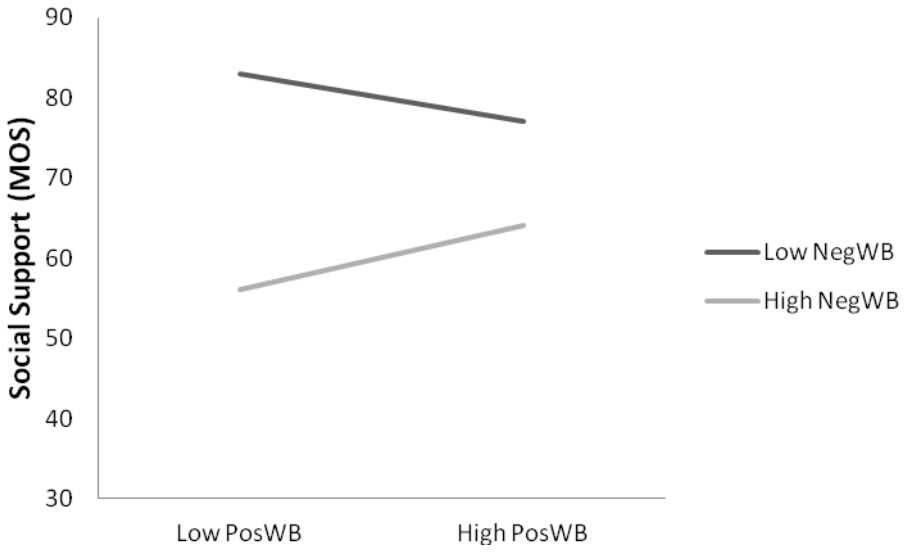

Figure 4-6 Positive well-being (PosWB) and negative well-being (NegWB) scores in relation to Social Support score

A two-way ANOVA analysis of the Perceived Wellness Scale found no interaction between PosWB and NegWB on the overall PWS ($F_{(1, 46)}$ = .452, p=.505), nor a main effect of PosWB ($F_{(1, 46)}$ = 1.482, p=.230) or NegWB ($F_{(1, 46)}$ = 1.171, p=.285). However, when analysing the six subscales of the PWS, physical, spiritual, intellectual, psychological, social and emotional wellness, it emerged that the PosWB had a significant main effect on the Spiritual Wellness scores ($F_{(1, 46)}$ = 9.057, p=.004) with participants in the PosWB quadrants reporting greater spiritual wellness (mean total=48) than the low PosWB quadrants (mean total=39), presented in Table 4.5 and Figure 4-7 respectively. NegWB had no effect on spiritual wellness ($F_{(1, 46)}$ = .028, p=.868) and no interaction between PosWB and NegWB was found ($F_{(1, 46)}$ = .763, p=.387). These findings suggest that spiritual wellness is associated with PosWB but not with NegWB.

Table 4.5 Mean score in each of the well-being quadrants in relation to spirituality as measured by the Perceived Wellness Scale

	LowPos	HighPos	Total
LowNeg	**20 (SD=2)**	**23 (SD=1)**	**43**
HighNeg	**19 (SD=5)**	**25 (SD=2)**	**44**
Total	**39**	**48**	

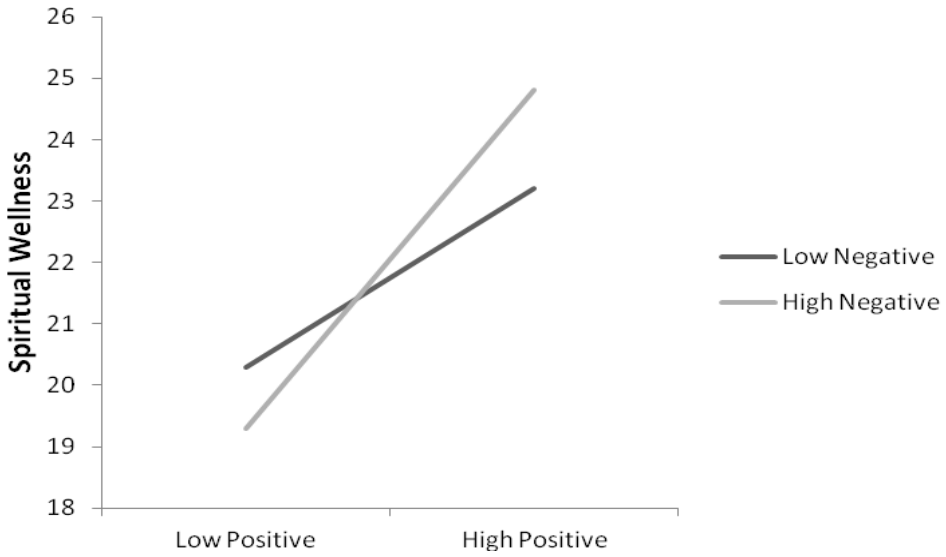

Figure 4-7 Positive well-being (PosWB) and negative well-being (NegWB) scores in relation to spirituality as measure on the perceived wellness Scale

The analysis of the CASP-19, which measures quality of life in older people, did not reveal an interaction between PosWB and NegWB ($F_{(1, 46)}$ = .641, p=.428), nor a main effect on PosWB and quality of life ($F_{(1, 46)}$ = 1.669, p=.203). However, the analysis revealed a main effect on NegWB on quality of life ($F_{(1, 46)}$ = 4.503, p=.039), as presented in Figure 4-8. Suggesting that participants who scored low on NegWB scored high on quality of life (mean total=93) and vice versa, participants who scored high on NegWB (mean total= 84) also reported low sense of quality of life, presented in table 4.6.

Table 4.6 Mean score in each of the well-being quadrants in relation to quality of life (CASP-19)

	LowPos	HighPos	Total
LowNeg	**46 (SD=5)**	**47 (SD=6)**	**93**
HighNeg	**40 (SD=8)**	**44 (SD=2)**	**84**
Total	**86**	**92**	

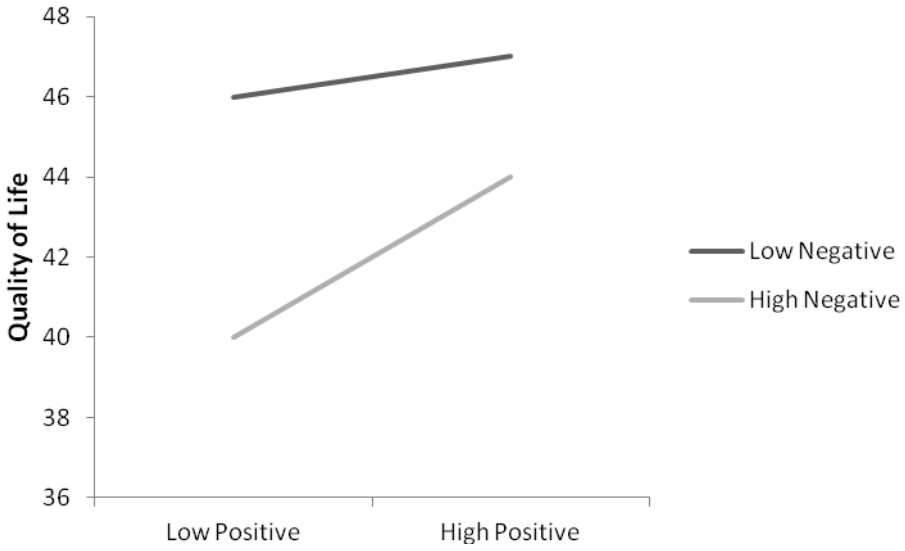

Figure 4-8 Positive well-being (PosWB) and negative well-being (NegWB) scores in relation to quality of life (CASP-19)

Physical and mental health was measured with the SF-36 questionnaire which is divided into eight sub categories; physical functioning, role limitations due to physical health problems, bodily pain, social functioning, general mental health (covering psychological distress and well-being), role limitations due to emotional problems, vitality, energy and fatigue and general health perceptions The results were first compared to normative data from the 1992 UK Omnibus Sample (age 65–85, n=577) (Bowling, Bond, Jenkinson, & Lamping, 1999). The results show that there was a significant difference between this group and

the normative data in two of the subcategories. This group reported better social functioning (t=2.089 df=49, p=.042) and better general mental health (t=1.934, df=49, p=.059) compared to the normative data.

The results from the analysis of overall subjective ratings of health on the two well-being scales showed that there was a significant main effect of NegWB on the total SF-36 score ($F_{(1, 46)}$ = 7.768, p=.008), as presented in Figure 4-9. Participants in the high NegWB quadrants had poorer physical health (mean total=133) in comparison to those in the low NegWB quadrants (mean total=159), see Table 4.7. PosWB was not associated with perceived health ($F_{(1, 46)}$ = .707, p=.405) and there was no interaction between PosWB and NegWB ($F_{(1, 46)}$ = .230, p=.634). These findings suggest that physical health was associated with NegWB but not PosWB.

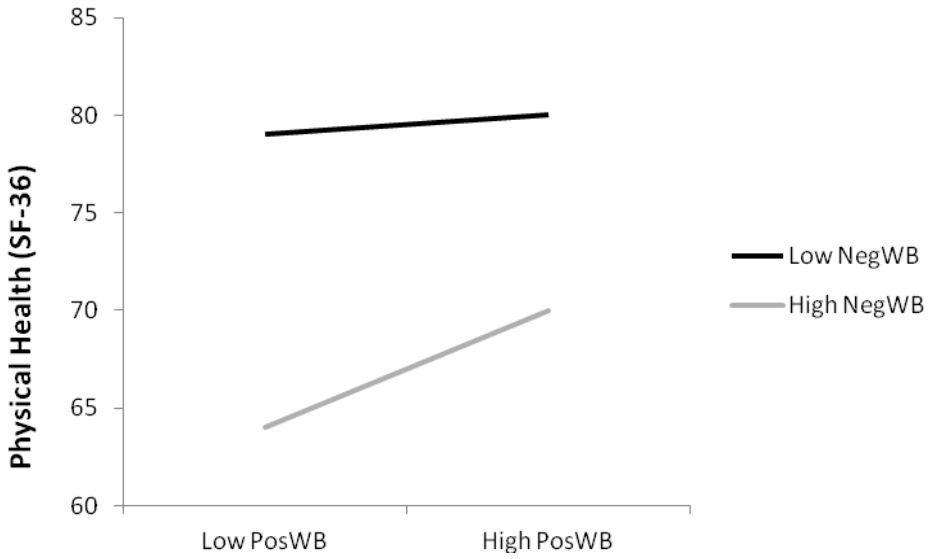

Figure 4-9 Positive well-being (PosWB) and negative well-being (NegWB) scores in relation to the physical health (SF-36)

Table 4.7 Mean score in each of the well-being quadrants in relation to overall physical health (SF-36)

	LowPos	HighPos	Total
LowNeg	**79 (SD=9)**	**80 (SD=13)**	**159**
HighNeg	**63 (SD=13)**	**70 (SD=16)**	**133**
Total	**142**	**150**	

4.3 Discussion

These results from a sample of fifty older community-dwelling participants support the theory that positive and negative well-being are not opposite poles of a single dimension. The analysis of the PosWB and the NegWB scores showed that despite a correlation between the dimensions, there were also differences between the scales, as demonstrated by the normal distribution of the PosWB scores and the skewed scores of the NegWB scale. When a median spilt was carried out on the two scales, the results further revealed that participants were allocated into all of the four different quadrants; LowPos/LowNeg, LowPos/HighNeg, HighPos/LowNeg and HighPos/HighNeg, in accordance with the findings by Huppert and Whittington (2003). Again, this supports the independence theory as almost one third of the participants gained scores to be categorised either in the LowPos/LowNeg or the HighPos/HighNeg quadrants.

The analysis from the demographical factors did not reveal any associations between demographical data and the well-being scales. The results also revealed that in contrast to Huppert and Whittington's (2003) findings, no significant difference between men and women emerged. This could be due to the relatively small sample size of fifty, where only sixteen participants were men. Accordingly, evidence for the "social indicators movement" which suggests that individual differences in well-being were thought to be by-products of demographical differences (Mroczek & Kolarz, 1998) was not found.

In addition to the demographical factors, the socioeconomic data did not reveal significant findings in relation to the well-being scales. However, the perceived rating of financial status revealed that people who reported high levels of positive well-being and high levels of negative well-being perceived their financial status as worse than the rest of the groups. Looking closer at the quadrants, these findings highlight one of the main concerns with the median split analysis. This particular quadrant, the HighPos/HighNeg, only consisted of scores from four participants, and the results from this particular quadrant can therefore not be considered very powerful.

The psychosocial factors, in comparison to the demographical data, were in general found to have much more impact on positive and negative well-being. Interestingly, PosWB and NegWB were associated with different and separate psychosocial factors. NegWB was associated with social support, quality of life and subjective health. In other words, participants who reported high levels of negative well-being had little social support, rated their quality of life as low and experienced their health as deteriorating. Vice versa, participants who reported low levels of negative well-being had good social support, reported high quality of life and described their health as good. Positive well-being was not associated with any of these factors. Hence, based on positive well-being alone it would be impossible to predict if a person would, for example, claim to have good quality of life or not.

Participants who scored high on PosWB also reported more successful ageing than participants who scored low. The same results were found with the subcategory spirituality on the Wellness scale, where participants who reported high levels of positive well-being also reported a high sense of spirituality. Negative well-being had no impact on these two psychosocial factors. It has previously been argued that spirituality and religious belief may have a significant influence on the psychological well-being of older adults (Mackenzie, Lavizzo-Mourey, Rajagopal, & Meibohm, 2000; Boey, 2003; Schickler, 2005). For example, a study by Boey et al. (2003) which looked at religious beliefs and well-being in older women, measured by a life satisfaction and depression

scale, found that an objective measure of attendance at religious activities was not related to positive well-being. However, the subjective feelings of religious faith were a source of strength and comfort which would help in times of difficulty and therefore was significantly associated with positive well-being.

Considering the findings from this chapter, as presented above, it is it obvious that the problem of causality needs to be raised. Interesting associations were found between the psychosocial factors and well-being, however it is not possible to predict if, for example, low levels of negative well-being results in better health, or if low levels of negative well-being is a 'by-product' of good health.

In sum, this research demonstrated evidence in support of the relative independence theory, as opposed to the bipolar theory. In accordance with the findings from Huppert and Whittington's (2003) research, this research also found evidence for different effects on positive or negative well-being on health and social roles. Huppert and Whittington (2003) found that disability and lack of social roles were important determinants of negative well-being, but had less influence on positive well-being. Similar results were obtained in this research when the results from the social support questionnaire, the quality of life questionnaire and the subjective state of health scale revealed that social support, life satisfaction and subjective ratings of health were associated with negative well-being but had no impact on positive well-being.

As in Huppert and Whittington's (2003) study neither socioeconomic status nor marital status did have an effect on well-being in this current research. No associations with positive well-being and negative well-being on age or sex were found. Additional factors that did show an association with the two well-being scales were social support, health, successful ageing, perceived financial status, spirituality and quality of life. These findings are supported by other studies with older people where it has been shown that despite negative social indicators associated with old age, the majority of older adults also maintain a positive sense of well-being (Diener, Sapyta, & Suh, 1998). Accordingly, in an older population, strategies to reduce negative well-being should concentrate on

policy which would lead to an increased sense of health, a better notion of quality of life and more social support available. However, in order to increase feelings of positive well-being it is important to emphasise factors such as nurturing a sense of life satisfaction in old age as well as feelings of spirituality.

Chapter 5 Cortisol secretory activity in older people

Overview

This chapter will introduce the biomarker cortisol as an important variable in relation to the study on positive and negative well-being. It will explore main features of the hormone cortisol and introduce the two distinct diurnal patterns; the cortisol awakening response and cortisol over the rest of the day. It will then move on to look at patterns of cortisol secretion in the participants and examine the results in relation to the positive and negative well-being measures. The discussion will summarise the results and consider the main findings from the cortisol data.

5.1 Introduction

Including an objective biomarker has been shown to add value to social psychological research as it provides additional and potentially improved assessment to self-report measures (for review see Smyth, et al., 2013). By adding objective biomarkers into the research this can also provide further opportunities for assessing if negative and positive well-being function as separate and independent domains. According to the two different well-being hypotheses, the bipolar view would predict that positive well-being and negative well-being have largely similar biological correlates but with opposite directional signs. In contrast, the independent view, would predict distinct biological correlates where positive well-being and negative well-being have different biological signatures. Accordingly, if the constructs or associations of positive well-being are different from those of negative well-being, there may also be distinct mechanism for preventing illness and disease (Evans, Forte, Jacobs, Fredhoi, Aitchison, Hucklebridge, & Clow, 2007).

There is in particular one important piece of research, which was briefly presented in the introduction (see Chapter 2, Section 2) which has examined whether positive and negative well-being exist independently or on a bipolar continuum in relation biological correlates. In this study Ryff and colleagues (2006) took, what they called, a 'multiple aspect of psychological well-being' by assessing positive well-being and negative well-being in a sample of older women (n=135, mean age=74 years). Positive well-being was measured with both a eudaimonic questionnaire, namely Ryff's scales of psychological well-being (Ryff, 1989), and a hedonic questionnaire, which was the positive items on the PANAS inventory scale (Watson, et al., 1988b). Negative well-being (or what they termed ill-being) was measured in terms of negative affects, as measured by the negative items on the PANAS inventory scale, depressive symptoms as measured by the Centre for Epidemiologic Studies Depression scale (Radloff, 1977) and anxiety as measured by the Trait-State Anxiety Inventory (Spielberger, 1983). Both positive well-being and negative well-being was examined in relation to ten different biomarkers, which included neuroendocrine factors (salivary cortisol, epinephrine, norepinephrine, Dehydroepiandrosterone sulfate) and cardiovascular factors (weight, waist-hip ratio, systolic and diastolic blood pressure, high-density lipoprotein (HDL) cholesterol, total/HDL cholesterol, glycosylated haemoglobin). The results from this study found that seven biomarkers supported the independent hypothesis, while only two biomarkers (weight and glycosylated haemoglobin) supported the bipolar hypothesis. Interestingly, one of the biomarkers which was particularly found to support the independence view between positive and negative well-being was the hormone cortisol. Significant positive associations were found between the average daily slope (three samples collected per day across four days) with personal growth and purpose in life, but only for the participant aged 75 and above (n=52).

The well-being scores further revealed that participants with high personal growth and purpose in life, as measured by the eudaimonic questionnaire, had a flatter daily slope in salivary cortisol. A closer examination of the results revealed that those who scored high on personal growth and purpose in life

started the day with lower levels of salivary cortisol and stayed lower throughout the day than those with reduced levels of growth and purpose. The authors concluded that positive well-being showed a more pervasive and distinct biological signature than was evident for negative well-being. However, this was only evident for a subset of those who reported eudaimonic well-being (positive relations with others, purpose in life and personal growth). Hedonic well-being showed few significant associations with the biomarkers.

The hormone cortisol is particularly interesting to examine in relation to well-being as it is traditionally referred to as the stress hormone, and is therefore often associated with the negative side of well-being. The level of cortisol in our body has been shown to increase when daily stressors activate the hypothalamic–pituitary–adrenal axis (Kirschbaum, Pirke, & Hellhammer, 1993; Ockenfels, Porter, Smyth, Kirschbaum, Hellhammer, & Stone, 1995; Smyth, et al., 1998; Hanson, Maas, Meijman, & Godaert, 2000; Peeters & Berkhof, 2003). However, newer research has shown that individual differences which are known to contribute to positive well-being can modulate stress-induced elevations in cortisol (Smyth, et al., 1998; Pruessner, et al., 1999; Polk, et al., 2005; Jacobs, et al., 2007). For more details on the hormone cortisol see Chapter 3, Section 5).

A healthy pattern of cortisol secretion is characterised by high levels in the morning followed by a steep decline during the day, leading to low levels in the evening (Edwards, Hucklebridge, Clow, & Evans, 2001; Thorn, Evans, Clow, Hucklebridge, & Esgate, 2004). A number of research studies have found that this healthy pattern is associated with high positive well-being, such as optimism and positive affect, but not with negative well-being, such as anxiety and negative affect (Lai, et al., 2005; Steptoe & Wardle, 2005; Ryff, et al., 2006; Steptoe, et al., 2007). This was also demonstrated in a study by Lindfors and Lundberg (2002) where they, with the use of Ryff's Psychological Well-being Scale, found that individuals who scored high on positive well-being had a significantly lower cortisol output than individuals with who scored low on the positive well-being scale. Negative well-being, as measured with a physical

symptoms and pain questionnaire, had no effect on cortisol. This study found interesting evidence for an association between positive well-being and lower cortisol secretion.

When measuring cortisol secretion it is common to collect several samples over the day in order to capture the dynamics of change. Studies on healthy adults have shown that salivary cortisol secretion during the day can be divided into two distinct phases; the Cortisol Awakening Response (CAR) and, for the purpose of this thesis what will be called, Cortisol Rest of the Day (CRD). The CAR is the cortisol level during the first 45 minutes after awakening and the CRD is the subsequent period of decline in secretion in cortisol level across the rest of the day (from 3-12 hours after awakening). Although the role of the CAR has not been clearly defined, evidence suggests that it is under a distinct regulatory influence which is sensitive to a range of psychosocial factors (Clow, Hucklebridge, Thorn, & Evans, 2004a; Evans, et al., 2007). Indeed this is also illustrated by the findings from Steptoe and colleagues (2007) where they reported that state happiness was found to be associated with reduced cortisol secretion in the post-awakening period but not over the rest of the day. Other studies (Steptoe & Wardle, 2005; Ryff, et al., 2006) which have not examined cortisol immediately after awakening but more generally point to collection of samples at certain times in the morning, rather than evening, have found cortisol secretion to be sensitive to individual differences in well-being. These findings suggest that it is important to examine the relationship between well-being and cortisol secretion in relation to the time of the day effects and carry out separate analysis of both aspects of the diurnal cycle; the CAR and the diurnal decline over CRD.

Aim and hypothesis

The aim of this chapter was to find further evidence for the independence view on well-being as proposed by Huppert and Whittington (2003) with the use of an objective biomarker of health, namely cortisol.

It was hypothesised that, in accordance with the relative independence theory, the hormone cortisol would provide further evidence for the distinct associations between positive and negative well-being.

5.2 Results from the biomarker cortisol

As described in detail in the previous chapter (Chapter 4 Section 3), the distribution of the PosWB and NegWB scores closely mirrored those given by Huppert and Whittington (2003). The results showed that NegWB was highly skewed, while PosWB was more normally distributed and with a small standard deviation. Measures of central tendency and dispersion were also near identical to those presented by Huppert and Whittington (2003). Accordingly, the results showed evidence both for some association and some independence of PosWB and NegWB, where the data yielded a Spearman's correlation coefficient of r=-0.59, similar to theirs of r=-0.63.

Following Huppert and Whittington's (2003) strategy of cross-tabulating median splits of both scales the results showed similar percentages in the resulting four quadrants (comparative percentages in parentheses): HighPos/LowNeg, 34% (30%); LowPos/HighNeg, 42% (35%); HighPos/HighNeg, 8% (17%); LowPos/LowNeg, 16% (18%) (this data is also presented in Chapter 4, Table 4.1). Thus approximately a quarter of this sample and nearer a third of Huppert and Whittington's (2003) sample showed evidence of independence between PosWB and NegWB.

The first part of the analysis looked at the demographic factors, which may have been related to both well-being scales and cortisol measures and as a result may have necessitated their inclusion as covariates in the subsequent analyses. No significant correlations were discovered. In particular, there were no associations between the two well-being categories and the major demographics age, sex and SES, as presented in Table 5.1. The reason why no correlations were found could probably be explained by the restricted age

range, the relatively small number of men in the study and the overall high SES scores as measured by the SES Ladder.

Table 5.1 Pearson correlation coefficient of PosWB and NegWB and demographical data

	PosWB	NegWB
Age	r= -.159 (p=.271)	r= .000 (p=.998)
SES	r= .124 (p=.389)	r= -.266 (p=.061)
CAR	r= -.038 (p=.794)	r= -.008 (p=.957)
CRD	r= -.161 (p=.263)	r= .129 (p=.370)

Well-being and the cortisol awakening response

Adherence in terms of collecting saliva samples at the correct time according to awakening was controlled for by inspecting the actimeter records and the recording table. The results from the data showed that all participants were clearly adherent in that the first button-press (coincident with the first sampling point) was consistent with contrasting levels of wrist activity before and after button-press and all further button-presses in the awakening period was close to the required 15 minute intervals.

The ANOVA for the CAR period yielded the expected highly significant effect of the time the samples were collected ($F_{(3, 138)} = 39.23$, $p<.001$) which confirmed the normal steep rise in cortisol over this 45 minute period after awakening, see Figure 5-1. These results are in line with previous observations with CAR data, where the time the samples were collected comprised both significant linear and quadratic components. This reflects a steep linear rise in the first half hour followed by a gradual falling off mean cortisol values in the final quarter hour.

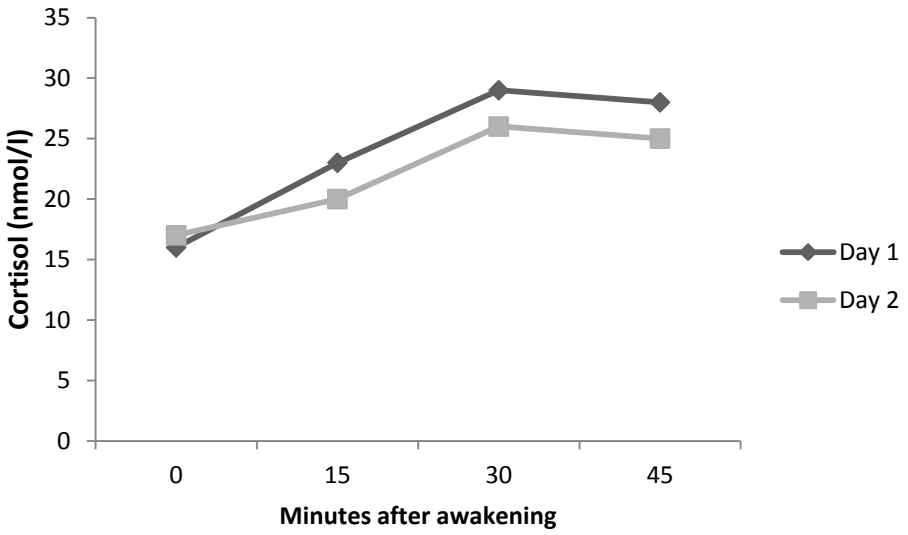

Figure 5-1 Cortisol awakening response (CAR) over two consecutive days

The two-way between subjects ANOVA analysis of PosWB and NegWB in relation to the CAR did not find a main effect for PosWB and the CAR ($F_{(1, 46)}$ = .014, p=.906) nor a main effect of NegWB and the CAR ($F_{(1, 46)}$ = 1.594, p=.213), however the results of the overall cortisol concentrations (AUCg) did reveal an interaction between PosWB and NegWB ($F_{(1, 46)}$ = 5.449, p=.024), see Figure 5-2. This suggests that the interaction between both PosWB and NegWB is associated with the CAR. Table 5.2 display the means and standard deviations for the participants' AUCg in the four well-being quadrants.

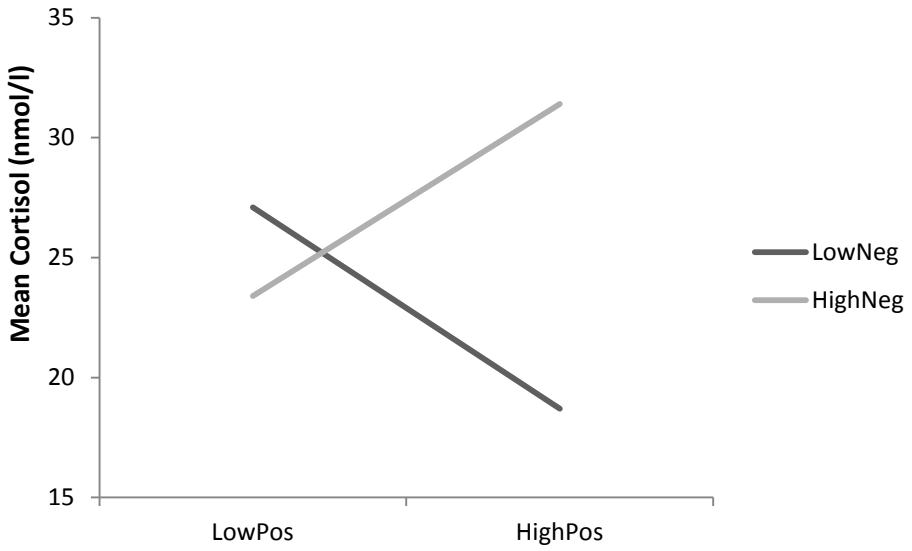

Figure 5-2 Positive Well-being (PosWB) and Negative Well-being (NegWB) in relation to mean Cortisol Awakening Response (as measured by the AUCg)

Table 5.2 Mean score in each of the well-being quadrants in relation to Cortisol Awakening Response (as measured by the AUCg)

	LowPos	HighPos	Total
LowNeg	27.1 (SD=8.3)	18.7 (SD=6.6)	45.8
HighNeg	23.4 (SD=11.0)	31.4 (SD=15.1)	54.8
Total	50.5	50.1	

When carrying out the post-hoc tests the results revealed that two components of the quadrant interaction were significant. At the low level of the negative well-being factor, high positive well-being participants had a lower cortisol mean than those with low positive well-being (t=2.335, df=23, p=.029). At the high level of the positive well-being factor, low negative well-being participants had a lower cortisol mean than those with high negative well-being (t=2.400, df=19, p=.027). The significance of these two components of the interaction indicate a powerful

synergy between the well-being factors with lower cortisol only evident in those with both high positive well-being and low negative well-being (contrast estimate =-.825; p=.011).

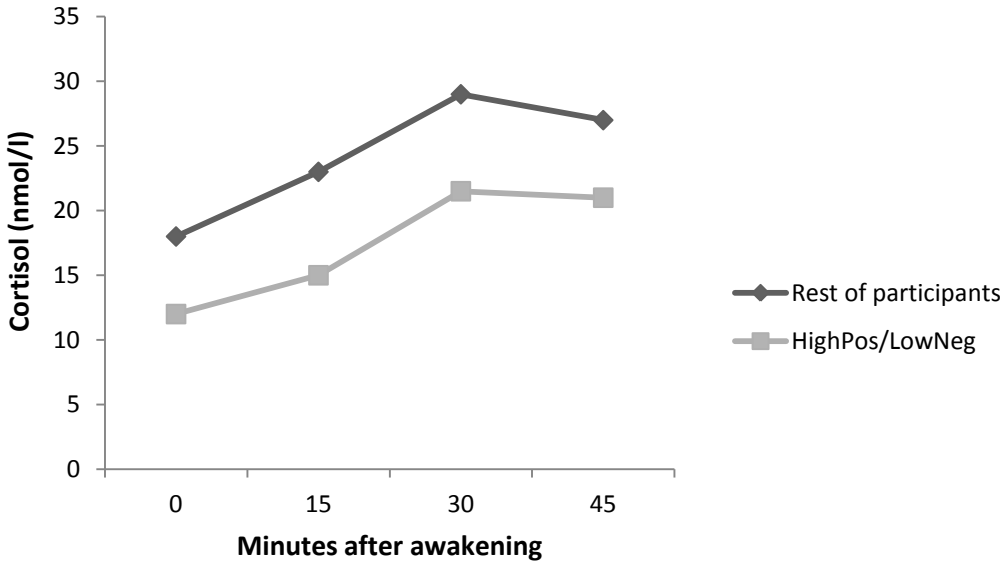

Figure 5-3 Cortisol awakening response in the HighPos/LowNeg (N=17) quadrant as compared to the rest of the group (N=33)

The significant contrast between the latter group and all others is illustrated in Figure 5-3, which for illustration purposes plots all the data for the key well-being sub-group and for the relevant comparison group (i.e. participants in all other groups). The results revealed an almost parallel profile between these two groups where the quadrant HighPos/LowNeg had a lower cortisol profile at the first sample and these lower levels of cortisol continued over the 45 minutes period. The results therefore suggest that mean cortisol over the whole post-awakening is significantly lower only in that sub-sample of participants who report more positive well-being and less negative well-being.

Well-being and the cortisol response during the day

A 4 (samples) x 2 (days) ANOVA for the diurnal profiles from 3 hours to 12 hours post-awakening (CRD) was also carried out. The results revealed the overall main effect for time of sample ($F_{(1,46)}$ = 5,668, p=.001). As expected, cortisol fell from as high as 15.07 nmol/l at 3 hours post awakening to a low as 2.51 nmol/l at 12 hours after awakening, as presented in Figure 5-4.

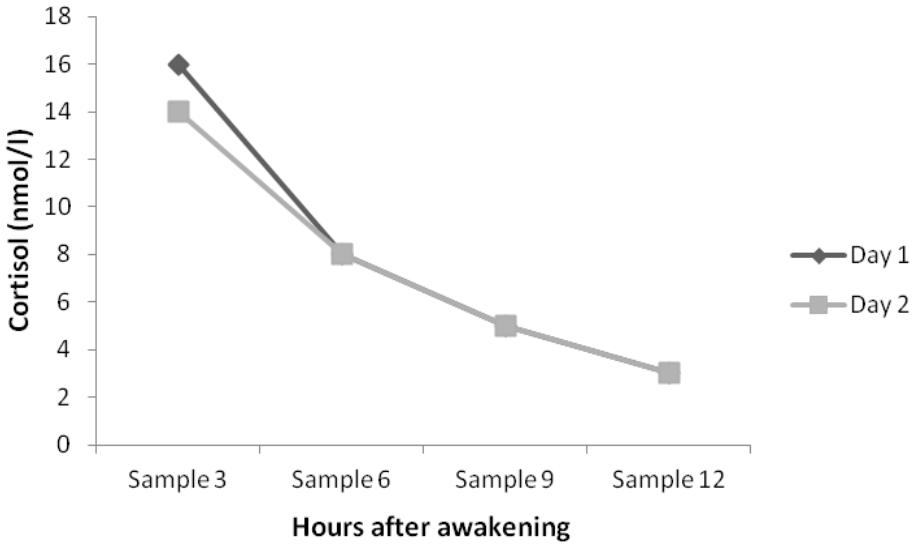

Figure 5-4 Cortisol response of the rest of the day (CRD) over two consecutive days

The analysis of the HighPos/LowNeg group in comparison to the rest of the group on the samples during the day did not reveal any significant findings. It can be seen in Figure 5-5 that the profile for the HighPos/LowNeg group is virtually identical to that for the rest of the total sample.

