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Resilience in the face of unemployment:

Developmental trajectories of protective resources.

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I, Richard John Shaw, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

Aim: The aim of the thesis was to identify how resources, developed in childhood, could help overcome adversity in adult life.

Methods: The analysed data came from the National Child Development Study. Resources were indicated by externalizing and internalizing symptoms, reading, mathematics and BMI. Operationalization of the resources was conducted using data measured at a single time point and group based developmental trajectories identified by mixture models. Associations between the developmental trajectories and birthweight, preterm birth and parental social class were tested in order to identify the trajectories' origins at birth.

A source of adversity was indicated by unemployment. Logistic regression was used to test if the resources could protect people from experiencing unemployment. Statistical interactions between unemployment and resources in the prediction of health consequences were used to test for resilience to the consequences of experienced unemployment. Health consequences were assessed by self rated health, limiting longstanding illness, Malaise, GHQ and weight change.

Results and conclusions: For both genders, group based developmental trajectories provided a reasonable summary of the data for externalizing symptoms, reading and mathematical ability and BMI. Parental social class was associated with all the disadvantaged developmental trajectories. Low birthweight and preterm birth were associated with disadvantaged emotional and cognitive development, and high birthweight was associated with trajectories that contained individuals who had a high BMI throughout childhood but did not develop adult obesity.

For women, the associations between unemployment and health consequences were limited. The only indicator of (lack of) resources associated with unemployment was internalizing symptoms.

For men, unemployment represented a challenge to health, all the resources protected men from experiencing unemployment, and reading skills and internalizing symptoms indicated resilience to the health consequences of unemployment. The theoretical and methodological issues raised by the use of developmental trajectories and traditional methods are discussed.

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Abbreviations

AIC	Akaike's Information Criteria
aLRT	Lo Mendell Rubin Likelihood Ratio Test, otherwise known as the adjusted Likelihood Ratio Test.
BCS70	The 1970 British Cohort Study
BIC	Bayesian Information Criteria
BMI	Body Mass Index
BSAG	Bristol Social Adjustment Guide
CFI	Confirmatory Fit Index
CVD	Cardiovascular disease
FIML	Full Information Maximum Likelihood
GHQ	General Health Questionnaire
MAR	Missing At Random
MCAR	Missing Completely At Random
MNAR	Missing Not AT Random
NCDS	National Child Development Study
NFER	National Foundation for Educational Research in England and Wales
PMS	British Perinatal Mortality Survey
RGSC	Registrar General's Social Classification
RMSEA	Root Mean Square Error of Approximation
ssaBIC	sample size adjusted Bayesian Information Criteria
SSRIs	Selective Serotonin Reuptake Inhibitors

Chapter 1: Introduction

The idea behind this thesis was to combine the concept of resilience with an interest in life course development. Thus the aim of this thesis became to understand how the ability to withstand adversity in adult life develops in childhood. The greatest challenge in achieving this was constructing a definition of resilience that was theoretically valid and could be operationalized with the data available.

1.1. Resilience

Resilience has been defined in many contradictory atheoretical ways which are often synonymous with other terminology (Kaplan, 1999). Often conceptual models define resilience and similar terminology without any theoretical justification. Some of the more didactic definitions of resilience, rather than providing a useful conceptual model, simply raise questions about the definer's ability to apply logic. However, within the resilience literature, some relatively common themes and conceptually distinct ideas could be found which enabled the operationalization of resilience.

The resilience concept that most strongly shaped this thesis was that 3 key requirements need to be identified to operationalize resilience. These requirements are; that there is exposure to a risk or adversity (Glantz & Sloboda, 1999; Luthar, Cicchetti & Becker, 2000; Masten, 2001), that there is a positive outcome or adaptation to that adversity (Luthar et al., 2000; Glantz & Sloboda, 1999), and that there is way of indicating protective mechanisms (Masten, Hubbard, Gest, Tellegen, Garmezy & Ramirez, 1999; Windle, 1999; Garmezy, 1993). Identifying variables that met these requirements within the data available shaped this thesis.

1.1.1. Operationalizing resilience

The original plan was to use data from both the National Child Development Study (NCDS) (Power & Elliott, 2006) and the 1970 British Cohort Study (BCS70) (Elliott

& Shepherd, 2006). As the hypotheses developed it became apparent that it was only practical to utilize data from one of these studies. The NCDS was selected for analysis because there were more sweeps (waves) of data available and fewer problems with missing data. The use of the NCDS determined what variables were available to indicate a risk/adversity, an outcome and protective mechanisms.

The risk / adversity

Ideally the risk/adversity would have met two criteria. The first criterion was that the adversity would be directly experienced by people rather than merely being a probabilistic challenge to health. The second criterion was that everybody within the population would be equally likely to have experienced the adversity. However, it is unlikely that an indicator meeting the second criteria would ever be common enough in a population to be useful for analysis.

For something to be analysed statistically it has to be a reasonably common occurrence. However, unless an adversity is incredibly rare, a combination of human nature and technological development will identify these adversities and take remedial action. Individuals with more wealth and power are likely to be those who have best access to means of avoiding adversity. Thus only very rare or unidentified risks are likely to be distributed randomly within the population. Neither very rare nor unidentified risks are practical propositions for analysis and so the measure of adversity was selected on the first criterion alone. As a consequence two types of protective mechanism could be modelled; firstly, protecting people from experiencing an adversity and secondly resilience to experiencing the consequences of an adversity.

A number of ways of operationalizing the risk/adversity were investigated. One possible option was to construct a life events scale which would contain items such as death of family members, moving home, changing jobs and marital separation (see Sarason, Johnson and Siegel (1978) or Hobson, Kamen, Szostek, Nethercut, Tiedmann and Wojnarowicz (1998) for more examples). However, there were not sufficient items available in the data set for this to be practical. Thus the aim was to select one particular type of event that would be sufficiently common for a reasonable proportion of the population to be exposed.

The event selected was unemployment. Using unemployment as the indicator of risk/adversity was not without problems but unemployment is a set of circumstances that require a response. One limitation of unemployment is that it does not necessarily lead to increased adversity for all individuals. Some people have improved health following unemployment (Dooley, Fielding & Levi, 1996; Bartley, Ferrie & Montgomery, 1999). Thus unemployment in the remainder of the thesis is described as a more general challenge, which for the majority would indicate adversity, but might for a minority indicate an opportunity for improved circumstances.

The positive outcome

It was decided to assess overcoming adversity with 4 measures commonly used to assess health. These measures were, self rated health (Manor, Matthews & Power, 2001), limiting longstanding-illness (Manor et al., 2001), the Malaise inventory (Rutter, Tizard & Whitmore, 1970) and the General Health Questionnaire (GHQ) (Goldberg, Gater, Sartorius, Ustun, Piccinelli, Gureje et al. 1997). In addition, it was decided that a measure based on BMI should be used to assess successfully overcoming unemployment. Initial thoughts were to use a measure of obesity. However, there is evidence that some individuals increase weight in response to stress whilst others lose weight (Kivimäki, Head, Ferrie, Shipley, Brunner, Vahtera et al. 2006) and it was decided a measure of BMI change should be used instead.

The resilience mechanism

Resilience to the effects of experiencing adversity is operationlized by identifying a simple mechanism. When people are faced with a challenge they will draw on resources to overcome the problems they face. The type and quantity of resources will determine how people will respond to the challenge and hence modify the effects that the challenge has on an outcome. In addition, an aim of the thesis was to model the development of resources, thus measures used to indicate resources had to be repeated throughout childhood. As demonstrated in chapter 2, emotional well-being, cognitive ability and body mass have the potential to indicate resources that modify unemployment's effects on health. Furthermore, measures of all three indicators of resources were recorded in each childhood sweep of the NCDS, enabling the development of resources across childhood to be modelled.

1.2. Development in childhood

The ideas on how to model childhood development were constructed in parallel to building the theories for resilience. Initial thoughts were to use path analysis to track development from early life characteristics, such as birthweight, gestational age and social class. However, such variable based methods, although identifying the chance that a person from a particular background will arrive at a destination, assume that everybody at a particular destination has the same characteristics irrespective of which route they took to get there. Instead, a person based approach was selected for the analyses. Person based approaches to analyses aim to identify individuals or homogenous groups of individuals by combining information from multiple variables, and in this thesis the models chosen to explain the data are developmental trajectories.

Developmental trajectories encompass a number of person based methodologies including; latent growth curve analysis, hierarchical linear modelling, growth mixture models, latent class growth analysis, latent profile analysis and latent class clustering. These methods allow information recorded at different times to be combined. Some methods, such as latent growth curve analysis and hierarchical linear modelling, model individual rates of development using continuous latent variables. Others methods, such as latent profile analysis and latent class clustering, enable the identification of qualitatively distinct groups using categorical latent variables, whilst growth mixture models include both continuous and categorical latent variables.

In the next chapter, the concepts behind resilience and developmental trajectories are expanded and the benefits of taking such approach are discussed. Additionally, evidence is presented to explain why unemployment represents challenges and why emotional well-being, cognitive ability and BMI indicate resources that can both protect against and provide resilience to unemployment.

Chapter 2: Unemployment and the development of protective resources: theoretical framework and review

2.1. Introduction

The aim of the thesis is to identify how resources, developed in childhood, could protect against adversity in adult life. Unemployment is used as an example of an adversity which people will face depending on the vagaries of the economic climate and people's resources. Resources in this thesis will be indicated by measures of emotional well-being, cognitive ability and Body Mass Index (BMI). The development of resources from childhood through to early adulthood will be modelled using data from the National Child Development Study (NCDS).

This chapter starts with a review and discussion of the evidence and mechanisms through which unemployment has an association with health. This is followed by the evidence that resources, as indicated by emotional well-being, cognitive ability and BMI, help prevent unemployment.

The second section of this chapter concerns those who experience unemployment. In this section the deficiencies of main effects models in explaining protection are discussed, the concept of resilience is introduced, and evidence to explain why emotional well-being, cognitive ability and BMI may provide protection specifically against unemployment is presented.

The third section discusses the benefits of using group based developmental trajectories to understand how resources develop. In addition, the possibility that people on different trajectories will experience different consequences is discussed.

The chapter concludes by summarizing the evidence and pointing ahead to the following chapters in this thesis.

2.2. The impact of unemployment on health

It has long been established that people registered as unemployed generally have poorer health and higher mortality than those in work (Whitehead, Drever & Doran, 2005; Ferrie, Shipley, Marmot, Stansfeld & Smith, 1995; Bartley et al., 1999; Dooley et al., 1996; Thomas, Benzeval & Stansfeld, 2007; Bartley, Sacker & Clarke, 2004).

In a systematic review of 104 studies, McKee-Ryan, Song, Wanberg and Kinicki (2005) found associations between unemployment and psychological and physical health and measures of life satisfaction. Psychological outcomes, which made up 77% of the correlations in the meta-analysis included, hostility, depression, frustration, anger, guilt, anxiety, psychiatric disorders, suicide and life or career satisfaction (McKee-Ryan et al., 2005). Physical health outcomes identified included; cardiovascular, immunological, gastrointestinal, biochemical and physical disease (McKee-Ryan et al., 2005). Although unemployment has been shown to be associated with many outcomes, the mechanisms which underlie this association have been disputed.

2.2.1. Mechanisms for unemployment's impact on health

Many mechanisms have been proposed to explain the associations between unemployment and health. They are not mutually exclusive (Bartley, 1994) and follow two basic types: causal mechanisms, for which unemployment indicates processes that are damaging to health, and selection mechanisms, which result in those with increased risk of ill health losing their jobs.

Causal mechanisms

Causal effects occur when unemployment has a direct role in the development of subsequent health. The best evidence for unemployment's effect on health is provided by individual level longitudinal panel data which allows for some statistical control of possible selection effects (Dooley, 2003). Many studies have shown an association between employment status and health after adjusting for pre-existing health (Montgomery, Cook, Bartley & Wadsworth, 1999; Virtanen, Vahtera, Kivimäki, Liukkonen, Virtanen & Ferrie, 2005b; Ferrie, Martikainen, Shipley, Marmot, Stansfeld & Davey Smith, 2001a; Bartley et al., 2004; Power, Li & Manor, 2000). There have also been studies that have demonstrated that the effects of unemployment have been found to be reversed on reemployment (McKee-Ryan et al., 2005).

A number of causal mechanisms have been proposed including, unemployment as a stressful life event, the absence of the resources provided by employment and unemployment as a turning point.

Unemployment has been portrayed in a large number of reviews as a highly stressful experience that provokes reactions such as anxiety, depression and lowered physical health among those who lose jobs (McKee-Ryan et al., 2005). For example, Holmes and Rahe (1967) found that getting fired from work is among the top eight life events requiring significant adjustment: only the death of a spouse or a close family member, divorce, marital separation, marriage and jail terms required greater adjustment. In addition to the initial stresses of becoming unemployed (Kinicki, Prussia & McKee-Ryan, 2000), long-term unemployment has stressful effects. There is evidence that as length of unemployment increases so do levels of serum cortisol, which is used to indicate stress (Maier, Egger, Barth, Winkler, Osterode, Kundi et al. 2006). Gender has been shown to affect sensitivity to stress, and may alter choice of coping strategies (Kivimäki et al., 2006) leading to differing effects by gender of unemployment. Unemployment has fewer adverse health consequences for individuals who do not experience the stresses of unemployment. For example, the effects of unemployment have been shown to be weaker for those who do not experience financial strain (Thomas et al., 2007). The latter would suggest that unemployment also has an effect because it represents an absence of the resources that are provided by employment.

A large number of resources are provided by employment. These include income, time structure, social support and a goal and meaning to life and these resources are critical for healthy development (Dooley et al., 1996; McKee-Ryan et al., 2005). Those who place less emphasis on employment to provide these needs have better health outcomes when unemployed (McKee-Ryan et al., 2005), and this may be especially true of women who have more well defined roles outside employment (Arber, 1997).

An alternative mechanism is that unemployment forces people to leave their current careers and seek employment in new areas thus acting as a turning point in a life course trajectory. Those people with the poorest job opportunities are more likely to be forced into unsatisfying and insecure jobs, with low wages, few perks and a heavy work load (Dooley et al., 1996). Thus individuals are exposed to socio-economic adversities such as income insecurity, low or no accumulation of pensions and poor opportunities for promotion (Virtanen et al., 2005b). The effects on mental and physical health of job insecurity (Ferrie, Shipley, Newman, Stansfeld & Marmot, 2005; Ferrie, Shipley, Marmot, Martikainen, Stansfeld & Smith, 2001b) and temporary employment (Virtanen, Kivimäki, Joensuu, Virtanen & Elovainio, 2005) are well established. Those who have been found to be reemployed into insecure jobs have been shown to have higher morbidity after adjusting for baseline characteristics (Ferrie et al., 2001a). Indeed for some workers, employed in the poorest jobs, unemployment may even lead to a recovery of health (Dooley et al., 1996; Bartley et al., 1999).

The effects of a disrupted employment trajectory may be less for some workers, particularly women who are more commonly employed in peripheral areas of the labour market (Virtanen et al., 2005b) and whose careers are naturally more disrupted (Arber, 1997). There is evidence that unemployment has an effect on health for women but it is less than for men (Artazcoz, Benach & Borrell, 2004).

Selection mechanisms

The alternative to mechanisms through which unemployment has a causal role in the development of health, are mechanisms which select people into or out of employment on criteria that are linked to health. Selection arises when an employer is selecting prospective employees or making a decision on who is to be made redundant. Those workers with the most favourable characteristics gain or regain a place in the "core" of the labour market with more secure jobs (Fergusson, Horwood & Ridder, 2005b). Selection can be directly made on the basis of health, for example, limiting longstanding illness is associated with increased risk of unemployment (Lindholm, Burström & Diderichsen, 2002). People with pre-existing health problems have been shown to have much reduced chances of reemployment (Claussen, Bjorndal & Hjort, 1993), and high sickness absence has been associated with job termination among women on temporary contracts and older workers on permanent contracts (Virtanen, Kivimäki, Vahtera, Elovainio, Sund, Virtanen et al. 2006). Alternatively, the effects of unemployment could be due to indirect selection (Bartley, Ferrie & Montgomery, 2005).When indirect selection occurs, people are selected on traits, such as education which are associated with both employment (Caspi, Entner Wright, Moffitt & Silva, 1998) and health (Chandola, Clarke, Morris & Blane, 2006).

2.2.2. Summary: unemployment and health

In summary, unemployment's association with health is due to several processes which are not mutually exclusive. Some of these processes are "causal" with unemployment playing a direct role in the development of health. There are also factors that select whether people become unemployed, thus identifying a manner in which people may be protected from experiencing unemployment.

2.3. Protection against employment

There are many factors on which people may be selected for unemployment, and they include physical development, cognitive ability and psychological capacities (Bartley et al., 1999). In this thesis indicators of emotional well-being, cognitive ability and body mass will be tested to see if they protect against unemployment.

2.3.1. Emotional well-being

Emotional well-being can be been defined as "a holistic state which is present when a range of feelings among them energy, confidence, enjoyment, happiness, calm and caring are combined and balanced" (Edmunds & Stewart-Brown, 2003). This is one of many definitions and there is much conceptual and theoretical disagreement surrounding definitions in the literature (Gallo & Matthews, 2003). Measures of emotional well-being in children rather than focusing on positive behaviour and feelings have been typically operationalized by the presence of negative symptoms and behaviour that is considered disruptive for others. Factor analysis of these behaviours tends to identify 2 or 3 factors with similar items and when additional factors are identified the comparability across studies is reduced (Ghodsian, 1977).

Two factor solutions generally represent internalizing and externalizing symptoms. Externalizing symptoms are characterized by an under control of emotions (Buchanan & Ten Brinke, 1998). Items measuring externalizing symptoms include, difficulties in interaction with other children and at home, difficulties in concentration, having a strong temper and being argumentative (McCulloch, Wiggins, Joshi & Sachdev, 2000). Internalizing behaviour is characterised by an over control of emotions and can lead to depressive disorders (Buchanan & Ten Brinke, 1998). Items used to measure internalizing symptoms include being withdrawn, demanding attention, being too dependent or clingy and feeling worthless or inferior (McCulloch et al., 2000).

Employment status has been associated with both externalizing symptoms such as antisocial behaviour and behavioural problems (Montgomery, Bartley, Cook & Wadsworth, 1996; Caspi et al., 1998; Virtanen, Kivimäki, Elovainio, Vahtera, Kokko & Pulkkinen, 2005a; Fergusson et al., 2005b; Fronstin, Greenberg & Robins, 2005; Montgomery et al., 1999; Kokko & Pulkkinen, 2000) and with internalizing symptoms (Claussen et al., 1993; Virtanen et al., 2005a; Feinstein, 2000; Bildt & Michelsen, 2003). In general people with poorer emotional well being have higher rates of job turnover (Caspi et al., 1998; Fronstin et al., 2005). The effects may be different for boys in comparison to girls: boys considered to be antisocial at age 10 are at greater risk of unemployment in early adulthood, whereas girls who scored similarly tended to earn more than their peers (Feinstein, 2000).

Emotional well-being could be protective against unemployment through a number of mechanisms. This could be direct, for example depressed people suffer from diminished interest in most daily activities and a lack of energy (Caspi et al., 1998; Breslin, Gnam, France, Mustard & Lin, 2006), which in turn would lead them to be less able or motivated to search for a job (Fronstin et al., 2005). Alternatively, the mechanisms could be indirect, for example behavioural problems disrupt educational attainment (van Bokhoven, Matthys, van Goozen & van Engeland, 2005), and thus lead to individuals having lower levels of job skills (Fronstin et al., 2005). In addition, there may be other factors such as parental socio-economic status, which are associated with both behaviour and labour market outcomes (Fronstin et al., 2005).

Thus there is evidence and plausible mechanisms to explain why emotionally well people are less likely to experience unemployment.

2.3.2. Cognitive ability

Cognitive ability in this thesis is operationalized by reading and mathematics scores. The distinction between mathematics and reading is being made because despite there undoubtedly being some general underlying cognitive factors relating the two (Gottfredson, 2004), there is evidence that there are differing underlying cognitive abilities in the development of mathematics and reading (Taylor, Burant, Holding, Klein & Hack, 2002).

Educational qualifications are determined by a combination of social circumstances and an individual's cognitive ability (Chandola et al., 2006) and have been proposed as providing protection against unemployment (Bynner, Wiggins & Parsons, 1996b). There is evidence for this as both educational qualifications (Montgomery et al., 1996; Kristensen, Bjerkedal & Irgens, 2004) and individual cognitive ability measures such as reading (Caspi et al., 1998), numeracy (Bynner & Parsons, 2001) and IQ (Fergusson, Horwood & Ridder, 2005a) are associated with employment status. The importance of reading and mathematics may be different for each gender. Women's reading scores have been found to be more important predictors of unemployment and wages than women's mathematics scores. In contrast, both men's reading and mathematic scores have been shown to be predictors of male wages and employment (Currie & Thomas, 1999). However, there are also times when the labour market has been benign and those with limited qualifications have been able to find jobs (Bynner & Parsons, 2001).

Cognitive ability will protect people from experiencing unemployment through many mechanisms, for example basic skills such as reading and simple arithmetic improve an individual's ability to compete in the labour market (Caspi et al., 1998). In addition, those with low cognitive ability may find school stressful and have poorer emotional well-being (Masten, Roisman, Long, Burt, Obradovic, Riley et al. 2005), whilst those with high cognitive ability may develop confidence, leadership skills and a network of peers which will help with subsequent achievement (Caspi et al., 1998). Cognitive ability is also likely to be correlated with underlying social position (Bynner et al., 1996b) and health characteristics (Power & Hertzman, 1999) on which people may be selected into employment. Thus there is evidence that cognitive ability indicates resources that protect against unemployment, and there are plausible mechanisms to explain the protection.