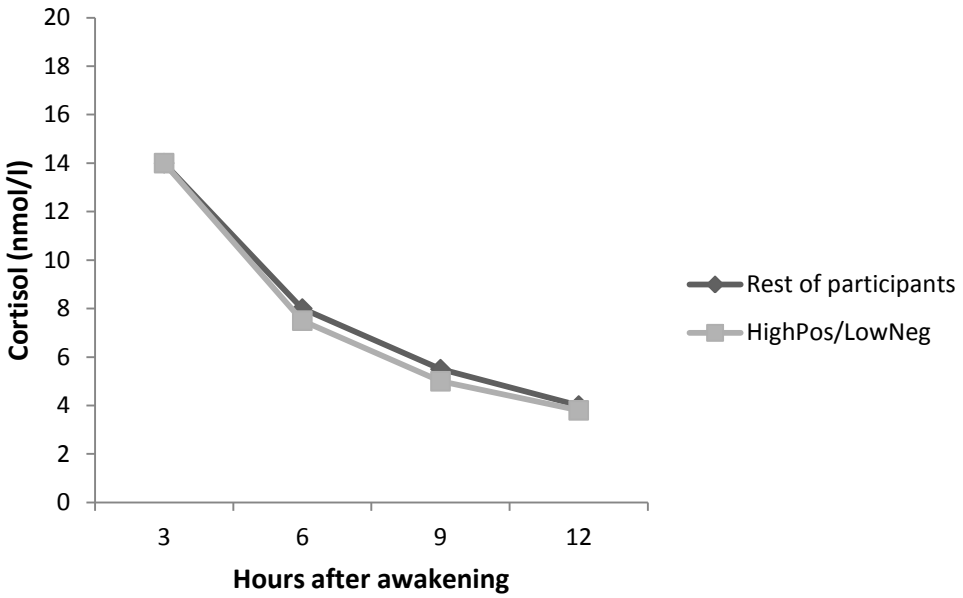

Figure 5-5 Cortisol Response rest of the Day in the HighPos/LowNeg (N=17) quadrant as compared to the rest of the group (N=33)

Correlation analysis of well-being and cortisol data

In order to check that the main effect analysis for the CAR in the above ANOVAs did not over-look weak but significant associations as a result of reducing well-being data to median splits, a Spearman's rank correlation coefficients were computed between mean post-awakening cortisol (AUCg of the CAR) and the raw scores on both positive and negative well-being. Both coefficients (r =-0.11 and r=0.02, respectively) were insignificant, mirroring the non-significant main effect reported in the ANOVA analysis of cortisol in the post-awakening period. Similarly, no significant correlations emerged between the mean cortisol over the CRD samples and scores on both positive and negative well-being (r=-0.03 and r=0.15, respectively).

5.3 Discussion

The results from this research demonstrated that the biomarker cortisol can be used as further evidence of the relative independence between positive and negative well-being, scored in the way suggested by Huppert and Whittington (2003). The results showed that there was no significant difference between the four well-being quadrants in relation to patterns of cortisol secretion across the day. However, when the participants who scored HighPos/LowNeg were analysed separately from the rest of the group it became apparent that these participants showed different patterns of cortisol secretion in the post-awakening period compared to the rest of the group.

The results from the analysis showed that for participants in the quadrant HighPos/LowNeg, cortisol levels were lower in the 45 minutes after awakening. Of the four quadrants, this group can be seen as the 'best' well-being group (34% of the participants) as they scored both high on positive well-being and low on negative well-being. In addition, since no evidence for increased cortisol levels were found for the 'worst' participant, those who scored LowPos/HighNeg (35% of the participants), this further supports the independence hypothesis. Accordingly, if the bipolar view was supported one would expect low cortisol in the HighPos/LowNeg and high cortisol level in the LowPos/HighNeg quadrants. However, it is worth emphasising that positive well-being was not found to be more or less important than negative well-being in predicting cortisol awakening response, as the correlations with each single dimensions was found to be trivially low and insignificant. This is interesting because it suggests, in this sample at least, a powerful relation between high positive and low negative well-being in possibly determining lower cortisol values. No difference between the quadrants in relation to cortisol and the well-being scales during the rest of the day were found.

These results are consistent with a range of studies demonstrating that aspects of well-being tend to be associated with cortisol secretion in the morning rather than later in the day (Lai, et al., 2005; Ryff, et al., 2006; Steptoe, et al., 2007). Although the results reported in this research do not demonstrate a difference in

the dynamic of the CAR (as reported by Lai, et al., 2005; Steptoe, et al., 2007) they are consistent with these studies in that better well-being (what they defined as optimism or momentary happiness) was associated with lower overall levels of cortisol secretion during the period of the CAR immediately after awakening. Similar to the studies by Lai et al. (2005) and Steptoe et al. (2007) these findings also show a difference in the CAR period where no association was found for cortisol secretion over the rest of the day.

The findings are also in line with the finding from Ryff's et al. (2006) study on well-being and biomarkers (as discussed in the introduction of this chapter), where they found that participants with high personal growth and purpose in life had a flatter daily slope in salivary cortisol. The results from their study also found that participants who gained scores that placed them in the 'best' well-being group, or the HighPos/LowNeg quadrant, had a lower cortisol awakening response. Other similarities were found in relation to Lindfors and Lundberg's (2002) study, where they found that individuals who scored high on positive well-being had significantly lower cortisol levels than individuals with who scored low on the positive well-being scale. However in contrast to Lindfors and Lundberg's (2002) study where negative well-being had no effect on cortisol, this research showed that negative well-being, or more accurately, low negative well-being (in association with high PosWB) was associated with lower cortisol secretion during the cortisol awakening response.

There is increasing evidence that the cortisol secretion in the first 45 minutes after awakening is distinct in relation to the cortisol rhythm and therefore that it is under different regulatory influences. It has, for example, been shown that cortisol is sensitive to light in the morning but not later during the day, see Clow et al. (2004a) for a review. Hellhammer and colleagues (2007) also found that the cortisol levels in the morning are more closely associated with state effects, which suggest that the morning cortisol response is more consistent over time, in comparison to the day samples which are more influenced by trait characteristics. Also of potential relevance, there is evidence that cortisol levels at 30 and 45 minutes after awakening, but not over the rest of the day, are to

some extent under the influence of genetic factors (Wust, Kirschbaum, Federenko, & Hellhammer, 2000; Bartels, de Geus, Kirschbaum, Sluyter, & Boomsma, 2003).

Measurement of cortisol concentration in the first 45 minutes after awakening usually relies upon self-collection of saliva samples within a domestic setting following careful instruction of the participants. Although this methodology does provide ecological validity it also relies upon participant adherence to the required saliva sampling protocol. The literature suggests that non-adherence by participants is a common problem and that this can affect the results obtained (Broderick, et al., 2004; Kupper, de Geus, van den Berg, Kirschbaum, Boomsma, & Willemsen, 2005; Thorn, Hucklebridge, Evans, & Clow, 2006). In this research, the sample consisted of highly motivated volunteers with a dedicated interest in the study. In addition, the researcher visited each participant in their own home, and among other things emphasised the importance of the correct timing of the saliva samples. As a result, these factors are presumed to have encouraged good adherence among the participants.

It may also be that the age of the participants was itself a factor which promoted adherence, since there is some evidence from psychotherapeutic interventions that older patients are significantly more adherent in both attendance and treatment completion (Ogrodniczuk, Piper, & Joyce, 2006). Furthermore, the wrist-worn actimeter acted as an objective measure of the awakening time. The results from the research indicated that, in this sample, non-adherence to protocol was probably not an issue. However, other researchers have argued that it is only strictly speaking possible to assert the exact timing of collection with the use of special electronic monitoring collection tubes which directly records use of the tubes (e.g.,Kudielka, Broderick, & Kirschbaum, 2003). Accordingly, a combination of electronically tagged tubes and objectively assisted estimation of awakening time would of course be an ideal method for self-administered saliva collection protocols.

In interpreting the well-being findings, it is important to emphasise that the underlying psychological dimension found to be important was an interactive

one, in the way that the high positive well-being and low negative well-being need to co-exist for an association with cortisol to be observed. There was no evidence that either dimension of well-being on its own related to cortisol, and, more importantly, there was no suggestion that simple summing across the two scales related any better to cortisol. This is theoretically important since, as mentioned earlier, a simple traditional bipolar theory suggests that 'bad' feelings and 'not good' feelings are functionally equal and can thus be summed to estimate position on a single dimension. However, it is equally important to highlight that these findings are rather different to those that have explored the utility of separating measures of positive and negative well-being. In other words, this research has shown that both measures in combination are related to cortisol, but in a synergic manner, whereas others have sought to demonstrate the usefulness of separated measurement by showing that each measure alone may related differently to other biomarkers.

In conclusion, this investigation of a sample of active, community dwelling older people has provided further support for the growing view that it is beneficial to explore positive and negative well-being as measures which can relate together, independently, or interactively with other factors. Although the scales were shown to moderately negatively correlate with each other, the results from this research found that neither dimension on its own was associated with patterns of cortisol secretion over the day. Instead, the results suggest there is a strong association between high positive and low negative well-being in determining lower cortisol values.

In sum, this chapter introduced the biomarker cortisol as an important variable in relation to the study of positive and negative well-being. The main features of the hormone cortisol were presented, and the differences between the two distinct diurnal patterns; the cortisol awakening response and the cortisol over the rest of the day was explained. The biomarker cortisol was analysed from saliva samples from 50 older people and examined in relation to the positive and negative well-being measures, which were scored in the manner suggested by Huppert and Whittington (2003). The median split did not find a significant

difference between the four well-being quadrants in relation to cortisol. However, when the well-being scales were examined further the results showed that the participants who gained scores in the quadrant HighPos/LowNeg were distinct to the rest of the group. This group had a significant lower cortisol awakening response to the rest of the sample, suggesting evidence for the independence view on positive and negative well-being.

Chapter 6 Well-being and Cognitive performance

Overview

This chapter argues the importance of considering measures of cognitive performance in studies on well-being in older people, and in particular in relation to executive functioning and declarative memory. It further explores the importance of cognitive functioning in relation to successful ageing. The aim is to examine if positive and negative well-being are associated with levels of cognitive performance. The importance of including age as a variable in the analysis on cognitive performance and well-being is highlighted. Information about the participants, procedures and materials used are explained, before the results are presented. Finally the results are summarised and discussed.

6.1 Introduction

The importance of well-being in relation to cognitive performance in older age has become more prominent in recent years, and the literature increasingly suggests that part of what it means to age well is to live a longer life while maintaining good cognitive functioning (e.g. Jones, Lichtenberg, Telmet, Rapport, & Hanks, 2003; Llewellyn, et al., 2008). To age well, or what is commonly known as successful ageing, includes the ability to function across physical, cognitive, emotional, and social domains. As presented in the introduction of this thesis (see Chapter 1) successful ageing is defined by Baltes and Baltes (1990) as being able to make the most of one's remaining capacities and compensating for losses and limitations. They acknowledge that ageing often leads to losses or limitation in cognitive functioning and propose that successful ageing includes the ability to optimise adaption regardless of these losses and limitations. Fiocco and

Yaffe (2010) also highlighted in their review, the importance of including cognitive functioning in defining successful ageing. They suggest that research on successful ageing and cognitive function need to include objective and standardised measures to complement and build on information gained from subjective self-reported measures. The authors further suggest that definitions of successful ageing should not be based solely on the absence of disease or physical functioning as there are several individuals who may have experienced and survived a disability while maintaining high quality in life and independence. In other words, Fiocco and Yaffe (2010) emphasis the importance of consider an independent approach on well-being when exploring successful ageing.

Evidence increasingly suggests that although some mental capabilities are well maintained into old age, there is a common decline from early adulthood in certain areas within cognitive performances such as reasoning, speed processing, memory and executive functioning (Levy, 1994; Celsis, 2000; Deary, Corley, Gow, Harris, Houlihan, Marioni, Penke, Rafnsson, & Starr, 2009). Accordingly, there is little doubt that age-associated cognitive decline, or what sometimes is referred to as normal cognitive ageing (Deary, et al., 2009), is a natural human experience. The research area within the field of normal cognitive ageing is substantial, and the contributions to understanding the inter-related factors range from genetics, lifestyle, diet, general health and medical disorder and more recently well-being. Despite this, the associations of age related differences in cognitive decline are not yet fully understood. Accordingly, there is little doubt that it is important to include cognitive functioning as a variable when carrying out research on older people in relation to well-being. This was demonstrated in a recent study by Allerhand et al. (2014). They found that although most variations in cognitive functioning could be explained by age, and most variation in well-being was explained by symptoms of depression, a significant association between cognition and well-being remained after variation in age and depression was controlled for.

Fortunately, cognitive decline is by no means an inevitable consequence of growing old and research is increasingly suggesting that maintaining a good outlook on life can help maintain good cognitive functioning in later life (Wright, Kunz-Ebrecht, Iliffe, Foese, & Steptoe, 2005; Gerstorf, Lövdén, Röcke, Smith, & Lindenberger, 2007). As well-being, and specifically positive well-being, has been shown to be an important factor in relation to successful ageing (see introduction, Chapter 1, Section 5) one would expect there to be close associations between well-being and cognitive functioning during the ageing process. Although some studies have found little or no link between well-being and cognition in older age (e.g. Diener, 1984; Gow, Whiteman, Pattie, Whalley, Starr, & Deary, 2005; Amieva, et al., 2008), most studies now report moderate associations between well-being and cognitive performance in older age (e.g. Isaacowitz & Smith, 2003; Gale, et al., 2012; Wilson, et al., 2013).

This importance of both positive and negative well-being in relation to cognitive performance has increasingly been studied. However, few studies have explored the independence view on well-being, as opposed to the bipolar view (see Chapter 1, Section 3 for the difference between independent and bipolar view). Several studies have found that higher levels of positive well-being is associated with reduced cognitive decline (Isaacowitz & Smith, 2003; Pitkala, et al., 2004; Boyle, et al., 2006; Gale, et al., 2012; Allerhand, et al., 2014). The importance of positive well-being was demonstrated in a study by Llewellyn et al. (2008) where they based their research on data from more than 11 000 participants who took part in the English Longitudinal study. Participants (aged 50 years and over) completed the well-being questionnaire CASP-19 and their cognitive functioning was assessed by a set of neuropsychological tests. These included time orientation, immediate and delayed verbal memory, prospective memory, verbal fluency, numerical ability, cognitive speed and attention. The results showed that after controlling for negative well-being (symptoms of depression) and psychosocial factors (age, sex, household wealth and socioeconomic position) those in the positive well-being group scored

significantly higher on the test than those in the negative well-being group. These findings were also found to be independent of gender.

A recent study which examined in particular the eudaimonic aspects of well-being, as opposed to the hedonic aspect (see Chapter 1, Section 2 for the difference between hedonic and eudaimonic well-being) in relation to cognitive functioning was carried out by Wilson and colleagues (2013). Wilson et al. (2013) found that cognitive functioning had an effect on purpose in life, as measured by Ryff's scale of psychological well-being (Ryff, 1989). They further found that decline in cognitive function, and especially in relation to executive functioning and memory, was associated with loss of positive well-being.

It is still unclear if negative well-being is associated with cognitive decline. Yaffe and colleagues (1999) found that elderly women (aged 65 years and older) without dementia but with depressive symptoms had worse cognitive function and greater cognitive decline than women with few or no symptoms. On the other hand, contradictory research suggests that cognitive decline appears to be accompanied by little, or no change in negative well-being (Amieva, et al., 2008; Wilson, Arnold, Beck, Bienias, & Bennett, 2008; Wilson, et al., 2010).

Ryan and Deci (2001) point out that people high in happiness or positive well-being tend to have attributional styles that are more self-enhancing and more enabling than those low in positive well-being, suggesting that happiness can lead to positive cognition which in turn can contribute to further happiness (Huppert, 2009). As stated above, it is of course plausible that this relationship between positive well-being and cognitive functioning is bidirectional. As one gets older, reduced cognitive functioning may limit the ability to manage usual activities of daily life and as a result this can again cause decline in well-being.

When looking at well-being in relation to cognitive performance it is important to define what is meant by the term 'cognitive performance'. Cognitive

performance is a wide concept which usually includes everything from attention, memory and reasoning to decision making, problem solving and production of languages. The definition does not only include abilities such as learning and memory, but may also include how we manage our day-to-day activities and how we process information to respond to positive and negative stimuli (Fiocco & Yaffe, 2010). For the current study two specific areas of cognitive functioning were explored in more detail, namely declarative memory and executive functioning.

There are two types of long-term memory, declarative and procedural. Declarative memory is used when a person can consciously recall and state memories in words, such as facts and knowledge. Procedural memory, refers to unconscious memories such as skills (for reviews see Tulving & Markowitsch, 1998; Ullman, 2004). Declarative memory is a useful part of memory to study as it is relatively easy to record and measure. Executive functioning is a general term for the management of cognitive processes, which include working memory, reasoning, planning, execution and problem solving (Elliott, 2003). As executive functioning is an umbrella term for cognitive processes it is a useful concept to measure in order to get a general understanding of participants' thought processes (for a review on executive functioinng see Diamond, 2013).

Aims and hypotheses

The aim of including cognitive functioning as a factor was to examine if positive and negative well-being was associated with cognitive performance, and in particular in relation to the cognitive domains of memory and executive functioning. The aim was also to establish the associations between increasing age on cognitive performance in relation to positive and negative well-being.

It was hypothesised that cognitive performance would be negatively associated with age and that both positive and negative well-being would be related to cognitive performance as a result of ageing.

6.2 Results from the cognitive performance

The descriptive data from each of the cognitive tests are listed in Table 6.1. The NART score, which is the estimated IQ, showed a mean of 116.13 (SD±5.5) which suggests that this population had an IQ score above average compared to the general population (with expected mean of 100).

Table 6.1 Descriptive statistics for age and cognitive tests

	Mean	SD	Median
Age (years)	74.3	7.1	74
NART	116.1	5.5	117
HVLT: immediate recall	6.9	2.2	7
HVLT: Recognition	22.3	2.3	23
HVLT: Delayed recall	8.5	3.1	10
Trail-making tests A	42.3	15.7	40
Trail-making tests B	92.9	30.0	85
Verbal fluency	46.2	11.0	45
Semantic fluency	18.0	5.9	18

In order to examine if positive and negative well-being was associated with cognitive performance it was first important to see if OCP was associated with demographical and psychosocial factors. The results from a one-way ANOVA did not find any difference between OCP and sex ($F_{(1,48)}$=.918, p=.343), marital status ($f_{(4,45)}$=.901, p=.471), living arrangements ($F_{(2,47)}$=.133, p=.876) retirement status ($F_{(1,48)}$=.250, p=.619) and level of education ($F_{(1,48)}$=.000, p=.999). However, as illustrated in Figure 6-1, a correlation

between age and the OCP showed that, as expected, there was an inverse and highly significant correlation (r=-.466, p=.000)

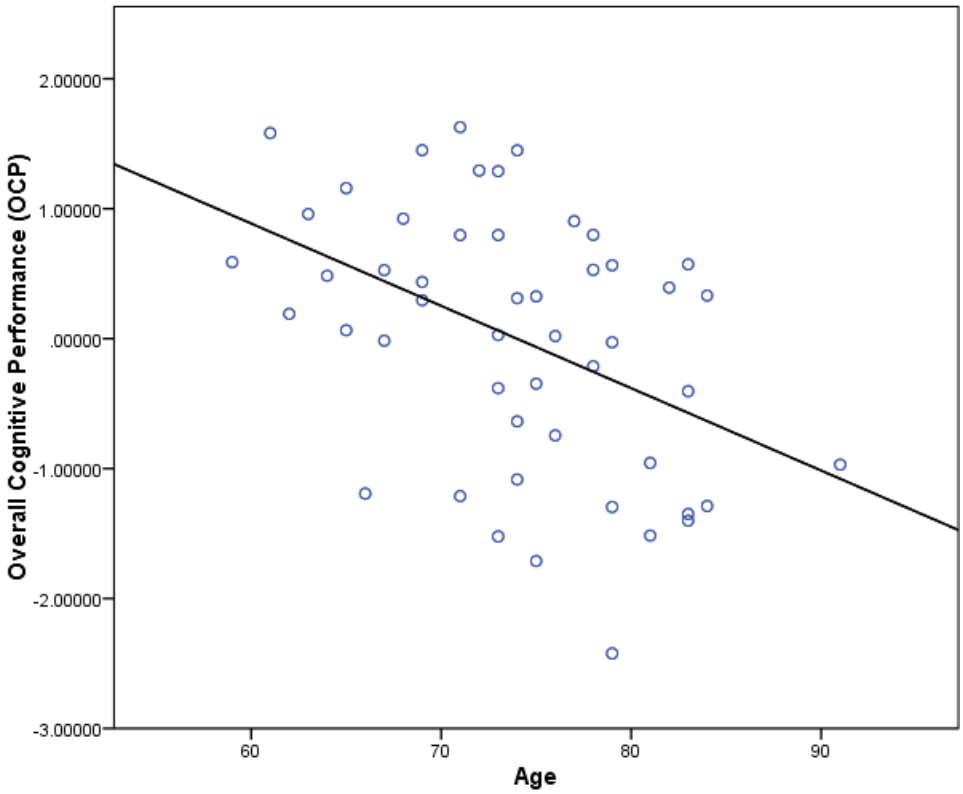

Figure 6-1 Correlation between overall cognitive performance (OCP) score and age

Correlation analysis between age and each of the cognitive scores were carried out. Coefficients involving time on trail-making was reversed, so that for all cognitive measures higher scores indicated better performance. The results which are presented in Table 6.2, showed that age correlated negatively with immediate recall (r=-.309, p=.029), recognition (r=-.301, p=.034) and delayed recall (r=-.402, p=.004). A correlation between age and trail-making test B was also found (r=.423, p=.022). In other words, the results revealed that there was a significantly poorer declarative memory

performance with age on all the HVLT measures, and poorer aspects of executive functioning associated with trail-making Part B. There was no evidence of any significant age-related deficits in reading or fluency measures, or simple processing speed as manifested in the trail-making Part A. When looking at age in relation to the well-being scales, age was not found to correlate with the PosWB scores (r=-.159, p=.271) nor the NegWB scores (n=50, r=.000, p=.998).

To establish if there were associations between OCP and PosWB and NegWB these scores were also correlated (see Table 6.2). Findings revealed no correlation between OCP and PosWB (r=.262, p=.066) and no correlation between OCP and NegWB (r=-.112, p=.349). Although one could argue there was a trend towards a correlation between OCP and PosWB with a p value of .066. However, when PosWB and NegWB were correlated with each of the cognitive scores separately the results revealed an association between PosWB and executive functioning as measured by the trail-making Part B (r=-.297, p=.038). Since the scores were reversed for the purpose of this analysis this negative correlation suggest that better PosWB is associated with faster reaction time on the executive functioning test.

Table 6.2 Spearman's rank correlation coefficients between age and positive well-being (PosWB) and negative well-being (NegWB) for each of the cognitive tests

Cognitive test	Age		PosWB		NegWB	
	r_s =	p=	r_s =	p=	r_s =	p=
OCP	-.441	.001**	.262	.066	-.112	.439
NART	-.067	.646	-.042	.772	-.064	.658
HVLT: immediate recall	-.309	.029*	.249	.081	-.060	.679
HVLT: Recognition	-.301	.034*	.205	.152	-.137	.342
HVLT: Delayed recall	-.402	.004*	.238	.097	-.066	.647
Trail-making tests A	.113	.436	-.087	.548	.040	.784
Trail-making tests B	.423	.002*	-.297	.038*	.217	.134
Verbal fluency	-.053	.717	-.170	.238	.108	.455
Semantic fluency	-.153	.289	.031	.831	.055	.705

*p<.005 **p<.001

In order to find out if the OCP could be explained by factors other than positive and negative well-being the OCP was correlated with each of the psychosocial factors, as presented in Table 6.3. The results only revealed a trend towards significance between OCP and the overall score on the health questionnaire (r=.273, p=.055), suggesting that better health may be associated with better cognitive performance.

Table 6.3 Spearman's rank correlation coefficients between overall cognitive performance (OCP) and psychosocial measures

Cognitive Performance (OCP)					
SES	r = -.189	p=.189	PW total	r = -.033	p=.822
VAS Health	r = -.163	p=.259	LISA total	r = -.044	p=.760
VAS Well-being	r = -.220	p=.125	CASP total	r = -.126	p=.384
VAS Financial	r = -.149	p=.303	SF-36 total	r = .273	p=.055
MOS total	r = -.032	p=.825			

As described in previous chapters (see Chapter 3, Section 8 and Chapter 4, Section 3) a cross-tabulating median split on both the PosWB and NegWB was applied to test the hypothesis that people with high levels of PosWB would gain higher scores on the cognitive tests than people in the NegWB groups. The well-being score of each participant was allocated into one of four quadrants; LowNeg/LowPos, HighNeg/LowPos, LowNeg/HighPos and HighPos/HighPos. The results from a one-way between-subjects ANOVA revealed no significant difference between the four quadrants and OCP ($F_{(3,46)}$=.917, p=.440)

However, since age was found to have an important influence on OCP and no difference was found between the four well-being quadrants in relation to OCP the next stage was to include age in the analysis. The data was again analysed by using the median splits, but this time in respect of each of the two well-being scales separately. The first correlation was carried out on the PosWB scores and OCP with respect to age. Figure 6-2 illustrates a powerful inverse correlation (n=29, r=-.600, p<.001) between age and OCP for those who scored low (or just average) on PosWB. By contrast there was virtually no correlation for those who were above average on PosWB (n=21, r=-.070, p=.762). These findings suggest that older people who report low levels of PosWB are more likely to experience worse cognitive function with increasing age than people who report high levels of PosWB. A high level of PosWB, on the other hand, was not associated with age-related cognitive function.

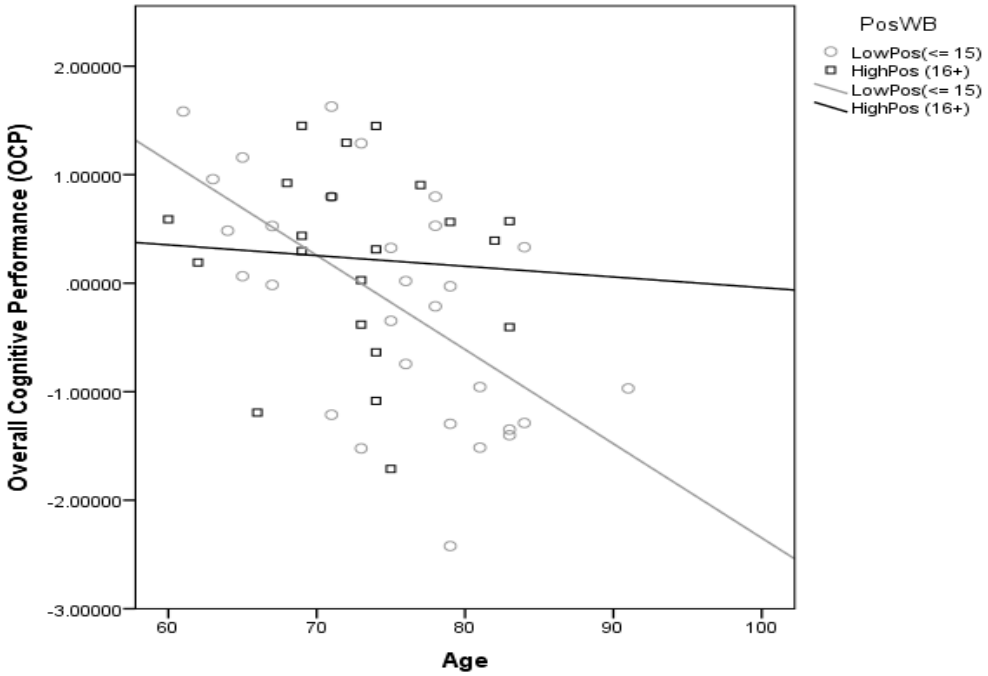

Figure 6-2 Correlation of age and overall cognitive performance (OCP) in respect to positive well-being (PosWB)

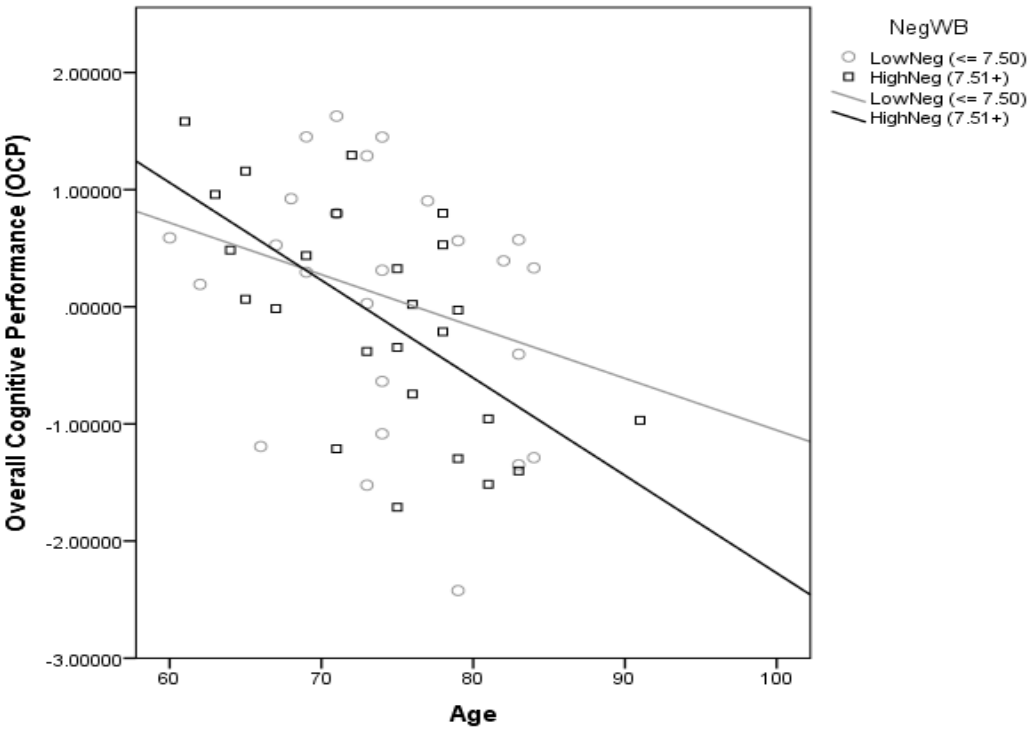

Figure 6-3 Correlation of age and overall cognitive performance (OCP) score in respect to negative well-being (NegWB)

The results from the NegWB scales, as illustrated in Figure 6-3, showed a powerful inverse correlation (n=25, r= -.631, p<.001) between age and OCP for those who score high on the NegWB scale. In contrast, there was virtually no correlation for those who scored below (or just on) average on NegWB (n=25, r=-.285, p=.167). This suggests that older people who report high levels of NegWB are likely to experience worse cognitive function with increasing age than people who report lower levels of NegWB. Low level of NegWB, on the other hand, was not associated with age-related cognitive decline.

6.3 Discussion

The overall results suggested that both positive and negative well-being was associated with cognitive performance when the variable age was added to the equation. The results revealed some interesting findings in relation to both declarative memory and executive functioning. Firstly, the results showed that, with increasing age, participants' immediate recall, recognition and delayed recall deteriorated accordingly, suggesting that declarative memory diminishes with age. The results further revealed a correlation between age and the trail-making test, where older-old people were slower in completing the test than younger-old participants. As this test was measuring executive functioning, the results suggest that younger-old people are quicker in their thought processes than older-old participants. The OCP did also negatively correlate with age, suggesting that as people get older their overall cognitive performance is reduced.

In relation to the demographic data the results from the individual cognitive tests, as well as the OCP, found no differences between the sexes, marital status, living arrangements or level of education, suggesting that these factors had no impact on cognitive performance in later life. However, as this was a very selective group of active community-dwelling participants these findings were not surprising. This was also reflected in the relatively high

SES of the participants. In addition, the overall estimated IQ of the participants in this research revealed a mean score of 116, which suggests that this group of older people had above average cognitive functioning.

While none of the psychosocial measures correlated with OCP, the correlation with the OCP and health, as measured by SF-36, found a trend towards significance, suggesting that there might be a link between OCP and physical health. This relationship between physical health and cognitive performance highlights the importance of keeping fit in older age. Hence, exercise in older age can act as an intervention to maintain the best possible cognitive functioning. Several studies in the literature support the findings that exercise is related to better cognitive performance (Cotman & Berchtold, 2002; Baker, Frank, Foster-Schubert, Green, Wilkinson, McTiernan, Cholerton, Plymate, Fishel, Watson, Duncan, Mehta, & Craft, 2010; Cheng, Chow, Song, Yu, Chan, Lee, & Lam, 2014). For example, in a study conducted by Baker and colleagues (2010) they found that six months of aerobic exercise improved cognitive performance on tasks of executive function including selective and divided attention, cognitive flexibility, and working memory in older adults. Also, a large, five-year prospective study revealed that physical activity was associated with lower risks of cognitive impairment, Alzheimer's disease and dementia in general (Laurin, Verreault, Lindsay, MacPherson, & Rockwood, 2001).

No significant results were found when OCP was correlated with the PosWB and NegWB scores. However, when PosWB and NegWB were correlated with each of the separate cognitive tests, the results revealed that PosWB was associated with the trail-making test, suggesting that people with higher PosWB had a better executive functioning than participants who reported low levels of PosWB. NegWB had no impact on executive functioning. There is little conclusive evidence for the effect of positive and negative well-being on executive functioning in the literature. In a review by Mitchell and Phillips (2007) cognitive effects on positive and negative well-being were evaluated, as measured by variations in mood on executive function and it was found

that negative mood appeared to have little effect on cognitive processes, whereas positive mood impaired executive functioning. Another study by Phillips and colleagues (2002) which also examined variations in mood in relation to cognitive functioning, by using the classic Stroop test, found that positive mood impaired performance on switching conditions but improved performance on test of fluency.

Following the median split of the well-being scales, as suggested by Huppert and Whittington (2003) the results revealed no difference in cognitive performance between the participants in each of the four quadrants. However, since age turned out to be an important variable in relation to cognitive performance, this variable was included in the equation. An association was found between low PosWB and OCP, but not between high PosWB and OCP, suggesting that older people who report low levels of PosWB are more likely to experience worse cognitive function with increasing age than people who report high levels of PosWB. A high level of PosWB, on the other hand, was not related to age-related cognitive function. The results further revealed similar findings with the NegWB scale, but this time with the high NegWB and not the low NegWB, suggesting that older people who reported high levels of NegWB were likely to experience faster cognitive decline with age than people who reported lower levels of NegWB. Low level of NegWB, on the other hand, was not associated with age-related cognitive function.

The results did not reveal any significant difference between the four well-being quadrants in relation to OCP. This could be due to the great effect of age on OCP. The results further disclosed that poorer OCP was significantly associated with both low PosWB and high NegWB when age was accounted for. When examining PosWB and NegWB separately the results revealed that low PosWB and high NegWB were associated with age-related cognitive function. Interestingly, this research revealed similar findings to Allerhand et al. (2014), where they reported that exercise and symptoms of depression were the most important moderating variables for those with high well-being.

The findings support the idea that cognitive performance is an important aspect that needs to be considered when carrying out studies on older people, as argued by Fiocco et al. (2010). Also, an important consideration for research on cognitive functioning depends, to a large extent, on participants' prior intelligence and does not always take into account whether a given level of cognitive function in old age represents a decline, in absolute terms, or relative to their age cohort, for that person (Deary, et al., 2009).

The findings from this research, which suggest that both positive and negative well-being is associated with cognitive performance when the variable age is accounted for, is of interest, as this group had an age span which ranged over more than 30 years, with the youngest participant being 59 and the oldest 91 years (mean 74 years old). This suggests that in studies on older people, researchers need to consider the age range closely as there might be great differences in cognitive functioning and well-being in participants in their 60s in contrast to participants in their 80s. Accordingly, it might be better to look at a smaller age range or classify participants into young-old and old-old.

In conclusion, even though no difference was found between the four well-being quadrants, the findings still support the independence hypothesis as the results showed that positive well-being had a trend for a positive effect on executive functioning, while negative well-being had no effect. In contrast, if the bipolar view was supported one would expect negative well-being to have a negative effect on executive functioning. In addition, in some ways these findings also support the findings from the cortisol data which was presented in the previous chapter (Chapter 5). The results from the cortisol data showed that the 'best' combination of well-being, the people in the HighPos/LowNeg quadrants, had the best cortisol profile with lower levels of cortisol awakening response. The findings in this chapter suggest that the people with the 'worst' combination of well-being, the participants who reported LowPos/HighNeg, had the worst cognitive functioning with increasing age.

It has been argued that cognitive decline is the most feared aspect of growing old (Deary, et al., 2009) and this research has helped to highlight the importance of maintaining high levels of positive well-being and low levels of negative well-being in older age. This study further highlights the need to identify associations between positive and negative well-being in relation to cognitive performance, as this may not only shape future definitions of successful ageing, but also influence prevention strategies to ensure optimal well-being and delay cognitive impairment in older age.

Chapter 7 Follow-up study 3 years later

Overview

This chapter will present the three year follow-up study where 74% of the participants from the original study participated. Associations with positive and negative well-being in relation to psychosocial factors and cortisol data will be explained, following similar procedures to the original study at Time 1. The introduction will summarise the main findings from the psychosocial and cortisol studies at Time 1, as described in Chapter 4 and Chapter 5 respectively. The results will be presented and the discussion will summarise, and critically evaluate, the findings.

7.1 Introduction

As one gets older, one would expect positive and negative well-being to change as a result of deteriorating health and reduced engagement with social networks. However, the direction of causality is difficult to determine. On the one hand, it could be that health and social support decline as a result of reduced positive well-being and increased negative well-being. On the other hand, positive and negative well-being can change because of changes to both health and social support.

The importance of positive well-being as a protective factor on age related illnesses has been demonstrated in a number of studies (e.g. Pitkala, et al., 2004; Ryff, et al., 2006; Chida & Steptoe, 2008). In addition, negative well-being has been shown to have a detrimental effect on health as one ages (Reynolds, Dew, Pollock, Mulsant, Frank, Miller, Houck, Mazumdar, Butters, & Stack, 2006). For example, the research by Huppert and Whittington (2003), described in Chapter 2 of the thesis, found that the absence of positive well-being was a stronger predictor of mortality than the presence of

negative well-being. Similar findings were reported in a meta-analysis with 70 studies by Chida and Steptoe (2008) where they found that positive well-being was associated with reduced mortality in both a healthy population and a diseased population. Chida and Steptoe's (2008) study also found that the protective effects of positive well-being were independent of the effects of negative well-being. Another study which demonstrated the importance of positive well-being on ageing was carried out by Gale, Cooper et al. (2014) where they showed that participants with higher levels of positive well-being were less likely to become frail over a 4-year follow-up period. This suggests that maintaining a stronger sense of positive well-being in later life may protect against the development of physical frailty.

A study which highlights the importance of following up participants over time was carried out by Pitkala and colleagues (2004). In this study the authors found that positive attitude had a long-standing impact on prognosis in old age. Of the 102 participants, aged 75-85 years old, 20% were classified with scores indicating a positive life orientation. These participants considered their health better than the rest of the group, they were significantly less clinically depressed and they had better cognitive functioning. They were also more active in their social networks. After 10 years, 54.5% of them were alive, whereas in the rest of the sample only 39.5% survived. After controlling for age, gender, and health measures, the impact of positive life orientation was still significant. At a 5 year follow up study, only 2.9% of those having a positive life orientation but 17.5% of the rest of the sample were in permanent institutional care ($p=.003$). It was found that positive life orientation remained a significant protector against institutional care. However, interestingly positive life orientation did not protect against a decline in mobility after 5 years or against cognitive decline after 10 years.

These studies highlight the need for using longitudinal design in order to find out if, and how, positive and negative well-being changes over time. The research findings reported in Chapter 4 showed that poor physical health was strongly associated with negative well-being, where participants in the

high negative well-being group had poorer physical health in comparison to those in the low negative well-being group. The findings from Chapter 4 also demonstrated that social support was associated with negative well-being which suggested that participants in the low negative well-being group scored high on social support in comparison to those in the high negative well-being group. Positive well-being was not related to physical health or social support in either of these scales. Since poorer physical health is associated with higher levels of negative well-being one can assume that negative well-being will increase with age. The same is true for social support where one would assume that as one gets older there will be less social support available as a result of reduced mobility and change in friendship status as a result of morbidity and mortality. The findings from Chapter 4 further revealed that positive well-being on the other hand was dependent upon life satisfaction, where participants in the high positive well-being group were more satisfied with life than people in the low positive well-being group. The findings also suggested that spirituality had an effect on positive well-being, where people with higher sense of spirituality also scored high on positive well-being.

The results reported in Chapter 5 showed that cortisol levels were lower in the cortisol awakening response (CAR) period for the participants who scored a combination of high on positive well-being and low on negative well-being. Positive and negative well-being had no effect on the cortisol level for the rest of the day. Interestingly the results revealed that low cortisol levels in the morning were determinants for both the positive and negative well-being scale. By contrast there were no mirroring findings where those combining low positive well-being and high negative well-being showed higher cortisol levels than the other groups. As such, in contrast to the findings from the psychosocial factors in Chapter 4, there was no evidence for either the positive well-being or the negative well-being scale to be more or less important in relation to cortisol. The CAR turned out to be associated with both positive and the negative well-being.

Aims and hypothesis

The aim of this follow-up study was to find out if participants' positive and negative well-being would change over a three-year period. The data from the psychosocial measures at Time 1 (as reported in Chapter 4) were used to compare the data from this follow-up study, at Time 2, to find out if the associations with health, social support and life satisfaction in relation to positive and negative well-being had changed. Since the Cortisol Awakening Response (CAR) was found to be a reliable biomarker of both positive and negative well-being at Time 1 (with the combination HighPos/LowNeg, as described in Chapter 5) the aim was also to find out if these findings in relation to the CAR would remain stable over a three-years period.

It was hypothesised that as a result of increasing age, the associations between positive and negative well-being on health, social support and cortisol secretion would change over a three-year period.

7.2 Methods

Participants

All the 50 participants in the first study (Time 1) were invited back to a research meeting three years after the initial study (Time 2). Of the 50 participants in the first study 37 participants (25 females and 12 males) took part in this follow-up study (74%). The age range of this study was 63-87 years old (mean 75, SD ±6). All the 37 participants completed a questionnaire pack which consisted of the same scales as in the first study (as described in Chapter 3, Section 4). Saliva samples were collected from 34 of the 37 participants, as three participants opted to refrain from saliva collection at Time 2.

Procedure

In the period between Time 1 (T1) and Time 2 (T2) the participants received newsletters (see Appendix 7 for example) about every eight months to keep them informed about progress and to keep them motivated for future participation. As part of the follow-up study they were invited to a research meeting in Kingston Community Hall, South London. Participants who replied, by phone, that they would participate received a copy by mail of the same questionnaire pack as in the first study by mail. They were asked to answer the questions at home and to bring the completed questionnaire pack with them to the research meeting. At the meeting participants were informed about the progress of the research and they were given an opportunity to give feedback and to share their experiences from the first study. Participants were also reminded how to collect the cortisol samples and were given cortisol packs to bring home. They were asked to collect four saliva samples (CAR) on two consecutive weekdays of the following week. Participants were instructed to post the samples back to the researcher within three days of collecting the samples. The questionnaire pack that was sent out to the participants in advance included the same questionnaires as in the first. See Chapter 3, Section 3 Psychosocial measure of well-being for a detailed description of each measure.

Cortisol collection

In this follow-up study only the cortisol awakening response (CAR) was collected since these samples were the only samples that yielded any significant findings in the first study. Samples were collected at awakening, 15, 30 and 45 minutes post awakening (see Figure 7-1). The collection and analysis of the saliva samples was carried out according to the procedure described in Chapter 3, Section 5 Biomarker Cortisol.

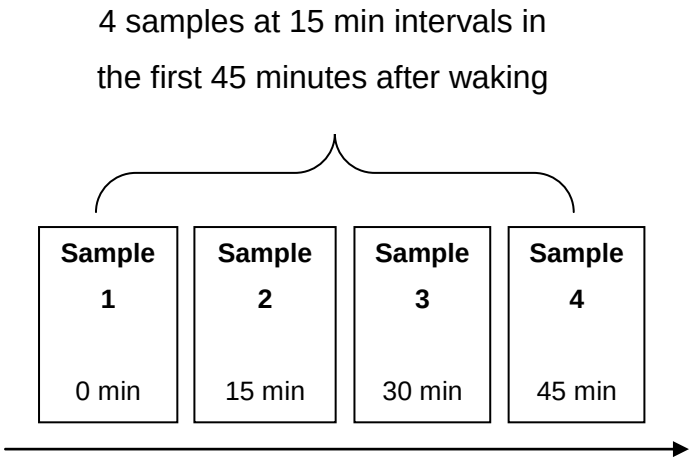

Figure 7-1 Schedule of cortisol awakening response saliva sampling

Statistical analysis

In the analysis of the data between Time 1 (T1) and Time 2 (T2) the comparison data at T1 was reduced to 37 participants so that only the data from the same participants at T1 and T2 was used in the analysis at this follow-up study. As in the first study it was important to establish the evidence for the relative independence between positive well-being (PosWB) and negative well-being (NegWB). A Spearman's rho was carried out to analyse the relationship between the PosWB and the NegWB scales. Chi-square was used to analyse the demographic data and paired t-tests were used to find out if PosWB, NegWB, psychosocial factors and cortisol levels had changed from T1 to T2.

As in the studies at T1, a median split was performed on both well-being scales in order to see if the participants were represented in all of the four well-being quadrants; LowPos/LowNeg, LowPos/HighNeg, HighPos/LowNeg and HighPos/HighNeg. The data was subsequently analysed with ANOVAs and Bonferroni Post Hoc tests.

7.3 Results from the follow-up study

It was unclear why 13 participants who took part at T1 did not participate at T2. Since participants were encouraged to contact the researcher only if they wanted to take part at T2, no data was collected as to why participants did not participate at T2. There are potentially several reasons for participant non-attendance at this follow-up research day, which could range from being unavailable on that particular date, to deteriorating well-being and health and even mortality. A drop-out analysis was carried out in order to find out if these 13 participants already were significantly different to the reminding 37 participants at T1. Accordingly, a number of independent t-tests were carried out on the demographical and psychosocial data collected at T1. The results only revealed a significant difference in age (t=2.389, df=48 p=0.21), where the 37 participants who took part at T2 had a mean age of 72.6 (sd±6.2) years at T1 while the 13 participants who did not continue the participation had a mean age of 77.7 (sd±7.2) years at T1. Hence, although the follow-up group were younger, there was no indication that the well-being scores of the two groups were different at T1.

Positive and Negative well-being as independent dimensions at Time 2

The results from the correlation analysis showed that there was a significant negative relationship between PosWB and NegWB (r=-.535, N=37, p<.001). These results mirror the findings Time 1 (see Chapter 4, Section 3) in that those participants who scored high on the PosWB scale were more likely to score low on the NegWB scale and vice versa, the participants who scored low on the PosWB scale were more likely to score high on the NegWB scale. See Figure 7-2 for an illustration of the correlation between PosWB and NegWB at Time 2.

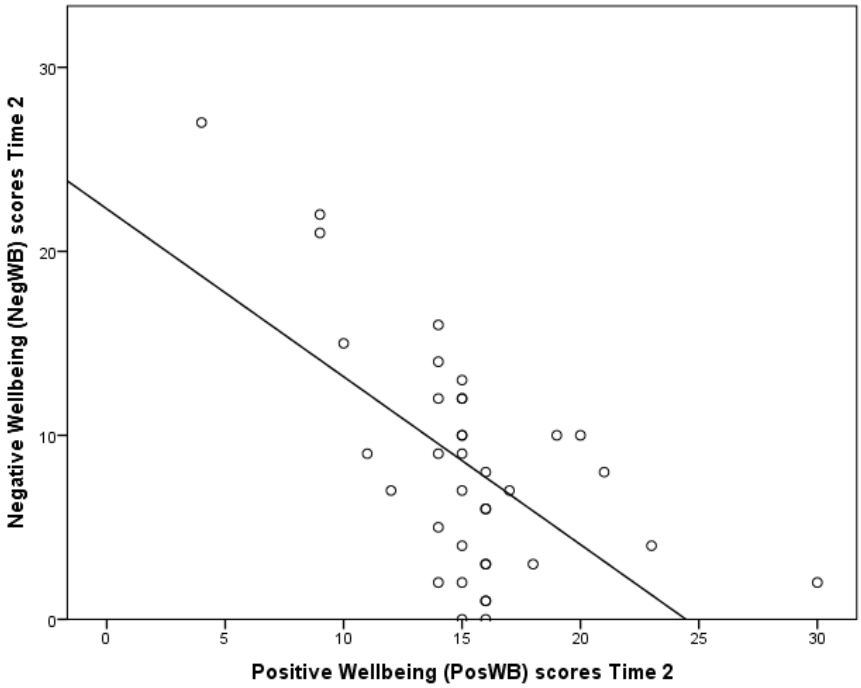

Figure 7-2 Scatter plot of correlation between Positive Well-being (PosWB) and Negative Well-being (NegWB) scales at Time 2

The next step in the analysis was to test the hypothesis that the overall scores on the two well-being scales had changed from T1 and T2. This descriptive statistic, together with results from the repeated t-test, is presented in Table 7.1 below.

Table 7.1 Change from Time 1 and Time 2 in Positive Well-being scores (PosWB) and Negative Well-being scores (NegWB) as measured by repeated t-tests.

	Time 1	**Time 2**	
PosWB	15.8 (SD±4.0)	15.3 (SD±4.2)	t=.738, df=36, p=.465
NegWB	8.4 (SD±6.3)	8.4 (SD±6.3)	t=.774, df=36, p=.444

The results from repeated t-tests revealed no significant difference in the scores on the PosWB scale (t=.738, df=36, p=.465) and the NegWB scale (t=.774, df=36, p=.444) from the studies at Time 1 to this follow-up study.

As at Time 1, a cross-tabulating median split on both the PosWB and NegWB was applied to find evidence for the relative independence between the PosWB and NegWB scales. On the basis of participants' scores on the two scales, participants were allocated into the four quadrants; LowPos/LowNeg, LowPos/HighNeg, HighPos/LowNeg and HighPos/HighNeg. The distribution of the four quadrants at T2 mirrors the results from T1 (see Table 7.2 for an overview of participants in each of the quadrants at T1 and T2).

Table 7.2 Number of respondents in each of the well-being quadrants of PosWB and NegWB scores at Time 1 (n=50) and Time 2 (n=37) with percentage in brackets.

	LowPos	HighPos
LowNeg	**8 (16%)** **7 (19%)**	**17 (34%)** **15 (41%)**
HighNeg	**21 (42%)** **13 (35%)**	**4 (8%)** **2 (5%)**

As in the first study all the quadrants were represented by participants in the follow-up study. 7 (19%) participants at T2 gained scores that placed them in the LowPos/LowNeg quadrant compared to 8 (16%) participants at T1. Fifteen (41%) of the participants gained scored which placed them in the LowPos/HighNeg quadrant in T2 compared to 17 (34%) participants at T1. Thirteen (35%) participants yielded scores which placed them in the HighPos/LowNeg quadrant in T2 compare to 21 (42%) at T1. Finally, 2 (5%)

participants gained scores that placed them in the HighPos/HighNeg quadrant compared to 4 (8%) at T1.

Psychosocial differences between Time 1 and Time 2

Paired t-tests were used to look for differences in the psychosocial data from the first study to the follow-up study. The socioeconomic status, as measured by the SES Ladder (scored on a scale form 1-10 where 10 indicated high status), found no difference from T1 and T2 (t=.614, df=34, p=.543). The VAS scales on health, well-being and financial situation were scored from 1 (low) to 100 (high). The results showed that there was no significant difference in financial situation between T1 to T2 (t=.317, df=34, p=.753), see Table 7.3 for the descriptive data. However, there was a significant difference in health self-rating (t=2.312, df=34, p=.027), where participants rated their health worse on T2 than T1. There was also a marginal difference in self-rating on Well-being (t=2.004, df=34, p=.053) where people indicated that their well-being had decreased from T1 to T2.

Table 7.3 Differences in perceived health, well-being and financial situation (VAS) with score range 0 (low) to 100 (high), at Time 1 and Time 2 as measured by repeated t-tests

	Time 1 Mean (SD)	**Time 2** Mean (SD)	**t** (df=36)	**Sig**
Health	69 (SD±15)	62 (SD±20)	2.588	.014*
Well-being	74 (SD±17)	68 (SD±21)	2.004	.053
Financial situation	64 (SD±25)	66 (SD±23)	.317	.753

*p<.005

The results from the health questionnaire SF-36 showed that there was a significant difference in the overall scores between T1 and T2 (t=2.623, df=36, p=.013), suggesting that health ratings had decreased over this 3-years period. The subcategories further exposed a change in overall physical functioning (t=2.705, df=36, p=.010) from T1 to T2, where participants reported having worse physical functioning at T2. The results also revealed that there was a significant difference in social functioning (t=-2.790, df=36, p=.008) from T1 to T2. Again, participants reported worse social functioning at T2. Finally, the results from the analysis showed that there was a significant difference in how the participants perceived their health to have changed over the last year from T1 to T2 (t=-2.7, df=36, p=.010). Participants reported a more negative health change over the last year than compared to three years earlier. No significant differences between T1 and T2 emerged in relation to the rest of the SF-36 categories, which include role limitations due to physical health (health problems), role limitations due to emotional health (emotional problems), vitality/energy/fatigue, mental health, bodily pain and general health perception. The results from the analysis are presented in Table 7.4

Table 7.4 Difference in subjective health scores (SF-36) and the subcategories at Time 1 and Time 2 (scores range 0-100), as measured by repeated t-tests

SF-36	**Time 1** Mean (SD)	**Time 2** Mean (SD)	**t** (df=36)	**Sig**
Total score health	72.2 (±14.9)	67.9 (±18.9)	2.623	.013*
Physical functioning	73.3 (±23.6)	70.0 (±26.8)	2.705	.010*
Health problems	66.5 (±37.5)	59.1 (±40.2)	1.243	.222
Pain	71.5 (±23.3)	66.8 (±20.2)	1.258	.216
Social functioning	88.9 (±17.1)	80.4 (±27.3)	2.790	.008*
Mental Health	62.2 (±19.0)	62.2 (±18.4)	.000	1.00
Emotional problems	89.2 (±23.6)	82.9 (±32.0)	1.419	.164
Vitality and fatigue	59.3 (±19.5)	55.7 (±22.0)	1.375	.178
Health Perception	81.5 (±15.4)	82.2 (±13.8)	0.371	.713
Health Change	58.1 (±21.3)	52.0 (±7.3)	2.700	.010*

*p<.005

The analysis from the social support questionnaire (MOS), as presented in Table 7.5, showed that there was no significant difference between number of friends and family in relation to social support, where mean at T1 was 10.8 (SD±8.8) and mean at T2 was 9.3 (SD±5.9). Further results from the MOS scale found no significant difference in affectionate support and positive social interaction between T1 and T2. However, there was a significant difference in emotional support (t=2.272, df=35, p=.029) and tangible support (t=3.080, df=36, p=.004). Both emotional support and tangible support had decreased from T1 to T2. There was also a significant difference in the overall scores on overall social support, where social support scores had decreased from T1 to T2 (t=2.542, df=34, p=.016).

Table 7.5 Difference in Social Support (MOS) scores at Time 1 and Time 2, as measured by repeated t-tests

MOS	**Time 1** Mean (SD)	**Time 2** Mean (SD)	**t** (df=36)	**Sig**
No. friends/ family	10.8 (±8.8)	9.3 (±5.9)	1.076	.289
Total MOS score	70.1 (±16.7)	66.3 (±17.7)	2.542	.016*
Emotional support	31.3 (±7.2)	29.8 (±7.7)	2.272	.029*
Tangible support	14.5 (±14.5)	13.0 (±5.4)	3.080	.004*
Affectionate support	11.4 (±3.4)	11.1 (±3.7)	.660	.513
Positive interaction	11.7 (±3.1)	11.5 (±2.8)	.449	.656

*p<.005

Analysis of the perceived wellness scale, as reported in Table 7.6, showed that there was a significant difference in emotional well-being (t=10.416, df=36, p=.000), social well-being (t=7.273, df = 36, p=.000), spirituality (t=2.188, df=36, p=.035) and mental well-being (t=9.660, df=36, p=.000). In all cases the mean scores decreased from T1 to T2. However, the results revealed no significant difference in psychological or physiological well-being.

Table 7.6 Difference in the categories of the Wellness scores at Time 1 and Time 2, as measured by repeated t-tests

Wellness	**Time 1** Mean (SD)	**Time 2** Mean (SD)	**t** (df=34)	**Sig**
Psychological	20.7 (±2.4)	20.2 (±2.6)	0.642	.525
Emotional	26.3 (±3.8)	14.2 (±3.9)	10.416	.000**
Social	24.6 (±2.7)	18.2 (±3.3)	7.273	.000**
Physiological	23.9 (±6.6)	20.0 (±6.7)	1.831	.076
Spiritual	21.5 (±4.5)	17.3 (±5.0)	2.800	.008**
Mental	25.6 (±3.6)	16.0 (±3.7)	9.700	.000**

**p<.001

Analysis of the CASP-19 and the LSIA revealed no significant difference between T1 and T2, as reported in Table 7.7 and 7.8 respectively.

Table 7.7 Differences in CASP-19 and the subcategories at Time 1 and Time 2, as measured by repeated t-tests

CASP-19	**Time 1** Mean (SD)	**Time 2** Mean (SD)	**t** (df=34)	**Sig**
Sum total	44.5 (SD±7.0)	44.8 (SD±6.4)	.175	.862
Control	12.0 (SD±2.8)	12.8 (SD±2.6)	1.890	.068
Autonomy	11.6 (SD±2.5)	11.1 (SD±2.6)	1.154	.257
Pleasure	10.5 (SD±2.3)	10.7 (SD±1.6)	.457	.651
Self-realisation	10.3 (SD±2.2)	9.8 (SD±2.2)	1.144	.261

Table 7.8 Difference in Life satisfaction scores (LSIA) at Time 1 and Time 2, as measured by a repeated t-test

LSIA	**Time 1** Mean (SD)	**Time 2** Mean (SD)	**t** (df=36)	**Sig**
Total score	29.8 (SD±6.0)	28.8 (SD±6.4)	1.587	.121

Predictors of PosWB and NegWB at Time 2

Since the results from this cross-tabulating median split revealed that only two participants were allocated to the HighPos/HighNeg quadrant in the follow-up study this group were excluded from the rest of the analysis due to lack of significant power in this data. Accordingly, the total number of people in the analysis consisted of 35 participants. These were distributed in the following analysis as 7 participants in the LowPos/LowNeg quadrant, 15 participants in the LowPos/HighNeg quadrant and 13 participants in the HighPos/LowNeg quadrant. In contrast to the first study where data was

analysed with two-way ANOVAs, the analysis of this data was carried out using 1-way independent groups ANOVAs with 3 levels of factor corresponding to the 3 quadrant groups. This was followed by Bonferroni Post-Hoc tests to find out which, if any, of the quadrants were significantly different.

The analysis revealed no difference between the three quadrants in relation to socioeconomic status, as measured by the SES Ladder (see Table 7.9). On the VAS which asked about ratings of well-being, health and financial situation a significant difference between the groups on the well-being scale emerged ($F_{(2,30)}$=4.919, p=.014). The post hoc test revealed that LowPos/LowNeg rated their well-being significantly higher than LowPos/HighNeg (p=.035). No other differences in the VAS were revealed.

Table 7.9 Difference between quadrants in relation to SES and VAS

	$F_{(2,30)}$	**Sig**
SES Ladder	.356	.703
Health	1.670	.206
Well-being	4.919	.014*
Financial situation	.472	.628

*p<.05

In the CASP-19 questionnaire a significant difference was found between the quadrants on control ($F_{(2,29)}$=4.984, p=.014). Employing the Bonferroni post-hoc test, the significant differences showed that LowPos/LowNeg scored higher than LowPos/HighNeg on control (p=.028). No other significant differences were found in the CASP-19 questionnaire. Results are presented in Table 7.10.

Table 7.10 Difference between quadrants in relation to CASP-19

CASP-19	$F_{(2,30)}$	P
Sum total	2.528	.099
Control	4.984	.014*
Autonomy	2.068	.145
Pleasure	2.180	.131
Self-realisation	2.931	.069

*p<0.05

The analysis of the MOS questionnaire also revealed some significant findings in relation to social support and the three quadrants (see Table 7.11) The total score shows a significant difference between the groups ($F_{(2,32)}$=5.929, p=.007), where those in the LowPos/HighNeg quadrant scored significantly lower in social support than those in the HighPos/LowNeg category (p=.007). The subcategory emotional support revealed a significant difference between the quadrants ($F_{(2,32)}$=9.095, p=.001), where those in the LowPos/HighNeg quadrant scored significantly lower than those in the HighPos/LowNeg quadrant (p=.001). Affectionate support revealed a significant difference between the three quadrants ($F_{(2,32)}$=4.768, p=.015) where those with LowPos/HighNeg scored significantly lower than those with HighPos/LowNeg (p=.019). The subcategory social support showed a significant difference between the quadrants ($F_{(2,32)}$=9.232, p=.001) where LowPos/LowNeg was significantly higher than LowPos/HighNeg (p=.014). There was no difference between the three quadrants in relation to tangible support.

Table 7.11 Difference between quadrants in relation to social support (MOS)

MOS	$F_{(2,32)}$	p=
Total MOS score	5.929	.007*
Emotional support	9.095	.001*
Affectionate support	4.768	.015*
Social support	9.232	.001*
Tangible support	2.551	.094

*p<.05

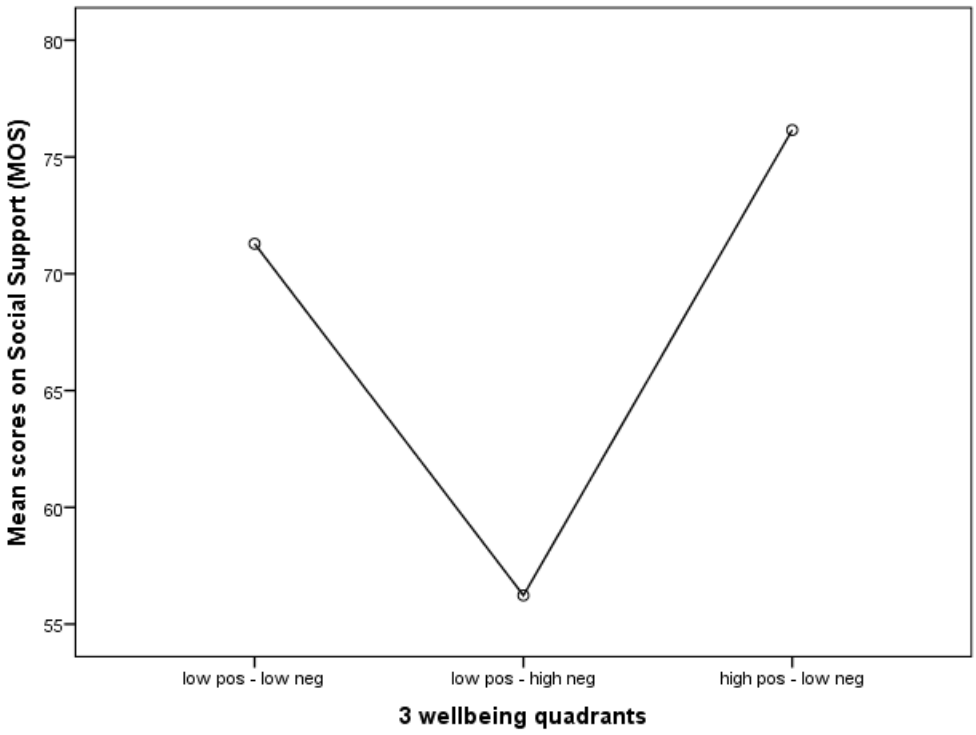

Figure 7-2 Difference in mean scores between quadrants in relation to social support (MOS)

The results from the SF-36 also revealed several differences between the three quadrants in relation to health. See Table 7.12 for a summary of the findings. There was a significant difference in relation to physical health ($F_{(2,32)}$=6.625, p=.004), in emotional health ($F_{(2,32)}$=3.430, p=.045), in

energy/fatigue ($F_{(2,32)}$=5.772, p=.007), social functioning ($F_{(2,32)}$=7.222, p=.003) pain ($F_{(2,32)}$=5.432, p=.009) and emotional well-being ($F_{(2,32)}$=7.310, p=.002). The Bonferroni post hoc test revealed that in all cases the LowPos/HighNeg group scored lower than the HighPos/LowNeg group (p=.047). In addition to this direction in the emotional well-being category, there was a difference where those in the LowPos/HighNeg quadrant scored lower than those in the HighPos/LowNeg quadrant (p=.003). Physical functioning and health change did not reveal any significant results.