2.3.3. BMI

Body mass in this thesis will be operationalized by the BMI which is a measure of relative weight and is calculated as follows,

BMI = weight (kg) / Height $(m)^2$ (Sadler, Garrow, Fehily, Prentice, Kopelman, Flynn et al. 1999).

There is some evidence that BMI is associated with unemployment. For women, it is the obese end of the spectrum that has the strongest association with unemployment (Sarlio-Lähteenkorva & Lahelma, 1999; Tunceli, Li & Keoki Williams, 2006), and there is evidence that obesity in childhood increases the risk of never being gainfully employed (Viner & Cole, 2005).

For men, there is some evidence that both obesity (Tunceli et al., 2006) and being too thin are associated with increased risk of unemployment (Sarlio-Lähteenkorva & Lahelma, 1999; Montgomery, Cook, Bartley & Wadsworth, 1998). The association between BMI and unemployment has been investigated in few longitudinal studies (Laitinen, Power, Ek, Sovio & Järvelin, 2002; Sarlio-Lähteenkorva & Lahelma, 1999) so the direction of causality is not clear. However, there is some evidence that the associations are bi-directional (Montgomery et al., 1998), and there are plausible mechanisms to explain why both obese men and women, and thin men are at increased risk of unemployment.

Those with higher BMI's have been found to be at increased risk of many social problems (Gortmaker, Must, Perrin, Sobol & Dietz, 1993; Power, Lake & Cole, 1997b). Obese and overweight individuals have been found to be discriminated against at every stage of the employment cycle including selection, placement, promotion, discipline and discharge (Roehling, 1999). This is particularly true for women. Recruitment experiments have found that obese women are more likely to be discriminated against (Ding & Stillman, 2005; Roehling, 1999; Brink, 1988; Rothblum, Miller & Garbutt, 1988). In addition, obesity may be a result of eating patterns developed in response to stress or underlying emotional problems (Korkeila, Kaprio, Rissanen, Koshenvuo & Sörensen, 1998). Thus, there are indirect mechanisms which could explain why heavy individuals are at increased risk of unemployment.

Thin women are unlikely to face discrimination in the labour market. For women, being thin is equated with beauty (Rothblum et al., 1988). The opposite is true for men. Skinny men are often the object of ridicule and are not considered masculine (Saporta & Halpern, 2002). There are professions for which men may lose their job if they become too thin (Prentice & Jebb, 2001) and this may not solely relate to jobs where physical attributes are required. Thin male lawyers have also been shown to have lower wages than lawyers of average weight (Saporta & Halpern, 2002).

Thus there is evidence and plausible mechanisms to explain why BMI is likely to indicate a degree of protection against experiencing unemployment.

2.3.4. Summary: protection against unemployment

There are reasons to explain why emotional well-being, cognitive ability and BMI could be indicative of factors that protect against experiencing unemployment. There is considerable evidence that cognitive ability and emotional well-being are indicators of protection against unemployment. The direction of causality between BMI and unemployment needs further investigation. It is likely that the processes are different for men and women.

2.4. Resilience in the face of unemployment

There is a second way in which resources can protect against the effects that unemployment has on health; that is to minimise the effects of unemployment. McKee-Ryan et al. (2005) created a taxonomy of factors that could protect against the consequences of unemployment. This taxonomy included factors such as personal, social and financial resources, coping strategies and demographic factors. McKee-Ryan et al. (2005) then conducted a meta-analysis to establish what evidence there was for protective effects. The results of the meta-analysis did identify factors that indicated better health for unemployed people but there were some flaws with the methodology. The focus was on main effects in populations of unemployed people so could not distinguish between general factors that enhanced well-being in all groups and factors that had protective effects specific to those experiencing unemployment.

The results for gender illustrate the flaws. Unemployed men were found to have fewer mental health problems than unemployed women (McKee-Ryan et al., 2005). This contradicts the general consensus, as acknowledged by Mckee-Ryan et al. that the effects of unemployment are generally less for women (McKee-Ryan et al., 2005; Artazcoz et al., 2004). The reason why unemployed women have worse health than unemployed men is that women generally have higher levels of depression and psychological distress (Breslin et al., 2006; Piccinelli & Wilkinson, 2000; Sacker & Wiggins, 2002). Thus there is a need to conceptualize research in a manner that acknowledges this and enables specific protective effects to be distinguished from main effects. The concept of resilience provides appropriate models.

2.4.1. History of resilience

The concept of resilience was developed in the field of developmental psychopathology (Masten, Best & Garmezy, 1990). It is not a unique concept being one of many that focus on predictors of well-being (Kaplan, 1999). In this context the term "resilience" was first coined in the 1970's by Garmezy (Garmezy & Streitman, 1974; Garmezy, 1971) who was trying to identify factors that might explain the origins and course of schizophrenia (Cicchetti & Garmezy, 1993). During this period other authors such as Rutter (1971), Anthony (1974), Elder (1974), and Werner and Smith (1979) were developing similar concepts. However, these authors did not use the term resilience until the '80s. Since then a wide variety of conflicting definitions and terminology have developed in the literature (Luthar & Cushing, 1999).

2.4.2. Definitions

The most commonly used definition of resilience is;

"Resilience refers to the process of, capacity for, or outcome of successful adaptation despite challenging or threatening circumstances" (Masten et al., 1990, p.424).

This is one of many different definitions (see table 2.1), which have been made arbitrarily (Staudinger, Marsiske & Baltes, 1993). The definitions are laden with subjective frequently unarticulated assumptions and there are often major logical,

Table 2.1: Resilience definitions: a subjectively selected sample

Source	Definition
Baldwin et al., 1993	Resilience is a name for the capacity of the child to meet a challenge and use it for psychological growth.
Bender & Castro, 2000	A universal capacity which allows a person, group or community to prevent, minimize or overcome the damaging effects of adversity.
Luthar et al., 2000	Resilience refers to a dynamic process encompassing positive adaptation within the context of significant adversity.
Masten et al., 1999	The construct of "resilience" broadly refers to the class of phenomena involving successful adaptation in the context of significant threats to development.
Masten et al., 1990	Resilience refers to the process of, capacity for, or outcome of successful adaptation despite challenging or threatening circumstances.
Oxford English Dictionary, Simpson & Weiner, 1989	Definition 1 a The act of rebounding or springing back; rebound, recoil.
	Definition 1 b. Revolt, recoil from something.
	Definition 2. The Power of resuming the original shape or position after compression bending, etc. spec the energy per unit volume absorbed by a material when it is subjected to strain, or the maximum value of this when the elastic limit is not exceeded.
Rutter, 1990	Resilience, the term used to describe the positive pole of ubiquitous phenomenon of individual difference in people's responses to stress and adversity.
Staudinger et al., 1993	Resilience refers to the potential for maintenance and regaining of levels of normal adaptation: that is residence is a subtype of the broader range of changes in adaptive capacity encompassed by plasticity.
Waller, 2001	Resilience simply stated, is positive adaptation in response to adversity.

measurement and pragmatic problems (Glantz & Sloboda, 1999) and because of this resilience's validity has been questioned (Cicchetti & Garmezy, 1993; Kaplan, 1999). As such resilience needs to be clearly operationalized and defined (Roosa, 2000; Cicchetti & Garmezy, 1993; Luthar et al., 2000). However, as Antonovsky (1984) suggested, rather than keep asking "what keeps one from getting sicker?" it is useful to ask how one becomes healthier as this will help us to develop models which may more accurately predict health than the deficit model (Werner, 1989). The concept of resilience has overturned many of the assumptions of deficit-focused models about the development of children (Masten, 2001), however, its application to adults has been somewhat limited so far.

There are many ways of conceptualizing resilience. The most important two concepts are resilience as a trait and resilience as a process.

Resilience as a trait

In early resilience research it was implied that resilience was a trait of individuals; Werner (1993) attributed successful outcomes amongst high risk children to those children's dispositions. Such explanations, however, were produced in part because they create entertaining stories of heroism and super human individuals (Tarter & Vanyukov, 1999). As a consequence people's abilities at overcoming obstacles and disabilities, were often ascribed to them being special people (Glantz & Sloboda, 1999) with little attributed to the environment in which they lived.

This has had two consequences. Firstly, the actual reality of adverse circumstances can be lost and with it the ability to understand what actually happens. Resilience, defined as a trait, can be invoked when other explanations are not found (Bartelt, 1994). This raises the risk of "ontogenetic fallacy" (Waller, 2001), in which the success has been attributed to factors within the individual, when equally environmental circumstances could have contributed to the success (Beauvais & Oetting, 1999). Attributing resilience to traits of individuals thus places a barrier to understanding the processes through which resilience arises, and it is understanding these processes that enables interventions to be developed (Luthar & Cicchetti, 2000).

Secondly, defining resilience as a trait judges both "resilient" and more vulnerable individuals unfairly. Terms such as "vulnerable but invincible" (Werner, 1989, p.160), and statements which suggest that resilience has been achieved by those who have "pulled themselves up by their own bootstraps" (Werner, 1997, p.105), may make emotive reading but also create unfair and unrealistic expectations of both resilient and non resilient people.

There is the risk that such language will spawn contemptuous views of non resilient or vulnerable individuals (Walsh, 1998). This tendency to pathologize suffering has been labelled as "blaming the victim" (Waller, 2001, p.291). Victim blaming has been used to suggest that the social problems of ethnic minorities are their own fault rather than recognizing society's responsibility in the formation and maintenance of these social problems (Waller, 2001).

Furthermore, this approach leads to resilient people being expected to carry on being resilient irrespective of how they are subsequently treated. However, exposure to adverse circumstance of extreme duration will lead even resilient individuals to have poor development irrespective of their constitution (Garmezy, 1993), and in part resilient children remain handicapped by the experience of early social disadvantage (Schoon & Parsons, 2002).

Thus resilience must be phrased very carefully to ensure it is not used to justify unpalatable political views (Glantz & Sloboda, 1999). Resilience is not an inherent characteristic of individuals (Waller, 2001) and does not imply resilient functioning across the board (Luthar & Cushing, 1999). Even "resilient" children will require support to overcome adversity throughout their lives (Cicchetti & Garmezy, 1993), and it has been concluded that it should be never be implied that resilience is a trait (Luthar et al., 2000).

Resilience as a process

Alternatively resilience can be defined as a process. This is done so that we can understand the mechanisms through which protective factors create resilience (Kumpfer, 1999; Rutter, 1990; Luthar & Cicchetti, 2000; Luthar, 1993), thus elucidating prevention and intervention strategies (Bradley, Whiteside, Mundfrom, Cassey, Kelleher & Pope, 1994; Luthar & Cicchetti, 2000). Additionally, the nature of resilience changes depending on the circumstances of the individual and their position in the life course. A variable may be considered a risk factor in one model (Glantz & Sloboda, 1999), yet in different circumstances it could be considered an outcome or a protective factor (Rutter, 1990; Egeland, Carlson & Sroufe, 1993).

For example, in the context of a disrupted family, divorce could be protective, however, in a less stressful family situation it could be considered a risk factor (Waller, 2001; Amato, Spencer Loomis & Booth, 1995). In addition, there will be cases where risk factors may hinder the ability of protective factors to work. This is illustrated by research on mother-child interactions. Most mothers on identifying disruptive child behaviour will respond appropriately. In contrast, a mother distracted by the stresses of poverty is less likely to correct such behaviour (Luthar et al., 2000). Thus a usually significant vulnerability factor (i.e. child disruptive behaviour) may do little to explain variations in the type of parenting displayed by a mother living in poverty (Luthar & Cicchetti, 2000).

Alternatively, a person's resilience status may change because the person may be manifesting resiliency according to one criterion but not according to another (Kaplan, 1999; Luthar & Cushing, 1999). Luthar (1991) found that children, who were exposed to a high stress environment and assessed as resilient on the basis of competent externalizing behaviour, were far more likely to have internalizing symptoms when compared to a competent group from a low stress background. In fact the resilient children's internalizing symptoms were comparable to the non-resilient group. In another study only 21% of academically resilient children manifested social competence (Luthar et al., 2000). Werner and Smith (1992) have shown that resilient children who are otherwise competent go on to have higher risk of stress related symptoms in adult life.

As life circumstances change new vulnerabilities and or strengths will emerge (Luthar et al., 2000; Cicchetti & Garmezy, 1993). Individuals may well respond very differently to the same stressors at different points in their lives (Waller, 2001), and resilience may develop at any point in life (Glantz & Sloboda, 1999). Indeed, damage caused at one point of time can be repaired at another. For example, children may recover if a discordant family becomes harmonious. Conversely no matter how good early circumstances are, a major incident in later life is likely to lead to adverse outcomes (Rutter, 1990; Masten & Obradovic, 2006).

To cope with the changing nature of resilience, either resilience needs to be based on identifying adaptation in multiple domains or resilience must be specified to the domain that it occurs in, and terms such as "educational resilience" or "behavioural resilience" should be used (Luthar et al., 2000). However, despite conceptual problems in defining resilience there are 3 generally agreed requirements.

Requirements of resilience

The three requirements of operationalizing resilience as a process are;

Firstly, a risk or adversity is required, (Glantz & Sloboda, 1999; Kaplan, 1999; Kumpfer, 1999; Luthar & Cushing, 1999; Luthar et al., 2000; Masten, 2001; Richters & Weintraub, 1990).

Secondly, a positive outcome or adaptation is required (Luthar & Cushing, 1999, Luthar et al., 2000; Glantz & Sloboda, 1999).

Finally, a protective measure must be described (Masten et al., 1999; Windle, 1999; Garmezy, 1993).

The definitions of risk, adversity, protection, vulnerability and other synonyms are potentially the greatest weaknesses of resilience research as the concepts have been blurred (Richters & Weintraub, 1990). For example, birthweight has been described as a risk variable (Windle, 1999; Masten, 2001; Wilson, 1985), a protective factor, (Barker, Forsen, Uutela, Osmond & Eriksson, 2001) and a vulnerability factor (Raum, Arabin, Schlaud, Walter & Schwartz, 2001).

If a medical disease model is being used to explain a process, identifying the risk factors and protective constitutional factors is relatively simple (Sameroff & Seifer, 1990). However, many risk and protective factors are "unrefined status variables" for which there is no clear explanation for associations with any particular outcome (Masten et al., 1990). These variables are often referred to as being uniquely protective or uniquely risk related (Stouthamer-Loeber, Loeber, Farrington, Zhang, Van Kammen & Maguin, 1993). However, one part of a variable's spectrum will be associated with the highest chance of an adverse outcome, and the other end will be associated with the highest chance of a positive outcome. Without a theoretical framework it is entirely arbitrary whether a variable is designated a risk or protective factor. This is especially important in the context of "protective factors" that are critical to survival and whose absence is impossible to observe. Low levels of a protective factor are highlighted as being a risk, suggesting an actively destructive process. Individuals associated with such risks, for example single mothers, may consequently be the recipients of harmful media coverage and policies, when in reality they are providing the best levels of protection that they can in difficult circumstances.

Conceptually it is much easier to label variables as being generic risk variables. Those in categories, which relative to other categories, have the better outcome can be said to be at "lower risk," "less vulnerable" or "more protected" whilst those in categories who have the poorest outcomes could conversely be called "higher risk," "more vulnerable" or "less protected." To distinguish meaningfully between risk and protective factors or other synonyms a conceptual model is required.

2.4.3. Models of resilience

Early models of resilience have been empirically driven (Luthar et al., 2000) and have generally taken two forms, described as person focused and variable focused (Luthar et al., 2000; Luthar & Cushing, 1999; Masten, 2001; Masten et al., 1999).

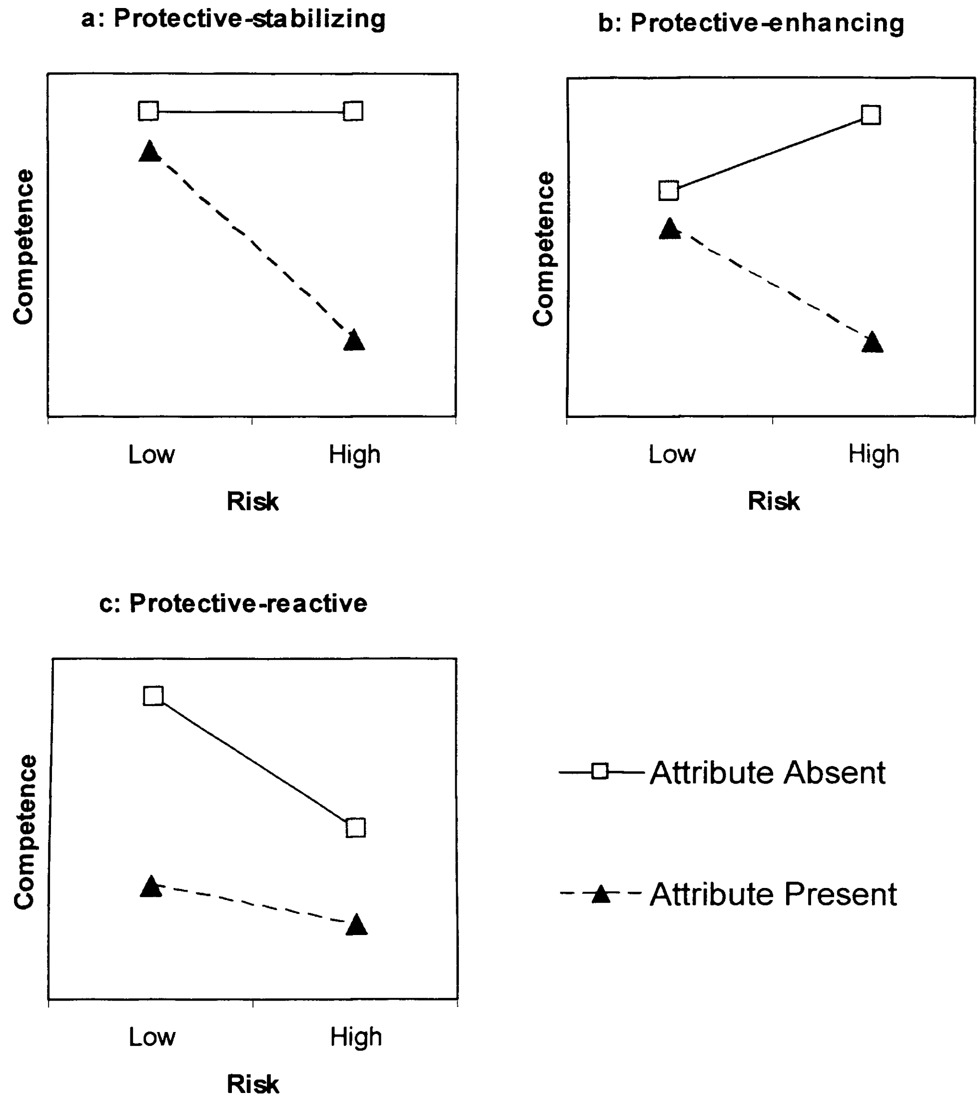
Person focused approaches in resilience research seek to classify people into resilient and non resilient groups and then identify what differentiates the two (Masten, 2001). Resilience is defined as having achieved a good outcome despite high risk status, and protective factors will be those which more commonly appear in the resilient group. Resilience in this context will be a relative concept. This methodology allows small numbers of individuals at the extremes of development problems to be examined (Luthar et al., 2000). This may be useful when looking at crime or other areas where a small proportion of individuals may be causing the majority of problems, but generalization to others in the population may be problematic if a factor is protective in the presence of adversity and a hindrance in other circumstances.

Variable focused approaches to resilience use multivariate statistics to test for linkages between outcomes, measures of adversity and factors that might compensate or protect against the consequences of adversity (Masten, 2001). Broadly 3 different types of variable focused resilience models have been identified (Fergus & Zimmerman, 2005; Schoon, 2006). The first type of model is the cumulative effects (Schoon, 2006) or compensatory model (Fergus & Zimmerman, 2005). The second is the "steeling" (Rutter, 2006) or challenge model (Schoon, 2006) and the third has been called the interaction effects (Schoon, 2006; Rutter, 2006) or protective model (Fergus & Zimmerman, 2005).

The cumulative effects model is based on the principle that there will be numerous "risk" and "protective" factors. Each risk factor independently and additively increases the risk of an adverse outcome, and each protective factor independently reduces the chance of an adverse outcome. This is essentially a main effects model and it does not distinguish itself from any other main effect models in protective research (Windle, 1999; Roosa, 2000) and if resilience is defined in this way the term resilience is redundant.

The "steeling" or challenge model is analogous to developing immunity to an infectious organism (Bender & Castro, 2000). Initial exposure to risk will have some adverse consequences. However, exposure will also enable skills and resources for overcoming exposure to the same or similar risks in the future to develop (Rutter, 2006). Thus if sufficient recovery time is allowed, the effects of subsequent exposures will be reduced.

Figure 2.1: Illustrative effects of moderator variables, in interaction with risk status in relation to competence outcomes



The interaction effects model is based on the principle that if a protective factor is present the effects of a risk factor are modified (Montgomery, Ehlin & Sacker, 2006).

There are many possible types of effects modification and not all would indicate protective processes. Luthar et al. (2000) have produced a classification system to define different types of protective processes. Classifications include "protective-stabilizing" when the attribute in question confers stability in competence despite increasing risk (see figure 2.1a), "protective-enhancing" when the attribute allows people to engage with stress such that their competence is augmented with increasing risk, (see figure 2.1b) and "protective but reactive" when the attribute generally confers advantages but less so when stress levels are high than low (see figure 2.1c). The interaction effects model potentially avoids committing fallacies and will the form the basis of the resilience model that will be used in this thesis.

2.4.4. Operationalizing resilience

The definition of resilience that will be used in this thesis is:

"Resilience is the capacity of the individual to meet a challenge and use it for growth or maintenance."

This is adapted from a definition by Baldwin, Baldwin, Kasser, Zax, Sameroff and Seifer (1993) but widening it to allow resilience to apply to adults as well as children and moving to domains beyond psychological functioning. Using such a definition, resilience can be considered an integral part of development (Baldwin et al., 1993), and the capacity to overcome challenges is provided by resources (Masten, Burt, Roisman, Obradovic, Long & Tellegen, 2004; Fergus & Zimmerman, 2005).