Table 7.12 Difference between quadrants in relation to health (SF-36)

SF-36	**$F_{(2,32)}$**	**p=**	**Post Hoc p=**
Physical health	6.625	.004*	.003*
Emotional health	3.430	.045*	.005*
Vitality/energy/fatigue	5.772	.007*	.006*
Social functioning	7.222	.003*	.002*
Pain	5.432	.009*	.013*
Emotional Well-being (graph)	7.310	.002*	.047* .003*
Physical functioning	3.060	.061	
Health Change	3.026	.063	

*p<0.05

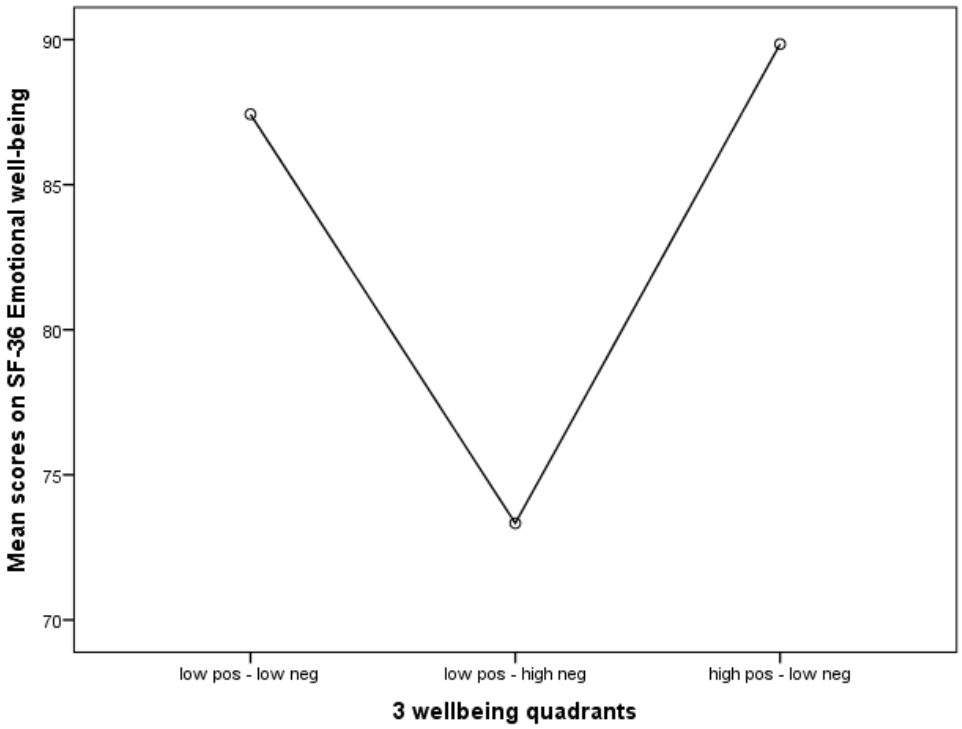

Figure 7-3 Difference in mean scores between quadrants in relation to SF-36 Emotional Well-being

No difference was found between the three quadrants in relation to the Wellness scale or any of the subcategories of this scale, see Table 7.13. The life satisfaction index (LSIA) also did not reveal any significant difference between the three quadrant ($F_{(2,31)}$=1.486, p=242)

Table 7.13 Difference between quadrants in relation to wellness

Wellness	**$F_{(2,31)}$**	**P=**
Psychological	.417	.663
Emotional	.084	.920
Social	1.292	.290
Physiological	.773	.471
Spiritual	1.010	.376
Mental	2.722	.082

Change in cortisol between Time 1 and Time 2

As the results from the first study did not find relationships between well-being and cortisol levels outside of the waking period, only the four morning samples (CAR) were collected and analysed in the follow-up study (see Chapter 3, Section 5 on how to analyse cortisol). To normalise the distribution to satisfy the requirements of a parametric analysis, the cortisol data was transformed using the square root method before it was analysed.

The mean concentration of the two consecutive days was used in the analysis, as no significant difference was found between Day 1 and Day 2 of collection. In this follow-up study, as with the first study reported in Chapter 5, the participants yielded no significant effect of time of awakening on cortisol. Also, the analysis did not find time of awakening associated with the PosWB and the NegWB scores.

A 2 (time) x 4 (samples) ANOVA was used to analyse the cortisol data. The results showed that there was a significant main effect of samples ($F_{(1, 33)}$=16.44, p<.001). As expected the CAR increased from time of awakening, to the 15 minute sample with a peak at 30 minutes and a drop at the 45 minutes samples. The result from the ANOVA also showed there was a significant main effect of time ($F_{(1, 33)}$= 33.01, p<.001) where overall cortisol level was higher at T1 than T2. The result from the ANOVA further showed that there was a significant interaction between time and samples ($F_{(1, 33)}$= 5.340, P=.002) where participants had an attenuated response at T2. See Figure 7-4 for the difference between mean cortisol awakening response at Time 1 and Time 2.

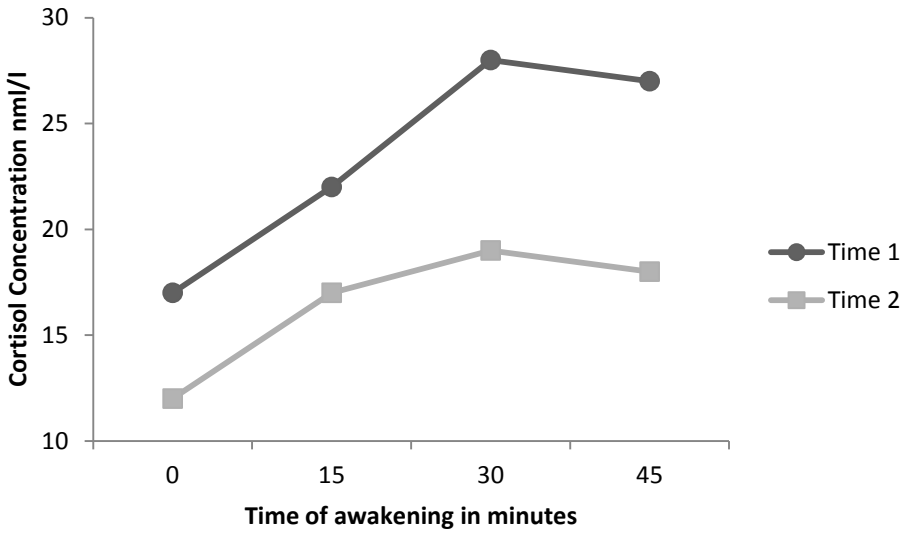

Figure 7-4 Mean cortisol awakening response at Time 1 and Time 2

The measure of cortisol increase was computed as the Area Under the Curve (AUCi) (see Chapter 3, Section 5 for a detailed description of the computation). The results from a repeated t-test (t=2.201, df=33, p=.035) revealed that the cortisol increase was significantly lower at T2 (mean 12. 7 SD±14) than at T1 (mean 20.0, SD±20).

Correlations were carried out to see if the changes in cortisol from T1 to T2 also corresponded with the changes to demographical and psychosocial data. No significant correlations with the MOS (r=.150, p=.421), SF-36 (r=.177, p=.332) or the Wellness scale (r=.256, p=.165) were found.

The cortisol concentrations were then analysed in relation to the well-being scales to determine if cortisol could be associated with PosWB and NegWB. As with the psychosocial data, this analysis only used the three quadrants that had a sufficient number of participants represented. The results from a 3-way ANOVA and the Bonferroni Post-Hoc test revealed there was a significant difference between the AUCi in the quadrants ($F_{(2,\ 29)}$=3.699, p=.037). Participants in the HighPos/LowNeg quadrant had a significantly lower AUCi than the participants in the LowPos/LowNeg (p=.034) quadrant.

See Figure 7-5 for the difference between the three quadrants in relation to cortisol

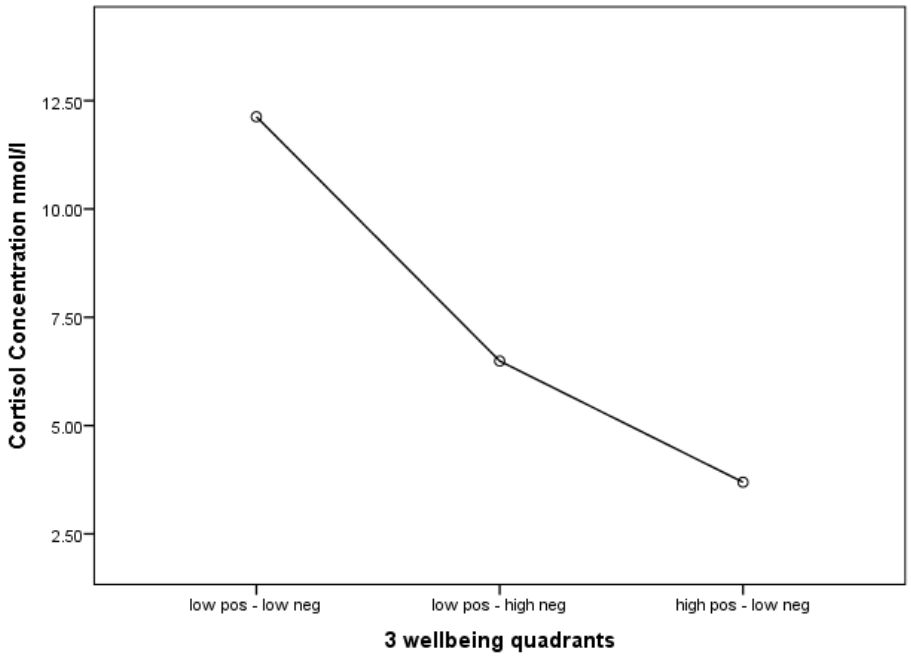

Figure 7-5 Difference in cortisol concentration (as measured by AUCi) in three of the well-being quadrants

These findings suggest a difference to what was found at T1, where the participants in the HighPos/LowNeg quadrants had a significantly lower CAR (AUCg) than the rest of the participants. However, there was no difference in the dynamic of the CAR, as found at T2. As a result, an analysis to see if it was possible to replicate the findings from T1 was carried out. As in T1 the quadrant HighPos/LowNeg quadrant (N=13) was analysed in relation to the rest of the well-being quadrants (N=21). A 2 (well-being) x 4 (samples) mixed ANOVA was applied. As expected there was a main effect of sampling time, indicating the rise in cortisol after awakening ($F_{(2,32)}$=18.592, p<.000) but there was no main effect on the two well-being groups ($F_{(2,32)}$=.186, p=.669), as illustrated in Figure 7-6. However, the analysis suggested there was a trend towards significant interaction between the groups ($F_{(2,32)}$=2.550 p=.060). This confirmed the difference in findings between T1 and T2. There

was an association between well-being and the dynamic of the CAR only at T2, and an association between absolute levels of the CAR and well-being only at T1. The results from Time 2 are illustrated in Figure 7-7.

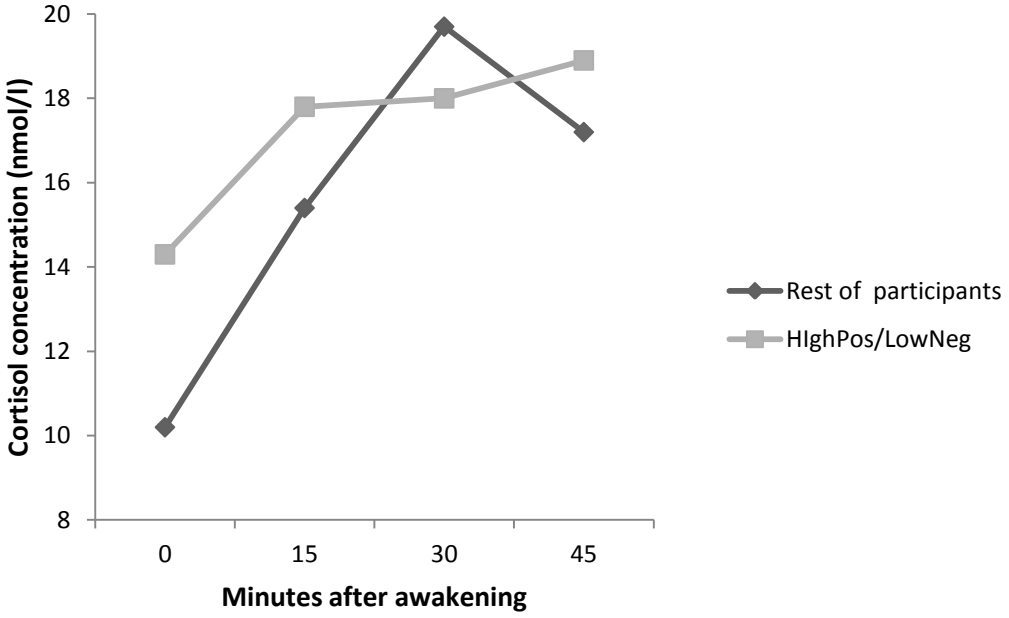

Figure 7-6 Cortisol awakening response in the HighPos/LowNeg (N=13) quadrant as compared to the rest of the group (N=21) at Time 2

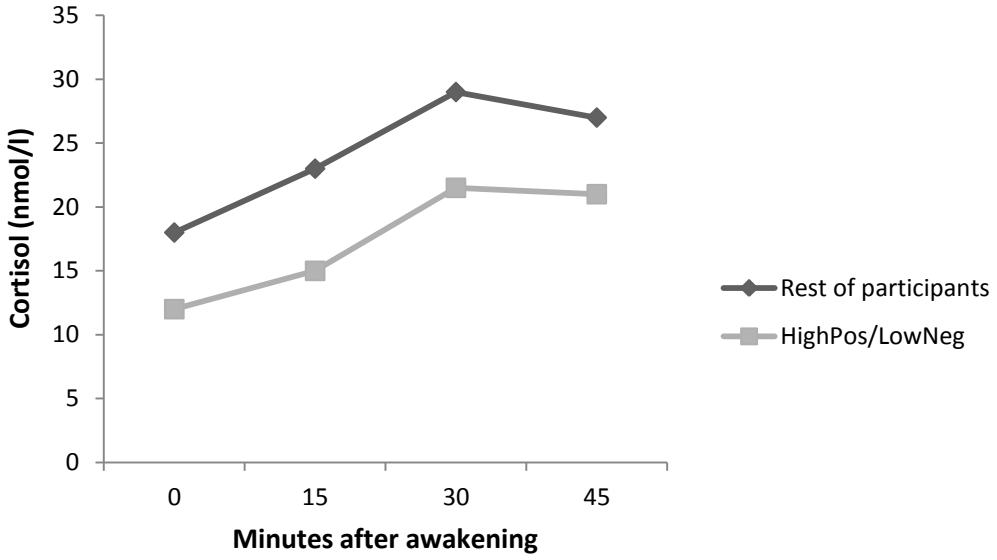

Figure 7-7 Cortisol awakening response in the HighPos/LowNeg (N=17) quadrant as compared to the rest of the group (N=33) at Time 1

The original scores from the PosWB and NegWB scales from T1 was then used to find out if it would be possible to predict cortisol concentrations based on the PosWB and NegWB scores from T1 at T2. Accordingly since the PosWB and NegWB scores did not change from T1 and T2, the PosWB and NegWB scores from T1 of the 37 participants who took part at both the original and the follow-up study were analysed.

In this way the well-being data from T1 was used to split the cortisol data at T2. Participants were split into two groups with the HighPos/LowNeg quadrant (N=14) compared with the remaining three quadrants (N=20) from T1. The cortisol data from these participants from T2 were analysed using a 2 (well-being) x 4 (samples) mixed ANOVA. This analysis revealed that, as expected, there was a main effect of samples ($F_{(1,32)}$=15.959, p<.001). The results further revealed that there was, as in the first study, a main effect of cortisol for well-being quadrants, where those in the HighPos/LowNeg quadrant (assessed at T1) had a CAR that was significantly lower than the rest of the quadrants ($F_{(1,32)}$=4.709, p=.038). The analysis revealed no interaction between the groups ($F_{(1.32)}$=2.051, p=.162). These results mirror

the findings from the first study, as illustrated in Figure 7-8 where the quadrants were associated with the total cortisol secreted during the CAR and not the dynamic of the awakening response. By replicating the findings of cortisol concentration at T2 this follow-up study is demonstrating how cortisol is consistent over time.

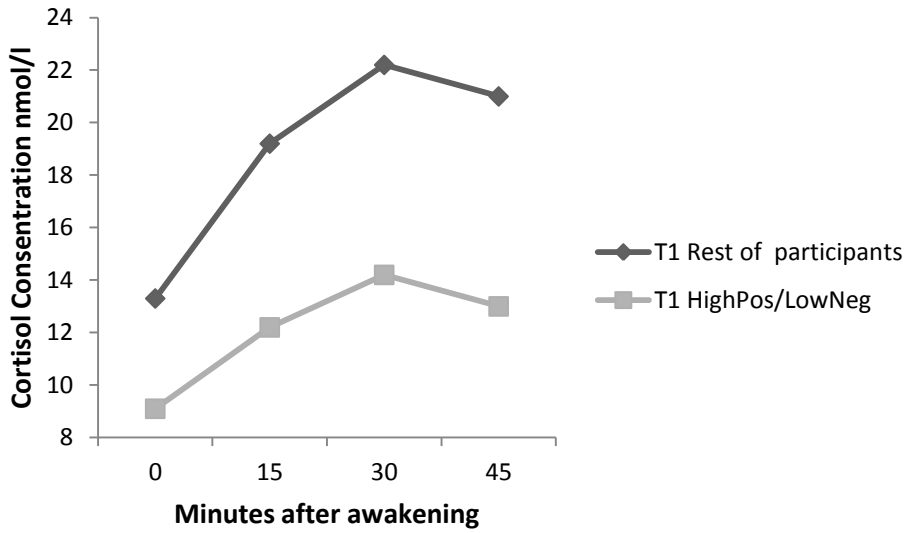

Figure 7-8 Cortisol awakening response at T2 for the HighPos/LowNeg (N=13) quadrant participants compared to the rest of the group assessed at T1 (N=21)

7.4 Discussion

The retention rate of 74% at Time 2 reduced the sample size from 50 participants at Time 1 to 37 participants at Time 2. Although those volunteering to participate at T2 were younger than those that did not, there were no differences between the two groups in terms of well-being at baseline suggesting that the findings at follow up may be representative of the entire group. As in the original study, the follow-up study supports the hypothesis of the relative independence between PosWB and NegWB. This

was demonstrated by the fact that participants were represented in each of the four well-being categories: LowPos/LowNeg, LowPos/HighNeg, HighPos/LowNeg and HighPos/HighNeg, though only two people gained scores which placed them in the HighPos/HighNeg category.

As the results did not reveal any significant difference between the PosWB and the NegWB score from Time 1 to Time 2, the findings did not find support for the theory that PosWB would decrease and NegWB would increase with age. One reason why differences in these scales were not found could be due to selection bias. Participants were required to attend a research meeting for data collection and only those capable of negotiating travel arrangements and having available time were therefore included in the follow-up study. These logistical factors may well map onto perceived well-being status, in that only the participants who did not feel a change in their well-being status, and in particular, in relation to the NegWB scale agreed to take part in this follow-up study. As a result, the current research could have missed data from participants who would have had a decrease in PosWB and an increase in NegWB.

However, when comparing the difference in the psychosocial factors between Time 1 and Time 2 some interesting findings emerged. As hypothesised, on the VAS participants rated their health and well-being worse at Time 2 than Time 1, indicating that they regarded their health and well-being as having declined within the three year period. This was further supported by the results from the SF-36 questionnaire, where physical and social functioning decreased. Participants also reported, on the particular question related to the last year on the SF-36 that their health had changed. The results from the MOS questionnaire further supported the hypothesis that social support would decrease with time. There was a significant reduction in overall social support over the last three years, with a particular reduction in emotional and tangible support. The participants also reported a reduction in emotional well-being, social well-being, spirituality and mental well-being from Time 1 to Time 2.

The findings from the first study at Time 1 suggested that NegWB was associated with subjective ratings of health and social support. The follow-up study was not able to find further support for these findings. In the first study spirituality, a subcategory of the wellness scale, seemed to be dependent upon PosWB, but this finding was not replicated in the data from the follow-up study. In the original study the results from the successful ageing questionnaire (LSIA) seemed to be dependent upon PosWB but independent of NegWB. These results were not found in this follow-up study.

The cortisol data also showed that the overall CAR was lower in the follow-up study. Evidence from studies presented in the introduction of Chapter 5 suggested changes in the AUCi is expected to go down with age (Seeman, Singer, Wilkinson, & McEwen, 2001; Evans, et al., 2007), findings which were supported in this study. However, evidence for age-related changes in cortisol in relation to CAR has been contradictory. Research including older participants tends to report increasing age to be associated with an attenuated CAR (Kudielka & Kirschbaum, 2003; Pruessner, Renwick, Meaney, Mahani, Baldwin, Dedovic, Lord, & Lupien, 2005; Knoops, van der Graaf, Mali, & Geerlings, 2010). However, a study by Almeida, Piazza and Stawski (2009) suggests that among men across a large adult age range the CAR may increase in amount, but also show more variability as one gets older. Accordingly, evidence is emerging of age-related changes in measures of cortisol dynamics (AUCi) as well as level (AUCg). However, it is unclear why the overall cortisol levels decreased so substantially from Time 1 to Time 2. One explanation could be due to a physical change of laboratory from Time 1 to Time 2, due to refurbishment to the building between the two time periods. As the cortisol assay is very sensitive to temperature and a small change in the temperature between the two laboratories could have resulted in changes to the overall cortisol concentration reported in the samples (Hansen, Garde, & Persson, 2008).

The relationship between the well-being quadrants at Time 2 and cortisol at Time 2 was not consistent with what was found at Time 1. At follow-up, in

this reduced sample size, there was no overall difference in levels of cortisol secreted between the well-being quadrants. However the HighPos/LowNeg quadrant presented a trend towards significant lower dynamic increase in cortisol compared to the rest of the sample. This was a surprising finding and the significance remains unclear. Despite this unexplained anomaly when the well-being quadrants from Time 1 were used to examine cortisol at Time 2 the results were consistent with what was found at Time 1. The participants that were high in positive and low in negative well-being at Time 1 retained a lower AUCg at Time 2 compared to the rest of the sample, with no difference between the dynamic of the cortisol increase. This finding substantiates the conclusion of consistency in the pattern of the CAR over a 3 year follow-up period.

Even though there was no significant difference in the scores on the PosWB scale and the NegWB scale between Time 1 and Time 2, the results from the psychosocial measures seem to suggest otherwise. This could suggest that using the GHQ-30 as a scale for PosWB and NegWB as suggested by Huppert and Whittington (2003) may not be a sensitive enough measure to use when exploring the relative independence between PosWB and NegWB. One of the reasons for this, could be that when scoring the data the PosWB scale includes only the positive loaded items, while the NegWB scale includes all the items, but reverses the positive loaded items. As a result, the scores of the two scales will always correlate and they appear to measure some of the same items in a way that would naturally support a bipolar hypothesis.

The findings from this follow-up study suggest that the psychosocial factors had changed over a three-year period. Participants reported worse health, less social support and less wellness (as reported by the wellness questionnaire). However, the scores from the PosWB and NegWB did not support these finding, as no change in well-being from Time 1 and Time 2 was reported. This can suggest that, even though the scales support the independence view at Time 2, the scales are not sensitive enough in relation

to picking up on change over time. The results from the cortisol date indicate a reduced dynamic of the cortisol response over the 3-year follow up period but suggested that patterns of cortisol secretion remain largely consistent over time, regardless of changes in psychosocial factors.

Chapter 8 Concluding discussion

Overview

This final chapter will present an overview of the key findings of the current work. It will argue that the independence hypothesis on well-being has been supported by demonstrating how psychosocial factors, cortisol and cognitive performance are all differentially associated with positive well-being and negative well-being. Methodological issues related to the current work will be discussed and limitations with the research will be presented. Future directions, which include suggestions of looking at additional factors such as personality and physical activities, will be suggested. Finally implications for practice will be explored before the final conclusion will be presented.

8.1 Introduction

To reduce burden and enhance the benefits associated with an ageing population, research must elucidate factors that decrease age-related disability and increase quality of life in later years. By expanding the collection of research data on the topic of well-being in older people this current work demonstrates the importance of considering both positive and negative well-being in ageing research. This work has replicated previous findings on positive and negative well-being, as measured by the GHQ-30 instrument, and by doing so, has further developed understanding of how and to what extent positive and negative well-being can be said to function as two relatively separate and independent domains. During the past decades, studies have attempted to define and determine predictive factors that are associated with successful ageing. However, studies to date have been limited in applying the independence framework and exploring the two well-being domains in order to examine which factors in older age are

associated with either positive well-being, negative well-being or a combination of both. The current work has further demonstrated the importance of including a variety of factors, such as psychosocial, cortisol and cognitive performance in order to measure successful ageing. The last part of the work has highlighted the necessity of carrying out longitudinal studies in relation to well-being research, where the overall findings suggest that psychosocial factors change with time, while cortisol and positive and negative well-being remain relatively consistent as one gets older.

8.2 Key findings

Although the research has been undertaken on a modest sample of 50 participants the data from the GHQ-30 are comparable with the published data from an extensive investigation of over 6000 participants in several ways. A similar level of correlation between the positive and negative dimensions (both in measures of central tendency and dispersion) as in Huppert and Whittington's (2003) study was obtained. Also, similar combinations of positive and negative well-being scores were acquired. This consistency between the studies provides reassurance that this sample is representative of the wider population. However, it is important to be cautious and not over-interpret the findings. The intensive nature of the research meant that the sample size was quite modest, the proportion of male participants was small, the participants were largely middle-class, white-British and well-educated.

The key findings suggest that positive well-being and negative well-being exist as two relatively independent domains, as opposed to the bipolar hypothesis which suggest that well-being exist on one single continuum. The analysis of the positive and negative well-being scales as measured by the GHQ-30 at both Time 1 and Time 2, mirrors the findings from Huppert and Whittington (2003). The scores showed that despite a correlation between the dimensions, there were also differences between the scales, as

demonstrated by the normal distribution of the PosWB scores and the skewed scores of the NegWB scale. When a median spilt was carried out, the results further revealed that participants could be allocated into four different well-being quadrants (LowPos/LowNeg, LowPos/HighNeg, HighPos/LowNeg and HighPos/HighNeg), with a similar distribution to that found by Huppert and Whittington (2003), as supported by the results in Chapter 4, Section 3. The results give further evidence of the independence theory, as almost one third of the participants gained scores which categorised them in either the LowPos/LowNeg or the HighPos/HighNeg quadrant.

Further findings suggest that demographical factors were not associated with either positive well-being or negative well-being. The participants were a very active group of older seniors, demonstrated both by the reported social activities during the week (mean of 8.2 (SD±3.1) hours a week) and the fact that many were recruited from the organisation University of The Third Age and Age Concern. This suggests that they might have been above average for their cohort in relation to both financial status and educational levels, something that was indeed supported by findings from the demographic data where the mean score reported on perceived financial status was 66 (SD±23) on the scale from 0-100 and 60% (n=30) had attended college or university.

Interestingly, no significant association with positive well-being and negative well-being in relation to sex or age was found. This is in contrast to the findings of Huppert and Whittington (2003) who found evidence that positive and negative well-being changed with age. However, since they measured well-being across the lifespan, and this current work only looked at older people, it might not be so surprising that the Huppert and Whittington (2003) results were different in relation to age. Nonetheless, the current research did find some interesting associations between age, well-being and cognitive performance. An illustration of the main findings based on the theoretical framework is presented in Figure 8-1. As can be seen in this figure, the

factors that were found to be associated with positive and negative well-being are highlighted in bold and italic,

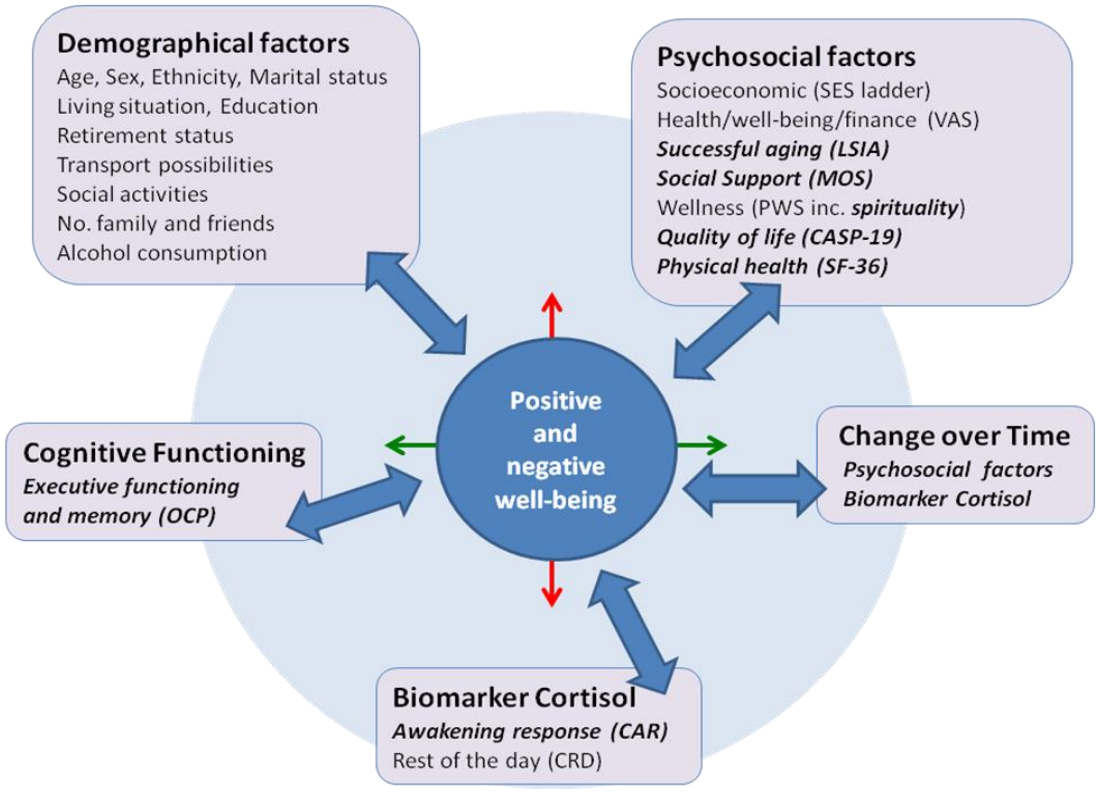

Figure 8-1 Illustration of the main findings based on the theoretical framework, with significant associations of factors in relation to positive and negative well-being (as highlighted in bold and italic)

In relation to sex, Huppert and Whittington (2003) found that for women, negative well-being increased and positive well-being fell with age. For men too, positive well-being declined steadily with age but negative well-being was higher in middle age and lowest in old age. In other words, older men seemed to score low on both the positive and the negative well-being scale. These sex differences were not replicated in the current work. However, the reason why no such difference was found in the current work could be due to the relatively small sample size of fifty, compared to over 6000 participants in

Huppert and Whittington's (2003) study. In addition, of the fifty participants only sixteen participants were men (32%).

The psychosocial factors, on the other hand, revealed some key findings which further supported the independence view by suggesting that different psychosocial factors were associated with different well-being measures. The results suggested that negative well-being was associated with subjective ratings of health (as measured by the SF-36) and social support (as measured by the MOS questionnaire). Positive well-being, on the other hand, was found to be associated with life satisfaction (as measured by the life satisfaction index) and spirituality (a subcategory of the wellness scale). As positive well-being was not associated with subjective health and social support and negative well-being had no impact on life satisfaction and spirituality, this provides further evidence for the independence hypothesis, as no opposite effect on the well-being scales was found, as illustrated in Figure 8-2.

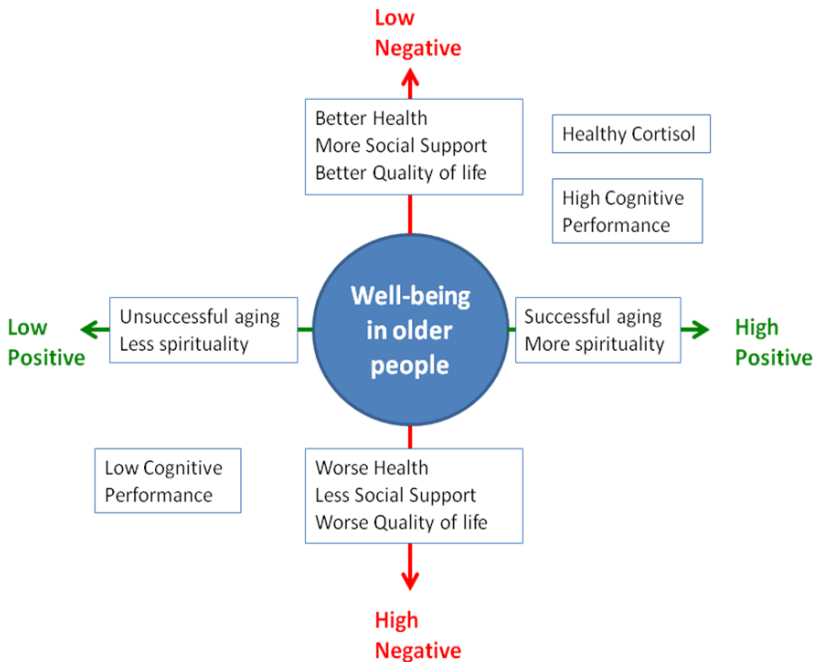

Figure 8-2 Visual illustration of the associations with positive and negative well-being on the factors found to be significantly related to the two well-being scales

It was interesting to find that health ratings were associated with negative well-being and not positive well-being, as the literature is increasingly presenting studies on how subjective health is associated with positive well-being. For example Diener and Chan (2011) conclude from their review that happy people live longer. They looked at evidence which indicated that high subjective well-being (such as life satisfaction, absence of negative emotions, optimism, and positive emotions) caused better health and longevity. However, one of the main problems in comparing research related to well-being and health is that many studies, including that by Diener and Chan (2011) do not consider positive well-being and negative well-being as two separate independent domains. As a result, when they conclude that positive well-being has health benefits this can equally be interpreted in a manner where reducing high negative well-being can have equally good health benefits. Hence, the current work contributes to the literature by demonstrating that in order to increase health related benefits in older age it is particularly important to reduce negative well-being. Positive well-being, according to the findings in this sample of 50 community dwelling older people seemed less important in relation to perceived health.

Social support was also associated with negative well-being, suggesting that participants, who received low social support from, in particular, family and friends, also reported higher levels of negative well-being, as illustrated in Figure 8-1 participants who scored high on social support reported low levels of negative well-being. Social support is one of the psychosocial factors in the literature where the distinction between the two well-being domains seem more frequently considered (e.g. Rackow, Scholz, & Hornung, 2014). For example, similar findings to this current work in relation to social support were reported by Brown et al. (2003), although they looked at providing social support rather than receiving social support. In the study they found that mortality was significantly reduced for individuals who reported providing instrumental and emotional support to spouse, friends, relatives and neighbours, and individuals who reported providing emotional support to their spouse. The associations between positive and negative well-being were

also examined in a recent lifespan study by Sedlecki et al. (2014). They reported that positive well-being, or positive affect as measured by the PANAS scale, was predicted by actual social support, while negative affect was predicted by perceived social support. Interestingly, they found no difference in social support across the age span.

Positive well-being, on the other hand, was found to be associated with life satisfaction and spirituality, while negative well-being was not associated with these factors. Participants who scored high on positive well-being reported more life satisfaction than participants who scored low on positive well-being, as illustrated in Figure 8-2. It is interesting how life satisfaction only revealed significant findings in relation to the positive well-being. The same results were found with the subcategory spirituality on the Wellness scale, where participants who reported high levels of positive well-being also reported a high sense of spirituality. Negative well-being had no impact on these two psychosocial factors. These findings are in accordance with previous research on spirituality and well-being of older adults (Mackenzie, et al., 2000; Boey, 2003; Schickler, 2005).

The analysis of the cortisol profiles revealed further key findings, in that both positive well-being and negative well-being was associated with the cortisol awakening response (as reported in Chapter 5, Section 3). The findings, as illustrated in Figure 8-2,showed that, in particular, the high positive well-being and low negative well-being combination was associated with a lower cortisol awakening response, which indicates that the cortisol response is associated with this particular combination of positive and negative well-being. Interestingly no opposite effect was found, where low positive well-being and high negative well-being was associated with high cortisol awakening response.

As it is evident from studies mentioned in the introduction of the chapter on cortisol (Chapter 5), the interpretation of the significant associations with cortisol is guided by prior expectation that well-being in general would, if anything, be inversely related to cortisol and this degree of effect may

depend on whether measures of positive and negative well-being is considered. Thus, the additional analysis of the data went on to examine simple main effects of one well-being factor at each level of the other. This a priori approach clearly indicated that cortisol was only lower in low negative well-being participants if their positive well-being was high, and only lower in high positive well-being participants if their negative well-being was low. Similarly significant associations between aspects of positive well-being (e.g. personal growth and purpose in life) and lower cortisol secretion have been reported, with the effect being most marked for morning cortisol levels and in those over 75 years of age. However, in the same study negative well-being (e.g. anxiety and anger) was not associated with cortisol secretion across the day (Ryff, et al., 2006).

Key findings further revealed how positive well-being and negative well-being were both associated with cognitive functioning when age was accounted for (as presented in Chapter 6, Section 3). An association was found between age, low positive well-being and overall cognitive performance, suggesting that people who reported low levels of positive well-being were more likely to have worse cognitive function the older they were than people who reported high levels of positive well-being, as can be seen in Figure 8-2. High levels of positive well-being, on the other hand, had no effect on the rate of cognitive decline. The results further revealed similar findings with negative well-being, but this time with the high negative well-being and not the low negative well-being, suggesting that older people who reported high levels of negative well-being were likely to have worse cognitive function with increasing age compared to people who reported lower levels of negative well-being.

The findings from the follow-up study (as presented in Chapter 6, Section 3) support the independence view by replicating the findings with participants in each well-being quadrant. However, even though no change in positive well-being and negative well-being scores was found, over the 3-year period the participants reported worse health, less social support and less wellness (emotional, social, mental and spirituality). The results from the follow-up

study also found that both positive well-being and negative well-being was associated with the cortisol awakening response. However, there was no overall difference in levels of cortisol secreted between the well-being quadrants, but the HighPos/LowNeg quadrant presented with a statistically significant lower dynamic increase in cortisol compared to the rest of the sample. Despite this unexplained anomaly, when the well-being quadrants from Time 1 were used to examine cortisol at Time 2, the results were consistent with what was found at Time 1. The participants that were high in positive and low in negative well-being at Time 1 retained a lower cortisol awakening response at Time 2 compared to the rest of the sample, with no difference between the dynamic of the cortisol increase. This finding substantiates the conclusion of consistency in the pattern of the CAR over a 3 year follow-up period.

In the original study by Huppert and Whittington (2003) they found that the probability of survival over a 7-years period was related to positive well-being at the baseline seven years earlier. This relationship held even when adjustments were made for psychosocial factors and physical health. The negative well-being scores were not associated with subsequent survival. A similar separation between the effects of positive and negative mental states were reported by Ostir et al. (2001) when they examined predictors of stroke in a sample of older people. By using the positively worded items on a depression scale, they found that lower positive scores at baseline were associated with a greater risk of stroke over the six-year follow-up period. The negatively worded items were not found to be associated with the incidence of stroke. The fact that this current work did not find a significant change in the two well-being scores from Time 1 and Time 2 might suggest that after a certain age people's sense of well-being remains relatively stable. These findings are also in line with previous findings which suggest that despite the decline in physical health and the deaths of peers and spouses and other objective factors that accompany old age, people's reported well-being remains stable over time (Mroczek & Kolarz, 1998; Blanchflower & Oswald, 2008; Windsor & Anstey, 2010).

8.3 Methodological issues

The analysis of the two well-being measures, derived from the GHQ-30, follow the same approach to analysis as suggested by Huppert and Whittington (2003), where the scores of each of the two scales were split in the middle in order to obtain four well-being quadrants. However, even if most of the participants in the positive well-being scale scored in the middle (with a mean score of 15, as demonstrated in Chapter 4, Figure 4-1), all of the participants with a score of 15 or less were allocated to the low positive well-being quadrants. As a result, out of 29 participants in this group 13 of these gained an overall score of 15. That means that 13 of the participants could have equally been classified as belonging to the high positive well-being groups if the median split instead was defined as those with scores of 15 and above were allocated to the high positive well-being quadrants. This was not an issue in relation to the negative well-being scales as none of the participants gained a score of 15 and as a result, the grouping of participants who were classified into the high and low negative well-being was more clear-cut. As a result of this approach to analysis, only four people were allocated to the HighPos/HighNeg quadrant at Time 1 and only two people were in this quadrant at Time 2. This meant that a comparison analysis between those participants in this quadrant at Time 1 and Time 2 was not feasible, and accordingly at Time 2 this quadrant of participants was excluded from the analysis.

In the original study, Huppert and Whittington (2003) used factor analysis to analyse the data. Due to the small sample size in this current work (50 participants at Time 1 and 37 at Time 2) neither a factor analysis nor a multiple regression was deemed appropriate to carry out. A combination of correlations, t-tests, and ANOVAs were carried out instead. Hence, this research has not been able to replicate the exact statistical analyses of the original study by Huppert and Whittington (2003).

Another methodological issue related to the study by Huppert and Whittington (2003) is connected with the scoring of the GHQ-30, where when

calculating the negative well-being scale, all of the 30 items were used by reversing the positive loaded items. However, in the positive well-being scale, only the positive loaded items from the original questionnaire were included. This means that half of the questions of the negative well-being scale included items from the positive well-being scale. This would naturally result in a correlation between the two scales since the same answers, only scored in an opposite manner, were scored in both scales. However, the rationale for scoring GHQ-30 in the current manner was due to the original aim of the questionnaire, which was to measure negative well-being (Huppert, Walters, Day, & Elliott, 1989). Despite this, it might have been more beneficial in relation to positive and negative well-being to create two scales, one based only on the positive loaded items and the other only on the negative loaded items. This would result in similar measures of well-being to the already well-established PANAS scale (Watson, Clark, & Tellegen, 1988a), which is measuring positive affects and negative affects as two separate scores. This alternative would apply a mix of both eudaimonic and hedonic well-being rather than the simple hedonic approach of the PANAS scale.

In relation to the cortisol data, the cortisol concentrations, as measured by the CAR, obtained from Time 1 to Time 2 were surprisingly lower at Time 2 than Time 1. It is unclear why the overall CAR decreased from Time 1 to Time 2 as one would expect the day samples to reduce with age but the absolute levels of the CAR (AUCg) to increase with age (Almeida, et al., 2009). One explanation could be due to a physical change of laboratory from Time 1 to Time 2. The cortisol assay is very sensitive to temperature and a small change in the temperature between the two laboratories could have resulted in changes to the overall cortisol concentration reported in the samples (Hansen, et al., 2008). In addition to the unexplained substantial reduction in overall cortisol levels at Time 2 a reduction in the dynamic of the CAR was observed. This finding is consistent with some evidence that increasing age is associated with a reduced CAR (Lai, et al., 2005; Ryff, et al., 2006)

Adherence to protocol is always an important factor to consider in studies on cortisol as findings have shown that the cortisol concentration is determined by awakening time (Clow, Thorn, Evans, & Hucklebridge, 2004b; Thorn, et al., 2006). Participants were encouraged to collect saliva samples according to the desired times (i.e. 0, 15, 30 and 45 min, and 3 and 12 hr post-awakening). They were further encouraged to be honest and accurate in reporting their awakening and saliva sampling times on the recording table spreadsheet and by pressing the wrist-watch actimeter. Hence, there was no reason to assume that participants did not adhere to the instructions in this current study. It has also been suggested that older people are significantly more adherent in both attendance and completion when participating in research studies than younger participants (Ogrodniczuk, et al., 2006). However, strictly speaking it is only possible to assert the exact timing of collection with the use of special electronic monitoring collection tubes which directly record use of the tubes (e.g.,Kudielka, et al., 2003). Accordingly, a combination of electronically tagged tubes and objectively assisted estimation of awakening time would be an ideal method for self-administered saliva collection protocols.

Twenty-three of the participants lived with a spouse (or family member), and in all cases but four, the spouse also participated in the research. Hence, the nine couples were given the instructions at the same time, which could benefit adherence in the sense that they could ask each in case they could not remember the instructions. Also, despite the researcher giving the couples a choice of carrying out the initial interview together or separately, all the couples decided to complete the interview together. Accordingly, this could have influenced the answers, although none of the questions in the interview were particularly related to confidential issues. In contrast, the researcher did encourage the couples to complete the questionnaire booklet on their own without discussing the questions with their partner prior to completion. However, it was not possible to control for this adherence and as a result it is difficult to establish if some of the participants were influenced by their partner when completing the questionnaire booklet.

The cognitive tests on the other hand were carried out separately as these tests included several recall tasks. The non-participating spouse was encouraged to leave the room and re-enter when the test had finished. It has been argued that older people often are aware of age-related declines in memory and therefore, explicitly describing something as a memory test heightens older participants' anxiety and makes them anticipate that they will perform poorly (Helmuth, 2003). Accordingly, participants could have scored lower on the cognitive tests than expected due to anxiousness, however, since the scores from the cognitive performance showed that the participants had a mean IQ of 116 (SD±5.5) one can assume the test did not necessarily have a negative effect on the results. Subsequently, the participants were also briefed and encouraged to express any discomfort related to the test.

8.4 Limitations

There is little doubt that the issue related to causal pathways, or bidirectional relationship, needs to be considered in all research on well-being. It is, for example, very difficult to determine if people are happy and content because they have good cognitive functioning, or if good cognitive functioning results in peoples' happiness and contentment. Also, for example in relation to cortisol (presented in Chapter 5, Section 3), it is possible that the effects of, as the current results suggest, the combination of high positive well-being and low negative well-being work through stimulating healthy cortisol patterns and if these persist in the long-term it will result in favourable health outcomes. A growing body of evidence demonstrates the effectiveness of positive psychological interventions in enhancing individual's well-being (Seligman, 2002). Hence, intervention studies in which well-being are enhanced by deliberate interventions could also determine the effects on factors such as cortisol and cognitive functioning.

The relatively small sample size of fifty participants makes it difficult to generalize the findings. The rationale for the relatively small sample size is

due to the intensive nature of the study. A substantial number of variables were investigated (including demographical, psychosocial, biomarker cortisol, cognitive factors), and the researcher visited the participants in their homes twice where each visit lasted around two hours. In addition saliva samples were analysed in the laboratory both at Time 1 and Time 2. However, there is little doubt that a larger sample size could have provided more statistical power to the results. The proportion of male participants was also small, with 16 males at Time 1 and 12 males at Time 2. The participants were largely middle-class, white-British and well-educated. As a result of these factors, caution needs to be applied when generalising from the results as this sample may not be very representative of the general aged population.

Due to the substantial nature of this research in terms of time and resources it was not possible to replicate the full study at Time 2. The participants attended an event-day instead of being visited in their homes, they collected four morning saliva samples over two consecutive days (rather than eight samples on each day at Time 1) and the saliva samples together with the questionnaire pack was posted back to the researcher. Cognitive data was not collected at Time 2 due to the limited time and difficult setting at the follow-up meeting. However, in hindsight, collecting cognitive data would have been useful at Time 2 in order to further establish the longitudinal impact on cognitive performance, age and well-being.

8.5 Future directions

Certainly it would be interesting to examine the same associations in populations of different ages to determine whether the results reported for this older population would be similar across the lifespan. Therefore a comparison study with a younger population or a study with more participants across different age groups would be beneficial to carry out. Comparisons between age groups over the lifespan would also give further

understanding of the concept of positive and negative well-being in relation to cognitive performance. Longitudinal evidence for the effects of well-being on health and cognitive performance are evident but longitudinal investigation of the physiological pathways mediating this relationship across the lifespan is needed. It is also likely that this particular group of older participants, are not necessarily representative of the older population in general, due to their high socioeconomic status, above average scores on health measures and higher than average cognitive performance. Therefore, carrying out similar studies in care homes could provide additional understanding of the importance of positive and negative well-being in older people.

By applying a mainly eudaimonic view on well-being this research is limited in the sense that it does not consider the importance of hedonic well-being for older people. Accordingly, future studies could apply an even broader multidimensional approach and include measurements of hedonic well-being, as well as eudaimonic well-being, in order to analyse both aspects of well-being.

Future research on well-being in older people should also consider including additional factors such as different personality traits. In a study by Gale et al. (2011) on older people, they found that negative well-being in later life, as measured by anxiety and depression scales, was strongly linked to personality. It would also be interesting to further explore how positive well-being and personality are associated. The idea that personality is the key to understanding well-being has emerged in later years (Mroczek & Kolarz, 1998). This perspective asserts that individual differences in well-being are highly heritable, particularly with regards to positive and negative affect (Lykken & Tellegen, 1996). Lykken and Tellegen (1996) argue that if long-standing, stable personality traits account for individual differences in well-being, then the influence of ageing may be irrelevant or insignificant. They further point out that stability in the traits that underlie well-being may overshadow any changes in affect that the ageing process may bring about.

Other personality traits that have been studied at great length are optimism and the opposite component of neuroticism. Optimism, for example, has been shown to predict less loneliness in older men independent of levels of negative well-being or change in social networks (Rius-Ottenheim, Kromhout, Mast, Zitman, Geleijnse, & Giltay, 2012) and several studies have found an association between optimism and positive well-being (e.g. Smith, Pope, Rhodewalt, & Poulton, 1989; Lai, et al., 2005). However, Isaacowitz (2005) found no significant relationship between age and optimism in the prediction of depression or life satisfaction in their sample of 280 young, middle aged and older participants.

Within ageing research, resilience is a concept that has received considerable attention but the relationship between resilience and positive and negative well-being has not yet been investigated fully. Stephens, Breheny and Mansvelt (2015) argue that resilience may be a useful way to understand and explain the diversity and richness of older people's experience of health. Rowe and Kahn (1997, p439) define resilience as 'the rapidity and completeness with which people recover from and return to meeting the criteria of success'. Resilience has also been defined as 'flourishing despite adversity', where adversity is interpreted as the increased chances of personal loss, exacerbated inequality, physical disability and general physical health challenges of ageing (Hildon, Montgomery, Blane, Wiggins, & Netuveli, 2009). Accordingly, it would have been interesting to include resilience as a factor in the current study in order to find out what impact resilience would have on both positive and negative well-being in older age.

The current research looked at social support as a factor, however, future studies could look at specific parts of social interactions such as the impact of isolation and loneliness on well-being. Various dimensions of social interactions are often included in research such as the size of an individual's social network, frequency of contact with people in that network and feelings of engagement or loneliness in social activities. Older people are often at

greater risk of isolation and loneliness due to the many changes that take place in later life, including retirement, bereavement and children and friends moving away (Shankar, Rafnsson, & Steptoe, 2015). Hence, loneliness and social isolation have been found to be detrimental to well-being (Dolan, Peasgood, & White, 2008).

In this current work questions were raised in relation to perceived health (as measured by the SF-36) and social activities. However, in addition, the importance of physical activities, such as exercise, in relation to positive and negative well-being are important factors that can be examined in greater detail in future studies. For example, research by Menec and Chipperfield (1997) found that participation in leisure activities and exercising were predictors of better perceived health and greater life satisfaction. The results suggest that involvement in physical exercise may promote positive perceptions of psychological well-being among the elderly. On the other hand, psychological well-being seemed to be an important predictor for staying physically active at advanced ages. Importantly, issues related to causality need to be considered in greater detail in future studies.

Comparisons between age groups over the lifespan would further give a better understanding of the concept of positive and negative well-being in relation to cognitive performance. Longitudinal evidence for the effects of well-being on health and cognitive performance are evident but longitudinal investigation of the physiological pathways mediating this relationship across the life span is needed.

McKee and Schüz (2015) argue that one of the most important influences on healthy ageing is sleep. Sleeping for less than seven hours per night with more than two hours of being awake has been shown to be associated with reduced physical functionality - affecting health, well-being and quality of life (Reyes, Algarin, Bunout, & Peirano, 2013). It has also been shown that sleeping for less than six and a half hours a night predicts cognitive decline (Keage, Banks, Yang, Morgan, Brayne, & Matthews, 2012) and sleeping more than nine hours can predict decline in high-level functioning (Tsubota-

Utsugi, Ito-Sato, Ohkubo, Kikuya, Asayama, Metoki, Fukushima, Kurimoto, Tsubono, & Imai, 2011). In the current research, participants were wearing an actimeter at night (see Chapter 3, Section 6) to control for compliance to the protocol for recording time of awakening. This actimeter was on all night and, accordingly, an analysis of the quality of sleep could have been carried out by looking at the level of activity during the night, such as movement in bed. However, since this was not considered a major focus of the study, and was not included in the consent form, such an analysis was not carried out. In future studies, analysis from the actimeter could be included. In addition, a quality of sleep questionnaire could be added to the questionnaire battery to find out how, and if, sleep duration and quality of sleep is associated with positive and negative well-being.

A semi-structured interview was carried out in the current research to collect mainly demographic data. However, to explore older people's values and in-depth thoughts about the importance of positive and negative well-being in older age, a thorough qualitative research interview could be carried out. The importance of looking at people's values in addition to their health has been highlighted by Stephens et al. (2015). They argue there should be a shift in the focus of research on older people from the requirement for individuals to achieve good physical health to focus on supporting the fundamental values of older people. A qualitative research study could provide researchers with a better understanding of the subjective experience of positive and negative well-being in older people.

8.6 Implication for practice

Well-being researchers have increasingly distinguished between eudaimonic well-being (e.g., meaning and purpose; taking part in activities that allow for the actualization of one's skills, talents, and potential) and hedonic well-being (e.g., high frequencies of positive affect, low frequencies of negative affect, and evaluating life as satisfying). However, Kashdan et al. (2008), argue that

this distinction (which is rooted in philosophy) does not necessarily translate well to science. They point out that among the problems of drawing too sharp a line between types of well-being is the fact that eudaimonia is not well-defined and lacks consistent measurement. Moreover, they argue that empirical evidence suggests that hedonic and eudaimonic well-being overlap conceptually, and may represent psychological mechanisms that operate together. Accordingly, Kashdan et al. (2008) argue that there are problems and costs of distinguishing between two types of well-being. This current work has attempted to address this issue by using the GHQ-30 measure and scored it in the manner suggested by Huppert and Whittington (2003).

This research has also highlighted the need for promoting positive well-being as well as trying to attenuate negative well-being. In other words, it is important to find methods that intervene with both increasing positive well-being and reducing negative well-being in older people. Hence, participatory qualitative research to improve overall well-being in older people could be implemented in future studies on older people.

It is now widely recognised that art and music for many older people is crucial in supporting a sense of well-being (Hays, Bright, & Minichiello, 2002; Cohen, 2009). A qualitative study by Hays and Minichiello (2005) revealed how music provides people with different ways of understanding and developing their self-identity, connecting with others, maintaining well-being and experiencing and expressing spirituality. Their study further demonstrated how music contributes to successful ageing by providing ways for older people to maintain positive self-esteem, by feeling competent, independent and avoiding feelings of isolation and loneliness. Dance programs have also been developed to increase positive well-being by providing entertainment and exercise for older people, either individually or through social engagement with groups at community centres (e.g. Keyani, Hsieh, Mutlu, Easterday, & Forlizzi, 2005).

Self-reported altruistic activity has also been examined as a predictor of positive and negative well-being. A study by Dulin and Hill (2003), for example, in a sample of 115 older adults who were actively providing services to others, found that altruistic activity was predictive of positive, but not negative affect. It was further found that altruistic activity was a significant predictor of positive affect after controlling for relevant demographic variables including social support and income.

As mentioned in the previous section, loneliness and social isolation has been found to be detrimental to positive well-being (Dolan, et al., 2008). Accordingly, to increase positive well-being more interventions should focus on how to increase older people's health, social support and quality of life. A recent study by Sandstom and Dunn (2014), for example, showed that a greater number of daily interactions with others, even those who were not close network members, was associated with higher levels of positive well-being. However, whilst the studies above indicate that on a small scale well-being is modifiable, they do not conclusively establish the effects of positive and negative well-being on health status. Here, large scale and expensive longitudinal cohort studies are required.

8.7 Conclusion

Overall this work, which has applied the method of analysing the GHQ-30, as proposed by Huppert and Whittington (2003) has provided evidence supporting the relative independence view on well-being. However, there are some methodological concerns related to measures which include allocation of participants into the well-being quadrants and the fact that half of the items in the negative well-being measure and all the items in the positive well-being measure are identical, but reversed, which automatically will result in a correlation between the two scales. The current work did not find support for the theory that high levels of positive well-being are more important for perceived health than low levels of negative well-being in old age. However, interestingly the current work has demonstrated that both positive well-being

and negative well-being are equally important, as suggested by the psychosocial data, the cortisol results and the cognitive data.

Identification of determinants of positive and negative well-being may not only help shape the definition of successful ageing, but also influence prevention strategies to ensure optimal health and to prevent or delay cognitive impairment in old age (Fiocco & Yaffe, 2010). Over the past two decades there has been a tremendous increase in life expectancy which is projected to increase further, which again gives rise to new medical, economic, and social challenges. To reduce the burden and enhance the benefits associated with an ageing population, research must elucidate factors that decrease age-related disability and increase quality of life in later years. The implication is that health care systems should not only be concerned with illness and disability, but also with supporting methods to improve positive psychological states. The idea of large scale clinical trials to increase well-being and possibly health and longevity are premature as it is unknown whether well-being is sufficiently modifiable by interventions at the psychological, societal or economic level to test effects on health outcomes (Steptoe, Deaton, & Stone, 2015). In fact, based on traditional twin study designs, psychological well-being has been shown to be partly heritable and research is now starting to investigate the specific genetic factors that influence well-being, including studies combining some of the most recent molecular genetic techniques and methods (Pluess, 2015).

Future research, therefore, should acknowledge individual differences, including genetic factors, as well as investigating underlying positive psychological states at older ages in low or middle income countries. Such knowledge will allow the question of well-being and economics and health policy to be addressed.

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Appendices

THE WELL-BEING RESEARCH PROJECT

INFORMATION FOR PARTICIPANTS
Thank you for agreeing to participate in this research study, which has been commissioned by the government-funded WestFocus Health Network.

This **information sheet** explains

- The aims of the Well-Being research project
- What is involved when you take part
- How the research will be used.

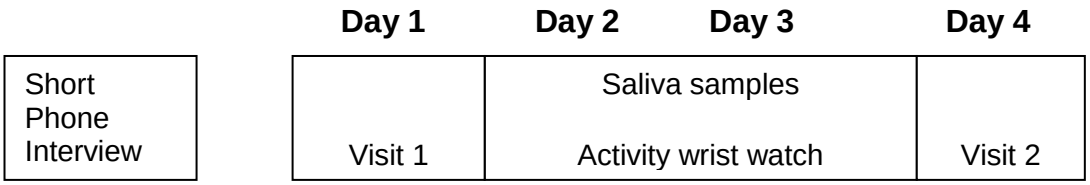
What is WestFocus?
WestFocus is group of seven west London universities funded by the government to work more closely with the local community and businesses. The WestFocus Health Network has been set up by academics from across the represented universities who meet regularly, undertaking listening events and planning projects. One focus of the network is understanding older peoples' well-being and addressing barriers to achieving well-being.

What is the goal of the well-being research project?
We hope to learn more about the meaning and measurement of well-being in older people. The project will provide future researchers with a validated well-being assessment tool that can be used to evaluate initiatives designed to increase well-being. Objective evaluation of community-based initiatives will increase the likelihood of funding for projects designed to increase well-being.

Why have you been selected?
You will be living in the WestFocus area and participate in community activities.

Is the research confidential?
Yes. You will be given an I.D. number which will be used on all questionnaires. All information will be stored without further identification of your name and will not be linked to you as an individual.

What will your participation in this project involve?
Your participation will involve a telephone call and the study will take part over four consecutive days. The participation includes two visits to your house by our researcher at times suitable to you, where each visit will last around an hour and a half. The two day in between the visits you will be asked to complete a questionnaire, collected saliva samples and wear an activity wrist watch.



Day 1 (Visit 1)

- You will be taken through the study information sheet and asked to sign a consent form.
- The researcher will explain to you how and when to collect saliva sample and answer any questions you might have in relation to the saliva samples.
- You will be informed on how to use the activity wrist watch and the researcher will help you with putting it on.
- You will be asked to fill in a questionnaire that will cover aspects of your life such as what well-being means to you, your physical health and supportive relationships. This may take you about 20-25 minutes to complete. You can chose if you want to complete the questionnaire while the researcher is with to answer any questions you might have, or you can fill it out in your own time and the researcher will collect it on visit 2 (day 4).

Day 2 and Day 3 (Saliva collection, wearing activity watch)

Saliva collection:

- Using a convenient and safe saliva collection device we will ask you to collect samples of your saliva on two consecutive days at set times per day. We will ask you to collect eight samples each day (a total of 16 samples over two days).
- The saliva samples are collected by taking a cotton swap out of a tube, putting the cotton swap in your mouth and gently chewing on it for 1-2 minutes before it is placed pack into the tube.
- From the saliva sample we will measure a hormone called cortisol. Levels of the hormone cortisol, at different times over the day, provides a biological measure which is known to relate to how we are feeling and coping with life's experiences.
- This is a well established, convenient and safe method used in research studies of this type.

Activity Wrist Watch:

- We will ask you to wear an activity recording wrist watch during the two saliva collection days. This device enables you to record the time you take your saliva samples. It also records your levels of physical

activity and we are interested in looking at transitions from sleep, to rest, to activity.

Day 4 (visit 2)

- Our researcher will collect the saliva samples and the wrist watch.
- She will also spend 20 minutes asking you set of cognitive tasks and ask for feedback about how you experienced the study.

CONSENT FORM AND AGREEMENT TO PARTICIPATE IN THE WELL-BEING PROJECT

THIS CONSENT FORM TO BE KEPT BY PARTICIPANT

Questionnaires & Interviews

- I understand that all the information provided by me will be kept confidential and will be stored in such a manner that no specific details will be linked to individual persons or families
- I understand that I will complete a range of questionnaires that will cover my health and well-being as well as relationships with friends and family.
- I understand that I will also spend approximately 20 minutes being asked to undertake a set of cognitive tasks.

Biological measures of well-being

- I understand that I will be asked to collect samples of my saliva on two consecutive days at set times per day and that a researcher will carefully explain all the procedures and that I will be given an instruction sheet detailing the timing and procedures for this research.
- I understand I will be asked to wear an activity recording wrist watch for two days and nights. This device will record my physical activity and allow me to record the time of my saliva sampling.
- I understand that I am able to withdraw from this project at any time.

Signed (participant) _____ **date**_____

Signed (researcher) _____ **date**_____

INTRODUCTORY PHONE CALL SCRIPT

Hello - is that Mr or Mrs _____?

I'm just calling about our well-being research project – I wonder if you received the letter I sent a week or so ago that told you a bit about our study?

Is now a good time to talk for 10-15mins, or would you prefer me to call back you back another time?

I'll start by explaining a little more about the project and will then ask a few questions about you, is that ok?

We're asking people to help us in the study by agreeing to two home visits and to take some easily collected saliva samples using cotton wool. We'll also ask you to wear an activity watch for two days.

The home visits will involve full explanation of the saliva collection, an interview about your current wellbeing and a cognitive test. Each visit will last around an hour and a half.

Now I'll just ask a few questions about you.

Could you let us have your date of birth? _____/ _____/ _____

Can you confirm your address please?

How long have you lived in the area? _____

Do you like it there?

One first thing I need to check is what medication you are currently taking?

MEDICATION	**FOR WHAT**
1.	
2.	
3.	
4.	
5.	
6.	
7.	

See list of exclusion medication

What do you think are the main things that affect how you are and how well you feel at the moment?

What would you say are your main social activities or hobbies?

Do you keep up with the news, read newspapers etc? Is there anything that has happened over the last week that has particularly caught your eye?

Do you have any health concerns at the moment?

Do you have any problems with your memory or concentration?

Thanks, do you might be interested in helping us with our research?

I'll look forward to meeting you on the _____ (date visit 1). In the meanwhile, if you have any questions at all, please contact me

DAY BEFORE REMINDER PHONE CALL

Hello - is that Mr or Mrs _____

I'm just calling to check whether _____ is still a good date for you to help us with our well-being research project?

VISIT 1

INTRODUCTORY CHAT

Are you retired, or do you still work?

What work did you do _____

What age did you leave school _____

Did you attend college or university? YES/NO

What were your main jobs? Last main job _____

How long ago did you retire? Years ago _____

Do you have any Brothers and sisters?

_____ Number of brothers or sisters seen regularly

Do you have any children or grandchildren?

_____ Number of children seen regularly

_____ Number of grand children seen regularly

ACTIVITES

When we spoke on the telephone I remember you told me about _____ hobby.

On average, how many times a week do you spend doing this? _____ hours

Do you have any other social commitments/ interests/ activities where you meet up with friends, neighbours or family?

INFORMATION SHEET & CONSENT

INFORMATION SHEET EXPLAINED.

CONSENT EXPLAINED AND OBTAINED

INSTRUCTIONS FOR WATCH & SALIVA COLLECTION

WELL-BEING QUESTIONNAIRE

Thank you very much for your help with our research!

I'll see you on _____ *(day) at* _____ *(time).*

VISIT 2

Collected watch and saliva samples

Any comments and feedback from the interviewee to be written here

COGNITIVE ASSESSMENT

NART

HOPKINS VERBAL LEARNING TASK (HVLT)

FAS VERBAL FLUENCY TASK

SEMANTIC FLUENCY TASK

TRAIL MAKING TASK

DELAYED RECALL & RECOGNITION TESTS

DEBRIEFING ASKED

Thanks again for all your time and help with our research!!!

A shortened version of the script, original 16 pages.

Well-Being Research Project

Questionnaires

PARTICIPANT ID

We would like to know how you have been feeling lately, so we have worked out a few questions which we would like you to answer.

- Please read each question carefully
- Choose the single answer that fits you best and tick the box under it.

For example	never	seldom	some-times	often	all the time
The British weather is beautifully sunny	□	□	√ □	□	□

- It would help if you answer all the questions as best you can even if you are not absolutely certain
- There are no right or wrong answers. It's what you think that matters.

All our research is carried out to a very high standard of confidentiality. You will be given an I.D. number which will be used on all questionnaires. All information will be stored without further identification and your name will not be linked to you as an individual.

Perceived Health, Well-being and Finance Single Items Visual Analogue Scales (VAS)

Cockerham, W. C., Sharp, K. and Wilcox, J. A. (1983) 'Ageing and perceived health status' Journal of Gerontology, 38 (3), 349-55.

*Please rate your current state of **health** by placing a cross on the line which you feel best corresponds to this.*

Poor ——— Perfect

P*lease rate your current state of **well-being** by placing a cross on the line which you feel best corresponds to this.*

Poor ——— Perfect

*Please rate how well off you feel **financially** by placing a cross on the line which you feel best corresponds to this (i.e. do you have enough money to do and have most of the things you would like in your life.)*

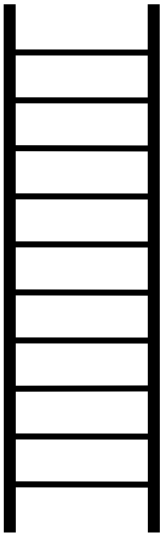
Poor ——— Perfect

Socio-Economic Status Ladder

Kilpatrick, F., and Cantril, H. (1960) 'Self-Anchoring scaling: A measure of individuals' unique reality worlds' Journal of individual Psychology, 16, 158-173.

This is a ladder as representing where people stand in our society. At the top of the ladder are the people who are the best off, those who have the most money, most education, and best jobs. At the bottom are the people who are the worst off, those who have the least money, least education, and worst jobs or no job.

*Please place an **X** on the rung that best represent where you think you stand on the ladder.*



The Life Satisfaction Index

Neugarten, B. L., Havighurst, R. J., Tobin, S. S. (1961) 'The measurement of life satisfaction' Journal of Gerontology, 16, 134-143.

Here are some statements about life in general that people feel differently about. Please read each statement in the list, and if you agree with it, put a check mark in the space under "Agree". If you do not agree with a statement, put a check mark in the space under "Disagree". If you are not sure one way or the other, put a check mark in the space under "?"

Please be sure to answer every question on the list.