In this context challenges and resources will be defined as;

Challenge: challenges are circumstances to which an individual has to respond. If the individual responds well to challenges the adverse consequences will be limited. In some cases it may be impossible to avoid all adverse outcomes, whilst in others there may be beneficial growth and development.

Resource: resources can be internal factors such as self efficacy and self esteem or external factors such as support or finances. The key features of a resource are that it can be utilized to resolve a challenge. If a resource requires effort to mobilize, and this effort is not guaranteed to be successful, it may be better thought of as the opportunity or a challenge to gain the resource. The use of resources may be conscious or unconscious.

In theory, utilizing one particular resource can have both positive and negative consequences depending on which outcome is used to assess the results. In addition, a resource for one challenge may not be relevant in the context of another challenge. Thus, when making conclusions about resources, the resources should be defined in relation to a specified outcome in the face of a specific challenge.

Protective factors, defined as variables that are positively associated with health, do not equate to resources as they could equally well be indicators of the absence of challenge(s), the presence of resource(s) or a combination of both.

Equally a risk factor defined, as a variable negatively associated with health, does not equate to a challenge, as it could equally well indicate the presence of challenge(s) the absence of resource(s) or a combination of both.

In this thesis the term protection and risk are used primarily as relative terms. The term protection or protective will be used when a positive association indicates an increased probability of a desirable outcome. Risk will primarily be used to describe when a positive association indicates an increased probability of an undesirable outcome. The key focus of this thesis will be on resources and challenges.

Determining whether one particular variable is a resource or a challenge is difficult, and will require information not necessarily testable using statistical methods. However, the possibility of factors being indicators of either a challenge or a resource requires evidence that there is no single cause of any outcome, and that there are factors whose impact on health are interdependent. Some evidence for this will be provided should interaction effects be found between resources and challenges.

In the context of this thesis unemployment will be defined as the challenge. Success in overcoming the challenge is assessed by 5 health outcomes which will be, self rated health, limiting longstanding illness, Malaise inventory, the General Health Questionnaire and weight change.

The indicators of resources are; emotional well-being, cognitive ability and BMI.

Resources promoting resilience to experienced unemployment

The challenge in this thesis will be represented by experiencing a period of unemployment of at least 3 months. This will be a broad indicator of many sub challenges, including specific events such as job loss, medium-term tasks such as job seeking and the long-term adversity of low or no income. In the case of the challenge of job seeking, one type of resilient individual will be indicated if they have the resources to find a job that enables a healthy standard of living. Thus the factors that determine whether an individual is employed are also likely to play a role in resilience. However, this is unlikely to be the only mechanism, and each of emotional well-being, cognitive ability and body mass will have alternative mechanisms.

Emotional well-being

Emotional well-being itself is an aspect of mental health and is inextricably linked with physical well-being (Manor et al., 2001). Mechanisms to explain the link between emotional and physical well-being include health behaviours, the immune system and the hypothalamic-pituitary-adrenal axis (Gallo & Matthews, 2003). Thus emotional well-being potentially plays a key role in moderating the effects that unemployment has on health.

There is evidence of interactions between hostility and unemployment when predicting health. In a cross sectional study Kivimäki, Elovainio, Kokko, Pulkkinen, Kortteinen and Tuomikoski (2003) demonstrated that hostile individuals irrespective of their employment status had increased chances of poor health, whilst non hostile individuals had better chances of good health unless they experienced unemployment. Hostility may prevent individuals from taking the opportunities presented by employment (Vahtera, Kivimaki, Uutela & Pentti, 2000; Kivimäki et al., 2003). In a longitudinal study, where hostility was measured 27 years prior to the health outcome, the health of employed hostile individuals was little different from employed non hostile individuals, however, unemployed hostile individuals had much worse health than unemployed non hostile individuals (Kivimäki et al., 2003).

In McKee-Ryan et al.'s (2005) meta-analysis, components of emotional well-being such as self appraisals, appraisals of stress and social support were shown to indicate better health in unemployed people. Additionally, aspects of emotional well-being such as self esteem, self efficacy, having a secure base (Bender & Castro, 2000; Gilligan, 2000; Kumpfer, 1999; Luthar & Cicchetti, 2000; Masten, 2001; Rutter, 1990; Werner, 1993; Werner, 1989) and the ability to understand and manage emotions (Bender & Castro, 2000; Kumpfer, 1999; Vaillant & Davis, 2000; Masten & Obradovic, 2006) have been shown to be key aspects of resilience in children. Therefore emotional well-being is likely to indicate resources that promote resilience in the face of unemployment.

Many potential mechanisms could explain why people with good emotional well-being are likely to have better outcomes when faced with the challenges presented by unemployment. Those with poorer emotional well-being, as indicated by depression, are less able to shape their environment (Taris, 2002) or maintain and perform other leisure activities (Breslin et al., 2006). This is likely to lead to fewer opportunities to build and maintain supportive relations. Those who express their poor emotional well-being through hostility are likely to push away potential sources of support (Kivimäki et al., 2003; Vahtera et al., 2000). Consequently those with poor emotional well-being have fewer options to manage the stresses presented by unemployment. Poor emotional well-being may lead to inappropriate coping strategies such as stress related eating and drinking (Laitinen, Ek & Sovio, 2002). In addition, emotional well-being is likely to indicate the manner in which people appraise stressful situations, and those with better appraisals are likely to have less severe physiological responses (Ferrie et al., 2001b). Thus there is evidence and explanations for why individuals with better emotional well-being are likely to be more resilient when experiencing unemployment.

Cognitive ability

Cognitive ability has regularly been found to be associated with health (Batty & Deary, 2004; Deary & Batty, 2006; Gottfredson, 2004) in addition to employment status, thus there is a good chance that it will play a role in resilience to the effects of unemployment.

During childhood, IQ and measures of academic functioning such as reading have been shown to be key resilience factors that protect against adversities (Buchanan & Flouri, 2001; Kumpfer, 1999; Luthar & Cicchetti, 2000; Masten, 2001; Vaillant & Davis, 2000; Werner, 1989; Tiet, Bird, Davies, Hoven, Cohen, Jensen et al. 1998; Masten et al., 1999). Education amongst the unemployed has been shown to have a small main effect protecting against poor mental health (McKee-Ryan et al., 2005).

Reading and mathematics are likely to be proxies for factors that will alter people's self perceived chances of reemployment. Those who perceive their employment chances as low are likely to see unemployment as more stressful which itself is likely to increase the risk of poor health (Ferrie et al., 1995). This may also result in more desperate job seeking activities, which has been demonstrated to have a detrimental impact on health (McKee-Ryan et al., 2005; Taris, 2002). Cognitive ability is also likely to be associated with greater wealth and those with better financial resources and lower financial strain have better health when unemployed (McKee-Ryan et al., 2005). Thus there are mechanisms and reasons to explain why cognitive ability may provide resilience in the face of unemployment.

BMI

A systematic review conducted by Reilly, Methven, McDowell, Hacking, Alexander, Stewart et al. (2003) demonstrated that obesity is associated with both poor psychological and physical health. Thus obesity could be implicated in processes for the development of ill health in the context of unemployment.

Men with a high BMI tend to gain weight in response to stress (Kivimäki et al., 2006), possibly due to stress related eating (Laitinen et al., 2002) whilst thin men have been shown to lose weight (Kivimäki et al., 2006). Similarly for women with high job demands, the greatest gains in weight were for those predisposed to weight increases (Overgaard, Gamborg, Gyntelberg & Heitmann, 2006). As people have been shown to both increase and decrease their dietary intake in response to stress (Zellner, Loaiza, Gonzalez, Pita, Morales, Pecora et al. 2006), BMI may act as an indicator for how people respond to the stresses presented by unemployment, and therefore may indicate people for whom the consequences of unemployment are different.

In addition, people's appearances, be it very thin or overweight, are likely to alter other peoples attitudes towards them (Shaw, Tunstall & Davey Smith, 2003); overweight in adolescence is associated with less social success in later life (Sadler et al., 1999). This is particularly important as social support has been shown to be a key factor for resilience (Bender & Castro, 2000; Garmezy, 1993; Gilligan, 2000; Luthar et al., 2000; Werner, 1993; Werner, 1997).

Additionally, despite BMI being most commonly used as an indicator of obesity and overweight, BMI is also used as an indicator of both lean and fat mass (Thorogood, Appleby, Key & Mann, 2003; Prentice & Jebb, 2001) and may be an indicator of the development of organs making up that mass. Thus, BMI is potentially an indicator of a person's functional capacity throughout life, and may partly explain why people who were not thin at birth were largely resilient to the effects that poor living standards have on heart disease (Barker et al., 2001).

Summary of resources

There is considerable evidence from childhood that cognitive ability and emotional well-being indicate resources for resilience. However, studies testing whether these concepts and BMI are indicators for resources to protect against unemployment have been very limited so far. These resources are developed throughout life (Bartley et al., 1999) and there may be critical periods (Beauvais & Oetting, 1999), therefore a life course perspective to the development of the resources is needed.

2.5. Development of resources through the life course

The popularity of life course research within epidemiology has fluctuated (Kuh & Davey Smith, 2004). A resurgence occurred in the 1990's following the publication of Barker's work on the foetal origins of cardiovascular disease (Barker & Martyn, 1992). Methods used in life course epidemiology have focused on using variable based approaches, looking at the timing, and duration of exposure to risks. However, to understand an individual's functioning, a holistic approach is needed that takes account of a specific individual's development (von Eye & Bergman, 2003). For example, at a clinical level children who have an extreme anthropometric measure such as height but have normal growth rates are likely to be healthy (Legler & Rose, 1998), conversely, individuals who may have a normal growth parameter at one point in time but have an abnormal growth rate are likely to be unhealthy (Legler & Rose, 1998). To take account of effects due to different patterns of development a person based approach to research is required.

Classic person based research involves identifying groups on the basis of their characteristics and then comparing them (Masten, 2001). Within the psychological literature there has long been group based approaches to theorizing about development (Nagin, 1999). Numerous examples abound including personality development, drug use, learning, depression, eating disorders, alcoholism, anxiety, and antisocial behaviors such as delinquency (Nagin & Tremblay, 2005). These theories predict different trajectories of development across populations (Nagin, 1999). The purpose of these studies is to draw attention to the different causes and consequences of particular trajectories rather than to infer they are the literal truth (Nagin, 1999). An example of a theoretical approach to identifying the trajectories is provided by Moffiit's taxonomy of anti-social behavior (Moffit, 1993). A similar theory has also been proposed by Patterson, DeBaryshe and Ramsey (1989). Moffit

(1993) proposed two groups of adolescents who exhibit antisocial behaviour, a life course persistent group and an adolescent limited group.

The life course persistent antisocial behaviour group was proposed to contain a small proportion of the population who start their antisocial behaviour in early childhood. The behaviour would initially consist of hitting and biting and progress into violent and non violent crime in adolescence. As adults group members would continue to perform antisocial behaviour (Moffit, 1993). Other adult consequences of membership of this group could include drug and alcohol addiction, unsatisfactory employment, debt, unstable relationships and high rates of psychiatric illness (Moffit, 1993).

In contrast, the adolescent limited antisocial behaviour group would contain a much greater proportion of the population whose antisocial behaviour was proposed to be restricted to short periods and to specific domains. For example, adolescents may steal and take drugs but would still obey school rules (Moffit, 1993). Adolescent limited antisocial behaviour would cease when the adolescent gained entry to adult roles, and adolescent limited antisocial behaviour was proposed to be a way of meeting a gap between physical maturity and the roles adolescents are limited to (Moffit, 1993). In contrast, the development of life time persistent antisocial behaviour was proposed to be a consequence of a transactional relationship between biological origins such as poor neurological functioning and a disadvantaged social environment. The antisocial behaviour results from few opportunities to develop pro-social behaviour compounded by an inability to make the most of these opportunities and as a consequence poor behaviour is reinforced eventually reaching a point where it is very difficult for the adolescent to ever change (Moffit, 1993).

In recent years the development of empirical models has enabled the identification of naturally occurring groups of antisocial behaviour. The evidence from these would suggest that adolescent onset of aggression is rare and that aggression is likely to reflect an innate tendency that most children unlearn (or learn to control) early in childhood (Maughan, 2005). The empirically identified groups that enable the theories of group based development to be tested are known as developmental trajectories.

2.5.1. Developmental trajectories

A developmental trajectory describes a person's development in one well defined domain (Raudenbush, 2001), and is based on there being a continuous and individual-specific underlying process that gives rise to an observed set of measures over time for a particular individual (Curran & Willoughby, 2003).

Early methods of identifying trajectories focus on hierarchical linear modelling or latent growth curve analysis (Nagin, 1999). These methods are useful when most individuals follow a common growth pattern for a particular dimension (Nagin & Tremblay, 2005; Brendgen, Wanner, Morin & Vitaro, 2005). However, in some cases a single developmental curve will not adequately summarize a population (Raudenbush, 2001) and in these cases group based trajectories need to be used (Nagin & Tremblay, 2005).

Group based developmental trajectories are based on the principle that there are clusters or groups of individuals within the population whose development on any given behaviour of interest follows differing age related patterns in its developmental course (Maughan, 2005; Nagin & Tremblay, 2005).

In early group based models, subjects were a priori allocated to theoretically determined trajectories (Nagin & Tremblay, 2005; Connell & Frye, 2006). Although generally reasonable, this does pose some pitfalls. Firstly, being allocated a priori to a trajectory means that it is impossible to test if certain trajectories exist (Nagin & Tremblay, 2005). Secondly, there is a danger that certain trajectories may only reflect random variation or there may be real developmental trajectories that are not identified (Nagin & Tremblay, 2005). Thirdly, such trajectories do not take into account that there may be some uncertainty about allocation to a particular trajectory (Nagin & Tremblay, 2005; Connell & Frye, 2006). Thus there is a need for analytic methods that can discern developmental trajectories of unobserved population subgroups (Bauer & Curran, 2003b): finite mixture models provides one such method.

Finite mixture models provide a method through which any continuous distribution can be summarized by approximating the distribution using a finite mixture of normal densities with a common variance, or for multivariate analysis, which is the case in this thesis, with a common covariance matrix (McLachlan & Peel, 2000). The continuous distribution of variables summarized by the mixture model can be repeated measures for a particular domain of development, for example emotional well-being, and each of the normal distributions used to approximate the continuous distribution can be said to represent a discrete group or trajectory.

Mixture models were first applied by Pearson in 1894 (Everitt & Hand, 1981; McLachlan & Peel, 2000), but, until recently, a lack of computing power meant that the mixture models were not practical for a wide range of applications. However, recent increases in computer power and developments in statistical packages such as Mplus (Muthén & Muthén, 2004), and a SAS based procedure called Proc Traj (Jones, Nagin & Roeder, 2001) have made the production of mixture models practical. Techniques utilizing mixture model to model developmental trajectories include latent class growth analysis (Nagin 1999), growth mixture models (Muthén 2004a) and latent class clustering (Vermunt & Magidson 2002), the latter is described in more detail on p.83. Areas to which mixture models have been applied to identify developmental trajectories include aggression (Broidy, Nagin, Tremblay, Bates, Brame, Dodge et al. 2003; Nagin & Tremblay, 1999), enuresis (Croudace, Jarvelin, Wadsworth & Jones, 2003), psychological distress, daily family hassles, (Szapocznik, Feaster, Mitrani, Prado, Smith, Robinson-Batista et al. 2004) poverty (McDonough, Sacker & Wiggins, 2005), technical reading development (Lerkkanen, Rasku-Puttonen, Aunola & Nurmi, 2004), anxiety (Brendgen, Vitaro, Bukowski, Doyle & Markiewicz, 2001), fearfulness (Côté, Tremblay, Nagin, Zoccolillo & Vitaro, 2002) obesity (Mustillo, Worthman, Erkanli, Keeler, Angold & Costello, 2003) and heart attacks (O'Rand & Hamil-Luker, 2005). Mixture models have the potential to explain the development of resources to face unemployment based on naturally occurring groups that takes account of uncertainties surrounding group allocation.

2.5.2. Trajectories of emotional well-being, cognitive ability and BMI

Tracking over time has been shown to occur for each of cognitive ability (Masten et al., 2005; Feinstein & Bynner, 2004; Bornstein, Hahn, Bell, Haynes, Slater, Golding et al. 2006), BMI (Wardle, Brodersen, Cole, Jarvis & Boniface, 2006; Hardy, Wadsworth & Kuh, 2000; Eriksson, Forsen, Tuomilehto, Osmond & Barker, 2001) and emotional well being, including externalizing symptoms (Buchanan & Flouri, 2001; Serbin & Kemp, 2004; Dubow, Huesmann, Rowell, Boxer, Pulkkinen & Kokko, 2006) and internalizing symptoms (Prior, Smart, Sanson & Oberklaid, 2000; Goodwin, Fergusson & Horwood, 2004).

This tracking does not take a fixed pathway across the life course for everybody. In the case of BMI there are gender specific developmental pathways (Sadler et al., 1999), and the majority of obese adults have been found not to be obese at earlier ages (Power, Lake & Cole, 1997a; Reilly et al., 2003). Similarly, although stability has been shown for internalizing and externalizing symptoms from childhood to adolescence, Hofstra, Van Der Ende and Verhulst (2000) showed that even for the most stable characteristic in their study, externalizing symptoms in adolescent girls, persistence only occurred for 52% of subjects. A study following boys from the age of 3 to 15 found that 5% of the population of boys accounted for 68% of the sample's stability of antisocial behaviour (Moffit, 1993). Thus it is likely that within populations there are groups of differing stability and that these groups will differ by gender. There has been work identifying group based developmental trajectories, in each of the domains of emotional-wellbeing, cognitive ability and body mass.

Emotional Well-being

For emotional well being, the greatest amount of research using group based trajectories identified by mixture models has been on aspects of aggression and antisocial behaviour for which more than 50 published articles have been identified (Nagin & Tremblay, 2005; Sampson & Laub, 2005).

One of the best examples of the use of developmental trajectories is provided by Broidy et al. (2003) who summarised the results from 6 cohorts which all had measures of physical aggression recorded from the age of 6 to 15. The trajectories were identified using latent class growth analysis. For boys, there were consistent results with each cohort being summarized by 3 to 4 trajectories (Broidy et al., 2003). In each cohort there was one trajectory, containing 14% to 64% of the population, who exhibited little or no aggression at all time points. In addition, there was a second trajectory, containing 4% to 11% of the population, who exhibited high aggression at all time points problems, with the remaining majority of the population being contained in one or two trajectories exhibiting moderate level of symptoms (Broidy et al., 2003).

For girls the results between the sites were less consistent, the number of trajectories required to describe the data varied somewhat more with the best fitting models requiring between 2 to 4 trajectories. Girls generally had lower levels of aggressive symptoms and a chronic high aggression trajectory was not identified for all samples (Broidy et al., 2003).

Similar results to the Broidy et al., 2003 study have been replicated using other samples (Schaeffer, Hanno, Ialongo, Masyn, Hubbard, Poduska et al. 2006; Kokko, Tremblay, Lacourse, Nagin & Vitaro, 2006) and for other measures of externalizing behaviour such as hyperactivity and oppositional behaviour (Nagin & Tremblay, 1999; van Lier, Wanner & Vitaro, 2007).

Trajectories have also been identified for aspects of internalizing disorders (Brendgen et al., 2005; Repetto, Caldwell & Zimmerman, 2004). For example, Brendgen et al. (2005) used latent class growth analysis to summarize data on depressed mood from the ages of 11 to 14 to identify 4 trajectories. The first trajectory consisted of 48% of the sample and indicated low rates of depressive symptoms. The second trajectory consisted of 30% of the sample and indicated elevated levels of depression which remained relatively stable. The third trajectory contained approximately 13% of the population, indicated low levels of depression which increased across the age range to high levels at age 16, and the fourth trajectory contained approximately 9% of the sample, who had very high levels of depressive feelings at age 11 which increased with age (Brendgen et al., 2005). Family adversity, a measure including educational, demographic and occupational aspects, was associated with increased odds of or membership to the consistently high depression trajectory, relative to the consistently low trajectory but was not related to the increasing or moderate trajectory (Brendgen et al., 2005).

Cognitive ability

There have also been group based trajectory models looking at the development of cognitive ability. Three trajectories of academic achievement and performance were identified in a study of children aged 10 to 13 (Duchesne, Larose, Guay, Vitaro & Tremblay, 2005); 63% of participants were in a high stable trajectory, 14% in a trajectory of declining academic functioning and 23% in a low stable trajectory. Mother's education was associated with increased chance of membership in the high stable group relative to the low stable group and the declining group (Duchesne et al., 2005). Muthén (2004a), in a population studied from grade 7 through grade 10, identified 3 trajectories of mathematics ability; a high trajectory contained 52% of the population, a middle trajectory containing 28% and a low trajectory containing 19% of the population. Home resources and mother's education were predictive of membership of the high mathematics trajectory (Muthén, 2004a).

BMI

Group based trajectory models of BMI have not yet been identified but trajectories of obesity have. Mustillo et al. (2003) identified 4 trajectories of obesity for children aged between 9 and 16. The first identified trajectory contained 72.8% of the population, who were non obese through out the study. The second trajectory contained 7.5% of the children, who developed obesity during the study. The third trajectory contained 14.6% of the children, who were obese throughout the study. The fourth trajectory, containing 5.1% of the children, who were obese at the start but declined to a normal weight (Mustillo et al., 2003). Chronically obese boys relative to the never obese were more likely to come from families with middle incomes, and have less educated parents (Mustillo et al., 2003). For girls none of the risk factors predicted chronic obesity, whilst members of the childhood limited obesity trajectory, relative to the never obese, were more likely to have less educated parents (Mustillo et al., 2003).