	Agree	Disagree	?
As I grow older, things seem better than I thought they would be.	□	□	□
I have gotten more of the breaks in life than most of the people I know.	□	□	□
This is the dreariest time of my life.	□	□	□
I am just as happy as when I was younger.	□	□	□
My life could be happier than it is now.	□	□	□
These are the best years of my life.	□	□	□
Most of the things I do are boring and monotonous.	□	□	□
I expect some interesting and pleasant things to happen to me in the future.	□	□	□
The things I do are as interesting to me as they ever were.	□	□	□
I feel old and somewhat tired.	□	□	□
I feel my age but it does not bother me.	□	□	□
As I look back on my life, I am fairly well satisfied.	□	□	□
I would not change my past life even if I could.	□	□	□
Compared to other people my age, I've made a lot of foolish decisions in life.	□	□	□
Compared to other people my age, I think I look good.	□	□	□
I have made plans for things I'll be doing a month or a year from now.	□	□	□
When I think back over my life, I didn't get most of the important things I wanted.	□	□	□
Compared to other people, I get down in the dumps too often.	□	□	□
I've gotten pretty much what I expected out of life.	□	□	□
In spite of what people say, the lot of the average man is getting worse, not better.	□	□	□

Perceived Wellness Scale

Adams, T., Benzer J. and Steinhardt, M. (1997). The conceptualization and measurement of perceived wellness: Integrating balance across and within dimensions, American Journal of Health Promotion, 11 (3), 208-218.

Please say if you agree or disagree with these statements on a scale of 1 to 6, where 1 is strongly agree and 6 is strongly disagree.

	Strongly Agree					**Strongly Disagree**
	1	**2**	**3**	**4**	**5**	**6**
I am always optimistic about my future.	□	□	□	□	□	□
There have been times when I have felt inferior to most of the people I knew.	□	□	□	□	□	□
Members of my family come to me for support.	□	□	□	□	□	□
My physical health has restricted me, in the past.	□	□	□	□	□	□
I believe that there is a real purpose for my life.	□	□	□	□	□	□
I will always seek out activities that challenge me to think and reason.	□	□	□	□	□	□
I rarely count on good things happening to me.	□	□	□	□	□	□
In general, I feel confident about my abilities.	□	□	□	□	□	□
Sometimes I wonder if my family will really be there for me when I am in need.	□	□	□	□	□	□
My body seems to resist physical illness very well.	□	□	□	□	□	□
Life does not hold much future promise for me.	□	□	□	□	□	□
I avoid activities which require me to concentrate.	□	□	□	□	□	□
I always look on the bright side of things.	□	□	□	□	□	□
I sometimes think I am a worthless individual.	□	□	□	□	□	□
My friends know they can always confide in me and ask me for help.	□	□	□	□	□	□
My physical health is excellent.	□	□	□	□	□	□
Sometimes I don't understand what life is all about.	□	□	□	□	□	□
Generally, I feel pleased with the amount of intellectual stimulation I receive in my daily life.	□	□	□	□	□	□
In the past, I have expected the best.	□	□	□	□	□	□
I am uncertain about my ability to do things well in the future.	□	□	□	□	□	□
My family has been available to support me in the past.	□	□	□	□	□	□
Compared to people I know, my past physical health has been excellent.	□	□	□	□	□	□
I feel a sense of mission about my future.	□	□	□	□	□	□
The amount of information that I process in one day is right for me (i.e. not too much and not too little).	□	□	□	□	□	□
In the past, I hardly ever expected things to go my way.	□	□	□	□	□	□
I will always be secure with who I am.	□	□	□	□	□	□

In the past, I have not always had friends with whom I could share my joys and sorrows.	□	□	□	□	□	□
I expect to always be physically healthy.	□	□	□	□	□	□
In the past, I have felt that my life is meaningless.	□	□	□	□	□	□
In the past, I have generally found intellectual challenges to be vital to my well-being.	□	□	□	□	□	□
Things will not work out the way I want them to in the future.	□	□	□	□	□	□
In the past I have felt sure of myself with strangers.	□	□	□	□	□	□
My friends will be there for me when I need help.	□	□	□	□	□	□
I expect my physical health to get worse.	□	□	□	□	□	□
It seems that my life has always had purpose.	□	□	□	□	□	□
My life has often seemed devoid of positive mental stimulation.	□	□	□	□	□	□

Control Autonomy Self-realization Pleasure Scale (CASP-19)

Hyde, M., Wiggins, R., D., Higgs, P. and Blane, D. B. (2003) A measure of quality of life in early old age: the theory, development and properties of a need satisfaction model

The following are some statements that you may agree or disagree with. Please tick the answer that most closely fits with your feelings and experiences.

	Often	Not often	Rarely	Never
My age prevents me from doing the things I would like to.	□	□	□	□
I feel that what happens to me is out of my control.	□	□	□	□
I feel free to plan for the future.	□	□	□	□
I feel left out of things.	□	□	□	□
I can do the things I want to.	□	□	□	□
Family responsibilities prevent me from doing what I want to.	□	□	□	□
I feel that I can please my self in what I want to do.	□	□	□	□
My health stops me from doing the things I want to do.	□	□	□	□
Shortage of money stops me from doing the things I want to do.	□	□	□	□
I look forward to each day.	□	□	□	□
I feel that my life has meaning.	□	□	□	□
I enjoy the things that I do.	□	□	□	□
I enjoy being in the company of others.	□	□	□	□
On balance, I look back on my life with a sense of happiness.	□	□	□	□
I feel full of energy these days.	□	□	□	□
I choose to do the things that I have never done before.	□	□	□	□
I feel satisfied with the way my life has turned out.	□	□	□	□
I feel that life is full of opportunities.	□	□	□	□
I feel that the future looks good for me.	□	□	□	□

The MOS Social Support Survey

Sherbourne, C. D. and Stewart, Anita, L. (1991) 'The MOS Social Support Survey' Social Science and Medicine, 32 (6), 705-714.

About how many close friends and close relatives do you have (a person you feel at ease with and can talk to about what is on your mind)?

Write in number of close friends ☐ and close relatives ☐

People sometimes look to others for companionship, assistance, or other types of support. How often is each of the following kinds of support available to you if you need it?

	None of the Time	A little of the Time	Some of the Time	Most of the Time	All of the Time
Someone to help you if you were confined to bed	□	□	□	□	□
Someone you can count on to listen to you when you need to talk	□	□	□	□	□
Someone to give you good advice about a crisis	□	□	□	□	□
Someone to take you to the doctors if you need it	□	□	□	□	□
Someone who shows you love and affection	□	□	□	□	□
Someone to have a good time with	□	□	□	□	□
Someone to give you information to help you understand a situation	□	□	□	□	□
Someone to confide in or talk to about yourself or your problems	□	□	□	□	□
Someone who hugs you	□	□	□	□	□
Someone to get together with for relaxation	□	□	□	□	□
Someone to prepare your meals if you were unable to do it yourself	□	□	□	□	□
Someone whose advice you really want	□	□	□	□	□
Someone to help with daily chores if you were sick	□	□	□	□	□
Someone to share your most private worries and fears with	□	□	□	□	□
Someone to turn to for suggestions about how to deal with a personal problem	□	□	□	□	□
Someone to do something enjoyable with	□	□	□	□	□
Someone who understands your problems	□	□	□	□	□
Someone to love and make you feel wanted	□	□	□	□	□

General Health Questionnaire (GHQ-30)

Goldberg D. P. (1972) The detection of psychiatric illness by questionnaire. London: Oxford University Press

We should like to know if you have had any medical complaints, and how your health has been in general, *over the past few weeks*. Please answer ALL the questions on the following pages simply by ticking the answer which you think most nearly applies to you. Remember that we want to know about present and recent complaints, not those that you had in the past. It is important that you try to answer ALL the questions.

Have you recently, been able to concentrate on whatever you're doing?	□	□	□	□
	Better than usual	Same as usual	Less than usual	Much less than usual
Have you recently, lost much sleep over worry?	□	□	□	□
	Not at all	No more than usual	Rather more than usual	Much more than usual
Have you recently, been having restless, disturbed nights?	□	□	□	□
	Not at all	No more than usual	Rather more than usual	Much more than usual
Have you recently, been managing to keep yourself busy and occupied?	□	□	□	□
	More so than usual	Same as usual	Rather less than usual	Much less than usual
Have you recently, been getting out of the house as much as usual?	□	□	□	□
	More than usual	Same as usual	Less than usual	Much less than usual
Have you recently, been managing as well as most people would in your shoes?	□	□	□	□
	Better than most	About the same	Rather less well	Much less well
Have you recently, felt on the whole you were doing things well?	□	□	□	□
	Better than usual	About the same	Less well than usual	Much less well
Have you recently, been satisfied with the way you've carried out your task?	□	□	□	□
	More satisfied	About same as usual	Less satisfied than usual	Much less satisfied
Have you recently, been able to feel warmth and affection for those near you?	□	□	□	□
	Better than usual	About same as usual	Less well than usual	Much less well

Have you recently, been finding it easy to get on with other people?	□	□	□	□
	Better than usual	About same as usual	Less well than usual	Much less well
Have you recently, spent much time chatting with people?	□	□	□	□
	More time than usual	About same as usual	Less than usual	Much less than usual
Have you recently, felt that you are playing a useful part in things?	□	□	□	□
	More so than usual	Same as usual	Less useful than usual	Much less useful
Have you recently, felt capable of making decisions about things?	□	□	□	□
	More so than usual	Same as usual	Less so than usual	Much less capable
Have you recently, felt constantly under strain?	□	□	□	□
	Not at all	No more than usual	Rather more than usual	Much more than usual
Have you recently, felt you couldn't overcome your difficulties?	□	□	□	□
	Not at all	No more than usual	Rather more than usual	Much more than usual
Have you recently, been finding life a struggle all the time?	□	□	□	□
	Not at all	No more than usual	Rather more than usual	Much more than usual
Have you recently, been able to enjoy your normal day-to-day activities?	□	□	□	□
	More so than usual	Same as usual	Less so than usual	Much less than usual
Have you recently, been taking things hard?	□	□	□	□
	Not at all	No more than usual	Rather more than usual	Much more than usual
Have you recently, been getting scared or panicky for no good reason?	□	□	□	□
	Not at all	No more than usual	Rather more than usual	Much more than usual
Have you recently, been able to face up to your problems?	□	□	□	□
	More so than usual	Same as usual	Less able than usual	Much less able

Have you recently, found everything getting on top of you?	□	□	□	□
	Not at all	No more than usual	Rather more than usual	Much more than usual
Have you recently, been feeling unhappy and depressed?	□	□	□	□
	Not at all	No more than usual	Rather more than usual	Much more than usual
Have you recently, been losing confidence in yourself?	□	□	□	□
	Not at all	No more than usual	Rather more than usual	Much more than usual
Have you recently, been thinking of yourself as a worthless person?	□	□	□	□
	Not at all	No more than usual	Rather more than usual	Much more than usual
Have you recently, felt that life is entirely hopeless?	□	□	□	□
	Not at all	No more than usual	Rather more than usual	Much more than usual
Have you recently, been feeling hopeful about your own future?	□	□	□	□
	More so than usual	About same as usual	Less so than usual	Much less hopeful
Have you recently, been feeling reasonable happy, all things considered?	□	□	□	□
	More so than usual	About same as usual	Less so than usual	Much less than usual
Have you recently, been feeling nervous and strung-up all the time?	□	□	□	□
	Not at all	No more than usual	Rather more than usual	Much more than usual
Have you recently, felt that life isn't worth living?	□	□	□	□
	Not at all	No more than usual	Rather more than usual	Much more than usual
Have you recently, found at times you couldn't do anything because your nerves were too bad?	□	□	□	□
	Not at all	No more than usual	Rather more than usual	Much more than usual

The Short-Form- 36 (SF-36)

Ware, J. E., Sherbourne CD. The MOS 36-item Short-Form Health Survey (SF-36) I. Conceptual framework and item selection. Medical Care 1992, 30, 473-483

Answer every question by marking the answer as indicated. If you are unsure about how to answer a question, please give the best answer you can.

1. In general, would you say your health is:

□ Excellent □ Very Good □ Good □ Fair □ Poor

2. *Compared to one year ago*, how would you rate your health in general now?

□	□	□	□	□
Much better now than one year ago	Somewhat better now than one year ago	About the same now as one year ago	Somewhat worse now than one year ago	Much worse now than one year ago

3. The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

Activities	Yes, Limited A Lot	Yes, Limited A Little	No,Not Limited At All
a. **Vigorous activities,** such as running, lifting heavy objects, participating in strenuous sports	□	□	□
b. **Moderate activities,** such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	□	□	□
c. Lifting or carrying groceries	□	□	□
d. Climbing **several** flights of stairs	□	□	□
e. Climbing **one** flight of stairs	□	□	□
f. Bending, kneeling, or stooping	□	□	□
g. Walking **more than a mile**	□	□	□
h. Walking **several blocks**	□	□	□
i. Walking **one block**	□	□	□
j. Bathing or dressing yourself	□	□	□

4. During the past *4 weeks*, have you had any of the following problems with your work or other regular daily activities as *a result of your physical health*?

	Yes	No
a. Cut down on the **amount of time** you spent on work or other activities	□	□
b. **Accomplished less** than you would like	□	□
c. Were limited in the **kind** of work or other activities	□	□
d. Had **difficulty** performing the work or other activities (for example, it took extra effort)	□	□

5. During the past *4 weeks*, have you had any of the following problems with your work or other regular activities as *a result of any emotional problems* (such as feeling depressed or anxious)?

		Yes	No
a.	Cut down on the **amount of time** you spent on work or other activities	□	□
b.	**Accomplished less** than you would like	□	□
c.	Did not do work or other activities as **carefully** as usual	□	□

6. During the *past 4 weeks,* to what extent has your physical or emotional problems interfered with your normal social activities with family, friends, neighbours, or groups?

□ Not at all □ Slightly □ Moderately □ Quite a bit □ Extremely

7. How much *bodily* pain have you had during the past *4 weeks*?

□ None □ Very mild □ Mild □ Moderate □ Severe □ Very Severe

8. During the past *4 weeks*, how much did *pain* interfere with your normal work (including both work outside the home and housework)?

□ Not at all □ A little bit □ Moderately □ Quite a bit □ Extremely

9. These questions are about how you feel and how things have been with you *during the past 4 weeks*. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks –

		All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
a.	Did you feel full of pep?	□	□	□	□	□	□
b.	Have you been a very nervous person?	□	□	□	□	□	□
c.	Have you felt so down in the dumps that nothing could cheer you up?	□	□	□	□	□	□
d.	Have you felt calm and peaceful?	□	□	□	□	□	□
e.	Did you have a lot of energy?	□	□	□	□	□	□
f.	Have you felt downhearted and blue?	□	□	□	□	□	□
g.	Did you feel worn out?	□	□	□	□	□	□
h.	Have you been a happy person?	□	□	□	□	□	□
i.	Did you feel tired?	□	□	□	□	□	□

10. During the past *4 weeks*, how much of the time has your *physical health or emotional problems* interfered with your social activities (like visiting with friends, relatives etc.)

□	□	□	□	□
All of the time	Most of the time	Some of the time	A little of the time	None of the time

11. How TRUE or FALSE is *each* of the following statements for you?

		Definitely True	Mostly True	Don't Know	Mostly False	Definitely False
a.	I seem to get sick easier than other people	□	□	□	□	□
b.	I am as healthy as anybody I know	□	□	□	□	□
c.	I expect my health to get worse	□	□	□	□	□
d.	My health is excellent	□	□	□	□	□

Cognitive Battery

Part A: Free Recall

	Trial 1	**Trial 2**	**Trial 3**	**Delayed**
LION				
EMERALD				
HORSE				
TENT				
SAPPHIRE				
HOTEL				
CAVE				
OPAL				
TIGER				
PEARL				
COW				
HUT				
Total/Correct				

Part B: Recognition

HORSE	ruby	CAVE	balloon	coffee	LION
House	OPAL	TIGER	boat	scarf	PEARL
HUT	EMERALD	SAPPHIRE	dog	apartment	penny
TENT	mountain	cat	HOTEL	COW	diamond

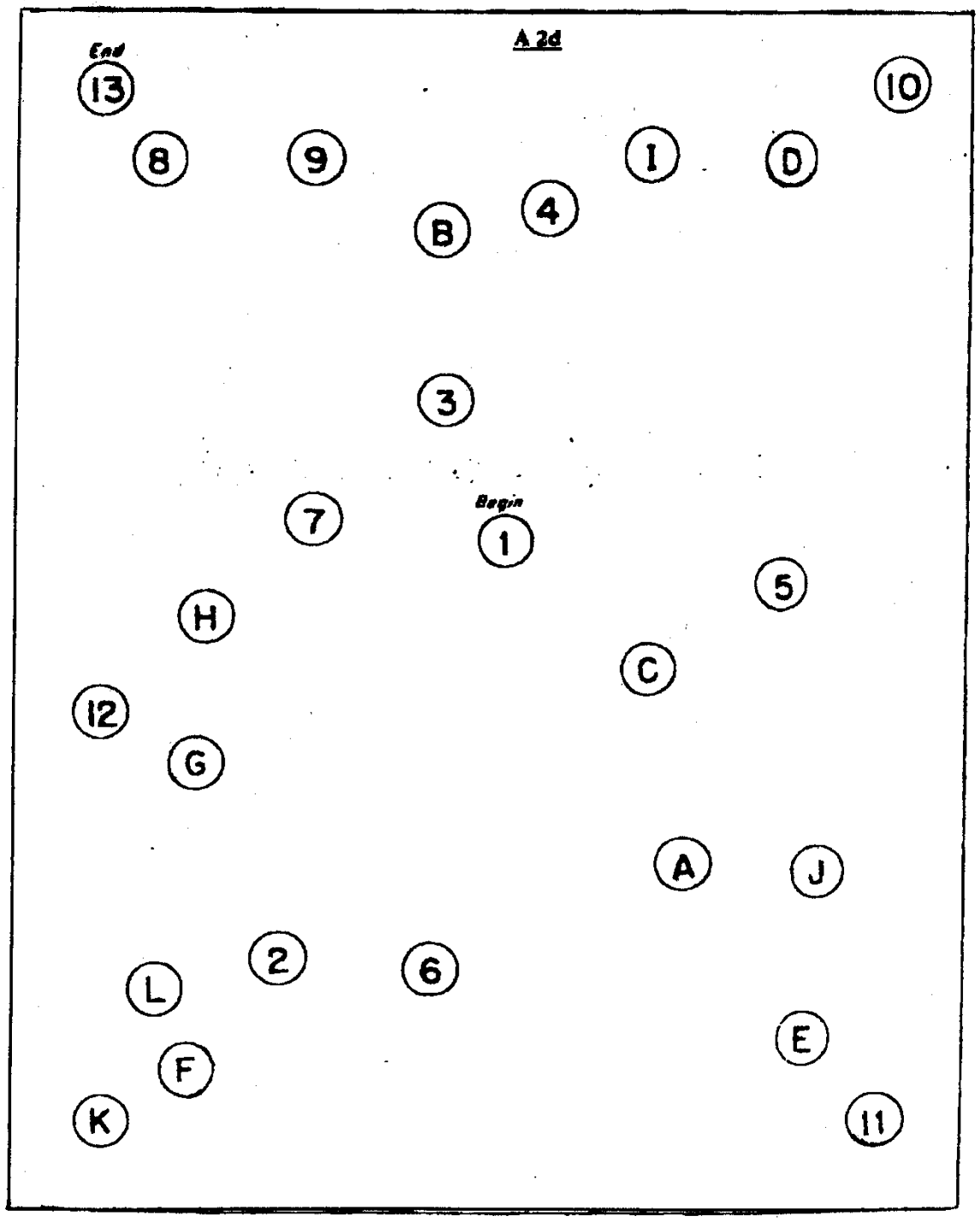
True Positives____/12

False Positive errors **Related___/6** **Unrealted___/6**

Discrimination Index (True Positive) – (False-Positive) =___

Word count 1 minute Number of animals_____

Letter F____ Letter A____ Letter S____



2-4. Trail Making Test -- Part B.

WHAT NOT TO DO DURING SALIVA COLLECTION

*Please **Do not** **eat, drink** (except water), **smoke or brush your teeth during collection** of the four awakening samples (tube 1, 2, 3 and 4), but apart from this, carry on with your normal routine (you can get up or stay in bed).*

***Do not** eat, drink (except water), **smoke or brush your teeth for half an hour** before collecting of the day samples (tube 5, 6, 7 and 8)*

P50

RECORDING TABLE

DAY 1

DAY 1

	Time to take samples	Time sample is taken
Tube 1 (immediately after awakening)	_____	_____
Tube 2 (15min after awakening)	_____	_____
Tube 3 (30min after awakening)	_____	_____
Tube 4 (45min after awakening)	_____	_____
Tube 5 (3 hrs after awakening)	_____	_____
Tube 6 (6 hrs after awakening)	_____	_____
Tube 7 (9 hrs after awakening)	_____	_____
Tube 8 (12 hrs after awakening)	_____	_____

THE WELL-BEING RESEARCH PROJECT

DETAILED INSTRUCTION SHEET FOR PARTICIPANTS

CONTENT

1. SUMMARY OF EACH VISIT

Visit 1
This takes around an **hour and a half** and our West Focus researcher will:

- Explain the study and take you through the consent form.
- Explain the procedure for collecting the saliva samples including an explanation on the use of an activity wrist watch.
- Leave a well-being questionnaire for you to fill out.
- Answer any questions you may have on the study.

In between visits you will be asked to

- Collect samples of saliva and wear the activity wrist watch during the day and at night.
- Complete the well-being questionnaire.

  Please make sure you do this before our WestFocus Researcher comes for visit 2. If there is anything you are unsure about she will be happy to go through this with you on visit 1 or over the phone.

Visit 2
This will also take around an **hour and a half.** At this visit our West Focus researcher will:-

- Collect your tubes of saliva samples and the activity wrist watch.
- Get feedback from you
- She will also spend another twenty minute doing a set of cognitive task with you.

Appendix 6: Detailed instructions to participants

2. DAYS TO COLLECT SALIVA SAMPLES

- Collect samples on 2 consecutive, normal weekdays.
- The time you wake up (& collect the first sample) should be approximately the same on each day.

3. WHEN TO TAKE YOUR FIRST SAMPLE

Please take your first sample on:_____

Day & Date

4. TIMES TO TAKE THE SAMPLES

Please make sure you have the wrist watch on before you go to bed prior to the first collection on day 1. Please place the saliva sample collection tubes next to your bed when you go to bed so that they are available as soon as you wake up the following day. Then collect saliva samples at the following times:

8 Samples in total

- *Immediately upon awaking (tube 1)*
- *15 minutes after awaking (tube 2)*
- *30 minutes after awaking (tube 3)*
- *45 minutes after awaking (tube 4)*

4 samples at 15 min intervals in the first 45 min after waking up

- *3 hours after awaking (tube 5)*
- *6 hours after awaking (tube 6)*
- *9 hours after awaking (tube 7)*
- *12 hours after awaking (tube 8)*

4 more samples at 3 hour intervals

5. HOW TO COLLECT YOUR SALIVA SAMPLES

- Take the cap off the correct labelled tube and remove the cotton swab from the top part of the tube.
- Place the swab in your mouth and chew gently for 1-2 minutes until it is wet.
- Return the swab to the top part of the tube and seal tightly with the cap.
- Push the button on your activity wrist watch – these records the exact time that you collected your sample.

- Record when you collected the sample on the recording table with a pen.
- Put the tube back in the correctly labelled bag (day 1 or day 2) when you have finished.
- At the end of the study place the bags with all the 16 tubes in your fridge or freezer.

6. USE OF THE ACTIVITY WRIST WATCH

- Our West Focus researcher will supply you with an activity wrist watch.
- The wrist watch is very simple to use. All you need to do is **place the device on your wrist and leave it there day and night for the 2 days** that you are collecting the saliva samples.
- You only need to take it off when you are having a bath or shower or if you go swimming, as it is not water-tight. When you have completed your bath/shower/ swimming please return the watch to your wrist.
- The watch will automatically record your activity data but please remember to push the central button to record the time that you take each saliva sample

7. RULES TO FOLLOW THAT WILL HELP OUR RESEARCH

- **WATCH ON**

  Please **Do** put the activity wrist watch on before you go to bed.

- **TUBES BESIDE BED**

  *Please **Do** place the tubes beside your bed the night before you go to sleep.*

- **FIRST SAMPLE AS SOON AS YOU WAKE UP**

  ***Do** take the first sample as soon as you are conscious of being awake*.

- **PUSH BUTTON ON WATCH WHEN TAKE EACH SAMPLE**

  ***Do** remember to push the button on the front of the Vivatec wrist watch to record the time of your saliva sampling.*

- **WRITE THE TIME YOU TAKE EACH SALIVA SAMPLE ON THE RECORD SHEET**

  You should also record the time of each saliva sampling on the record sheet we will provide for you.

- **KEEP SALIVA COLLECTION TUBES WITH YOU ALL DAY**

Do *remember to keep saliva collection tubes with you during the day so that you can make each collection at the correct time, even if you are away from home.*

WHAT NOT TO DO DURING SALIVA COLLECTION

Please ***Do not*** ***eat, drink*** *(except water),* ***smoke or brush your teeth during collection*** *of the four awakening samples (tube 1, 2, 3 and 4), but apart from this, carry on with your normal routine (you can get up or stay in bed).*

- ***Do not*** *eat, drink (except water),* ***smoke or brush your teeth for half an hour*** *before collecting of the evening samples (tube 5, 6, 7 and 8)*

8. ANY QUERIES

Cathrine Fredhoi can be contacted
- in her office on **0207 911 5000** extension. **2003**
- or on her mobile on 078 9600 4465

You can also contact Professor Angela Clow, who is coordinating the project, at any time. Her number is 0207 911 5000 extension 2174.

Many thanks for your time and help with this research study!!

24th August 2006

Well-being in Older People

http://www.ageing-well.org.uk

Feedback Event 14th September

We hope you have received your invitation to our event at the Granfers Community Centre on the morning of 14th September. We very much hope you will be able to come along. This will be our chance to thank you for participating in the project and to share our main findings with you. This will also give you an opportunity to meet other participants, share your experiences and help us identify the next steps in taking forward this interesting project.

If you want to join us please contact Ursula Hawgood on phone 020 8725 3924 or email uhawgood@hscs.sgul.ac.uk

Conference in Portugal

We attended a very successful conference in Braga, Portugal in July. This conference gave us a chance to share our results with an international audience of researchers. You can find a brief summary of what we presented on the next page and find out more on 14th September.

One more Questionnaire!!!

We would be very grateful if you could spend ten minutes of your time to complete the questionnaire included with this newsletter. This questionnaire concerns how you feel about relationships. Please bring the completed questionnaire with you on the 14th September or return it to us in the stamped envelope. Thank you very much!

WestFocus

Realising Potential Through Collaboration

Appendix 8: Ethical Approval letter

OFFICE USE: ___ / ___/ _____

University of Westminster

University Ethics Committee

Application for Approval of a Proposed Investigation, Demonstration, Research or Experiment

Section 1 – to be completed by all applicants

1.1 Project Title

Engaging with Community Partners: Follow up study exploring wellbeing and attitudes to medical decision making among older people.

1.2 Applicant Details

Name:	**Email:**
Angela CLOW	clowa@wmin.ac.uk
Address: Dept Psychology University of Westminster 309 Regent Street London W1B 2UW	**Telephone Number:** 0207 911 5000 ext 2174

Please tick relevant box:

☐ **Undergraduate** ☐ **Postgraduate** ☐ **PhD Student** ☑ **Staff**

Section 2 – to be completed when applicable

Please note that all applicants with a supervisor(s) must ensure that the supervisor signs the declaration. All staff must obtain the signature of their Dean of School, or School Research Director, as appropriate.

2.1 Supervisor Details

Name:	**Email:**
School/Department:	**Telephone Number:**

Declaration:

In accordance with the University's Code of Practice Governing the Ethical Conduct of Investigation, Demonstrations, Research and Experiments, I agree that the applicant named in 1.2 above should submit their proposal to the Ethics Committee for consideration.

Signed:
Date:

Section 3

3.1 Does your work relate to any of the following areas? Please tick box

☑ Human Participants in Health and Community settings
☐ Work with prescription drugs
☐ Work involving foetal tissue
☐ Drug Studies on human participants
☐ Pre-marketing drug trials

3.2 Are you proposing work using participants from any of the following categories? Please tick box:

☐ Prisoners sectioned under the Mental Health Act
☐ Prisoners or arrestees
☐ Persons with severe mental illness
☐ Persons with learning difficulties or brain damage

☐ Persons with a reduced level of consciousness

3.3 Any work where a qualified clinical person is required to:
☐ Be responsible for all work carried out
☑ Be in attendance when certain procedures are carried out
☐ Ensure that facilities for emergency medical care are at hand

If you have ticked one or more boxes in Section 3, please contact your supervisor and discuss sending your proposal for external approval. More information can be found at: www.wmin.ac.uk/page-3380

In addition, please complete this form up to Section 3, sign the declaration in Section 11 and send it to:
Huzma Kelly
Senior Research Officer (Policy and Governance)
Academic Registrar's Department
University of Westminster
115 New Cavendish Street
London W1W 6UW

If you have not ticked any boxes in Section 3, please continue to Section 4

Section 4

4.1 Is your work related to any of the following areas? Please tick relevant box:
☐ Any work involving patients
☑ Non-clinical work involving bodily fluids
☐ Administering of a non-food substance
☐ Work with children
☐ Deception of participants
☐ Data not already in the public domain that bears on the issues of criminality
☐ Work which requires participants to reveal medical history

If you have ticked one or more boxes in Section 4, your proposal will need approval from the University Ethics Committee – please continue to fill out the rest of this form giving as much detail as possible.

If you have not ticked any boxes in Section 3 or Section 4, your work does not require approval by the University Ethics Committee. Please refer to the University of Westminster 'Code of Practice Governing the Ethical Conduct of Investigations, Demonstrations, Research and Experiments' and consult with your supervisor.

Section 5

5.1 Please provide a brief description of your proposed work below:

Activity as part of the WestFocus Health Network has facilitated development of a community of 'project partners' living in south London. In 2006 an intensive cross-sectional study of this group (n=50, average age 74 years) involved 2 visits to each participants' home. Information was gathered about their views on wellbeing and on factors that predict well-being and active aging. The proposed work is a follow up study enabling extension of the original findings by adding a 'longitudinal' examination of within-subject change.

There will be a single day event to which all previous participants will be invited. The event will include: a focus group to explore attitudes to and experience of medical decision making in the current NHS, the opportunity to learn at least two complementary self management techniques to help relaxation and well-being, a questionnaire following up current status of wellbeing and the collection of a small blood sample.

In addition we would like to re-examine the awakening cortisol response as a follow up study, which will give us a unique opportunity to investigate change in cortisol over time. This is a simplified repetition of the original study with this particular group for which ethical approval has already been given

Following the event, the questionnaire data will be analysed to show any within-subject change over time and results compared with data from the original study of wellbeing and cortisol secretory activity. Telomere length and telomerase activity are markers of cellular aging, data on these will be collected from the blood samples and results compared with questionnaire data and cortisol data from both this and the previous study..

This is a rare opportunity to undertake such an investigation in a population in this age group and will give rise to a peer-reviewed publication and conference presentation.

5.2 What are the specific aims of the work you plan to carry out?
This is a follow up study (initial data was collected in 2006) the project aims to explore participants changing attitudes to, and experience of, participating in medical decision making (i.e. doctor/ patient interaction) and its influence on self-efficacy and sense of well-being. Participants current status on some of the original variables (psychological, cognitive and biological) measured will be established in order to measure any physical and/or mental deterioration over time. This will be achieved through a wellbeing questionnaire and the collection of a blood sample to look at two additional biological markers (telomere length and telomerase activity in white blood cells).

5.3 Please outline the design and methodology of your work
The project focuses around a single-day event (planned for 10th November 2008) to which all participants will be invited. The event will include: a focus group to explore attitudes to and experience of medical decision making in the current NHS. Participants will complete a questionnaire following up their current status of wellbeing compared with results derived from the initial (2006) study. A small blood sample will be collected and later analysed for telomere length and telomerase activity. Participants will also be requested to give four saliva samples over two consecutive days to monitor any change in cortisol secretion activity.

5.4
Start Date: 10th November 2008
Estimated duration of work: One day for blood sample collection and questionnaire filling. Twelve weeks to allow for sample and data analysis.

5.5 If your work is a multi-centred study, please provide details of any other organisations involved

Contact Name Denise FORTE	**Contact Name**
Address Faculty of Health and Social Care Sciences St George's Hospital Medical School Cranmer Terrace London SW17 0RE	**Address**
Telephone Number 020 8547 8728	**Telephone Number**

Please provide a copy of any agreement between the organisations **None**

Section 6

6.1 Describe any potential physical/emotional discomforts to participants in the investigation: Possible slight bruising from vena puncture during blood collection

6.2 Aside from 6.1 above, describe potential hazards which may be suffered by the participants? Please give details of any measures taken e.g. COSH, Risk Assessment etc. Trained phlebotomists, who are members of St. George's Hospital staff, will collect the blood samples. Detailed COSHH forms will be completed before laboratory analysis of the blood takes place.

6.3 Outline the degree to which these risks are balanced against potential benefits

Compared to the potential benefits of these research results the procedural risks are minimal.

6.4 What criteria will be employed for deciding the end point at which:

a) **the investigation will stop because of unjustifiable further risk?** Vena puncture will only be attempted once with any one participant, should the initial sample collection fail no further attempt will be made.
a) **one method is declared the preferred option and the investigation terminates?** This is not a relevant concern in this instance. The project only consists of very low risk questionnaires and low risk blood sample collection for one-off analysis, therefore method comparison is not an issue

6.5 What monitoring mechanisms will be in place to decide when participants should be withdrawn from the research?
As for point 6.4a, above vena puncture will only be attempted once with any one participant, should the initial sample collection fail no further attempt will be made. Staff involved in the project will be vigilant in looking for any signs of participant discomfort or confusion, ensuring that consent is fully informed. Participants will be made aware that they may withdraw at any time.