In summary, despite there being a large body of research focusing on aggression, there are relatively few studies identifying group based developmental trajectories for cognitive ability, body mass, or more general measures of internalizing and externalizing. The predictors of these trajectories have so far been limited primarily to parental education and indicators of childhood disposition and temperament, however, the trajectories are likely to have both social and biological origins. In this thesis Registrar General's Social Classification (RGSC), will be the indicator of social origins, whilst birth-weight will be used to indicate biological origins.

Predictors of trajectories

Registrar General's Social Classification

The RGSC is directly an indicator of standing in the community or occupational skill (Bartley, 2004) and indirectly a measure of other aspects of the social environment and so will also indicate material resources such as income, wealth, educational credentials (Krieger, Williams & Moss, 1997) and the broader physical environment (Evans & Kantrowitz, 2002). Differences in childhood social circumstances are likely to set children on course for different adult outcomes (Sacker, Schoon & Bartley, 2002).

So far the prediction of group based developmental trajectories by indicators of social circumstances has been limited largely to maternal education. However, disadvantaged social circumstances are a well established risk factor for measures of emotional well-being, such as psychological health, and cognitive development (Serbin & Kemp, 2004; Schoon, Sacker & Bartley, 2003; Bradley & Corwyn, 2002), and have been proposed as being important for the development of obesity (Ball & Mishra, 2006). A systematic review found that childhood socio-economic circumstances were better predictors of adult obesity than childhood obesity (Parsons, Power, Logan & Summerbell, 1999). Lyratzopoulos, McElduff, Heller, Hanily and Lewis (2005) have suggested that the effects of socio-economic circumstances on obesity primarily occur before the age of 35, however, other studies have shown the effects of social class on obesity increase across adult life (Hardy et al., 2000).

Socio economic circumstances have been used to predict development as modelled by latent growth curve models. For example, those from advantaged social backgrounds initially have lower levels of externalizing symptoms which then decrease rapidly (Kraatz Keiley, Bates, Dodge & Petit, 2000), girls from low income homes have been shown to have high levels of internalizing symptoms that increase rapidly (Leve, Kim & Pears, 2005), whilst those from disadvantaged social classes are more likely to be slow at improving in mathematics ability (Jefferis, Power & Hertzman, 2002).

Social circumstances have been used to predict trajectories based on a priori criteria. Using this methodology, Feinstein and Bynner (2004) found that amongst those who were in the top quartile of educational functioning at age 5, high SES children had a 65% chance of being in the top quartile at age 10, whilst low SES children had a 34% chance of remaining in that quartile (Feinstein & Bynner, 2004). Conversely amongst children in the bottom quartile at age 5, those who were high SES had only a 34% chance of remaining in that quartile whilst for low SES children the persistence was 67% (Feinstein & Bynner, 2004). This is supported by earlier work in the National Survey of Health and Development (Douglas, Ross & Simpson, 1968) and the NCDS (Goldstein, 1979; Fogelman & Goldstein, 1976; Fogelman, Goldstein, Essen & Ghodsian, 1978) which found that children, with parents in non manual occupations, had greater improvements in both mathematics and reading when compared to offspring of parents with manual occupations.

Birthweight

Birth weight is a product of foetal growth rate and gestational age at delivery (Leon, Johansson & Rasmussen, 2000). It is particularly important to take gestational age, which explains 30 to 50% of variance in birth weight (Pietiläinen, Kaprio, Räsänen, Rissanen & Rose, 2002), into account as otherwise it is impossible to distinguish between the effects of preterm birth and foetal growth (Savitz, Hertz-Picciotto, Poole & Olshan, 2002). Gestational age itself has been shown to predict cognitive development (Bergvall, Iliadou, Johansson, Tuvemo & Cnattingius, 2006), behaviour (Gardner, Johnson, Yudkin, Bowler, Hockley, Mutch et al. 2004; Delobel-Ayoub, Kaminski, Marret, Burguet, Marchand, N'Guyen et al. 2006), adolescent depression (Costello, Worthman, Erkanli & Angold, 2007) and personality traits that predispose to mental illness (Allin, Rooney, Cuddy, Wyatt, Walshe, Rifkin et al. 2006). The factors affecting length of gestational age and foetal growth rate are different (Hennessy & Alberman, 1998).

One of the key mechanisms for birthweight's association with subsequent outcomes throughout the life course may be through impaired development of organs. The organ systems associated with poor uterine development include the musculo-skeletal system, muscle mass (Phillips, 1995; Gale, Martyn, Kellingray, Eastell & Cooper, 2001), muscle metabolism (Kuh, Bassey, Hardy, Aihie Sayer, Wadsworth & Cooper, 2002), muscle strength (Sayer, Syddall, Gilbody, Dennison & Cooper, 2004b) and bone mass (Sayer, Poole, Cox, Kuh, Hardy, Wadsworth et al. 2003). This potentially has consequences for an individual's robustness in the face of challenges and may explain associations between low birth weight and outcomes such as osteoarthritis (Sayer et al., 2003; Sayer et al., 2003). Foetal growth measures have also been associated with poorer development of abdominal organs including the kidney, liver and spleen (Latini, De Mitri, Del Vecchio, Chitano, De Felice & Zetterstron, 2004). Low birth weight has also been shown to be associated with poorer development of structural units within organs such as nephrons, cardiomyocytes and pancreatic Beta-cells (McMillen & Robinson, 2005). Other systems shown to be associated with foetal development include the visual system

(Martin, Ley, Marsal & Hellström, 2004), and overall poor uterine growth may put individuals on a trajectory of low body mass due to poorer development of organs.

Heavier weights at birth have also been shown to have poorer development when compared to normal weight infants. For example, heavier weight at birth has been found to be associated with the metabolic syndrome based on criteria adapted for children (Boney, Verma, Tucker & Vohr, 2005), and heavy infants have an increased risk of an earlier adiposity rebound and have increased levels of adiposity at age 6 (Hediger, Overpeck, McGlynn, Kuczmarski, Maurer & Davis, 1999). Thus potentially both low and high birthweights place infants on particular developmental trajectories of BMI.

There is some evidence for this as higher birthweights are associated with higher BMI (Dietz, 2004; Rogers, 2003; Baird, Fisher, Lucas, Kleijnen, Roberts & Law, 2005; Pietiläinen et al., 2002) and overall the association between birthweight and BMI is considered to be linear, U or J shaped (Rogers, 2003; Oken & Gillman, 2003), although the association between high BMI and low birth weight may be due to inadequate control of socio-economic status (Rogers, 2003). Birth weight is more strongly associated with fat free mass than fat mass (Rogers, 2003; Sayer, Syddall, Dennison, Gilbody, Duggleby, Cooper et al. 2004a; Sachdev, Fall, Osmond, Lakshmy, Dey Biswas, Leary et al. 2005) and potentially heavier trajectories indicated by birth weight may not necessarily indicate disadvantage.

Overall the development and mass of organs should be indicated directly by the development of BMI. However, organ development will also influence functioning in general, and will have implications for both emotional well-being and cognitive ability.

Birth weight has been associated with indicators of emotional well-being in childhood including, general behaviour problems (Wiles, Peters, Leon & Lewis, 2005; McCormick, Brooks-Gunn, Workman-Daniels, Turner & Peckham, 1992; McCormick, Workman-Daniels & Brooks-Gunn, 1996; Kelly, Nazroo, McMunn, Boreham & Marmot, 2001), internalizing disorders, conduct problems (Breslau & Chilcoat, 2000) and specific disorders such as inattention, hyperactivity (Saigal, Hoult, Streiner, Stoskopf & Rosenbaum, 2000; Breslau & Chilcoat, 2000) and depression (Costello et al., 2007). Birthweight has also been associated with adult disorders including; nervous conditions (Fan & Eaton, 2001), depression (Thompson, Syddall, Rodin, Osmond & Barker, 2001) and psychological distress (Gale & Martyn, 2004; Wiles et al., 2005; Cheung, Khoo, Karlberg & Machin, 2002).

Cognitive ability has been predicted by birthweight after adjusting for numerous confounders (Richards, Hardy, Kuh & Wadsworth, 2001; Breslau & Chilcoat, 2000; Jefferis et al., 2002; Aylward, 2002; McCormick et al., 1992; Terry & Susser, 2001; Wilson, 1985; Corbett, Drewett, Durham, Tymms & Wright, 2007). In a systematic review, which aimed to identify the effects of birth weight for term births with a birthweight greater than 2,500g, Shenkin, Starr and Deary (2004) found a small positive association between birth weight and cognition. The relationship is likely to be nonlinear; children with the heaviest birthweights have lower cognitive ability when compared to those with above average birthweights, and the slope between birth weight and cognitive ability is likely to be steepest at the lowest end of the spectrum. Birthweight may not be an indicator for all aspects of cognitive development as there are fewer associations between birthweight and reading than between birthweight and mathematics (Taylor et al., 2002; Breslau, Johnson & Lucia, 2001), and there is the possibility that reading may be determined more by social than biological factors (Hutton, Pharoah, Cooke & Stevenson, 1997).

Research using birthweight to predict trajectories is limited. Jefferis et al. (2002) using hierarchical linear modelling, found that birth weight was associated with cognitive ability at age 7 but not with the growth of cognitive development at subsequent ages. There is the potential that biological factors will predict trajectories which stay relatively stable relative to others throughout time, whilst social class will have increasing effects as risks accumulate across childhood.

2.5.3. Consequences of trajectories

Research on the consequences of trajectories identified using mixture models has primarily concentrated on subsequent delinquency and offending. One study found that desisters from criminality were more likely to have stable jobs (Laub, Nagin & Sampson, 1998). However, the direction of causality was not clear: persistent criminals were those who carried on criminality into their 30s, and it may be that unemployment drives the persistence of crime. Mustillo et al.'s (2003) trajectories of obesity were associated with concurrent psychopathologies. However, again temporal coincidence makes determining the direction of causality difficult.

There have been other methods used to identify trajectories which have enabled temporal sequences to be distinguished. Individuals, allocated a priori to a group of life course persistent anti-social behaviour, have been shown to have consistently worse mental health and increased risk of unemployment when compared to individuals allocated to a groups of adolescent limited anti social behaviour and non antisocial adolescents (Moffit, Caspi, Harrington & Milne, 2002). In addition, the age of onset of depression has been associated with differences in subsequent BMI (Anderson, Cohen, Naumova & Must, 2006).

Feinstein and Bynner (2004) used a priori criteria to define trajectories of cognitive ability. These trajectories showed those who managed to escape from poor cognitive performance in early childhood, were little different from those who consistently had at least moderate cognitive ability throughout childhood on a number of outcomes measured at age 30 (Feinstein & Bynner, 2004). These outcomes included wages; depression and work status of household members (Feinstein & Bynner, 2004). Those whose poor cognitive ability persisted, were more likely to have poorer functioning as adults (Feinstein & Bynner, 2004).

Work in epidemiology has linked changes in BMI to subsequent health. Rapid growth in BMI from the age of 2 has been associated with cardiovascular disease (CVD) (Barker, Osmond, Forsen, Kajantie & Eriksson, 2005). Those who have the worst risk of heart disease are those that start thin and put on most weight, however, such individuals are impossible to identify without using methods that are tracked across time (Barker, 2007). During late adult life, increases and decreases in BMI have been associated with increased all cause and CVD mortality, whilst only decreases in BMI were associated with increased risk of respiratory disease mortality (Breeze, Clarke, Shipley, Marmot & Fletcher, 2006). For women, obesity that has persisted from childhood has been shown to predict never being gainfully employed, when adult obesity alone has not (Viner & Cole, 2005). Thus for some outcomes changes in BMI need to be taken into account (Hardy & Kuh, 2006) .

The Feinstein and Bynner study would suggest that those who increase their cognitive ability from a lower baseline are not greatly different from those who are always of moderate ability. In this case identifying trajectories may not be critical in determining future circumstances. In contrast, the results for antisocial behaviour and the development of body mass would suggest that developmental trajectories across the life course are of key importance and that measures in isolation tell us very little. Thus the question arises for each resource "does the trajectory simply summarize development, or does it also tell us something about future consequences that would not be concluded from a single measure at one time point?" Future work needs to use person centred approaches that enable people to be clustered according to their developmental attainments (Feinstein & Bynner, 2004).

2.6. Summation and pointing forward

Unemployment is associated with health, partly through causal mechanisms such as stress and the absence of employment. This association is stronger for men than it is for women.

The consequences of unemployment can be reduced either by avoiding becoming unemployed or by being more resilient to the consequences of unemployment.

Resilience is the result of life long processes which enable people to build resources to face challenges. Resilience needs to be conceptualized in an accurate non judgmental way, and operationlized in a manner that does not lead to misleading results.

Resources develop throughout life and group based developmental trajectories enable better understanding of the developmental process and potential consequences of this development.

Emotional well-being is commonly summarized into two factors representing internalizing and externalizing symptoms. Both aspects of emotional well-being have been associated with the chance of becoming unemployed, and there is some limited evidence that emotional well-being indicates resources that help tackle unemployment should it occur.

Cognitive ability is associated with a decreased risk of becoming unemployed and has been shown to be a key protective factor for resilience in childhood. Thus cognitive ability potentially indicates greater resilience to the consequences of becoming unemployed. Aspects of cognitive ability represented by reading and mathematics, which have different degrees of biological and social causality, may also offer differing degrees of protection.

There is evidence of limited associations between BMI and unemployment. However, further evidence from longitudinal studies is needed to determine the direction of causality. It is likely that thin men and heavy women will be at greatest risk for poor outcomes.

Birth weight and social circumstance have been shown to predict internalizing and externalizing symptoms, mathematics, and BMI, as assessed by measures at a single time point, but there is an absence of research on whether birthweight and social circumstances predict group based developmental trajectories.

The identification of predictors for and consequences of group based developmental trajectories of externalizing and internalizing symptoms, reading, mathematics and BMI are extremely limited. A priori based developmental trajectories of cognitive ability would suggest that trajectories may just be a way of summarizing how people have developed, whilst results for BMI and for antisocial behaviour would suggest that trajectories are critical for understanding development and future consequences.

The consequences of unemployment and the development and consequences of resources are different for men and women so the analyses in this thesis will be conducted separately by sex.

In chapter 3, the NCDS data set used in this thesis is described, along with the variables and the statistical methodology used.

In chapters 4 through 6, questions surrounding the development of trajectories are addressed. Does latent class clustering identify naturally occurring group based developmental trajectories and are those trajectories predicted by social class, birth weight and gestational age? In chapter 4, the trajectories identified represent internalizing and externalizing symptoms. In chapter 5, separate trajectories are identified which represent reading and mathematics, and in chapter 6, trajectories for BMI are identified.

In chapter 7, the hypotheses that experiencing unemployment between the ages of 24 to 42 has an association with health and that unemployment is predicted by resources are tested. Resources are operationalized using both developmental trajectories indicated by latent class clusters, and variables generated from a single indicator of resources at one time point (single time point measures). The use of single time point measures and latent class indicators to predict unemployment are compared.

In chapter 8, the hypothesis that the relationships between unemployment and health are modified by indicators of resources is tested. The resources are again operationalized by both latent class clusters and single time point measures.

In chapter 9, the implications and themes developed through the thesis are brought together and discussed, as the thesis is drawn to a conclusion.

Chapter 3: Data and methodology

3.1. Introduction

The previous chapter established that resources indicated by emotional well-being, cognitive ability and BMI potentially protect against unemployment. It was also established that the underlying resources may be better understood if the variables indicating these resources are summaries of their developmental trajectory. In this chapter the data set and the statistical methods used to identify the developmental trajectories and to test whether the resources protect against unemployment, are described.

The chapter starts with a description of the National Child Development Study (NCDS), including the NCDS's origins and a brief description of each data collection sweep. This is followed by a description of the methods and data used to generate the variables in this thesis. The first variables to be described are the indicators of resources including; externalizing and internalizing symptoms, used as indicators of emotional well-being, reading and mathematics, used as indicators of cognitive ability, and BMI. Next, the background variables are described namely birthweight, gestational age and parental social class. Following this, the measure of unemployment is presented. The section ends with a description of the variables used to indicate health; self rated health, limited longstanding illness, the Malaise inventory, General Health Questionnaire and weight change.

The fourth section describes the statistical methodology used in this thesis. An emphasis is placed on the methodology used to identify developmental trajectories for each of the resources. The fifth section discusses the missing data strategy to be implemented in this thesis.

3.2. The National Child Development Study

The data used in this thesis come from the NCDS, which was commissioned by the Central Advisory Council for Education (The Plowden Committee) to monitor subjects' educational, physical and social development, following the success of the National Survey of Health and Development (Power & Elliott, 2006).

The NCDS consists of all children who were born from the 3rd to the 9th of March 1958 and living in Great Britain at the age of 7. The origins of the NCDS are in the British Perinatal Mortality Survey (PMS) which was funded under the auspices of the National Birthday Trust Fund (Butler, 1961b). The PMS was not originally envisaged as a longitudinal study (Fogelman, 1983), and was initially created to address concerns regarding the stillbirth rate not falling and aimed to identify social and obstetric factors linked to still birth and neonatal death (Power & Elliott, 2006). The subjects who went on to comprise the members of the NCDS were recruited as a comparison group to all still births and neonatal deaths collected in a three-month period (Butler, 1961a).

17,733 infants were identified as being born from the 3rd to the 9th of March 1958, for which data was obtained on 17,414 (98.2%) (Parsons, Manor & Power, 2006). Approximately 800 subjects had died by the time it was decided to make the study longitudinal, leaving a target sample of 16,597 to be used in this thesis. (Data have also been collected on people born in the week of 3rd to 9th of March who migrated into the UK prior to their 16th birthday, but for these subjects it is impossible to look at development from birth to adulthood so they have been excluded from the study).

In addition to the PMS conducted in 1958, data was also collected for all cohort members in 6 sweeps. These sweeps were conducted when study members were aged 7 (1965), 11 (1969), 16 (1976), 23 (1981), 33 (1991) and 41/42 (1999-2000). Some measures have been repeatedly collected throughout the study but most questions have been asked to address particular developmental stages or policy needs at the time of a particular sweep.

The questionnaires used to generate the PMS were completed by the midwife in attendance at delivery after an interview with the mother and with reference to all available records. The completed forms were checked by the midwives' supervisors and returned to the medical officers of health for the county or county borough where the birth took place.

The age 7 data contained information from 4 sources. The first was a home interview of a parent completed by an officer of the local authority. The second source was a medical examination conducted by a local authority medical officer. The third source was the head and class teachers, who provided information on the school and the pupil, and the fourth was the child who completed tests administered in school. Data were collected from the same sources at ages 11 and 16, although there were some changes in the questionnaires, especially at age 16 when the study child also had a self-completion questionnaire.

At age 23 the cohort members were interviewed by a professional interviewer who asked questions on their employment status, training, post-school education, marriage, household details, income, voluntary and leisure activities, and health.

In the fifth sweep when the cohort members were aged 33, the cohort members completed questionnaires collecting information on their attitudes, economic activity, housing, children and relationships. Further data on these issues and others, notably health, were recorded in an interview. In addition, questionnaires were given to the study members' partners, and data were collected on the children of one in three cohort members.

The sixth sweep was conducted over an extended period from July 1999 to September 2000, 56% of participants being aged 41 and 44% aged 42. The participants were interviewed using computer assistance which enabled inconsistencies and errors to be checked whilst the questionnaire was being completed. Data collected included information on household details, relationships, children, employment, life-long learning and health. In addition, subjects completed a questionnaire on attitudes, contact with the police and the Malaise inventory.

Table 3.1: Numbers and percentages of those participating in each sweep for data used in this thesis

	Total population		Male		Female	
	n	%	N	%	n	%
Birth (Target)	16597	100.0	8550	100.0	8047	100.0
Age 7	14813	89.0	7610	89.0	7203	89.5
Age 11	14224	85.7	7318	85.6	6906	85.8
Age 16	13211	79.6	6800	79.5	6411	79.7
Age 23	11887	71.6	5925	69.3	5962	74.1
Age 33	10832	65.3	5321	62.2	5511	68.5
Age 42	10822	65.2	5331	62.4	5491	68.2

The NCDS has lower rates of attrition than most panel studies (Schoon, 2006). Table 3.1 shows the number of participants in each sweep. Within each sweep there will be variation in the numbers of people responding to particular questionnaires (Fogelman, 1983). The NCDS is considered to have minimal attrition bias (Fogelman, 1983; Power et al., 2000), but there is a tendency for more women than men to continue to participate (Hawkes & Plewis, 2006), and there has been found to be a moderate degree of attrition bias from certain groups. Most of the biases are as would be expected. For example, those with lower educational attainment, less stable employment patterns (Hawkes & Plewis, 2006), being born illegitimate or being in care (Fogelman, 1983) are underrepresented. However, there are some unexpected biases, for example, in some of earlier sweeps the parents of boys in social class I and II were more likely to prevent their children from participating (Fogelman, 1983).

Overall, with the limitation that month of birth has minor influences on development (Lawlor, Clark, Ronalds & Leon, 2006), the NCDS can be considered a random sample of those born in 1958 (Plewis, Calderwood, Hawkes & Nathan, 2004) and is an ideal sample to investigate people's development into the middle of their working career.

3.3. Variables

3.3.1. Resources

The indicators of resources are used to generate both latent classes indicating developmental trajectories, and to generate variables based on only one indicator at a single time point.

Emotional Well-being

Emotional well-being was assessed by the teachers at ages 7, 11 and 16 and a self-report measure of internalizing symptoms was used at age 23. Teachers spend a long time with children and should be able to identify behavioural problems which are not situation-specific (Puura, Almqvist, Tamminen, Piha, Kumpulainen, Räsänen et al. 1998). The teacher scales have established coding schemes to distinguish externalizing and internalizing symptoms, and teacher report measures of emotional well-being have been shown to be more strongly related to unemployment than parent report measures (Fronstin et al., 2005).

At the ages of 7 and 11 the instrument used was the Bristol Social Adjustment Guide (BSAG) (Stott, 1969), at age 16 the instrument was the Rutter "B" scale (Rutter et al., 1970) and at age 23 the Malaise inventory was used (Rutter et al., 1970).

The BSAG is nominally for "detecting and diagnosing maladjustment, unsettledness or other emotional handicap in children of school age" (Stott, 1969) and consists of 175 statements describing child behaviour, which the teacher underlines if he or she thinks that they accurately describe the child's behaviour or attitudes. The items consist of 29 items of normal behaviour which are not scored and 146 items which indicate one of 12 syndromes.

Ghodsian (1977) has produced a two factor solution to summarise the BSAG syndromes. One factor corresponds to externalizing symptoms and contains the syndromes: anxiety for acceptance by adults, hostility towards adults, anxiety for acceptance by children, hostility towards children, restlessness and inconsequential behaviour. The other factor corresponds to internalizing symptoms and contains the syndromes unforthcomingness, withdrawal, depression and miscellaneous symptoms. Total scores in the NCDS ranged from 0 to 45 for externalizing and 0 to 34 for internalizing.

There is a high correlation (r=0.92) between scores for children from the BSAG and scores for the same children on the Rutter "B" questionnaire indicating a high reliability (Fronstin et al., 2005).

The Rutter "B" questionnaire was developed to discriminate between different types of "behavioural or emotional disorder," and contains 26 items in total (Rutter, 1967). Teachers were asked if a list of statements, "Doesn't apply," (Score of 0), "Applies Somewhat," (Score of 1), or "Certainly Applies" (Score of 2).

2-month test retest reliability is (r=0.89) and inter-rater reliability is (r=0.72) (Rutter, 1967). Macmillan, Kolvin, Garside, Nicol and Leitch (1980) have suggested that internalizing and externalizing symptoms can be indicated by two separate sub-scales each containing 9 items (See table 3.2).

At age 23 internalizing symptoms were assessed using the Malaise inventory and those participants omitting 1 or 2 items were included in the analysis. Those failing to complete the full scale potentially have the poorest mental health (see section 3.3.4. for a fuller description).

To identify the developmental trajectories used in chapters 4, 7 and 8, the scores of the emotional well-being internalizing and externalizing subscales were used.

To generate the single time point measure of externalizing symptoms, used in chapters 7 and 8, the Rutter "B" externalizing subscale at age 16 was divided into three categories. Those exhibiting, no externalizing symptoms as potentially the

Table 3.2: Items from the Rutter "B" questionnaire used in internalizing and externalizing scales at age 16

Externalizing:

Very restless, difficulty staying seated for long.

Squirmy, fidgety

Often destroys, damages own or others' property

Truants from school

Is often disobedient

Cannot settle to anything for more than a few moments

Often tells lies

Has stolen at least once in past year

Bullies other children

Internalizing:

Often worries, worries about many things

Tends to be on own - rather solitary

Often appears miserable, unhappy, tearful or distressed

Has twitches, mannerisms, or tics of face or body

Tends to be absent from school for trivial reasons.

Tends to be fearful of new situations and new things

Fussy or over-particular

Often complains of aches or pains

Has tears on arrival or has refused to enter school building in the past 12 months

most resilient are placed in one category "no symptoms", those scoring 1 - 3 symptoms in the next category "low symptoms", whilst those scoring 4 or more (a cut-off suggested by Macmillan et al. (1980) as indicating antisocial behaviour) were considered to be exhibiting "high symptoms".

The single time point measure of internalizing symptoms, used in chapters 7 and 8, was based on the Malaise inventory (Rutter et al., 1970) recorded at age 23. Those scoring 0 are placed in a "no symptoms" category, 1 through 6 placed in "low symptoms", and 7 or more into a "high symptoms" category.

Cognitive ability

Cognitive ability is assessed using tests in reading and mathematics which were recorded when the study participants were aged 7, 11 and 16.

Reading at age 7 was assessed with the Southgate reading test. This is a test of word recognition and comprehension, and is particularly suited to identifying poor readers (Southgate, 1962). At both the ages of 11 and 16 reading was assessed using the Reading Comprehension Test. This test was constructed by the National Foundation for Educational Research in England and Wales (NFER) specifically for use in this study and was derived from the Watts-Vernon test (Start & Wells, 1972) with very minor modifications (Fogelman & Goldstein, 1976).

Mathematics was assessed at age 7 using the Problem Arithmetic test (Pringle, Butler & Davie, 1966). At age 11, mathematics was assessed by using a measure constructed specifically for the use in the NCDS by the NFER (Fogelman, 1983), whilst at age 16 mathematics was assessed by a mathematical comprehension test originally developed at the university of Manchester for NFER who wanted it for a study of comprehensive schools (Sacker et al., 2002).

To identify the indicators of the developmental trajectories used in chapters 5, 7 and 8, raw scores of cognitive ability are used. To generate resources as indicated by a single time point measure used in chapters 7 and 8, the age 16 measures of reading and mathematics are used. Cut points are generated that correspond approximately to the 20th and 80th percentiles, resulting in 3 categories. For reading the cut-points were the same for boys and girls. Poor readers are considered to score 0 to 20, moderate readers 21 to 31 and good readers 32 to 35. For mathematics different categories are used for boys and girls. For boys those scoring 0 to 7 are in the poor mathematics category, 8 to 20 in the medium mathematics category, and 21 to 31 in the good mathematics category. For girls, those scoring 0 to 6 are in the poor mathematics category, 7 to 17 in the medium mathematics category, and 18 to 31 in the good mathematics category.

BMI measures

BMI is calculated as follows,

BMI = Weight (kg) / Height $(m)^2$ (Sadler et al., 1999).

BMI was first proposed as a measure of weight independent of height by the Belgian astronomer Adolphe Quetlet in the 19^{th} century (Rössner, 2007), and was reinvented by Ancel Keys in the 1950's and called the Body Mass Index (Hall & Cole, 2006). BMI does have a small correlation with height (Power & Jefferis, 2002), indicates both lean and fat mass (Thorogood et al., 2003; Prentice & Jebb, 2001; Sayer et al., 2004a) and for a given BMI there is wide range of percentage body fat (Eriksson et al., 2001). Despite these problems BMI is considered the best measure of relative weight available to use across the life course in population-based surveys (Power et al., 1997b).

In this thesis, heights and weights collected at ages 7, 11, 16, 23 and 41/42 are used to calculate BMI. At ages 7, 11 and 16 the heights and weights of the cohort members in their underclothes were recorded by trained medical personnel. At the ages of 23 and 42 self-report measures were collected.

The raw BMI scores are used to indicate the developmental trajectories in chapters 6, 7 and 8. The single time point measure of BMI is operationalized using a categorical measure based on BMI measured at age 23. The categories are generated using standard cut-offs; <18.5 kg/m^2 indicating thin, 18.5-25 kg/m^2 indicating normal, 25-30 kg/m^2 indicating overweight and >30 kg/m^2 indicating obesity (NHBLI, 2000).

3.3.2. Social and biological origins

The data for birth weight, gestational age and Registrar General's Social Class at birth were all collected in the Perinatal Mortality Survey.

Birthweight

Birth weights were originally coded in pounds and have been recoded into grams. The values were checked for implausible scores. However, the lightest surviving birth, at 1021 grams, would have been plausible for the time period (Lubchenco, Searls & Brazie, 1972), and the heaviest birth 6010g was some way short of the record birthweight for the period (10,205 grams) (Young, 1998).

As birthweight has been shown to have non-linear relationships with subsequent outcomes, birthweight is divided into 5 categories as used by Richards et al. (2001). The categories used are: <2.51 kg, 2.51-3.00 kg, 3.01-3.50 kg, 3.51-4.00 kg, and >4.01 kg.

Gestational age

Gestational age in the NCDS is assessed using the last menstrual period. This measure can be somewhat inaccurate. One particular problem is that there were more infants reported as having a gestational age greater than 42 weeks than would be expected biologically (Wilcox, Gardosi, Mongelli, Ray & Johnson, 1993) with the most probable cause being misreporting (Wilcox et al., 1993). Therefore, a continuous measure of gestational age would, at the upper end of the gestational age range, be heavily confounded by factors that lead to misreporting of gestational age. To avoid potential problems a simplified dichotomous measure was implemented using the standard cut offs for preterm birth: those completing less than a 37 week pregnancy are considered preterm, all other births were considered to be term births.

Parental social class

Parental social class was assessed using the RGSC, which is an indicator of standing in the community or occupational skill (Bartley, 2004) and is assessed by the current or last held job. Individuals are classified into separate classes as follows:

Class I: Professional

Class II: Managerial

Class IIInm: Skilled non-manual

Class IIIm: Skilled manual workers

Class IV: Semi skilled manual

Class V: Non-skilled manual

In this thesis social class is based primarily on the occupation of the mother's husband. If for whatever reason a husband's social class was not available, the mother's occupation or that of her father was used instead. In all analyses used in this thesis Classes I and II are merged to form a reference category.

3.3.3. Unemployment

Information on the study participants' economic activity for each month has been summarised by Galindo-Rueda (2002) from January 1974 to the subjects' interview at age 41/42 in 1999/2000. To help determine the direction of causality between unemployment and the indicators of resources, the economic activity data used in this thesis are for the months following the completion of interviews for the 4th sweep and so the economic activity data used starts from March 1982 onwards. These economic activity data were collected in sweeps 5 and 6 when the study participants were aged 33 and 41/42.

For each month individuals could be classified into one of 6 economic activities: full-time employment, part-time employment, government training scheme, out of the labour force, in education or unemployed seeking work. In addition, there may have been months for which subjects could not recall their economic activity, in which case such subjects were classified as unallocated. Subjects are considered to have experienced unemployment if they had experienced a period of 3 months or more in which they defined themselves as either being unemployed and seeking work, or in a government training scheme. Analysis of recall bias has shown that periods of unemployment less than three months in this cohort were poorly remembered (Montgomery et al., 1998).

In order to reduce biases in analyses of unemployment included study participants had to meet a number study of requirements. Included individuals had to respond to both sweeps 5 and 6. Thus the sample was initially reduced from 8550 men and 8047 women to 4519 men and 4853 women because of individuals who do not have data for one or both of sweeps 5 and 6. In addition, further individuals were excluded from analyses because they failed to meet at least one of two not mutually exclusive conditions. Firstly, 325 men and 543 women who had more than 18 months of economic activity data unallocated are coded as missing because there is a chance that those 18 months could have included periods of unemployment. Secondly, 40 men and 177 women, who spent less than 12 months economically active (economically active defined as in work, both full- and part- time, unemployed seeking work, or in a government training scheme), were also coded as missing because those individuals were at very limited risk of experiencing unemployment. This left 4177 men and 4145 women who have sufficient economic activity data to be included in analyses.

3.3.4. Health

Health is assessed using self rated health, limiting longstanding illness, the Malaise inventory and General Health Questionnaire, all collected during the age 41/42 interview, and weight change based on data recorded at the age 23 and 41/42 interviews.

Self rated health

Self rated health summarises a broad range of health-related information about an individual (Martikainen, Aromaa, Heliövaara, Klaukka, Knekt, Maatela et al. 1999). A review of 27 studies found that in 23 of them self rated health was associated with mortality after adjusting for age, gender and social position (Idler & Benyamini, 1997). Self rated health has also been used as a global indicator of morbidity (Manor et al., 2001). Outcomes that self rated health has been associated with include, fitness

(Power, Matthews & Manor, 1996), migraines (Perry Carson, Rose, Sanford, Ephross, Stang, Hunt et al. 2004; Manor et al., 2001), health care use (Martikainen et al., 1999), poor physical functioning (Manor et al., 2001; McDonough et al., 2005), respiratory symptoms, obesity, asthma, hay fever, diabetes, heart trouble, arthritis, cancer, smoking, drinking and unhealthy diet (Manor et al., 2001). After adjusting for socio-economic circumstances, self rated health has been shown to be primarily determined by physical and mental health (Singh-Manoux, Marikainen, Ferrie, Zins, Marmot & Goldberg, 2006).

Self rated health was assessed in the NCDS at age 41/42 by the question:

"I would now like to ask you a few questions about your health. Firstly, how would you describe your health generally? Would you say it is ....." excellent, good, fair or poor"

In this thesis self rated health is dichotomized with "excellent" or "good" in one category and "fair" or "poor" in the other.

Test-retest reliability, using two assessments of self rated health conducted 1-6 weeks apart, has shown the measure has fair to good reliability (Martikainen et al., 1999). Longer term self rated health has been shown to be stable: 87% of men and 85% of women reported no change in self rated health between the ages of 23 to 33, with most of the changes due to a deterioration of health (Manor et al., 2001).

Limiting longstanding illness

Limiting longstanding illness is a common indicator of chronic illness and widely used to indicate health (Power et al., 2000; Lahelma, Arber, Kivelä & Roos, 2002; Manor et al., 2001). Limiting longstanding illness correlates with health service usage (Thompson, 1991) and is associated with mortality (Cheung, 1998; Arber, 1997). In adults between the ages of 16 to 64 limiting longstanding illnesses has been found to be more strongly associated with physical limitations than indicators of mental and social well-being (Cohen, Forbes & Garraway, 1995), and at younger ages may be a better indicator of physical disability (Ayis, Gooberman-Hill & Ebrahim, 2003), which is less stigmatizing to admit than psychological illness (Cohen et al., 1995). Limiting longstanding illness is also more likely to be associated with multiple health problems (Ayis et al., 2003) and more serious medical conditions (Manor et al., 2001). It should be noted that long term limiting illness is a time varying phenomenon (Bartley et al., 2004) and does not necessarily indicate a permanent disability.

In the NCDS at age 41/42 limiting longstanding illness was assessed by the use of a series of questions, the first of which was:

"Do you have any long-standing illness, disability or infirmity? By long-standing I mean anything that has troubled you over a period of time, or that is likely to affect you over a period of time?"

If an affirmative response was obtained for the first question the following questions were asked:

"Does this/Do these conditions limit the kind of paid work that you can do or could do if you wanted to?"

"Does this/Do these conditions limit your daily activities in any way compared to people of your own age?"

Individuals are defined as having a limiting longstanding illness if they have a limiting longstanding illness that either affects their performance at work, their daily activities or both.

Malaise

The Malaise inventory was developed by Rutter in the 1960's to sample the different types of emotional disturbance commonly seen in adults (Rutter et al., 1970) and was originally based on the Cornell Medical Index Health questionnaire (Brodman, Erdmann, Lorge, Wolff & Broadbent, 1949).

The Malaise inventory contains 24 items (see table 3.3) which refer to both emotions such as "Are you easily upset or irritated?" and "Do you often feel miserable or depressed?" to aspects of the physical state which have an important psychological component such as "Do you feel tired most of the time?" and "Is your appetite poor?" To each of the items the respondent is asked to reply "Yes" or "No" (Rutter et al., 1970). The scale identifies both people with long term problems for a particular symptom, and a "grumble factor" for those who have a pre-occupation with health and are likely to place more emphasis on occasional minor symptoms (Rutter et al., 1970).

It has been suggested that the Malaise inventory contains two sub-scales (Grant, Nolan & Ellis, 1990). However, the majority of studies support the idea of one underlying indicator of emotional disturbance (Rodgers, Pickles, Power, Collishaw & Maughan, 1999), and in the NCDS the full 24 item scale has shown to have better internal consistency when compared to a 15 item psychological subscale (Rodgers et al., 1999). The Malaise inventory has also been shown to be valid for different socio-economic groups and to have a high retest reliability over a period of a month ($r=0.91$) (Rutter, Tizard, Yule, Graham & Whitmore, 1976). In the NCDS, the correlation between the age 23 and age 33 scores on the Malaise inventory has been shown be 0.55 for men and 0.52 for women (Rodgers et al., 1999).

A score of 7 or more on the Malaise inventory is indicative of depression (Rutter et al., 1976; Richman, 1978; Power & Manor, 1992) and is used in this thesis to generate a dichotomous variable.

Table 3.3: Malaise Inventory items

Do you often have back-ache?
Do you feel tired most of the time?
Do you often feel miserable or depressed?
Do you often have bad headaches?
Do you often get worried about things?
Do you usually have great difficulty in falling asleep or staying asleep?
Do you usually wake unnecessarily early in the morning?
Do you wear yourself out worrying about your health?
Do you often get into a violent rage?
Do people often annoy and irritate you?
Have you at times had a twitching of the face, head or shoulders?
Do you often suddenly become scared for no good reason?
Are you scared to be alone when there are no friends near you?
Are you easily upset or irritated?
Are you frightened of going out alone or of meeting people?
Are you constantly keyed up and jittery?
Do you suffer from indigestion?
Do you suffer from an upset stomach?
Is your appetite poor?
Does every little thing get on your nerves and wear you out?
Does your heart race like mad?
Do you often have bad pains in your eyes?
Are you troubled with rheumatism or fibrositis?
Have you ever had a nervous breakdown?

General Health Questionnaire

The GHQ was developed by Goldberg in the 70's (Montazeri, Harirchi, Shariati, Garmaroudi, Ebadi & Fateh, 2003; Bynner, Butler, Ferri, Shepherd & Smith, 2002) and is designed to identify short changes in mental health symptoms such as

Table 3.4: General Health Questionnaire items

Have you recently....
...been able to concentrate on whatever you're doing?
...lost much sleep over worry?
...felt that you were playing a useful part in things?
...felt capable of making decisions about things?
...felt constantly under strain?
...felt you couldn't overcome your difficulties?
...been able to enjoy your normal day-to-day activities?
...been able to face up to your problems?
...been feeling unhappy and depressed?
...been losing confidence in yourself?
...been thinking of yourself as a worthless person?
...been feeling reasonably happy, all things considered?

depression, anxiety, social dysfunction and somatic symptoms (Goldberg et al., 1997). The GHQ is a pure state measure responding to how much a subject feels that their present state over the past few weeks differs from their normal state rather than an indicator of long-term health (Bynner et al., 2002).

The 12 item version of the GHQ is used in the NCDS at age 41/42. Each item is rated on a four-point scale (less than usual, no more than usual, rather more than usual, or much more than usual - items in table 3.4). The most common scoring methods are bi-modal (0-0-1-1) and Likert scoring styles (0-1-2-3) (Montazeri et al., 2003), with the bi-modal version being the preferred method (Goldberg et al., 1997). Cronbach's alpha is reported to range between 0.82 to 0.86 (Goldberg et al., 1997). For a sample based in Manchester the instrument had sensitivity 84.6% and specificity 89.3% (Goldberg et al., 1997). The threshold that provides the best trade off between sensitivity and specificity varies between populations. In this thesis those scoring above 4 using the bimodal scoring style are considered a case, which corresponds to approximately 20% of the population and is the threshold identified for use in a sample collected in Manchester (Goldberg, Oldehinkel & Ormel, 1998).

Weight change

In contrast to the other health measures for which only one end of the spectrum is associated with health, BMI has a more complex relationship with health. Both low and high BMI scores are associated with increased risk of mortality (Corrado, Kawas, Mozaffa & Paganini-Hill, 2006; Thorogood et al., 2003). Minimum mortality risk is associated with having a constant weight between the ages of 20 and 50 years (Garrow, 1999), and studies have found that both losing and gaining weight is associated with mortality (Corrado et al., 2006; Hardy & Kuh, 2006; Breeze et al., 2006). In addition, weight change is particularly important to assess in the context of stress as people can potentially either gain or lose weight (Kivimäki et al., 2006). Weight change is a difference score, and objections have been raised about the use of difference scores for a number of reasons including floor and ceiling effects and regression to the mean (Clarke, 2004). However, it has been demonstrated that these problems are not inherent and that the difference score is a valid measure of change (Clarke, 2004).

In this thesis weight change is calculated by subtracting BMI at age 23 from BMI at age 41/42, and is categorized into 3 categories: any fall in BMI; a moderate weight gain category with a BMI rise of 0 to 4; and a high weight gain category reflecting a rise in BMI of greater than 4. Two weight gain categories were generated because BMI generally increases up to the ages of 55-60 (Hardy & Kuh, 2006) and it is only the faster rates of growth that should be considered unhealthy.

3.4. Statistical analyses

The statistical analyses used in this thesis are a mixture of person- and variable-based approaches. The person-based approaches comprise the use of latent class clustering to identify developmental trajectories. The variable-based approaches are used to test for interactions between resources and unemployment. The statistical analyses in this thesis fall into five stages:

1. Exploratory analyses identifying the developmental trajectories
2. Prediction of the developmental trajectories by exogenous variables
3. The prediction of unemployment by resources
4. Testing for an association between unemployment and health
5. Testing if resources modify unemployment's effects on health

3.4.1. Selecting the developmental trajectories

In the exploratory stage, latent class clustering is used to identify the developmental trajectories. Latent class clustering has been given alternative names including: mixture-likelihood approach to clustering, model-based clustering, mixture-model clustering, probabilistic clustering, Bayesian classification and unsupervised learning (Vermunt & Magidson, 2002).

The roots of latent class clustering lie in latent profile analysis, which was originally proposed by Gibson (1959) and Lazarsfeld and Henry (1968). Latent profile analysis assumes that the distribution of a series of continuous variables can be completely explained by a set of discrete categorical variables (Bauer & Curran, 2004) (see figure 3.1). The "Y" variables are continuous observed indicators and are considered endogenous to the model. The "C" variable is a latent categorical variable also known as a class. The model assumes that there is no association between the "Y" variables beyond that explained by the latent class "C" i.e. local independence. This is unlikely to be literally correct but is specified by theory (Bauer & Curran, 2004). In contrast, latent class clustering differs in that it makes allowances for covariance amongst the "Y" variables (see figure 3.2), thus enabling models to fit the data better.