6.6 What procedures and subsequent observations are to be made on participants for the purpose of detecting any complication arising from the investigation?
There will be no medical follow up check once blood collection has taken place. At the time of sampling participants will be made fully aware of any side effects that may occur as a result of vena puncture (bruising) and will be given contact details for members of staff should they have any concerns following the study.

6.7 Do participants have any previous or existing professional relationship with the investigator? Yes.
If yes, please explain the circumstances:
This is a 'follow up' study. Information about views on aging and well being has previously been collected (2006) from this community of project partners (n=50; average age 74yrs).

Section 7 – Consent of Applicants

7.1 What type of consent will you seek?
☑ Written (including email)
☐ Verbal only
☐ Not applicable (please give justification below as to why consent is not applicable)

7.2 How and where will you make contact with the participant(s) in order to obtain consent?
Participants will be sent written invitations to attend, full details of the project will be sent with the invitation to give participants time to think of any questions. Attending participants will be asked to read and sign consent forms (see attached), after being given the opportunity to ask questions.

7.3 Is there a subject information sheet?
☑ Yes (Please enclose a copy with this application). Appendix 1 for information sheet and appendix 2 for consent form.
☐ No

7.4 Is parental consent required?
☐ Yes
☑ No

Section 8 – Confidentiality of Information

8.1 Will the sharing of information be communicated to others working on the project?
☐ Yes (Please attach a copy of the Participant Confidentiality Code of Practice which will be used)
☑ No
Only one member of staff will have data linking participant names to data generated

8.2 Will the work include:
☐ Named participants

☑ Participants whose names have been separately coded
☐ Unnamed participants

8.3 Where will locked files of investigation material be stored?
Room 4.01
Dept Psychology
University of Westminster
309 Regent Street
London W1B 2UW

8.4 If the investigation involves storage of computerised data which might enable the participant it be identified, please name the investigator in charge of Computer System Security for the investigation?
Cathrine FREDHOI

8.5 Does the investigation and any planned publication include the use of photographs or videos either of individuals or tissues?
Tissues Yes ☐ No ☑
Individuals Yes ☐ No ☑
If yes to either of these, please provide a copy of the consent form which participants will be asked to sign for this purpose.

Section 9 – Finance

9.1 Will expenses be paid to participants?
☐ Yes (If yes, how much?)
☑ No

9.2 Will a reward over and above expenses be made to participants?
☑ Yes (If yes, please give more details)
A gift voucher will be given to each participant (£25)
☐ No

9.3 Is this study initiated/sponsored by a pharmaceutical or other industrial company?
☐ Yes (If yes, what is the name of the company?)
☑ No

9.4 Detail any financial or other direct interest to you or to your department arising from this study.
None

9.5 Will this project increase work/cost to any other Department or School?
☐ Yes (If yes, obtain and include the name and signature of the relevant Dean(s) of School(s) concerned:

Name	**Signature**

☑ No

Section 10 – Insurance

10.1 Are manufacturers providing insurance cover?
☐ Yes (If yes, please enclose a letter confirming insurance cover, including the names of all covered)
☑ No

10.2 Are all of the investigators employees or students of the University of Westminster?
☐ Yes
☑ No
If no, please provide evidence of insurance cover, including:

- list of all people involved in the investigation
- details of the form this cover will take

10.3 Does the investigation involve the use of equipment or medicines?

☑ Yes ☐ No If yes, please give details of *manufacturer's indemnity*:
10.4 Does the investigation involve the use of equipment or medicines which are manufactured on site but are not covered by insurance? ☐ Yes ☑ No If yes, appropriate insurance cover must be arranged and written confirmation of such cover must be attached
Section 11 – Declaration – this Section must be completed by all applicants
Please Read and Sign **The information I have given on this form is true and to the best of my knowledge correct:** **Signed:** **Date:** **Send the completed form to:** Carl Hornsey Assistant Registrar (Student Information) Academic Registrar's Department University of Westminster 115 New Cavendish Street London W1W 6UW

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Cortisol secretory activity in older people in relation to positive and negative well-being

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KEYWORDS
Human;
Cortisol;
Saliva;
Awakening cortisol response;
Positive and negative well-being;
Stress

Summary
Secretion of the hormone cortisol, a physiological correlate of affect, has been studied mostly in relation to negative states, especially stress. By contrast, policy initiatives aimed at older populations now routinely emphasise well-being and a 'positive ageing' perspective.

In this study, we examined diurnal salivary cortisol profiles from 50 active seniors recruited into a wider community research project (mean age 74 years; 34 F/16 M). Participants' wrist activity was continuously monitored by actimeters in their homes over a 48 h period. During this time two diurnal cycles of cortisol data were collected (8 samples per day); with actimeter data providing a compliance check in regard to timing of self-administered saliva collections. Prior to the trial, participants had completed the GHQ-30 which was scored separately to yield both positive and negative well-being scores which matched closely normative data from over 6000 cases in a large survey.

Our data suggest that positive and negative psychological well-being are quite strongly and inversely correlated. However, neither on their own was associated with basal levels of cortisol. Rather, for cortisol secretion in the 45-min period following awakening, but not during the rest of the day, we found a significant interaction between positive and negative well-being ($p < 0.024$). Further analysis of this interaction showed that among participants low on negative well-being, higher positive well-being was significantly associated with lower cortisol; equally, among participants high on positive well-being, lower negative well-being was significantly associated with lower cortisol. Thus, a powerful synergy seemed to be operating in this early morning period such that cortisol secretion was 27% lower in participants with both higher-than-average positive well-being and lower-than-average negative well-being (comprising 34% of the sample). We conclude that cortisol

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doi:10.1016/j.psyneuen.2007.06.017

secretion in the first 45 min following awakening is distinct from the rest of the day and most able to discriminate well-being states.

1. Introduction

It is well established that both laboratory-induced and naturalistic daily stressors activate the hypothalamic–pituitary–adrenal axis (HPA-axis) as evidenced by increased cortisol levels (e.g., Kirschbaum et al., 1993; Ockenfels et al., 1995; Smyth et al., 1998; Hanson et al., 2000; Peeters et al., 2003). However it is clear that individual differences known to contribute to general well-being (such as in self-esteem and affect) can modulate stress-induced elevations in cortisol (Smyth et al., 1998; Pruessner et al., 1999; Polk et al., 2005; Jacobs et al., 2007). The importance of subjective measures of well-being in relation to health outcomes is increasingly being recognised. However, to date relatively little has been published linking measures of well-being and cortisol status. Human well-being is a complex phenomenon and currently there is no single agreed formula for its measurement. In the past, measures of psychological well-being tended to focus upon the presence or absence of negative symptoms such as anxiety or low self-esteem. Recently, more recognition is being given to the importance of positive well-being including components such as autonomy, environmental mastery, personal growth, positive relations, purpose in life and self-acceptance (Ryff, 1989; Ryff and Singer, 1996). Interestingly, psychometric exploration of positive and negative well-being has tended to indicate that they can function somewhat independently and that positive well-being is not simply the absence of negative feelings and experience, or vice versa (Diener and Emmons, 1984; Watson et al., 1988; Huppert and Whittington, 2003).

An important psychometric approach to the measurement of well-being is seen in the work of Huppert and Whittington (2003) where they construct separate positive and negative well-being scales from the 30-item General Health Questionnaire (GHQ-30) (Goldberg, 1972). A particular benefit of using the GHQ-30 for measures of positive and negative well-being in this way derives from its extremely widespread and global use as self-report instrument in medical research. Using this approach it has been shown that although positive and negative well-being are quite strongly and significantly negatively correlated, there is also evidence of some degree of independence. Approximately, 40% of variance is shared, but just over a third of over 6000 participants in a large survey were either above average on both positive and negative well-being or below average on both. The importance of recognising this partial independence of scales is forcefully underlined by a previous report (Whittington and Huppert, 1998) that absence of positive well-being is more predictive of 7-year follow-up mortality than presence of negative well-being.

There are relatively few studies which have examined the importance of positive in addition to negative well-being in relation to cortisol secretion. Seeman and McEwen (1996) reported that HPA axis reactivity was lower in participants with more supportive social relationships. Moreover, among women with breast cancer, mean daytime salivary cortisol levels were significantly lower in those whose perceived quality of social support was higher (Turner-Cobb et al., 2000). More recently, trait optimism in a sample of students was shown to be inversely related to salivary cortisol levels, particularly in a 40-min period immediately after awakening. By contrast, trait pessimism was not related to cortisol levels (Lai et al., 2005). Similarly significant associations between aspects of eudaimonic positive well-being (e.g., personal growth and purpose in life) and lower cortisol secretion have been reported, with the effect being most marked for morning cortisol levels and in those over 75 years of age. In the same study, negative well-being (e.g., anxiety, anger) was not associated with cortisol secretion across the day (Ryff et al., 2006). These results also support the partial 'independence view' of positive and negative well-being, at least in relation to associations with cortisol secretion. Consistent with these findings, state happiness, assessed from aggregated momentary experience samples of happiness over the working day, was inversely related to total cortisol secretion over the day (from 08:00 to 22:00 h) an effect independent of psychological distress (Steptoe et al., 2005). A follow-up study from the same group using a similar method of momentary assessment of state happiness found a comparable inverse association between cortisol and happiness (again, independent of psychological distress) but this time the effects were limited to the first 60 min after awakening—the awakening cortisol response (ACR) (Steptoe et al., 2007). The authors claimed that these results supported the notion that positive well-being was directly related to health-related biological processes.

The ACR is a discrete aspect of the cortisol circadian cycle. In healthy adults salivary free cortisol concentrations increase by 50–160% in the first 30 min immediately after awakening (see Clow et al., 2004 for a review). Although the physiological role of the ACR has not been clearly defined, evidence suggests that it is under a distinct regulatory influence, different from the rest of the diurnal cortisol secretory cycle and sensitive to a range of psychosocial variables (Clow et al., 2004). Indeed, this is illustrated by the findings of Steptoe et al. (2007) cited above, where state happiness was found to be associated with reduced cortisol secretion in the first 60 min post-awakening but not over the rest of the diurnal cycle. Other studies (Steptoe and Wardle, 2005; Ryff et al., 2006) have not examined cortisol immediately after awakening (the ACR) but more generally point to morning, rather than evening, cortisol secretion as most sensitive to individual differences in well-being. Examination of the relationship between well-being and cortisol secretion therefore necessitates careful examination of time-of-day effects and warrants separate analysis of both aspects of the

diurnal cycle: the ACR and the diurnal decline over the rest of the day.

Because positive and negative well-being, while clearly related to each other, do not always relate to other variables in the same way, we believe that more detailed examination of interactive as well as main effects of the positive and negative dimensions of well-being are warranted. In the light of the role of cortisol in a range of health related outcomes and policy initiatives aimed at the promotion of 'positive ageing', we chose to explore these questions in a sample of community dwelling older people. This study population was also warranted as it has been shown that well-being and cortisol secretion were most clearly associated in those over 75 years of age (Ryff et al., 2006). This may partly reflect greater potential variation in cortisol measures as a result of the aging process. There is evidence that the HPA-axis may become more dysfunctional as people age, with generally higher levels of cortisol frequently being observed and changes in normal circadian rhythms (Sapolsky, 1999). However, such changes vary considerably amongst older adults, especially in circadian patterning (see, for example, Ice et al., 2004) which argues the importance of examining for psychosocial correlates of such variation. Thus, in this study we set out to explore possible relationships between diurnal cortisol secretion (the ACR and the diurnal decline) and aspects of well-being in a group of high functioning home dwelling senior citizens.

It was our general guiding hypothesis that positive and negative well-being would not simply represent opposite ends of a bi-polar continuum and this may be evidenced by more complex associations with measures of cortisol secretion across the day. We specifically wished to extend our analytic strategy by examining interactive as well as simple effects of positive and negative well-being. It was also our hypothesis that well-being would be more closely related to cortisol secretion in the morning (the ACR) than cortisol secretion across the rest of the day.

2. Methods

2.1. Participants

The study sample consisted of 16 men and 34 women. Age ranged from 59 to 91 years with a mean age of 73.98 ± 6.96 (S.D.) years. There were 26 people who lived alone and 24 people who lived with a partner or family member. None of the participants smoked cigarettes. There were 43 people who were retired and 7 people semi-retired; 30 participants had attended college or university. Mean perceived socio-economic status (possible range 1–10, see later) was 7 ± 1.76. No participants were taking any medication (notably corticosteroids) known to affect cortisol status.

2.2. Procedure

This investigation was approved by the ethics committee of the University of Westminster. The study was conducted as part of a wider-ranging community consultation exercise ('WestFocus') involving a consortium of universities in the south-west London area, with the aim of identifying needs and research questions concerned with the well-being of older people in the region. Participants were recruited via a range of organisations (e.g., 'University of the Third Age' and local agencies of 'Age Concern', a leading UK charity dealing with the needs of older people). Following an expression of interest, each participant received an initial general information letter describing the project. This was followed up with a standardised informal telephone call in which the researcher checked for exclusion criteria and, if appropriate, invited the volunteer to participate in the project. Three persons who were initially approached were excluded because they were on steroid medication, and a fourth person had recently been diagnosed by their medical practitioner as suffering from an anxiety disorder. For those not excluded, the project was then explained in more detail and dates for home visits arranged.

At the first visit (lasting about one-and-a-half hours) the participants were asked to sign a consent form. Each participant was given a detailed instruction sheet which explained exactly what was required of them and how to contact the researchers with any queries. A semi-structured interview was used to assess demographic and other variables such as living arrangements, family background, education and retirement status. They were also given a questionnaire booklet, asking about their perceived socio-economic status and the GHQ-30, which they could complete at any time before the return visit of the researcher. The researcher demonstrated how to use the special wrist-worn actimeter, and the procedures for collecting their own saliva samples at the appropriate times. They were asked to put on the wrist device prior to going to bed that evening, and follow the procedures of the protocol for a period of 48 h.

At the second home visit, which was within 2 days of completing the protocol and of approximately the same duration as the first, the researcher collected the wrist device, saliva samples and completed questionnaires. In addition, the researcher conducted an interview to explore participants' experience of the study.

2.3. Materials and measures

Participants were provided with a saliva self-collection pack containing full written instructions, self-recording sheets for the timing of saliva collections and pre-labelled Salivettes (saliva sampling devices, Sarstedt Ltd., Leicester, UK). On their return to the laboratory, samples were centrifuged at 3500 rpm for 10 min. Cortisol concentration was determined by enzyme-linked immuno-sorbent assay developed by Salimetrics LLC (USA). Standard range in assay: 0.33–82.77 nmol/l. Correlation of assay with serum: $r = 0.960$, $p < 0.0001$, $n = 19$ samples. Intra- and inter-assay variations were both below 10%.

Wrist activity was continuously monitored in 42 of our participants during the study period by an actimeter device (WristCare, Vivatec Ltd., UK). We could not install the base unit in eight homes, because of the prior installation of an alarm system with its own base unit. The choice of device was based solely on our assessment of how easy and convenient it would be for participants to use and prior demonstration of its prime function for us to provide an objective check on reported awakening times. The device

consisted of a special wrist-worn apparatus, the signals from which were sent to a base unit connected to the telephone point in the participant's home, and thence relayed to the Vivatec centre. The raw data output is minute-by-minute level of wrist activity. The technology is widely used by UK health authorities to monitor the activity of vulnerable people living alone and can be used to send alarms when suspicious periods of inactivity are recorded. To be fit for such purpose, its algorithms had to be well-proven, and it was thus well able to discriminate periods of sleep and wakefulness. As just stated, our interest in this study was to make use of its algorithm-derived output to check self-reported awakening times. In particular, we were interested in using the actimeter data as an objective check on compliance in regard to the reported timings of self-collected saliva samples, especially in the period immediately after waking.

Perceived socioeconomic status was derived from a 10-cm ladder with the instructions: 'This is a ladder representing where people stand in our society. At the top of the ladder are the people who are the best off, those who have the most money, most education and best jobs. At the bottom are the people who are the worse off, those who have the least money, least education and the worse jobs or no job. Please place an X on the rung that best represents where you think you stand on this ladder' (Adler et al., 2000).

Psychosocial well-being was measured using Goldberg's (1972) GHQ-30 scored in the manner described by Huppert and Whittington (2003) to produce two scores: positive well-being (POS-GHQ) and negative well-being (CGHQ). In this sample, the items for each achieved high Cronbach alpha reliability coefficients: for POS-GHQ alpha = 0.87 and for CGHQ alpha = 0.91. The 30-item version (GHQ-30) is a well-known instrument for measuring psychological distress and has the advantage of no items relating to physical illness; it is therefore specific to psychological state. Participants are asked to report whether they have recently experienced each of 30 symptoms, worded half in a negative way (e.g., Have you recently been feeling unhappy and depressed?), and half in a positive way (e.g., Have you recently felt that on the whole you were doing things well?). According to this method, positive well-being is derived from positive responses to the 15 positively worded items whereas negative well-being is derived from the total score of negative responses to positively worded items and positive responses to negatively worded items. Both POS-GHQ and CGHQ yield scores in the range of 0–30. The CGHQ scoring differs from the conventional GHQ-30 by counting all negative items as 'symptoms' unless they are endorsed by the responder as applying 'not at all' to them. The authors identified the positive well-being factors derived from this questionnaire as sociability, optimism and two aspects of life satisfaction: competence/self-efficacy and coping/contentment (Huppert and Whittington, 2003).

2.4. Saliva collections

Eight self-collected saliva samples were taken on two consecutive weekdays synchronised to time of waking: Four samples at 15 min intervals in the first 45 min after waking up and four more samples at 3 h intervals timed from the point of awakening. Participants were asked to record the time each sample was taken, and also to press a button on their wrist watch which automatically recorded the exact time on the actimeter record. Participants were asked to take nil-by-mouth for 30 min prior to each sample (except water) and to refrain from brushing teeth until after the final post-awakening period sample.

2.5. Statistical analysis

Cortisol data were, as expected, significantly skewed. Square root transformation optimally reduced the skew statistic and all inferential analyses were done on these transformed scores. For descriptive purposes, mean data in figures and tables is re-transformed to original units (nmol/l).

We carried out separate ANOVAs because of the two very distinct periods of cortisol measurement, i.e., the first four samples which constitute the period of the ACR, i.e., 0, 15, 30, and 45 min post-awakening and for the last four samples which reflect the normal diurnal decline in cortisol (3, 6, 9, and 12 h after awakening). In order to examine the cortisol profile, including mean values and dynamic changes across sample points and interactive as well as main effects of both positive and negative well-being, we first performed four-way mixed ANOVAs with cortisol sampling times (4), and day of sampling (2) as within-subjects factors and median splits as described above of positive (2) and negative well-being (2) as between-subjects factors. Significance probabilities where appropriate were corrected for sphericity violation by using the Greenhouse–Geisser method.

The strategy of using median splits to define factors and sub-groups enabled us to compare our descriptive data directly with that of Huppert and Whittington (2003), and provided a clear method of testing and illustrating interactive effects. However, to check that between-subjects ANOVA effects were not significantly distorted by the dichotomising of the well-being data, we also report additional simple correlations between variables.

3. Results

3.1. Distribution of positive and negative well-being scores

Figure 1 presents the frequency distributions of the negative (CGHQ) and positive (POS-GHQ) well-being scales.

The distributions in Figure 1a and b closely mirror those given by Huppert and Whittington (2003), based on over 6000 participants. It shows that negative well-being is highly skewed, while positive well-being is more normally distributed with a small standard deviation. Measures of central tendency and dispersion were also near identical to those presented by Huppert and Whittington (2003) for their over-65 age group. We found evidence both for some association and some independence of positive and negative well-being. Our data yielded a Spearman correlation coefficient of −0.59, similar to theirs of −0.63.

Furthermore, following their strategy of cross-tabulating median splits of both scales we obtained similar percentages in the resulting four quadrants (comparative percentages in

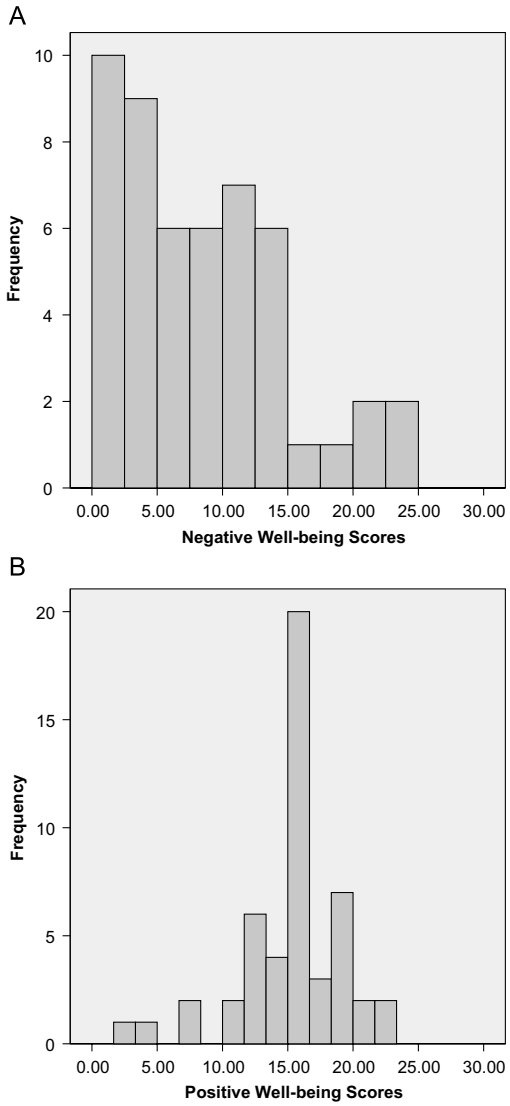

Figure 1 Frequency distributions for negative (A) and positive (B) well-being scores derived from the GHQ-30 (see Section 2 for scoring). The range of possible scores for both is 0–30.

parentheses): High Positive and Low Negative, 34% (30%); Low Positive and High Negative, 42% (35%); High Positive and High Negative, 8% (17%); Low Positive and Low Negative, 16% (18%). Thus, approximately a quarter of our sample and nearer a third of theirs exhibited independence of positive and negative well-being.

Before carrying out inferential analyses we checked socio-demographic variables which may have been related to both well-being and ACR which may have necessitated inclusion of covariates in the subsequent analyses. No significant effects were discovered. In particular, there were no associations between well-being categories and major demographics (age, sex and SES). This probably reflects the restricted age range, the relatively small number of men recruited and the overall high SES scores of most of the sample. In a previous study of a young population (Edwards et al., 2001), it was found that the ACR was more pronounced in participants who awoke earlier in the morning. In the present study, our elderly sample yielded no significant effects of time of awakening on cortisol, and nor was time of awakening associated with well-being measures. It may be relevant that our elderly participants awoke on average approximately an hour earlier (06:45 h) than the young sample of Edwards et al. (2001), and the range of times in the present sample was considerably narrower.

3.2. Well-being and cortisol: the awakening cortisol response

The ANOVA for the post-awakening period yielded the expected highly significant effect of sample-point ($F = 39.23$; d.f. $= 3,138$; $p < 0.001$) confirming the normal steep rise in cortisol over this 45-min period. In line with all our previous observations with post-awakening cortisol data, the main effect of sample-time comprised both significant linear and quadratic components, reflecting a steep linear rise in the first half hour followed by a gradual falling off of mean cortisol values in the final quarter hour. There were no effects of day of sampling. Nor were there any interactions between the well-being factors and sample point. Analysis of between-subjects main effects were insignificant (negative well-being: $F = 1.59$; d.f. $= 1,46$; $p < 0.224$; positive well-being: $F = 0.015$; d.f. $= 1,46$; $p < 0.902$), but the interaction between them was significant ($F = 5.45$; d.f. $= 1,46$; $p < 0.024$). Means (standard errors) for the interaction sub-groups were as follows: High Negative Well-Being+Low Positive Well-Being $= 4.65$ (0.21), High Negative Well-Being+High Positive Well-Being $= 5.38$ (0.48), Low Negative Well-Being+Low Positive Well-Being $= 5.01$ (0.34), Low Negative Well-Being+High Positive Well-Being $= 4.19$ (0.23).

Further analysis of this interaction followed the conventional approach of analysing simple main effects. Two components of the omnibus interaction were significant. At the low level of the negative well-being factor, high positive well-being participants had a lower cortisol mean than those with low positive well-being ($p < 0.029$). At the high level of the positive well-being factor, low negative well-being participants had a lower cortisol mean than those with high negative well-being ($p < 0.024$). The significance of these two components of the interaction indicate a powerful synergy between the well-being factors with lower cortisol only evident in those with both high positive well-being and low negative well-being (contrast estimate $= -0.825$; $p < 0.011$). The significant contrast between the latter group and all others is evident also in Figure 2A, which for illustration purposes plots all the data for the key well-being sub-group and for the relevant comparison group (i.e., participants in all other groups). As can be seen from the roughly parallel group profiles in

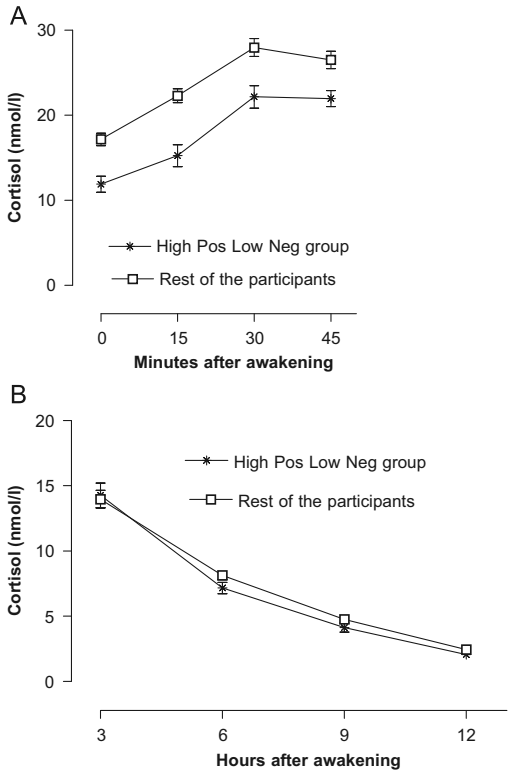

Figure 2 (A) The awakening cortisol response in the sub-group with high positive and low negative well-being ($n = 17$) and the rest of the participants ($n = 33$). (B) The diurnal decline in cortisol from 3 to 12 h post-awakening in the high positive and low negative sub-group ($n = 17$) and the rest of the participants ($n = 33$). Cortisol is expressed and mean ($\pm$S.E.M.) nmol/l at each time interval.

Figure 2A and the absence of interactions involving sample point, the lower cortisol was evident at the first awakening sample and continued throughout the 45-min period. We therefore conclude that mean cortisol over the whole 45 min post-awakening is significantly lower only in that sub-sample of participants who report more positive well-being and less negative well-being. There was no difference between groups and the dynamic of the ACR.

We were able to examine adherence in terms of the reported exact timing of samples by inspecting actimeter records in 42 of our 50 participants. All participants were clearly adherent in that the first button-press (coincident with the first sampling point) was consistent with contrasting levels of wrist activity before and after the button-press and all further button-presses approximated closely the required 15-min intervals. In practically all cases, the software's own automated setting of an activity-based criterion for distinguishing sleep from wakefulness was fully consistent with the timing of the first button-press. In the few cases where it was not, there was still a clear contrast in the visual read-out between levels of activity immediately preceding the first button-press and that following it.

3.3. Well-being and cortisol: the diurnal decline

The ANOVA for the diurnal profiles from 3 to 12 h post-awakening revealed no significant effects except the overall main effect for time of sample ($F = 147.47$; d.f. = 3,138; $p < 0.001$) whereby cortisol fell from a high at the 3-h point of 15.07 nmol/l to a low of 2.51 nmol/l at the 12-h point. In particular, it can be seen in Figure 2B that the profile for the high positive and low negative well-being group is virtually identical to that for rest of the total sample.

3.4. Correlational analysis of well-being and cortisol data

As a check that main effect analyses in the above ANOVAs were not over-looking weak but significant associations as a result of reducing well-being data to median splits, we computed Spearman rank correlation coefficients between mean cortisol and the raw scores on both positive and negative well-being. Both coefficients (-0.11 and 0.03, respectively) were insignificant, mirroring the non-significant main effects reported in the ANOVA analysis of cortisol in the post-awakening period. Similarly, no significant correlations emerged between mean cortisol (3–12 h post-awakening) and raw scores on both positive and negative well-being ($r = -0.03$ and 0.15, respectively).

4. Discussion

The main finding of this study was that cortisol levels were lower in the 45 min post-awakening period for a sub-group of overall 'best' well-being participants (34%), i.e., those who combined high scores on positive well-being and low scores on negative well-being. By contrast, there was no mirroring finding whereby the 'worst' well-being participants, i.e., those combining low positive well-being and high negative well-being (35%) showed higher cortisol levels than other sub-groups. Indeed, mean cortisol for this sub-group was the next lowest mean after that of the 'best' well-being group, a point that we take up in the next paragraph. It is worth emphasising that we did not find positive well-being to be more or less important than negative well-being in predicting post-awakening cortisol levels, correlations with each single dimension being trivially low and insignificant. This is interesting because it suggests, in this sample at least, a powerful synergic action between high positive and low negative well-being in possibly determining lower cortisol values.

As is evident from studies mentioned in Section 1, our interpretation of the significant omnibus interaction is guided by prior expectation that well-being in general would, if anything, be inversely related to cortisol, but that degree of effect may depend on whether measures of positive or negative well-being or their interaction were being considered. Thus, our further analysis of the interaction was non-arbitrary and systematic in going on to examine simple main effects of one well-being factor at

each level of the other in the classic text book manner. This a priori approach clearly indicated that cortisol was only lower in low negative well-being participants if their positive well-being was high, and only lower in high positive well-being participants if their negative well-being was low. These two tested effects therefore must concentrate our attention on the low cortisol of just one sub-group with the best well-being on both measures. However, there is another possible interpretation of the significant omnibus interaction pointed out by an anonymous referee. If we were to combine the means of the 'best' and 'worst' sub-groups as representing those participants where both well-being measures are most correlated, and contrast that pooled mean with the pooled mean of the other two sub-groups which represent participants whose positive and negative well-being scores are most independent it would follow that the pooled mean of the correlated groups will be higher than the pooled mean of the relatively independent groups. However, we can think of no compelling hypothesis which would demand this contrast and it would therefore have been clearly post hoc. For information, it may be added that on its own the 'worst' well-being sub-group is not significantly lower in cortisol mean than either of the sub-groups where positive and negative well-being are relatively independent, whereas that of the 'best' well-being sub-group is. That said, there is some evidence in the literature (see Clow et al., 2004) that the awakening response may be blunted, and cortisol lower, in some groups which may plausibly have endured severe chronic stress (e.g., 'burned-out' individuals). We are not persuaded that this would be a relevant consideration in respect of this sample of largely well-functioning participants, but it is worth stating that our data are at least consistent with a view that lower cortisol may be evident both in the 'worst' and 'best' well-being groups as defined above.

Although this study has been undertaken on a modest sample size of 50 participants (due to the intensive nature of the investigation) our data from the GHQ-30 are comparable with that published from an extensive investigation of over 6000 participants in three ways: a similar level of correlation between the positive and negative dimensions of well-being, similar frequency distributions (both in measures of central tendency and dispersion) and similar combinations of positive and negative well-being scores (Huppert and Whittington, 2003). This consistency between the studies provides reassurance that our sample are representative of the wider population.

Our results are also consistent with a range of studies demonstrating that aspects of well-being tend to be associated with cortisol secretion in the morning rather than later in the day (Lai et al., 2005; Ryff et al., 2006; Steptoe et al., 2007). Although the results reported here do not demonstrate a difference in the dynamic of the ACR (as reported by Lai et al., 2005; Steptoe et al., 2007) they are consistent with these studies in that better well-being (or optimism or momentary happiness) was associated with lower overall levels of cortisol secretion during the period of the ACR, immediately after awakening. Like these other studies, we also show independence of effects with no association found for cortisol secretion over the rest of the diurnal cycle. There is clear evidence that the cortisol secretion in the first 30–45 min after awakening is a distinct aspect of the cortisol cycle and is under different regulatory influences (e.g., sensitive to light in the morning but not later in the day). For a review, see Clow et al. (2004). In particular, it has been shown that cortisol secretion in the immediate post-awakening period is sensitive to state effects and trait characteristics whereby the dynamic of the increase is more related to state influences and total cortisol secretion to trait measures (Hellhammer et al., 2007). Also of potential relevance, there is evidence that cortisol levels 30 and 45 min after awakening (but not over the rest of the day) are to some extent under the influence of genetic factors (Wüst et al., 2000; Bartels et al., 2003).

We need to be cautious and not over-interpret our findings. The intensive nature of the study meant that the sample size was quite modest, the proportion of male participants was small, the participants were largely middle-class and well-educated. These factors all make it difficult at present to generalise from our results. Certainly it would be interesting to examine the same associations in populations of different age to determine whether the results reported for this older population are generalisable across the life span and across a different range of positive and negative well-being scores.