Latent class clustering is similar to cluster analysis in that both methods identify groups of similar individuals where the number and form of groups is unknown (Vermunt & Magidson, 2002). However, latent class clustering has a number of advantages over cluster analysis. Latent class clustering is a model-based approach in which a set of clusters are modelled that best fit the data and each individual is allocated probabilistically (DiStefano & Kamphaus, 2006) rather than on the basis of

Figure 3.1: Latent profile analysis

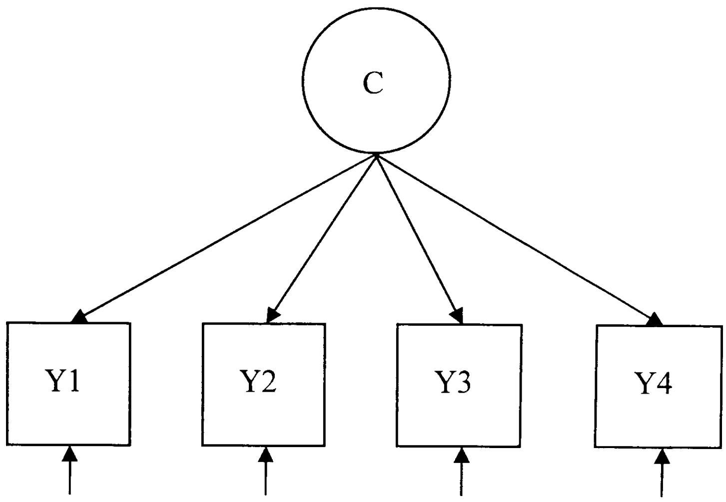
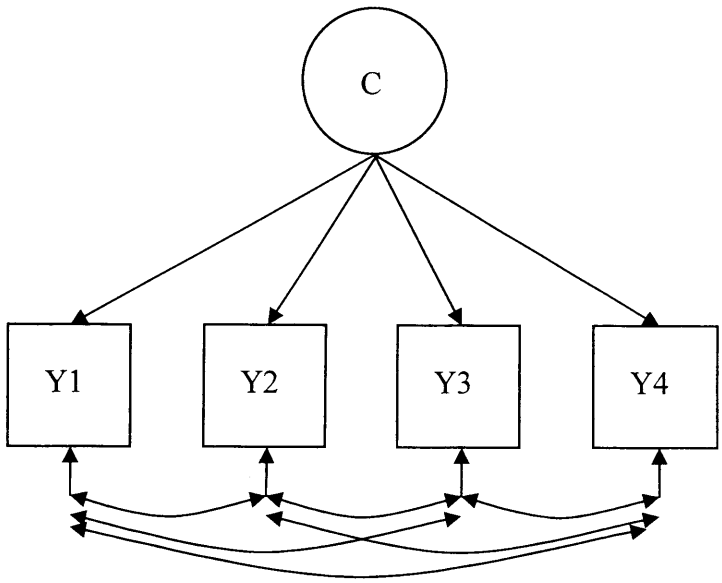


Figure 3.2: Latent class clustering



certain allocation, which in reality is unlikely (Vermunt & Magidson, 2002; Greenbaum, Del Boca, Wang & Goldman, 2005; Colder, Campbell, Ruel, Richardson & Flay, 2002). Other advantages of latent class clustering are that it offers more formal criteria on which to make decisions about the number of clusters and other model features (Vermunt & Magidson, 2002) and that it allows the inclusion of participants with missing data (Greenbaum et al., 2005). Latent class clustering can also be used with variables with different scale types. This is an advantage over not only cluster analysis, but also latent class growth analysis and growth mixture modelling.

Estimation of the latent class clusters is through identification of mixture components. It is not an entirely new method, having its origins in the work of Newcomb in 1886 and Pearson in 1894 (Land, 2001), but mixture modelling has only recently become practical following the development of software and computing power (Vermunt & Magidson, 2002).

Model identification

To identify models a finite mixture modelling approach is used. Finite mixture models assume that the observed distribution of the total population is the result of random variation around a series of sub-populations which will be indicated by latent variables (Bauer & Curran, 2004). The number of sub-populations or classes is specified by the modeller, and the random variation of sub-populations is typically assumed to be normal, although other distributions can be assumed. For sub-populations to be identified the observed data have to be non-normally distributed. The model summarizes this non-normal distribution by identifying K sub-populations which are all normally distributed, but have different means and standard deviations, and make up different proportions of the total population. Although non-normality is required to identify sub-populations, non-normality may also be explained by other characteristics such as inherent properties of the scales used, in which case the model can be considered a means of summarizing a complex distribution of data in a simpler manner (Bauer & Curran, 2003b).

Model fitting

Model fitting is a two stage process. In the first stage, maximum likelihood is used to estimate the parameters that fit the data (Bauer & Curran, 2003b). The latent classes

"C" (see figure 3.2) are considered to be missing data and are estimated using maximum likelihood estimated using an EM algorithm (Muthén, 2004b). In this thesis the means for the Y values vary by class. In order to aid model fitting and identification, the within class variances and covariances are constrained to be the same for each of the K latent classes. Once the parameters of each class have been identified, individuals are then allocated a probability of class membership in each class. From a Bayesian perspective, this could be considered the posterior probability of group membership (Muthén, 2004b).

The likelihood used to estimate mixture models is known to be vulnerable to having local maxima (Vermunt & Magidson, 2002; Muthén, 2004b; Hipp & Bauer, 2006). To ensure that the true maximum likelihood is identified it is recommended that multiple, typically at least 50-100 (Hipp & Bauer, 2006), starting values are used to estimate the models. In this thesis model estimation is repeated until the best-fitting model was identified in multiple replications or it appeared that a stable model could not be replicated.

Model selection

The number of classes is specified by the modeller, who has the aid of a number of pragmatic and statistical criteria to help determine the number of classes in the selected model.

Statistical criteria

When a K class model is compared with a model with K + 1 classes the conditions required for a conventional likelihood ratio test statistic do not hold (Croudace et al., 2003; Nagin, 1999; Vermunt & Magidson, 2002). A traditional chi square test over estimates number of classes and the problem increases with increasing sample size (Nylund, Asparouhov & Muthén, 2007). This has resulted in the on-going development of numerous ways of assessing model fit but as yet there is relatively little consensus on which are the best criteria (Greenbaum et al., 2005). The fit indices available in Mplus v 3.12 broadly divide into three types: information criteria, entropy index (probability of class membership), and the Lo-Mendell Rubin Likelihood Ratio Test (Lo, Mendell & Rubin, 2001).

Information criteria

Information criteria measures aim to combine assessment of a good fitting model with a correction for parsimony (Croudace et al., 2003) and are a measure of relative rather than absolute fit (Bauer & Curran, 2003b). The statistical package Mplus calculates three different information criteria: The Bayesian Information Criteria (BIC), Akaike's Information Criterion (AIC) and the sample size adjusted BIC (ssaBIC) which are calculated as follows:

$$AIC = -2 \log likelihood + 2r;$$
$$BIC = -2 \log likelihood + r \ln n,$$

Where r is the number of free model parameters and n is the sample size. The ssaBIC replaces n with:

$$n = (n + 2)/24$$

The BIC is the most commonly used measure for identifying developmental trajectories. It has been suggested that there is a tendency for BIC to under-estimate and AIC to over-estimate the number of classes (Bauer & Curran, 2003b), and Lin and Dayton (1997) have suggested that the AIC may be more appropriate than BIC for complex models. Yang (1998) has provided support for the sample size adjusted BIC comparing latent class models in a psychometric context. When two models are compared using any of the three information criteria the model having the lower score is considered the better fitting.

Lo Mendel Rubin Likelihood Ratio Test

An alternative method to test model fit is through the use of the Lo Mendell Rubin likelihood ratio test (Lo et al., 2001) otherwise known as the adjusted Likelihood Ratio Test (aLRT) (Lubke & Muthén, 2007). The aLRT uses a likelihood ratio test to compare models with K classes to those of K-1 classes, and overcomes the problems in using a likelihood ratio test for non-nested models by the application of a different distribution to the chi-square (Muthén, 2004a). The use of the aLRT has, however, been disputed (Jeffries, 2003; Bauer & Curran, 2004). Most notably, because the test depends on deleting one class from the model, the results depend heavily upon which class is deleted. As such, the analysis should be constructed so that the newest-added class for that analysis is deleted (Connell & Frye, 2006). Even this is not without problems as it should not be assumed that all the classes found in a K-1 model will be found in a K class model.

Entropy index

The other statistical fit measure in use is the entropy index which is a measure of the clarity of allocation to classes and is an average of the highest posterior probability of class membership for each individual. Entropy scores can range from 0 to 1 with 1 indicating a perfect fit (Bauer & Curran, 2003b), and a score of 0.70 or above is considered acceptable (Loughran & Nagin, 2006; Duchesne et al., 2005).

Pragmatic criteria

Models can also be selected on the basis of pragmatic criteria such as the usefulness of classes, the similarity of the trajectories and the number of individuals in each class (van Lier & Crijnen, 2005; Muthén & Muthén, 2000; Connell & Frye, 2006). In this thesis three pragmatic criteria will primarily be used. The first is that by generating a model with an additional class a new distinctive trajectory is added. The second criterion is that the classes contain sufficiently large samples to be of use in future analyses and as rough guide classes should contain more than 200 individuals. The third criterion is that the trajectories produced by the fuller samples and complete cases are comparable.

The complete cases samples have complete data for all indicators for the relevant trajectory. The fuller samples consist of cases which have valid data for at least two of the trajectory's indicators. A comparison between the fuller and complete cases samples is being carried out to identify any potential impact the use of slightly different samples have and to identify any potential biases caused by the methodology. Using the fuller sample has advantages over the complete cases sample in that it increases the usage of available information and maintains the sample size for the most disadvantaged trajectories. However, there are concerns that the estimation process may enable the formation of developmental trajectories that primarily consist of cases allocated on the basis of estimated values, and the use of trajectories which are not identifiable using cases with complete data would be questionable. Comparing the trajectories identified using the complete cases sample with those trajectories identified using the fuller sample, ensures that any fears over the separate methodologies producing different conclusions can be assuaged.

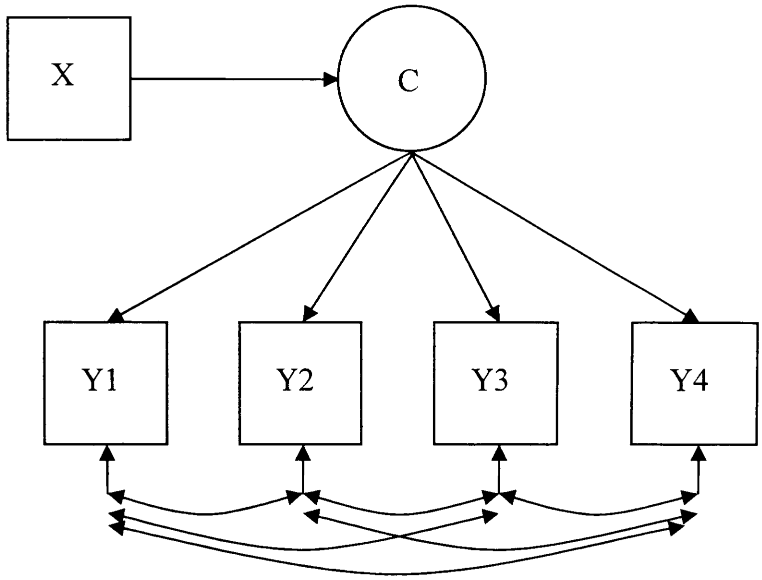
In addition, when deciding which trajectories most usefully modelled the data, some weight was placed on the similarity of the classes generated by men and women.

3.4.2. Prediction of developmental trajectories by exogenous variables

Multinomial logistic regression can be used to test if variables outside the model (exogenous variables) are associated with membership of the latent class cluster (see figure 3.3).

Cases which have missing data for exogenous variables are excluded from analyses, as values for exogenous variables cannot be estimated during model identification. In

Figure 3.3: Prediction of a latent class cluster by an exogenous variable

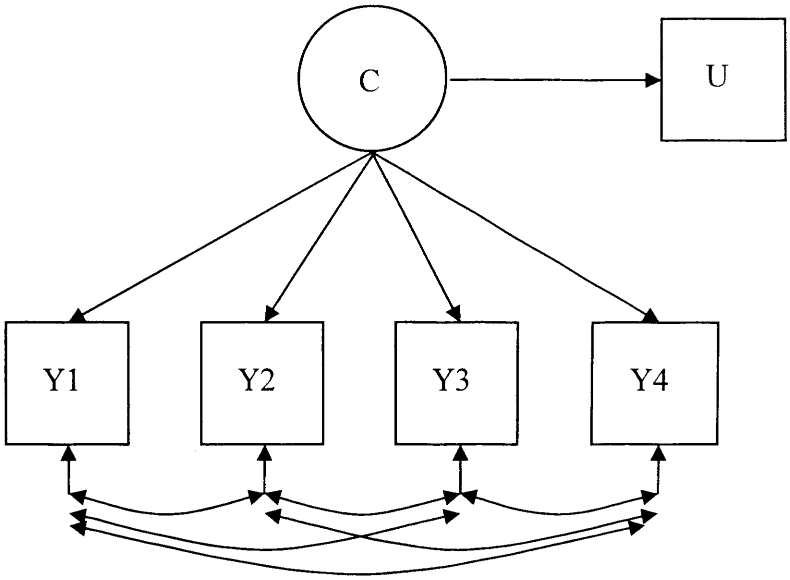


order to ensure that the developmental trajectories identified in these analyses are the same as those for the whole population, the model parameters are constrained to those obtained for the full population, and the estimation at this stage is to predict class membership. Class membership can then be regressed on to the exogenous variables, which in this thesis are birthweight, gestational age and parental social class.

3.4.3. Prediction of unemployment by resources

In the model to test whether the developmental trajectories are associated with unemployment, an extra endogenous categorical indicator (U) is added to the model (see figure 3.4). The number of classes (K) and model parameters for the Y indicators are fixed using values determined in the selected model without endogenous indicator U, and each case is allocated to a trajectory on that basis. Variation in the parameters of U is determined on how cases are allocated by the Y variables: from this the odds of scoring on U for each latent class can be identified and odds ratios calculated.

Figure 3.4: Latent class clustering with an additional categorical indicator



3.4.4. The association between unemployment and health

Logistic regression is used to test if unemployment is associated with for self rated health, limiting longstanding illness, Malaise and GHQ. Multinomial logistic regression is used to test if unemployment is associated with weight change. For the single time point measures the analyses were conducted in Stata 9 (Statacorp, 2005) for the developmental trajectories the analyses were conducted in Mplus 3.12 (Muthén & Muthén, 2004).

3.4.5. Effects modification by resources

A statistically significant interaction needs to be identified for there to be evidence that resources modify the effects of unemployment on health. For testing interactions where resources are indicated using a single indicator variable, a likelihood ratio test is conducted using Stata 9 (Statacorp, 2005). A standard multi-variate logistic regression model (multinomial when weight change is the health outcome) is considered to be nested within a model where additional parameters are generated for unemployed*resource status. If removal of the unemployed*resource status indicators does not result in a significant reduction in model fit there is no evidence of an interaction.

To test if interactions between unemployment and resources as indicated by developmental trajectories occur a likelihood ratio test is conducted, this time using Mplus 4.0 (Muthén & Muthén, 2006). Two models are generated. In the first, the odd ratios for the prediction of health by the latent classes are allowed to differ depending on unemployment status. In the second nested model, the odds ratios for the prediction of health are constrained to be the same for those who experience unemployment and those who do not.

3.5. Missing data

The NCDS has lower rates of attrition than most panel studies (Schoon, 2006), despite this, there are still problems with missing data in the study. Missing data can take many forms. These include: item non-response, where an individual has participated in a sweep but does not have valid responses for all items; wave non-response, where an individual does not participate for one wave but subsequently rejoins, and attrition, where individuals permanently leave the study (Schafer & Graham, 2002).

Missing data leads to two main problems. Firstly, a loss of information and power due to a reduction in sample size (Allison, 2001). Secondly, the sample may no longer be an unbiased representation of the population from which it was taken (Schafer & Graham, 2002). Solutions to the problems of missing data are based on a framework of inference introduced by (Rubin, 1976) whose paper forms the basis of how missing data is now defined (Schafer & Graham, 2002; Allison, 2001).

3.5.1. Missing data definitions

The key terms that describe missing data are: missing completely at random (MCAR), missing at random (MAR) and missing not at random (MNAR).

The data on variable Y are said to MCAR, if the probability of missing data on Y is unrelated to the value of Y itself or the values of any other variables being analyzed data set (Allison, 2001). If MCAR is assumed the data can be said to be a random sub-sample of the original set of observation (Schafer & Graham, 2002).

The data are said to be MAR if the probability of missing data on Y is unrelated to the value of Y, after controlling for other variables in the analyses (Allison, 2001). In other words, the probability of being missing for a particular variable is independent of its own scores when other explanatory factors have been taken into account.

There are advantages if the data can be assumed to be MCAR or MAR as, under these assumptions, there are many analysis techniques which minimise the loss of information and biases. Unfortunately the assumptions underpinning MCAR and MAR can not always be upheld. In some cases the data can be missing for "Y" through mechanisms which are explained by values of Y itself (Allison, 2001).This is known as MNAR which can also be described as occurring when the probability of missingness is dependent on values which are themselves more likely to be missing (Buhi, Goodson & Neilands, 2008). In this case the missing data mechanism is said to be non-ignorable (Allison, 2001).

It is possible to test between the MAR and MCAR assumptions for missing data. However, it is impossible to test if missingness is due to MNAR as opposed to MAR or MCAR assumptions, because this would require knowledge of the true values for the missing data (Peugh & Enders, 2004).

The assumptions underlying the processes leading to missing data are one key feature determining which methods should be utilised to tackling missing data.

3.5.2. Missing data solutions

The most important factor when trying to solve the problems presented by the missing data is to ensure that the solution provides an honest unbiased representation of the populations from which sample data is drawn (Schafer & Graham, 2002). Many approaches have been utilized to tackle missing data. However, these approaches can cause more problems than they solve (Schafer & Graham, 2002). Three approaches are briefly discussed here: list-wise deletion, imputation and full information maximum likelihood (FIML) using the EM algorithm.

List-wise deletion is the most common approach to missing data and is often applied unconsciously. Individuals for which there is missing data on any variables included in an analysis are excluded from that analysis, and then the analysis is run as normal. This has a number of benefits in that it can be used for any statistical method and no special computational methods are needed (Allison, 2001). However, there are disadvantages. Information is discarded, leading to smaller samples sizes and increased standard errors, and depending on assumptions about how missing data is distributed, list-wise deletion can potentially lead to biases (Little & Rubin, 1987). These biases will be most problematic if the probability of having missing data for a dependent variable depends on an independent variable (Allison, 2001). In other circumstances the use of list-wise deletion is less prone to bias. In regression analysis, if missing data for an independent variable does not depend on the values of a dependent variable then regression estimates using list-wise deletion will be unbiased (Allison, 2001). For logistic regression estimates will also be unbiased unless the probability of having missing data depends on both the independent and dependent variables (Allison, 2001).

Imputation is a general term for filling data with plausible values (Schafer, 1997). There are many different types of imputation some of which pose more problems than list-wise deletion. However, multiple imputation is currently considered the state of art approach to missing data (Schafer & Graham, 2002). Multiple imputation identifies missing values for each participant using predictions based on each participant's values on other variables. Random noise is added to preserve the correct amount of variability in the imputed data (Schafer & Graham, 2002). Multiple imputation has advantages in that it can use all of the data available and provides an honest representation of the variability in the sample. However, multiple imputation is very sensitive to the assumptions about the mechanism underlying the missing data and the distributions of the variables (Allison, 2001).

The basic goal of FIML it to identify the population parameter values most likely to have produced a particular sample of data (Peugh & Enders, 2004). This is achieved by maximizing a likelihood function (see Arbuckle, 1996) using an iterative process using the EM algorithm. In each iteration the means and covariance are estimated. (Peugh & Enders, 2004) and the best filleting model is identified when the Mahalanobis distance is minimised (Peugh & Enders, 2004), i.e. the model in which there is the smallest distance between observed scores and those estimated by parameters for all observed individuals (Peugh & Enders, 2004; Enders, 2001). One of the advantages of FIML estimation is that the Mahalanobis distance for each individual is calculated based only on scores that are available for that individual (Peugh & Enders, 2004). Missing values are not imputed during the process, but the partial data implies probable values for the missing data (Peugh & Enders, 2004).

Apart from ensuring that the amount of missing data is minimised, there is not a single best method of tackling missing data, and the method should be selected using a number of criteria including the missing data assumption, the statistical method to be utilized and the parameters to be estimated.

One key factor when adopting a strategy for missing data is the mechanism assumed to cause the missingness. If missingness is assumed to be MCAR or MAR then generally maximum likelihood or multiple imputation methods perform better (Buhi et al., 2008; Schafer & Graham, 2002). However, there are exceptions, for example, Cheung (2007) found that list-wise deletion performed better than multiple imputation when data was assumed to be MCAR. If missingness is assumed to be NMAR no method can avoid bias (Buhi et al., 2008).

The statistical method and the parameters to be investigated also have an influence on the best approach to be used. Some methods are more vulnerable to missing data than others, with regression being less vulnerable to the effects of missing data than other statistical methods such as structural equation modelling (Enders, 2001). It has been claimed that list-wise deletion is the method most robust to violations of MAR (Allison, 2001). However, the benefits of using list-wise deletion to tackle missing data when conducting regression under MNAR depend on the parameters to be estimated. In comparison to FIML under MNAR, list-wise deletion produces less biased regression coefficients, but increase biases for R^2 and greater sampling variability (Enders, 2001). Overall different approaches to missing data are required depending on the context of a particular analysis.

3.5.3. Missing data in this thesis

Within this thesis there are 4 different areas of concern for missing data: the trajectory indicators, the predictors of the trajectories (birthweight, preterm birth and parental social class), unemployment status and the health outcomes.

Trajectory indicators

Trajectory indicators are inherently included in the model used to identify trajectories. This means that it is a relatively simple operation to extend the model estimation process so that values for missing data can be estimated with FIML. However, it was decided that partial case deletion may be necessary given the assumptions underlying the model.

One of the assumptions underlying the use of the trajectories is that a single time point measure is not an adequate representation of an individual's development. Given this assumption it is unlikely that trajectory indicators can be reliably estimated if only one indicator or no indicators are available for a trajectory. Thus it was decided that trajectories should only be estimated for participants with at least two indicators with the remaining participants being excluded from that analysis. The resulting sample has been termed "fuller sample". This needs to be differentiated from the "complete cases" sample which contains only participants which have complete data for all indicators for a particular trajectory. Using the fuller sample has advantages over the complete cases sample in that it increases the usage of available information, maintaining the sample size of potentially the most disadvantaged groups in terms of development.

The predictors of the trajectories

The predictors of the trajectories, birthweight, preterm birth and parental social class, pre-date the development trajectories. Excluding the possibility of genetic factors underpinning both the developmental trajectories and the predictor variables, it is reasonable to assume that missingness for the predictor variables is not dependent on the developmental trajectories. As a result when conducting multinomial logistic regression to predict trajectory membership, list-wise deletion should provide unbiased regression coefficients.

Unemployment status

The greatest concern with missing data status is for the unemployment status measures, for which there are many potential causes of missing data. One possible cause is that the stigma of unemployment results in individuals who had experienced unemployment being less willing to describe their economic history. Another possible cause of missing data is a chaotic and disorganised life which may increase the risk of item non-response, wave non-response and attrition as well as unemployment. Alternatively, participants may have missing data because they have a strong commitment to their career. Such individuals may have little time to participate in the study and have a high degree of geographic mobility, making attrition and wave non-response more likely. Thus it is highly unlikely that MAR assumptions can be upheld. List-wise deletion was decided to be the best approach for analyses focused on unemployment. The NCDS provides a reasonably large sample size even after cases have been excluded due missing data, and possible increases in biases for regression coefficients were felt to be a greater concern than other potential biases.

Health outcomes

The health outcomes are only investigated in the context of unemployment. Once those who are missing on employment data are taken into account, the amount of data missing for the health outcomes is relatively limited and missing techniques are likely to have little further impact. For analyses using single time point measures list-wise deletion is used. For the interactions between the developmental trajectories and unemployment in the prediction of the health outcomes, it is relatively simple to use FIML to estimate the missing data as the health outcomes are included within the estimated models.

3.6. Pointing Forward

The methods for identifying latent classes and then the regression of the latent classes on to birth weight, gestational age and social class, are used to investigate the development and origins of emotional well-being in chapter 4, cognitive ability in chapter 5 and BMI in chapter 6.

The associations between the developmental trajectories and unemployment are tested for in chapter 7, as are associations between unemployment and health.

The statistical methods for identifying interactions are utilized in chapter 8 to test whether resources could alter unemployment's effects on health and thus provide some evidence that processes leading to resilience do exist.

Chapter 4: Development of emotional well-being

4.1. Introduction

Emotional well-being has been defined as "a holistic state which is present, when a range of feelings, among them energy, confidence, enjoyment, happiness, calm and caring, are combined and balanced" (Edmunds & Stewart-Brown, 2003). This is one of many definitions and the conceptualization and operationalization of emotional well-being has been the subject of much disagreement (Gallo & Matthews, 2003). Many aspects of emotional well-being, such as confidence and energy, are key factors in the development of resilience to adversity. However, instruments capable of measuring the more positive aspects of emotional well-being in children have only recently been developed (Edmunds & Stewart-Brown, 2003) and the majority of research has focused on using instruments that have identified the absence of well-being through the identification of pathology.

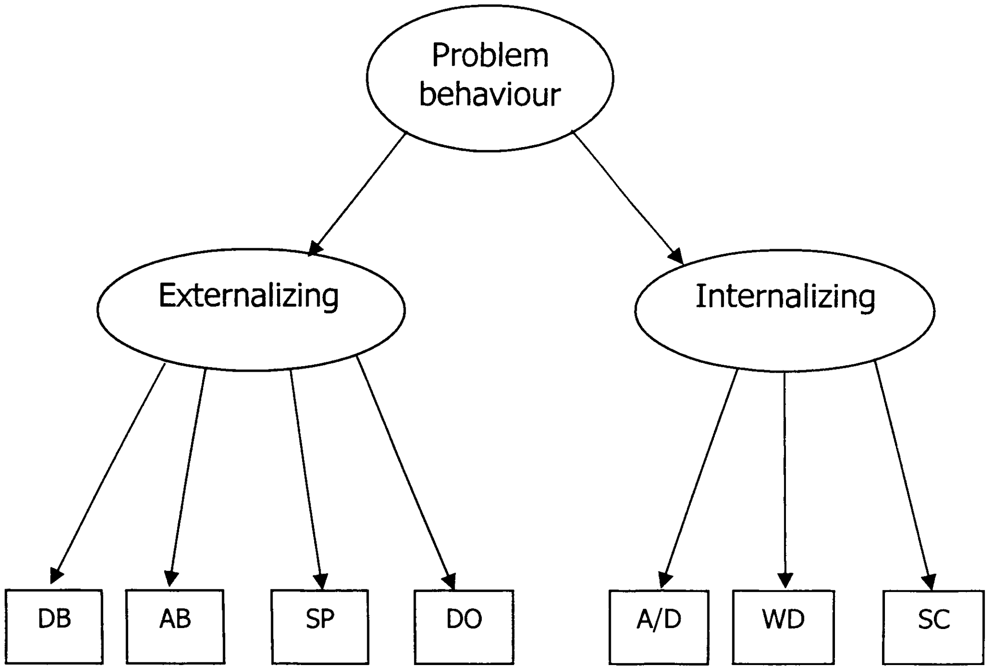
Two approaches have been used to define pathology (Hartman, Hox, Mellenbergh, Boyle, Offord, Racine et al. 2001). One has been based on clinical diagnosis of commonly co-occurring symptoms (Hartman et al., 2001). The other approach is based on empirically defined syndromes which are generated on the basis of statistical covariation of symptoms without a priori conception of what the structure should be (Hartman et al., 2001).

The clinical approach to conceptualizing psychopathology is dominated by the diagnostic and statistical manuals of mental disorders (American Psychiatric Association., 1980, 1987, 1994) and based on the defining of categorical pathologies. However, there is much controversy around the use of discrete categories for pathologies as there is a high degree of comorbidity between different disorders (Oland & Shaw, 2005; Ollendick, Shortt & Sander, 2005; Krueger, 2002; Frick & Kimonis, 2005). For example, Krueger and Piasecki (2002) found that 79% of all the lifetime mental disorders observed in the US National Comorbidity Study were observed in persons with a history of more than one disorder. This has lead to a great deal of debate on whether different problem behaviours during adolescence reflect a single underlying dimension or whether they are better conceived as multiple phenomena (Reitz, Dekovic & Meijer, 2005; Frick & Kimonis, 2005) and a number of methods have been proposed to resolve the situation.

One approach would be to measure problem behaviour using items that are highly specific to a particular disorder (Hartman et al., 2001). Another approach is to treat comorbid disorders as representing distinct meaningful disorders in themselves (Oland & Shaw, 2005), a third approach is to ignore comorbidity (Krueger, 1999). However, there is evidence that there may be common factors underlying many disorders, and addressing these underlying factors has the potential to cure many different disorders. For example, selective serotonin reuptake inhibitors (SSRIs), although initially regarded as antidepressants, have been found to be effective in treating other internalizing conditions, such as panic disorder and dysthymia, and SSRIs may influence a core internalizing process (Krueger, 1999). In addition, there is evidence that some risk factors, whether biological mechanisms such as genetics (Krueger, 1999), or social factors such as poverty and inter-parental conflict (Oland & Shaw, 2005), are associated with a higher risk of many different internalizing and externalizing disorders, and there is a general consensus that there is some form of latent structure underlying problem behaviour symptoms.

Factor analyses attempting to understand the structure tend to identify 2 or 3 factors with similar items. However, when additional factors are identified the comparability across studies is reduced (Ghodsian, 1977). A reasonably consistent 3-factor structure solution during childhood has been found, consisting of conduct disorder, attention deficit/hyperactivity disorder and anxious withdrawn behaviour (Goodwin et al., 2004). However, alternative 3-factor structures have also been found. For example, Krueger (1999) identified a structure consisting of one externalizing factor, and two internalizing factors named "anxious misery" and "fear". The number of factors identified is in large part determined by the items selected to operationalize behaviour and thus will be the product of subjective decisions made by researchers. However, there is undoubtedly an underlying structure including both higher order and lower order factors (Reitz et al., 2005; Krueger & Piasecki, 2002).

Figure 4.1: An example of a higher order factor structure for problem behaviour



DB: Delinquent Behaviour; AB: Aggressive Behaviour; SP: School Problems; DO: Disobedience; A/D: Anxious/Depressed; WD: Withdrawn; and SC: Somatic Complaints.

An example of a possible higher order factor structure is shown in figure 4.1 (taken from Reitz et al. 2005). There is a factor of problem behaviour, which contains two sub-factors; externalizing and internalizing problems. These in turn consist of other disorders that in figure 4.1 are represented by: delinquent behaviour, aggressive behaviour, school problems; disobedience, anxious/depressed, withdrawn; and somatic complaints. There are numerous other ways of conceptualizing the disorders within externalizing and internalizing, but the two factors of externalizing and internalizing are widely acknowledged (Reitz et al., 2005; Krueger & Piasecki, 2002; Frick & Kimonis, 2005; Krueger, 2002).

Externalizing behaviour is characterized by an under-control of emotions, (Buchanan & Ten Brinke, 1998; Cherlin, Chase-Lansdale & McRae, 1998), which can result in delinquency, aggression (Reitz et al., 2005) and other anti-social behaviours. Items measuring externalizing symptoms include: difficulties in interaction with other children and at home, difficulties in concentration, having a strong temper and being argumentative (McCulloch et al., 2000).

Internalizing behaviour is characterized by an over-control of emotions and can lead to depressive disorders (Buchanan & Ten Brinke, 1998; Cherlin et al., 1998). Symptoms of internalizing disorders are related to: worry, fear, shyness, low self-esteem, sadness and depression (Ollendick et al., 2005). Items used to measure internalizing symptoms include: being withdrawn, demanding attention, being too dependent or clingy and feeling worthless or inferior (McCulloch et al., 2000).

The Rutter “B”, a questionnaire for completed by teachers of NCDS participants at age 16, was originally developed to distinguish externalizing and internalizing behaviours (Rutter, 1967; Cherlin et al., 1998), and there are acknowledged ways of summarizing the Bristol Social Adjustment Guide (Ghodsian, 1977) and the Rutter “B" (Macmillan et al., 1980).

4.1.1. Developmental trajectories

Hither to, the identification of group-based developmental trajectories has been concentrated on very narrow bands of emotional well-being. The modelling of externalizing disorders has focused on specific aspects such as aggression and oppositional defiant disorder, whilst the modelling of internalizing disorders has focus on depressed mood.

Externalizing trajectories

The majority of research on group-based trajectories of externalizing symptoms has focused on aspects of aggression. Five papers (Broidy et al., 2003; van Lier & Crijnen, 2005; Bongers, Koot, Van Der Ende & Verhulst, 2004; van Lier et al., 2007) utilizing data from 10 cohorts suggest that most populations contain individuals on 3 or 4 parallel trajectories of declining aggression. Similar numbers and shapes of trajectories have been found for other aspects of externalizing disorders including hyperactivity (Nagin & Tremblay, 1999; van Lier et al., 2007), opposition disorders (Nagin & Tremblay, 1999) and property and status violations

(Bongers et al., 2004). Thus it is expected that this thesis will identify models containing 3 or 4 parallel trajectories of declining externalizing symptoms.

Of these trajectories, one is likely to be a trajectory of high levels of externalizing symptoms and would contain 4-11% of the population. There would then be one or two trajectories of moderate externalizing symptoms containing 15 to 45% of the population, and the final trajectory would be of consistently low symptoms containing anywhere from 30 to 75% of the population.

However, 3 or 4 parallel trajectories of decreasing externalizing symptoms should not be assumed. Other studies have identified trajectories of increasing externalizing symptoms as represented by opposition disorder (Bongers et al., 2004), aggression (van Lier et al., 2007), and criminal offending (Fergusson & Horwood, 2002). In addition, although the 3 or 4 parallel trajectories of externalizing symptoms are consistent with Moffit's theory of life course persistent anti-social behaviour (Moffit, 1993) they are not consistent with Moffit's theory of adolescent limited anti-social behaviour trajectory. So it is possible that other types of trajectories will be found.

Girls are generally considered to have fewer externalizing problems (Ackerman, Brown & Izard, 2003) and it has been suggested that girls are likely to restrict anti-social behaviour to a relatively limited period during early adolescence (Fergusson & Horwood, 2002) so it is possible that the trajectories identified for girls are different to those identified for boys. However, when developmental trajectories have been modelled for both genders the models have been found to be very similar (Broidy et al., 2003; Bongers et al., 2004; Schaeffer et al., 2006).

Internalizing trajectories

There may be limited comparability between models generated using the NCDS, which spans an age range from 7 to 23 years, and the models generated by Repetto et al. (2004) and Brendgen et al. (2005) but more comparable studies do not exist. Both the Repetto et al. (2004) and Brendgen et al. (2005) studies identified models containing 4 trajectories of depressive symptoms spanning 4 years of adolescence.

Three of the trajectories identified in the Repetto et al. (2004) study matched those in the Brendgen et al. (2005) study. Assuming development is similar in the NCDS, expected trajectories would include a trajectory containing 40-50% of the population which had consistently low depressive symptoms, a second trajectory, containing 10-20% of the population with consistently high levels of symptoms and a third trajectory indicating rising symptoms. In the NCDS, which covers a longer time span than the Brendgen et al. (2005) and Repetto et al. (2004) studies, the rise in internalizing symptoms may only occur during adolescence.

The 4th trajectories in both the Repetto et al. (2004) and Brendgen et al. (2005) studies were not comparable. The 4th trajectory in the Brendgen et al. (2005) study, who were aged 11 at the start of the study, had moderate levels of depressive symptoms that remained steady, whilst the 4th trajectory in the Repetto et al. (2004) sample, aged 14 at the start of the study, had initially raised levels of depressive symptoms that decreased over time. In general populations, internalizing symptoms tend to plateau or decline in late adolescence (Ge, Natsuaki & Conger, 2006), and this would suggest that in the NCDS there would be a trajectory that had moderately raised symptoms at ages 7 and 11 and that these symptoms would then decline.

In early childhood levels of internalizing symptoms are similar for both genders, but in adolescence they have been found to rise more rapidly for girls (Ge et al., 2006; Brendgen et al., 2005; Leve et al., 2005) and this may be reflected in the trajectories identified in the NCDS.

4.1.2. The origins of emotional well-being

The research published on relationships between social class, birthweight and gestational age, and group-based trajectories so far has been extremely limited. Brendgen et al. (2005) demonstrated that a general measure of family adversity including family structure, parents' age, and parents' occupational standing has been shown to predict membership of a trajectory of consistently high depressive symptoms. Other methods, have demonstrated a fairly consistent link between disadvantaged social circumstances and poorer emotional well-being (Bradley, Whiteside, Mundfrom, Casey, Kelleher & Pope, 1994; Gallo & Matthews, 2003; Ackerman et al., 2003; Bradley & Corwyn, 2002). Methods for summarizing development have suggested that levels of externalizing symptoms tend to be lower initially for those from advantaged social circumstances and that these levels fall more rapidly (Kraatz Keiley et al., 2000), whilst those from more disadvantaged social backgrounds have been shown to have faster rates of growth of internalizing symptoms (Leve et al., 2005).

Birthweight and gestational age have been shown to predict increased risk of both externalizing and internalizing symptoms in children and adults (Kelly et al., 2001; Wiles, Peters, Heron, Gunnell, Emond & Lewis, 2006; Bhutta, Cleves, Casey, Cradock & Anand, 2002; Delobel-Ayoub et al., 2006; Fan & Eaton, 2001; Thompson et al., 2001; Costello et al., 2007; Gardner et al., 2004). However, there is an absence of research on how these factors shape overall development. Birthweight and gestational age have tended to show an association with increased risk of emotional problems in both children and adults, which would suggest that birthweight and gestational age would predict trajectories that have relatively high levels of symptoms throughout. However, there is some evidence that birthweight is associated with increased social withdrawal (Harrison, 2002) and neuroticism (Allin et al., 2006; Harrison, 2002), leading to a lower chance of risky anti-social behaviour in young adults (Hack, Flannery, Schluchter, Carter, Borawski & Klein, 2002).

4.2. Methods

4.2.1. Data

In this chapter the data collected in the NCDS at age 7, 11 and 16 sweeps are used to generate the trajectories of externalizing symptoms. To generate the trajectories of internalizing symptoms additional data collected in the age 23 sweep are used. Data collected during the Perinatal Mortality Survey at birth are used to indicate birthweight, gestational age and parental social class.

The focus of the analyses is the fuller samples which are a compromise between minimising risk of any potential biases due to attrition and having sufficient data to estimate trajectories. The fuller samples contain all cases that have valid data for at least two of the variables used as indicators for the developmental trajectories. The externalizing fuller sample consists of 7274 men and 6892 women. The internalizing fuller sample consists of 7666 men and 7294 women.

In addition, there are samples of complete cases (cases which have complete data on all indicators for that trajectory) used to help select the model used for further analysis. The complete cases sample for externalizing behaviour contains 4643 men and 4511 women. The complete cases sample for internalizing behaviour contains 3726 men and 3767 women.

4.2.2. Variables

The variables used as indicators for the latent class developmental trajectories of emotional well-being are derived from the BSAG (Stott, 1969) at age 7 and 11, the Rutter "B" scale at age 16 (Rutter et al., 1970) and at age 23 the Malaise inventory (Rutter et al., 1970).

The sub-scales from the BSAG were summed as suggested by Ghodsian (1977) to generate separate internalizing and externalizing scales. The items forming the Rutter "B" were allocated and summed to form separate externalizing and internalizing scales at age 16, using the schema suggested by Macmillan et al. (1980). The complete scale for the Malaise inventory was used to indicate internalizing symptoms at age 23.

The exogenous variables used in the analyses are birthweight, gestational age and parental social class.

Birthweight in ounces has been converted into kilograms and is in 5 categories: <2.51 kg, 2.51-3.00 kg, 3.01-3.50 kg, 3.51-4.00 kg, and >4.01 kg. The 3.51-4.00 kg is used as the reference category.

Gestational age is dichotomised; those babies born before completing 37 weeks of pregnancy being considered preterm births.

Parental social class was based on Registrar General's Social classification. If the mother was married, the mother's husband's occupation was used to indicate social class. If for what ever reason a husband's social class was not available, the mother's own or the mother's father's social class were used instead. Classes I and II were merged to create a reference category, while the remaining classes; III non-manual, III manual, IV and V, were left as independent categories.

4.2.3. Statistical analyses

Prior to conducting the main statistical analyses the samples used in the analysis were tested for any possible significant biases. The mean scores for the behavioural variables for the fuller samples and complete cases samples were compared with those of cases excluded from the respective samples, due to having too much missing data using t-tests in order to test for any biases in attrition. Chi-square tests were also conducted to investigate if there were any significant biases in membership of the fuller samples predicted by parental social class, birthweight and gestational age.

The main statistical analyses in this chapter are presented in two stages. Firstly, exploratory analysis is used to identify the developmental trajectories. Secondly, a hypothesising testing stage is conducted to determine whether the identified trajectories are associated with parental social class, birthweight and gestational age.

In the exploratory stage, latent class clustering is used to identify a series of models with k number classes for both the fuller sample and the complete cases sample. The complete cases sample is used as a comparison to help evaluate whether the fuller sample is an accurate representation of the population.

The statistical criteria, used to help decide the number of classes that the model used for further analysis contains are, the AIC, BIC, ssaBIC, entropy Index and Lo Mendel Rubin Likelihood Ratio Test (aLRT). The pragmatic criteria used to decide the best models are: 1. that each developmental trajectory is reasonably distinct; 2. that the classes contain sufficiently large samples to be of use in future analyses, and 3. that the trajectories identified using the fuller samples have similar shapes to trajectories identified using complete cases.

Having established models to summarize both internalizing and externalizing symptoms, the next stage of the analysis is to regress the developmental trajectories identified in these models on to the exogenous variables birthweight, gestational age and social class using multinomial logistic regression. Cases that have missing data for an exogenous variable are excluded from the analyses involving that variable.

4.3. Results

The means and standard deviations for the indicators of internalizing and externalizing behaviour are presented in tables 4.1 and 4.2. When the means for behaviour of the fuller samples were compared to the means of behaviour for cases excluded from the fuller sample (see tables 4.1 and 4.2) the only significant difference for men was that those excluded from the fuller sample had a higher mean internalizing symptoms score at age 11 ($p<0.01$) and age 16 ($p<0.05$). For women there were significant differences between those included in the fuller sample and those left out for externalizing at age 7 ($p<0.05$), internalizing at age 7 ($p<0.05$) and internalizing at age 11 ($p<0.05$). In each case those excluded from the fuller sample had a higher mean behaviour score. When the means for behaviour of the complete cases were compared to the means of behaviour for cases excluded from the complete cases sample all the means were significantly higher, with the exception of externalizing symptoms at age 16 for both sexes and internalizing symptoms at age 23 for women.