Measurement of cortisol concentrations in the first 30–45 min after awakening usually relies upon self-collection of saliva samples within a domestic setting following careful instruction of the participants. Although this methodology does provide ecological validity it also relies very heavily upon participant adherence to the required saliva sampling protocol. The literature shows that non-adherence by participants is a common problem and that this can affect the results obtained (Broderick et al., 2004; Kupper et al., 2005; Thorn et al., 2006). In this study, our sample consisted of highly motivated volunteers with a keen interest in the project. In addition, our researcher visited each participant in their own home, and among other things emphasised the importance of the correct timing of the saliva samples, which we presumed to have fostered better than normal adherence. Equally it may be that the age of our sample was itself a factor promoting adherence, since there is some recent evidence from psychotherapeutic interventions that older patients are significantly more adherent in both attendance and treatment completion (Ogrodniczuk et al., 2006). Furthermore, we had an objective measure of awakening time and of participants' recorded saliva-sampling times derived from the activity meters which indicated that in this sample at least non-adherence to protocol was probably not an issue. It is true that objectively we can only strictly speaking assert that we pin-pointed the exact timings of reported (via button-presses) saliva sampling, whereas the use of special electronic monitoring collection tubes (e.g., Kudielka et al., 2003) directly records use of the tubes. However, our procedure does map reported collection times directly to the reported times of awakening which were checked against the actimeter records. In terms of past uncontrolled studies, our major concern was that unverified self-reports of times could not themselves be relied on in several cases. We have more confidence that if, as here, participants are shown to be actively involved in self-reporting at the correct

times in relation to an objectively checked time of awakening, there is less reason to suppose that they will not also carry out the actions which they are reporting. Nonetheless, a combination of electronically tagged tubes and objectively assisted estimation of awakening time would of course be an ideal method for self-administered saliva collection protocols.

In interpreting our well-being findings, we must re-emphasise that the underlying psychological dimension found to be important was an interactive one—the degree to which high positive and low negative well-being need to co-exist for an effect on cortisol to be observed. There was no evidence that either dimension of well-being on its own related to cortisol, and, more importantly still, there was no suggestion that simple summing across the two scales related any better to cortisol. This is conceptually important since, as we mentioned in Section 1, a simple traditional bipolar theory suggests that 'bad' feelings and 'not good' feelings are functionally equivalent and can thus be summed to estimate position on a single dimension. However, it is equally important to realise that our findings are rather different from others that have explored the utility of separating measures of positive and negative well-being. Succinctly, we have shown that both measures in combination are related to cortisol, but in a synergic manner, whereas others have sought to demonstrate utility of separate measurement by showing that each measure alone may relate differently to other measures, including biological ones. This different demonstration of utility is seen clearly in the recent paper by Ryff et al. (2006) These authors attempted to examine whether positive and negative well-being (they call the latter 'psychological ill-being') have distinct or mirrored biological correlates. If biological correlates of positive and negative well-being are the mirror images of each other, i.e., positive = not-negative and negative = not-positive, then this is clearly evidence of a functionally single bipolar dimension. However, their findings using a variety of biological measures suggested strongly that positive and negative dimensions had many more distinct biological correlates than shared ones.

In conclusion, then, this investigation into a sample of active, community dwelling old people has provided further support for what we believe is a growing view that it is beneficial routinely to explore positive and negative well-being as measures which can relate together, independently, or interactively with other variables. Although moderately negatively correlated with each other, we have found that neither dimension on its own was associated with patterns of cortisol secretion over the day. Instead, we have found a powerful interactive and synergic action between high positive and low negative well-being in determining lower cortisol values. Well-being measures were only associated with cortisol secretion in the first 45 min after awakening and not over the rest of the day. These findings are consistent with other reports that have shown lower morning cortisol secretion to be associated with measures such as optimism and state happiness. We are however aware that the results reported come from a restricted and homogeneous sample of only modest size. The extent to which we can generalise from them remains to be seen.

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Conflict of interest

We declare that there are no conflicts of interest involved for any of the authors of this manuscript.

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The diurnal cortisol cycle and cognitive performance in the healthy old

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ABSTRACT

Associations between cognitive performance and cortisol have variously been reported for measures of both cortisol level and change, and for some domains of cognitive functioning more than others. In this study, associations between cortisol secretion measures and cognitive performance were examined in 50 healthy older people (mean age 74 years; 34 F /16 M). Participants provided 16 accurately timed saliva samples over 2 consecutive days to determine diurnal profiles of cortisol secretion. Overall cognitive performance (OCP) was measured as the principal component of a comprehensive battery of cognitive tests.

Across a 30 year age range, there was a strong inverse correlation between age and OCP. Age and poorer OCP were also associated with an attenuated cortisol awakening response (CAR), defined as the rise from 0–30 min after awakening, and a subsequent less steep fall in cortisol level over the rest of the day. Partialling analyses, suggested that the correlation between fall in cortisol over the day and OCP was independent of age. Both older age and less cortisol change were particularly related to poorer performance on tests of declarative memory and executive functioning.

Our conclusions are that during the short post-awakening period, an exception exists to the generally pertaining association between higher levels of cortisol and poorer cognitive performance. Consequentially dynamic measures reflecting the rise (CAR) and fall from the post-awakening peak may be particularly salient in helping to explain links between cortisol and cognitive performance. Finally our pattern of results across different cognitive tests suggests an association between cortisol and those domains of cognitive functioning which depend crucially on the integrity of the hippocampus and pre-frontal cortex.

1. Introduction

Few would disagree that part of what it means to age well is to live a long life while maintaining good cognitive functioning. Advancing age is associated with decreases in cognitive performance, but it is by no means an inevitable consequence (Wright et al., 2005). Factors which accelerate or attenuate age-related decline are not fully understood. One potential mediator of cognitive decline is the hypothalamic pituitary adrenal (HPA) axis and, in particular, secretion of glucocorticoid hormones (Wright et al., 2005; de Quervain et al., 2009). In humans, cortisol is the principal glucocorticoid and has been studied in relation to both aging and cognitive function (e.g. Lupien et al., 2007). Chronic stress is thought to cause dysregulation of the HPA axis, sustained aberrant basal patterns of cortisol secretion, with consequential negative effects on cognition, including possibly raised vulnerability to cognitive decline in old age. However investigations are complicated by the dynamic nature of the cortisol cycle, involving discrete components such as the cortisol awakening response (CAR) and the rest of the diurnal cycle. This necessitates the computation of reliable measures, synchronised to time of awakening rather than clock time, which can capture accurately both basal levels and dynamics of change over the day (Clow et al., 2004). We are not aware of any existing studies within older populations which have systematically examined in detail the entire diurnal cortisol cycle, including the CAR, in relation to robust measurement of cognitive performance, based on a comprehensive battery of tests. This was the primary objective of the current study.

Glucocorticoid secretion has been linked to memory processes through the mediation of glucocorticoid receptors in key anatomical sites such as the hippocampus (de Quervain et al., 2009; Lupien et al., 2007). Although many of these studies have investigated the effects of acute bursts of glucocorticoids (e.g. Buchanan and Tranel, 2008), chronically higher basal levels of cortisol have been observed in Alzheimer's Disease as well as milder conditions of cognitive impairment (Arsenault-Lapierre et al., 2010), and one particular memory deficit (reduced 'primacy effect' following the learning of word lists), is both characteristic of Alzheimer's patients and has been associated with higher cortisol levels in a non-clinical older population (Suhr et al., 2008). In a large sample of community residents, Lee et al. (2007) found high cortisol levels to be associated

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with poorer performance across a wide range of cognitive domains. Prospective studies have given less consistent results. Higher basal levels of cortisol, assessed by overnight urinary excretion, have been shown to predict subsequent cognitive impairment in an older population (Karlamangla et al., 2005). However over a 6 year period, Comijs et al. (2010) did not find that higher (serum) cortisol predicted cognitive decline, although cross-sectional associations were evident. Negative results from prospective studies have also been reported by Fonda et al. (2005) and Peavy et al. (2009), with the latter study even showing a small protective effect of higher cortisol levels among a sub-group already diagnosed with mild cognitive impairment.

As already stated, studies which have examined links between cognition and cortisol, have typically lacked consideration of diurnal profiles, and this may explain some of the inconsistencies in the literature. The importance of diurnal cycle information is illustrated by studies showing that diurnal change can be significantly associated with cognition. Studies by Abercrombie et al. (2004) and Power et al. (2008) both implicate less steep diurnal decline from early morning peak as a factor related to poorer cognitive performance. This is of interest since less steep diurnal decline in cortisol has been linked to a number of adverse mental and physical outcomes, e.g. poorer maternal relationships (Adam and Gunnar, 2001) post-traumatic stress disorder (Yehuda et al., 2005), poorer prognosis in breast cancer patients (Sephton et al., 2000), poorer declarative memory performance, social support, and perceived stress (Abercrombie et al., 2004). As a key dynamic measure, the CAR too has been linked to cognitive performance. Pharmacological suppression of the CAR, for example, has been shown to impair free recall in comparison to placebo control (Rimmele et al., 2010). In addition the CAR has been shown to be attenuated in patients with memory disorders related to hippocampal damage (Buchanan et al., 2004; Wolf et al., 2005). Although reports of associations between basal HPA activity and increasing age have tended to be equivocal, recent studies have demonstrated increasing age (from 20 to 80 years) to be associated with an average 20%–50% increase in basal cortisol levels (see Chahal and Drake, 2007 for a review). In particular there have been reports of age-related reduced amplitude in the diurnal pattern of cortisol secretion with less difference therefore between high and low points (Deuschle et al., 1997) and higher evening cortisol concentrations (Knoops et al., 2010). Evidence for age related changes in cortisol in the highly dynamic period immediately following awakening has been conflicting. Studies including older participants tend to report increasing age to be associated with an attenuated CAR (Kudielka and Kirschbaum, 2003; Pruessner et al., 2005; Knoops et al., 2010), although a recent study by Almeida et al. (2009) suggests that across a large adult age range, but only for men, the CAR may increase in magnitude, but also show more variability. Thus evidence is emerging of age-related changes in measures of cortisol dynamic as well as level, justifying closer examination of cognitive performance in relation to both age and the full diurnal profile of cortisol secretion.

In this study we examine which, if any, aspects of the cortisol diurnal cycle are associated with overall cognitive performance and with age in a sample of older community residents. We also examine whether any relationships between cortisol and cognitive performance are independent of age. A second objective of our study is to examine associations between cortisol measures and performance on individual cognitive tests and ask whether there may be some cognitive domains which may be more closely linked than others to both cortisol and age. While higher basal cortisol may to an extent be associated with poorer cognitive performance across virtually all domains (Lee et al., 2007) there is evidence that higher cortisol may be more particularly associated with weaker performance on tests with strong hippocampal involvement, e.g. tests of declarative memory, and also tests of so-called 'executive functioning', which typically require planning, flexible responding, and pre-frontal cortex involvement (Egeland et al., 2005; Hinkelmann et al., 2009; Li et al., 2006; McCormick et al., 2007; Gomez et al., 2009). By contrast, tests which emphasise different domains of cognitive processing, e.g. simple processing speed and mental rotation do not seem to be related to higher cortisol levels (Egeland et al., 2005; McCormick et al., 2007).

In summary, our hypotheses are that poorer cognitive performance among older community-dwelling residents will be associated with older age and that both will be linked to higher basal levels and less dynamic patterns of cortisol secretion across the day. Subsidiary hypotheses are that relationships between cortisol and cognitive performance may be most evident for specific cognitive tasks which make greater demands on declarative memory and executive functioning.

2. Methods

2.1. Participants

Fifty participants (16 men and 34 women, mean age 74 and ranging from 60–91 years) were recruited into the study. 26 lived alone and 24 with a partner or family member. None smoked, 43 were retired and 7 semi-retired, and 30 participants had attended college or university. The "nine rung ladder" scale developed by the MacArthur Foundation Network on SES and Health was used to assess perceived socioeconomic status (Adler et al., 2000) which was for most of the sample middling to high ($M = 6.99$; $sd = 1.80$). No participants were taking medication known to affect cortisol status.

2.2. Procedure

This study was approved by the ethics committee of the University of Westminster and conducted as part of a wider-ranging community study (see Evans et al., 2007). Participants were recruited via a range of organisations (e.g. University of the Third Age and Age Concern). Participants received an initial letter describing the project, followed by a standardised informal telephone call in which the researcher checked for exclusion criteria, including current medications and medical (mental and physical) conditions which might impact cortisol and /or psychometric assessment and the integrity of the sample as one of healthy community-dwelling older persons. At this stage three people were excluded because they were on steroid medication and a fourth person due to a diagnosis of anxiety disorder. For those not excluded, the project was explained in detail and dates for home visits arranged.

At the first home visit (lasting about one and a half hours) the participants provided informed consent. Following this a semi-structured interview was used to assess demographic and other variables such as living arrangements, family background, education and retirement status. The researchers demonstrated how to use the special wrist-worn actimeter (see below) and the procedures for collecting their own saliva samples at the appropriate times. They were asked to put on the wrist device prior to going to bed that evening and follow the procedures of the protocol for a period of 48 h.

At the second home visit, of similar duration to the first and undertaken within 2 days of protocol completion, the researchers delivered the battery of cognitive tests described below, collected the wrist device, saliva samples and completed questionnaires, and conducted an interview to explore participants' experience of the study. Home visits were scheduled at time of day convenient to individual participants, but the great majority took place between 10 am and 2 pm.

2.3. Materials and measures

2.3.1. Overall cognitive performance

This was assessed using a battery of tests, selected on the basis that they would provide a comprehensive assessment of overall cognitive performance and also cover specific domains of declarative memory and executive function, aspects of cognition associated with the

hippocampus and prefrontal cortex. The battery consisted of the National Adult Reading Test, which provides an estimate of pre-morbid IQ, the Hopkins Verbal Learning Test (HVLT), which provides measures of immediate recall, learning, recognition memory, and delayed recall, Verbal and Semantic Fluency Tests, which tap into some aspects of executive functioning and The Trail-Making Test which has two parts A and B, the former a measure of general psychomotor speed and the latter a good index of executive functioning. The initial and primary focus was to explore cognitive performance as a single outcome variable in relation to age and diurnal cortisol profiles, and the correlation matrix for all cognitive tests was expected to reveal substantial inter-correlation, enabling overall cognitive performance (OCP) to be expressed as a principal component following standard orthogonal factor analysis of all individual test-scores.

2.3.2. Diurnal cortisol assessment

This followed a protocol fully described elsewhere (Evans et al., 2007). Participants were provided with a saliva self-collection pack containing full written instructions, self-recording sheets for the timing of saliva collections and pre-labelled Salivettes (saliva sampling devices, Sarstedt Ltd., Leicester England). On delivery to the laboratory, samples were centrifuged at 3500 rpm for 10 min. Cortisol concentration was determined by Enzyme Linked Immuno-Sorbent Assay developed by Salimetrics LLC (USA). Standard range in assay: 0.33–82.77 nmol/l. Intra and inter-assay variations were both below 10%. In order to compute composite measures which would capture accurately the principal elements of the diurnal cortisol cycle, eight self-collected saliva samples were taken on 2 consecutive weekdays synchronized to time of waking: four samples at 15 min intervals in the first 45 min after awakening and four more samples at 3 h intervals timed from the point of awakening. Participants recorded the time each sample was taken, and also pressed a button on a special wrist-worn device which automatically recorded the exact time on the actimeter record. Participants were asked to take nil-by-mouth other than water for 30 min prior to each sample (except water) and to refrain from brushing teeth until after the final post-awakening period sample. Wrist activity was continuously monitored in 42 of our participants during the study period by an actimeter device (WristCare, from Vivatec Ltd, UK). We could not install the base unit in 8 homes, because of prior installation of an alarm system with its own base unit. Choice of device was based on ease and convenience of usage and its ability to provide an objective check on compliance in regard to self-reported awakening times, by means of proven algorithms for distinguishing periods of sleep and wakefulness.

2.4. Statistical analyses

In order to test the integrity of the overall pattern of cortisol secretion, data was plotted and test-retest correlation coefficients were computed to examine stability of cortisol measures across the two days of testing prior to their being aggregated. Zero-order correlation was used to test whether composite cortisol measures were related to age, OCP, and each specific cognitive test. Partial correlation was used, in the event of statistically significant zero-order coefficients, to test whether cortisol associations with OCP were independent of age, and, in the case of dynamic cortisol measures, of absolute levels at 30 min post-awakening.

3. Results

3.1. Treatment of data

The expectation of significant inter-correlation among the tests in the cognitive battery was confirmed. Accordingly the first principal component was extracted from a factor analysis of all tests, which explained approximately 40% of total variance, and on which all tests loaded positively, although the loading for one of the nine tests (verbal fluency) eluded statistical significance. The principal component scores were saved and used as our primary outcome measure of overall cognitive performance: OCP.

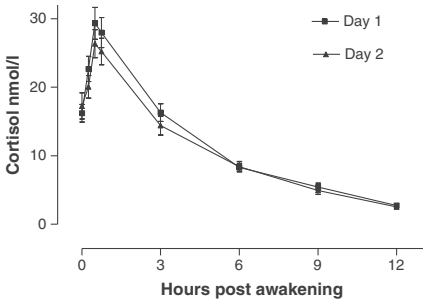

Fig. 1. The diurnal pattern of salivary cortisol on 2 consecutive days in the entire population of 50 participants with plots of cortisol concentrations ± S.E.M. for each sample point from awakening time.

Prior to computation of composite cortisol measures and as reported elsewhere in an examination of different hypotheses using these cortisol data (Evans et al., 2007), we initially checked actimeter records to see whether self-reported times of awakening matched the actimeter's algorithm marking a transition from a sleep to a waking denoted period. As reported by Evans et al. (2007), there was very close agreement between self-recorded times and actimeter-indicated times of awakening, and thus no data were excluded because of suspected non-compliance with protocol. Prior analysis also confirmed that equivalent samples on both days were highly correlated permitting 2-day averaging to be used to provide best-estimate data in the computation of five composite measures which together capture the essence of each individual's full diurnal profile in terms of absolute levels and change-dynamics. These were: (1) mean cortisol during the post-awakening peak period (0–45 min samples); (2) mean cortisol during the rest of the day (3–12 h samples); (3) overall mean of all samples regardless of time of day (4) the degree of rise (CAR) within the first half-hour following awakening when cortisol typically peaks (30 min minus 0 min samples)[1]; (4) the average diurnal cortisol fall from 30 min to levels prevailing during the non-peak (3–12 h) period. The computation: sample 0.5 h–1/4 ($\sum$ samples 3 h,6 h,9 h,12 h) produces a measure near-identical to that representing an area under the curve for data referenced to the 30 min base, but makes no assumptions about levels pertaining between three hour intervals. See Fekedulegn et al. (2007) for further elucidation of graphic and formulaic representation of cortisol across time-points.

As is normally the case, cortisol measures were mostly distributed with highly significant degrees of skewness. Also, age, diurnal cortisol fall, and OCP each had at least one significant outlier (greater than at least 2.4 sd units distant from the mean and with SPSS frequencies histogram output showing a distinct discontinuity in the distribution). Therefore, non-parametric correlation coefficients (Spearman's 'r_s') were computed.

The group as a whole ($n = 50$) showed the same expected diurnal pattern of cortisol secretion on both days, including a pronounced cortisol awakening response (CAR) and declining levels thereafter (see Fig. 1). The pattern of secretion was consistent across both sampling days with significant correlations evident for all eight sample points (range of $r_s = 0.34$ to 0.64).

[1] Maximum cortisol was observed at the 30 min sample on at least one of the two days in 76% of individuals, and the average estimate of peak-time across days was 29 min.

Table 1
Descriptive statistics for age, cognitive tests and cortisol measures.

	Mean	(sd)	Median	(IQR)
Age (years)	73.96	(6.93)	74	(10)
HVLT measures				
Learning	24.42	(6.923)	26	(10.25)
Immediate recall	6.88	(2.154)	7	(4.00)
Recognition	22.26	(2.337)	23	(3.00)
Delayed recall	8.48	(3.092)	10	(4.25)
Trail-making tests				
Trail-making A (s)	42.34	(15.688)	40	(18.00)
Trail-making B (s)	92.92	(30.035)	85	(35.75)
Reading test (errors)	6.88	(5.374)	6	(7.25)
Fluency measures				
Verbal fluency	46.22	(11.029)	45	(16.00)
Semantic fluency	17.96	(5.893)	18	(8.00)
Cortisol measures (nmols/l)				
Mean cortisol 0–45 min	23.14	(10.11)	20.32	(12.82)
Mean cortisol 3–12 h	7.88	(3.52)	7.18	(4.78)
Overall mean cortisol	15.51	(5.71)	14.03	(6.73)
Diurnal fall	19.90	(12.64)	17.04	(17.97)
CAR	11.05	(10.46)	9.62	(12.18)

Descriptives for all measures are listed in Table 1. Since non-parametric correlations are used, medians and inter-quartile ranges are given as well as means and standard deviations.

3.2. Main analyses

Correlation coefficients between cognitive performance (OCP together with the specific tests from which it is derived) and age and cortisol measures are presented in Table 2. Coefficients involving trail-making and reading scores were reversed for sign, so that for all cognitive measures higher scores indicate superior performance.

3.2.1. Age and cognitive performance

The correlation between age and OCP was inverse and highly significant ($r_s = -0.455$; $p < .001$). Table 2 reveals that this effect is largely due to significantly poorer declarative memory performance with age on all HVLT measures, and poorer aspects of executive functioning associated with Trail-making Form B. There was no evidence of any significant age-related deficits in reading or fluency measures, or simple processing speed as manifested in Trail-making Form A.

3.2.2. Age and the diurnal cortisol cycle

Table 2 shows that age was not associated with higher mean levels of cortisol across the entire diurnal cycle, nor in the post-awakening period, nor during the rest of the day. The dynamic measure of diurnal fall in cortisol was inversely related to age ($r_s = -0.286$; $p < .05$). Similarly the CAR was also inversely correlated with increasing age ($r_s = -0.282$; $p < .05$). Thus, increasing age was inversely related to both dynamic cortisol measures, but not to levels of cortisol secretion across the day.

3.2.3. Cognitive performance and the diurnal cortisol cycle

OCP was not associated with overall higher mean levels of cortisol. There was a trend for OCP to be associated positively with mean post-awakening peak levels of cortisol ($r_s = 0.209$; $p < .10$) and inversely with levels pertaining thereafter ($= -0.229$; $p < .10$). OCP was related to both cortisol diurnal fall ($r_s = 0.360$; $p < .01$) and the CAR ($r_s = 0.245$; $p < .05$), indicating that better OCP was associated with greater post-awakening cortisol rise and steeper fall thereafter.

Given the significant overall finding for average diurnal fall, we examined post-hoc the relationship between OCP and cortisol fall in each of the consecutive intervals from 30 min post-awakening to 3 h, from 3 to 6, from 6 to 9, and finally 9–12 h. All of the overall effect for average fall was driven by that in the first period from post-awakening peak to 3 h post-awakening ($r_s = 0.361$; $p < .005$) with no trend evident for later intervals. For illustrative purposes, Fig. 2 plots cortisol falls in these consecutive intervals for participants above and below (median) average on OCP.

Relationships with specific cognitive tests are listed in Table 2. Poorer memory, as indicated by two of the four HVLT tests, and poorer executive functioning, as indicated by trail-making form B, were significantly associated with less steep diurnal fall in cortisol. The overall pattern of correlation is similar to that between OCP and age. This is illustrated in Fig. 3 where the magnitude of effect sizes (r_s) for each cognitive measure with age (ordinate) and cortisol diurnal fall (abscissa) are plotted. A similar pattern for the CAR can be gleaned from Table 2.

3.2.4. Partial correlation analyses

To test whether the significant zero-order correlation between OCP and cortisol fall was independent of age, we re-computed the bivariate correlation coefficient with the effects of age partialled out. Although the effect size was reduced, it remained significant ($r_s = 0.27$; $p < 0.03$). The significant but smaller correlation between CAR and OCP, after partialling out age, proved insignificant ($r_s = 0.136$).

Table 2
Spearman rank correlation coefficients between age, cortisol measures, and overall cognitive performance, as well as individual cognitive tests.

	Age	Mean cortisol 0–45 min	Mean cortisol 3–12 h	Overall mean cortisol	Diurnal fall	CAR
Age		−.17	.18	−.09	**−.29***	**−.28***
Overall cognitive performance	**−.46*****	**.21**†	**−.23**†	.09	**.36****	**.25***
Individual tests						
Learning	**−.36****	.17	−.15	.08	**.29***	**.23**†
Immediate recall	**−.35****	.12	−.07	.07	**.22**†	.17
Recognition	**−.32***	**.26***	−.17	.19	**.31***	.15
Delayed recall	**−.44*****	.06	**−.23**†	−.03	.15	.17
Trail-Making A	−.17	−.05	−.05	−.10	.01	.07
Trail-making B	**−.42*****	**.20**†	**−.19**†	.08	**.36****	**.25***
Reading test	−.17	.13	−.01	.14	.19	.17
Verbal fluency	−.05	−.02	−.14	−.03	.05	**.24***
Semantic fluency	−.11	.09	−.14	.00	.13	.04

For coefficients in bold:
*** $p < .001$.
** $p < .01$.
* $p < .05$.
† $p < .10$.

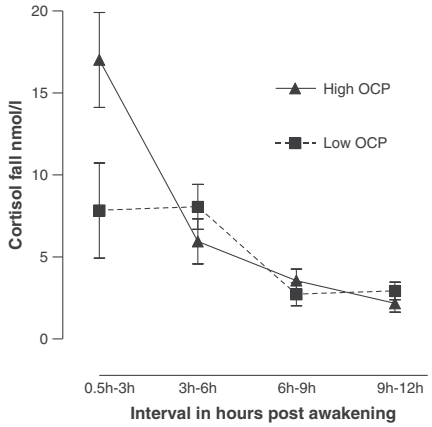

Fig. 2. Mean falls in cortisol for participants scoring above or below average on overall cognitive performance. Means (±S.E.M) are plotted for consecutive periods of the day after the 30 min post-awakening sample-point.

Since absolute cortisol level at 30 min post-awakening was a defining component of both dynamic measures (CAR and diurnal fall) we used partial correlation to examine the extent to which the significant zero-order correlations between the latter and OCP may have been driven by the former. The partial correlation between OCP and diurnal fall was reduced but retained significance ($r_s = 0.270$; $p < 0.03$), whereas the partial correlation for OCP and cortisol level at 30 min controlling for diurnal fall was insignificant ($r_s = 0.10$). Neither the partial correlation between OCP and CAR controlling for 30 min levels ($r_s = 0.10$) nor that for OCP and 30 min levels controlling for CAR $r_s = 0.16$) were significant.

3.2.5. Potential confounders: sex of participant and awakening time

The sample was predominantly female. We made no hypotheses in relation to sex of participant but re-analyses of the coefficients in Table 2 for females and males separately yielded very similar results; patterns of correlation were near identical across the sexes.

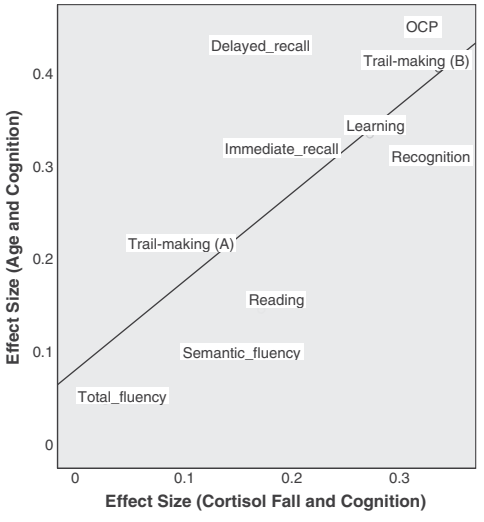

Fig. 3. A scatter-plot of effect sizes (r_s Age — Performance and r_s Diurnal Fall — Performance) for each individual cognitive measure, illustrating that tests most strongly related to age are also most strongly related to cortisol fall.

Among student participants, we have previously reported larger CARs in those who awoke earlier (Edwards et al., 2001). These older participants awoke considerably earlier on average (06 h:44 min) and with a narrower range of awakening times (05 h:15 min to 07 h:47 min) which were not significantly correlated with either cortisol measures or OCP.

4. Conclusions

Older age was associated with globally poorer OCP, but neither age nor poorer OCP were linked to higher overall mean cortisol levels. Poorer OCP was significantly associated with less change on both cortisol dynamic measures, i.e. a shallower diurnal fall, and a smaller CAR. Both dynamic measures were also inversely related to age. The association between OCP and diurnal fall remained significant after controlling for age. Magnitudes of correlations of specific tests with age and with cortisol diurnal fall strongly mirrored each other, with higher correlations being found for HVLT tests and trail-making Form B, suggesting the relevance of cognitive tests which emphasise declarative memory and executive functioning.

5. Discussion

Previous studies have tended, but with much inconsistency, to show poorer cognitive performance to be associated with higher basal levels of cortisol. Inconsistent results may be due to a scarcity of studies which have looked at the full diurnal cycle and mapped cortisol levels to time of day and time of awakening. This may indeed be an important consideration: we found no association between poorer OCP and higher overall mean cortisol, but a trend for opposite effects for the post-awakening mean (i.e. a positive correlation) and the daytime cortisol mean (a negative correlation).Thus the overall null finding is the result of the cancelling-out of directionally opposite trends at those different periods of the day which we have measured in this study. Since the overall mean, however, combines a very brief period (post-awakening) and a much longer period (rest of the day), it is important to emphasise that our results would still be consistent with the view that poorer OCP may be associated overall higher mean cortisol secreted over an entire 24 h cycle if that was accurately measured.

However the clearest findings in this study do not concern mean levels of cortisol but point instead to the importance of dynamic change in them. Individuals who performed better on the cognitive tests tended to have a more dynamic CAR, i.e. their cortisol rose to higher peaks in the thirty minutes after awakening, and then showed an equally more dynamic (steeper) average fall from that peak. By extension, poorer OCP was associated with an attenuated CAR and a shallower cortisol fall across the day. The effects for diurnal fall were larger than those for CAR and withstood statistical control for absolute levels of cortisol at 30 min after awakening.

The association of an attenuated CAR with age and poorer OCP is consistent with a role for the hippocampus in the regulation of post-awakening cortisol secretion. Research shows that the CAR is attenuated in patients with memory disorder related to hippocampal damage (Buchanan et al., 2004; Wolf et al., 2005) as well as reduced hippocampal volume (Dedovic et al., 2010). This evidence indicates that functional integrity of the hippocampus is associated with the CAR and it has been suggested by these authors that there is a causal linkage (see also Clow et al., 2010). The data presented here is consistent with these hypotheses as the cognitive tests most closely associated with reduced dynamics of cortisol secretion were those mostly closely associated with hippocampal function. There may also be parallels here between dynamic endocrine and dynamic autonomic measures, notably heart rate variability (HRV). Although a recent

study by Stalder et al. (2010) found no easily interpreted relationships between measures of CAR and HRV, the latter has been linked to adaptive cognitive functioning, notably in regard to executive functioning (Thayer et al., 2009) and both may be useful indices to monitor when researching, for example, associations between neuroplasticity and variables such as activity or exercise.

The relationship between poorer OCP and a flatter cortisol slope across the day invites comparison with several studies where such a profile has been linked to a variety of adverse mental and physical outcomes, e.g. poorer maternal relationships (Adam and Gunnar, 2001) post-traumatic stress disorder (Yehuda et al., 2005), poorer prognosis in breast cancer patients (Sephton et al., 2000), poorer declarative memory performance, social support, and perceived stress (Abercrombie et al., 2004).

The post-awakening period of cortisol secretion is short (typically no more than 45 min) and the rate at which lower levels, which characterise most of the day, are re-established, may be a relevant dynamic in determining exposure to cortisol over the day as a whole. It is interesting that the post-hoc examination of our data indicated that the fall from peak to just three hours post awakening seemed to be the crucial period of fall, where lower and higher OCP individuals most differed from each other. This could suggest that the rate of cortisol fall immediately following the CAR period may be a crucial factor in determining long-term exposure to higher cortisol levels which is theoretically linked to poorer aspects of cognition (de Quervain et al., 2009). It is noteworthy that the fall in cortisol over a similar interval was predictive of cognitive performance in a study by Power et al. (2008).

Both dynamic cortisol measures were related to age as well as OCP. For the CAR, the significant zero-order correlation with OCP was itself a relatively small effect size and its significance did not withstand partial correlation analysis controlling for age. However diurnal fall was still significantly related to OCP when the effects of age were partialled out. The evidence is thus further supportive of the view that less steep diurnal fall may ultimately lead to chronically greater overall daytime cortisol exposure and, possibly therefore, increased vulnerability to age-related cognitive decline. Longitudinal research will of course be crucial in investigating further any possible causal contribution that diurnal fall may make to cognitive decline.

A secondary objective of this study was to examine whether associations would be apparent in some cognitive domains more than in others. More specifically, we expected that poorer performance on tests of declarative memory, linked to the hippocampus, and tests of executive function, linked to the pre-frontal cortex, would be selectively associated with both older age and cortisol measures. This expectation was borne out. The learning and memory measures of the HVLT and the Trail-making Form B measure accounted for most of the associations with cortisol and age. By contrast measures such as reading ability, often used in clinical studies as a proxy for pre-morbid IQ, and the Trail-making Form A, a test of relatively simple processing speed were not related to cortisol or age.

A limitation of the study was the modest sample size. However this limitation is offset by the very careful collection of both cortisol measures and those of cognitive performance collected by trained research associates within the participants' home setting. Confidence in data is especially an issue for post awakening salivary cortisol measures collected within the domestic setting; where non-adherence to sampling regime is known to substantially affect the quality of the resultant data (Broderick et al., 2004). Confidence in compliance is increased if participants' self-reports of saliva sample collection times can be linked to an independent index of awakening time, which was a significant strength of this study (Evans et al., 2007), and the patterns and levels of cortisol secretion on two consecutive days were consistent. Additionally the intensive nature of the study, involving two home visits by our researchers, meant there was a very high level of engagement by project participants, who were keen to follow the instructions accurately, and had ample time and opportunity to ask questions about the methodology. Other limitations of the current study are the cross-sectional design and the relatively high socio-economic status (SES) of the participants. Certainly caution needs to be exercised in any generalization of our findings to populations significantly lower in SES.

In conclusion, we have confidence in the robustness of our findings for the population represented, with hypotheses in large degree supported by the data. Shallower diurnal cortisol fall appears to be a significant independent predictor of poorer OCP whilst also being a marker of increasing age. Results suggest that the decline in cortisol levels from the post-awakening peak may be a very relevant factor deserving further enquiry.

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