Table 4.1: Externalizing symptoms at age 7, 11 and 16: numbers, proportions, means and standard deviations for cases included and excluded from the fuller sample and complete cases (men and women)

	Fuller sample			Excluded from fuller sample			Complete cases			Excluded from complete cases		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Men												
Age 7	6891	4.58	5.65	494	4.93	6.15	4643	4.40	5.46	2742	4.95***	6.04
Age 11	6734	4.56	5.84	190	5.27	5.95	4643	4.33	5.63	2281	5.09***	6.22
Age 16	5566	1.94	3.30	160	2.16	3.23	4643	1.91	3.28	1083	2.10	3.38
Total	7274			1276			4643			3907		
Women												
Age 7	6556	3.22	4.58	467	3.85*	5.51	4511	3.12	4.50	2512	3.52***	4.90
Age 11	6350	2.82	4.43	184	3.11	5.50	4511	2.71	4.32	2023	3.11***	4.75
Age 16	5389	1.12	2.39	141	1.26	2.39	4511	1.12	2.41	1019	1.16	2.32
Total	6892			1155			4511			3536		

* $p < 0.05$, ** $p < 0.01$, *** $p < .001$

Table 4.2: Internalizing symptoms at age 7, 11 and 16: numbers, proportions, means and standard deviations for cases included and excluded from the fuller sample and complete cases (men and women)

	Fuller sample			Excluded from fuller sample			Complete cases			Excluded from complete cases		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
	Men											
Age 7	7067	4.19	4.70	318	3.76	4.24	3726	3.94	4.51	3659	4.41***	4.83
Age 11	6838	3.87	4.32	86	5.34**	4.46	3726	3.68	4.24	3198	4.13***	4.40
Age 16	5787	1.70	2.14	50	2.98*	3.91	3726	1.61	2.09	2111	1.89***	2.27
Age 23	5831	2.05	2.49	59	1.85	2.15	3726	1.98	2.44	2164	2.15**	2.56
Total	7666			884			3726			4824		
	Women											
Age 7	6749	3.31	4.32	275	3.89*	4.83	3767	3.05	4.14	3257	3.66***	4.54
Age 11	6457	3.29	4.15	77	4.69*	5.24	3767	2.98	3.88	2767	3.75***	4.50
Age 16	5521	1.81	2.27	39	2.41	2.49	3767	1.67	2.13	1793	2.09***	2.51
Age 23	5883	3.40	3.20	50	4.10	3.39	3767	3.35	3.18	2166	3.48	3.23
Total	7294			753			3767			4280		

* $p<0.05$, ** $p<0.01$, *** $p<.001$

Table 4.3: Numbers and proportions for birthweight, gestational age and social class for those included and excluded from the externalizing and internalizing fuller samples (men)

	Externalizing				Internalizing			
	Fuller sample		Excluded from		Fuller sample		Excluded from	
	n	%	n	%	n	%	n	%
Birthweight								
<2.51 kg	349	5.0	64	5.2	369	5.0	44	5.1
2.51-3.00 kg	1221	17.4	216	17.5	1286	17.4	151	17.6
3.01-3.5 kg	2368	33.8	413	33.5	2494	33.8	287	33.5
3.51-4.00 kg	2254	32.2	394	32.0	2380	32.3	268	31.3
>4.01 kg	811	11.6	145	11.8	849	11.5	107	12.5
Total	7003	100.0	1232	100.0	7378	100.0	857	100.0
Missing	271		44		288		27	
Gestational age								
Term birth	6248	95.4	1071	95.7	6575	95.4	744	96.4
Preterm baby	298	4.6	48	4.3	318	4.6	28	3.6
Total	6546	100.0	1119	100.0	6893	100.0	772	100.0
Missing	728		157		773		112	
Social Class								
I an II	1209	16.7	248	21.1	1251	17.2	175	21.5
III non-manual	758	10.5	108	9.2	722	9.9	79	9.7
III manual	3615	50.0	579	49.3	3688	50.7	417	51.3
IV	923	12.8	117	10.0	876	12.0	70	8.6
V	726	10.0	123	10.5	744	10.2	72	8.9
Total	7231	100.0	1175	100.0	7281	100.0	813	100.0
Missing	43		101		385		71	

Table 4.4: Numbers and proportions for birthweight, gestational age and social class for those included and excluded from the externalizing and internalizing fuller samples (women)

	Externalizing				Internalizing			
	Fuller sample		Excluded from		Fuller sample		Excluded from	
	n	%	n	%	n	%	n	%
Birthweight								
<2.51 kg	445	6.7	78	6.9	472	6.7	51	7.0
2.51-3.00 kg	1549	23.2	285	25.4	1659	23.4	175	23.9
3.01-3.5 kg	2552	38.2	434	38.6	2700	38.1	286	39.1
3.51-4.00 kg	1682	25.1	245	21.8	1758	24.8	169	23.1
>4.01 kg	460	6.9	81	7.2	490	6.9	51	7.0
Total	6688	100.0	1123	100.0	7079	100.0	732	100.0
Missing	204		32		215		21	
Gestational age								
Term birth	5911	96.1	971	94.9	6256	96.2	626	93.6
Preterm baby	240	3.9	52	5.1	249	3.8	43	6.4
Total	6151	100.0	1023	100	6505	100.0	669	100.0
Missing	741		132		789		84	
Social Class								
I an II	1172	17.1	214	20.2	1247	17.2	148	19.8
III non-manual	731	10.7	83	7.8	769	10.6	67	9.0
III manual	3374	49.2	524	49.4	3562	49.1	359	48.0
IV	924	13.5	134	12.6	983	13.6	100	13.4
V	651	9.5	105	9.9	691	9.5	74	9.9
Total	6852	100.0	1060	100.0	7252	100.0	748	100.0
Missing	40		95		42		5	

The distributions of birthweight, gestational age and social class of those included and excluded from the fuller samples and all cases are presented in tables 4.3 and 4.4. Those cases that had too many missing data to be included in the fuller samples are little different from those in the fuller sample, with two exceptions. Males born of parents in social classes I and II are significantly under-represented ($p<0.005$) in both the internalizing and externalizing fuller samples, and women born preterm were significantly less likely to be in the internalizing fuller sample ($p<0.005$). Of social class I and II males, 82% are included in the externalizing fuller sample compared with 85.1% for all social classes, and 85.2% of women born preterm are included in the internalizing fuller sample compared to 90.1% of term births.

The distribution of the behavioural variables is distinctly non-normal and because of this a number of other methods of coding and modelling the data were used. Log transformation of the variables resulted in mean scores for the trajectories that were difficult to interpret and trajectories that were not particularly easy to differentiate. Converting the continuous indicators into categorical variables resulted in models that failed to converge. In addition, models were identified using a censored normal distribution to describe the mixture components. These models led to classes that were not as useful on pragmatic grounds and had means for the age 16 indicators that were outside the range of scores possible for that indicator. The presented results are from models generated by the latent class clustering method which had the highest entropy index scores. Entropy scores are the only statistical criteria that are comparable across different types of model.

4.3.1. Selection of the developmental trajectories

Externalizing symptoms trajectories

To identify developmental trajectories of externalizing symptoms, models comprising at least 8 classes were successfully generated for both men and women. The information criteria measures (AIC, BIC, ssaBIC) suggested that as the number of classes increased better fitting models were produced (see table 4.5). The

Table 4.5: Model fit indices for latent class cluster models summarizing externalizing symptoms (men)

Number of classes	AIC	BIC	ssaBIC	aLRT p value	Entropy
Men					
Two	109770.02	109859.62	109818.31	<0.001	0.873
Three	107522.67	107639.83	107585.81	<0.001	0.889
Four	106201.07	106345.81	106279.07	<0.001	0.888
Five	105179.46	105351.76	105272.32	0.023	0.880
Six	104347.11	104546.98	104454.82	0.245	0.880
Seven	103531.82	103759.26	103654.39	0.110	0.872
Eight	102909.97	103164.98	103047.40	0.077	0.872
Women					
Two	94258.87	94347.77	94306.46	<0.001	0.924
Three	91652.04	91768.29	91714.26	<0.001	0.927
Four	89833.12	89976.72	89909.98	<0.001	0.927
Five	88505.50	88676.45	88597.00	0.024	0.920
Six	87330.07	87528.38	87436.22	0.228	0.916
Seven	86465.54	86691.20	86586.33	0.191	0.922
Eight	85796.20	86049.21	85931.64	0.156	0.921

entropies for all models for both sexes were acceptable, with little variation between the entropies of models with differing number of classes (see table 4.5). The aLRT would suggest that for both men and women a 5-class model fitted the data best. Thus on statistical criteria, for both sexes, 5-class models were thought to be the best summary of developmental trajectories of externalizing symptoms.

The pragmatic criteria also suggested that 5-class models most usefully described the externalizing symptoms for both sexes, although the case was clearer for men. For both sexes all the models containing up to 8 classes have reasonably distinct trajectories.

For men all models containing up to 7 classes had classes that had a sample size greater than 200 (see table 4.6). However, two of the classes identified in the six and seven class models were barely greater than 200, supporting a 5-class model (see table 4.6). The sample sizes for women fell below 200 in a 6-class model suggesting the 5-class model was most useful (see table 4.7).

For men, when comparing the complete cases with the fuller sample, the patterns of class means are similar for all the models up to 8 classes, (although there are some discrepancies for the 6-class model; see table 4.6) This did not contradict the 5 class model suggested by other criteria.

When comparing the complete cases with the fuller sample for women, the most comparable set of trajectories are for the 6-class models (see table 4.7) rather than the 5-class model that the other indicators would suggest. However, it was decided that a 5-class model summarized the data best for women because the trajectories found in a 5-class model for women were relatively similar to the trajectories found in a 5-class model for men.

The trajectories in the 5-class models are described in figures 4.2 for men and 4.3 for women, and in table 4.8. As the trajectory indicators were on different scales, the population mean was subtracted from the mean of each indicator for each class, and the total was divided by the population standard deviations for men and women to produce the z scores used in the figures. The 5 classes are similar for both men and women and have been given the same names.

The first class identified was the "high increasers," and contains 4.3% of the men and 3.2% of the women respectively. This class starts with relatively high levels of externalizing symptoms which then increase.

The second class was the "late childhood", of which 5.6% of the men and 4.6% of the women were members. This class had high levels of externalizing symptoms at age 11, and slightly elevated levels of externalizing symptoms at age 7 and age 16.

Table 4.6: Mean externalizing symptoms scores for each class in models of K classes: complete cases and fuller sample (men)

Number of classes	Complete cases Age 7	Age 11	Age 16	n[1] in class	Fuller sample Age 7	Age 11	Age 16	n[1] in class
Two								
Class 1	7.1	8.7	9.5	548	8.0	10.4	9.7	802
Class 2	4.0	3.7	0.9	4095	4.1	3.7	0.9	6472
Three								
Class 1	17.0	7.8	2.2	415	17.5	8.9	2.4	710
Class 2	6.2	8.8	9.8	490	6.3	10.0	10.0	652
Class 3	2.7	3.3	0.8	3738	2.8	3.3	0.9	5912
Four								
Class 1	6.0	7.7	6.6	533	6.8	18.5	3.0	491
Class 2	17.6	7.8	1.6	322	17.9	7.4	2.3	573
Class 3	7.5	9.8	12.8	195	6.2	8.0	10.2	543
Class 4	2.7	3.2	0.6	3593	2.7	2.5	0.8	5667
Five								
Class 1	6.0	6.9	6.9	482	5.3	5.7	6.8	548
Class 2	6.5	18.2	2.2	233	6.7	18.9	2.7	404
Class 3	17.7	6.6	1.6	302	18.4	7.4	1.7	507
Class 4	7.5	10.3	12.9	181	8.7	12.3	12.8	310
Class 5	2.6	2.4	0.6	3445	2.7	2.5	0.6	5505
Six								
Class 1	5.5	8.5	8.7	322	13.4	19.6	9.3	544
Class 2	4.0	6.2	4.1	581	4.8	4.6	6.4	230
Class 3	19.1	9.9	6.0	124	5.8	16.9	1.8	457
Class 4	16.0	6.7	0.7	296	18.1	6.8	1.5	466
Class 5	8.5	11.0	14.1	121	7.0	8.0	13.1	209
Class 6	2.5	2.9	0.3	3199	2.7	2.3	0.6	5368
Seven								
Class 1	6.0	18.7	1.6	154	6.2	19.2	1.9	321
Class 2	5.5	8.6	8.8	321	5.3	8.5	8.8	396
Class 3	3.8	5.1	4.2	539	3.7	4.6	4.3	636
Class 4	19.1	9.9	6.0	123	20.3	12.3	1.9	209
Class 5	16.2	5.9	0.7	279	16.0	5.5	0.7	456
Class 6	8.5	11.0	14.1	121	9.6	12.3	14.3	202
Class 7	2.5	2.4	0.3	3106	2.5	2.4	0.4	5054
Eight								
Class 1	8.0	18.5	8.7	125	9.7	19.8	8.8	193
Class 2	6.2	17.3	1.5	232	5.5	17.1	1.6	391
Class 3	4.6	4.4	8.7	221	4.2	4.5	8.9	283
Class 4	3.7	4.6	4.2	514	3.7	4.4	4.4	624
Class 5	19.1	9.3	5.9	117	20.6	11.7	5.8	195
Class 6	16.3	5.6	0.6	262	16.0	5.3	0.7	434
Class 7	8.5	10.5	14.3	114	9.7	11.5	14.5	169
Class 8	2.5	2.2	0.3	3058	2.5	2.3	0.4	4985

1 Based on the most likely class of membership

Table 4.7: Mean externalizing symptom scores for each class in models of K classes: complete cases and fuller sample (women)

Number of classes	Complete cases				Fuller sample			
	Age 7	Age 11	Age 16	n[1] in class	Age 7	Age 11	Age 16	n[1] in class
Two								
Class 1	5.9	6.2	7.9	377	6.9	8.2	7.9	575
Class 2	2.9	2.4	0.5	4134	2.9	2.3	0.5	6317
Three								
Class 1	4.5	5.2	4.6	513	8.4	15.3	2.0	485
Class 2	7.4	6.9	10.3	169	6.8	4.8	8.2	437
Class 3	2.8	2.2	0.3	3829	2.5	1.6	0.5	5970
Four								
Class 1	15.7	6.6	1.0	254	16.4	5.2	1.6	383
Class 2	3.6	4.9	4.7	469	6.9	16.1	2.3	365
Class 3	7.6	6.9	10.3	169	4.8	4.6	8.3	366
Class 4	2.0	2.0	0.3	3619	2.0	1.6	0.5	5778
Five								
Class 1	5.7	6.2	7.3	212	6.6	16.5	2.0	314
Class 2	15.9	6.4	0.6	182	16.3	5.0	1.0	324
Class 3	4.0	4.6	3.7	391	3.1	3.5	5.3	371
Class 4	7.6	8.2	12.1	85	9.3	8.2	10.5	223
Class 5	2.0	1.9	0.2	3641	2.0	1.6	0.3	5660
Six								
Class 1	9.9	19.4	8.0	70	10.8	20.3	7.9	120
Class 2	6.5	13.7	1.0	256	5.8	13.2	1.0	408
Class 3	17.0	4.3	1.0	154	16.7	4.5	1.0	286
Class 4	3.2	3.1	4.7	399	3.0	3.0	4.7	468
Class 5	6.9	4.2	10.4	135	7.3	4.6	10.4	183
Class 6	2.0	1.4	0.3	3497	1.9	1.4	0.3	5427
Seven								
Class 1	9.5	11.0	13.5	45	10.9	11.3	13.3	77
Class 2	10.2	19.2	6.4	62	11.2	20.2	6.7	106
Class 3	6.8	14.0	0.9	214	5.6	13.5	0.9	354
Class 4	17.1	4.1	0.6	123	16.7	4.4	0.8	265
Class 5	3.4	3.2	4.1	405	3.3	3.1	4.1	474
Class 6	5.7	4.0	8.6	153	5.6	3.8	8.6	186
Class 7	2.0	1.5	0.2	3509	1.9	1.4	0.2	5430
Eight								
Class 1	5.9	4.3	8.6	157	21.7	8.3	10.0	57
Class 2	9.5	11.7	13.3	47	16.0	15.7	1.3	135
Class 3	10.1	19.2	6.0	56	7.5	20.6	7.8	114
Class 4	7.1	14.6	0.8	171	4.0	3.7	10.3	130
Class 5	17.5	4.3	0.5	115	13.7	3.1	0.9	346
Class 6	3.9	3.5	4.9	262	3.5	11.3	0.9	384
Class 7	3.0	2.9	2.5	370	2.8	3.0	4.8	375
Class 8	2.0	1.5	0.1	3333	1.8	1.3	0.3	5351

1 Based on the most likely class of membership

Figure 4.2: Externalizing developmental trajectories (men)

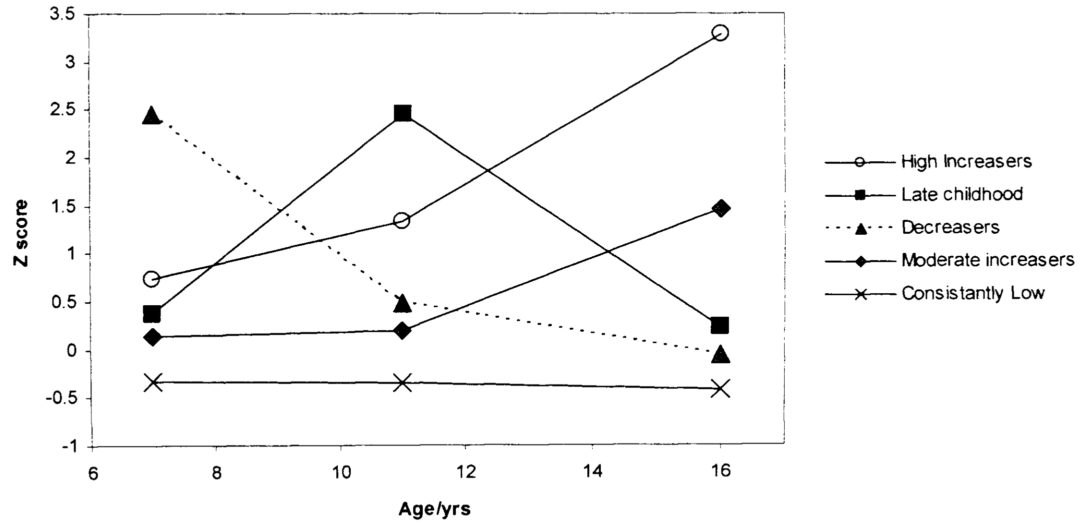
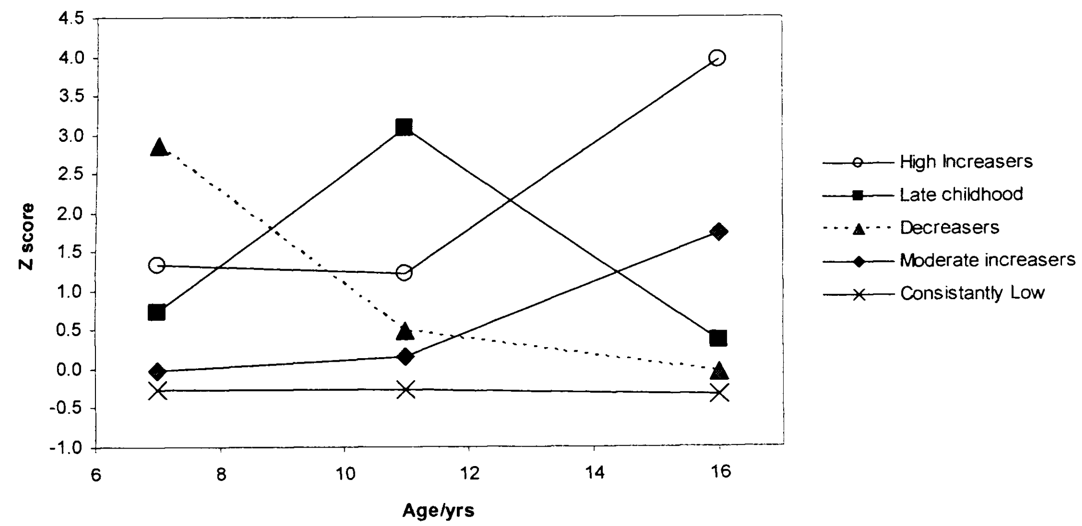


Figure 4.3: Externalizing developmental trajectories (women)



The third class was the "decreasers", who started with high levels of externalizing symptoms at age 7, have moderate levels of externalizing symptoms at age 11, and relatively low levels at age 16. The proportions in this class were 7.0% for men and 4.6% for women.

Table 4.8: Developmental trajectories for externalizing symptoms: names, means for each indicator, n and proportions in each class

Class name	Age 7	Age 11	Age 16	N in class	% in Class
Men					
High increasers	8.7	12.3	12.8	310	4.3
Late childhood	6.7	18.9	2.7	404	5.6
Decreasers	18.4	7.4	1.7	507	7.0
Moderate increasers	5.3	5.7	6.8	548	7.5
Consistently low	2.7	2.5	0.6	5505	75.7
Women					
High increasers	9.3	8.2	10.5	223	3.2
Late childhood	6.6	16.5	2.0	314	4.6
Decreasers	16.3	5.0	1.0	324	4.7
Moderate increasers	3.1	3.5	5.3	371	5.4
Consistently low	2.0	1.6	0.3	5660	82.1

The fourth class, "moderate increasers", had levels of externalizing symptoms that are moderately raised at all ages with the levels slightly higher at age 16. Seven and half percent of men and 5.4% of women were members of this class.

The final class, the "consistently low" trajectory, was the largest for both men and women and contained 75.7% of men and 82.1% of women. The mean indicator scores for this trajectory were low at every wave.

Internalizing symptoms trajectories

Stable models to summarize the internalizing trajectories could be identified with up to 8 classes for women and 7 classes for men. The information criteria measures (AIC, BIC, ssaBIC) stated that of all the models that converged the one with the largest number of classes fitted the data best (see table 4.9). The aLRT would suggest that for both men and women generating models containing up to 7 classes significantly improved model fit. Whilst entropies for all models, irrespective of the number of classes, were acceptable, there was a slight preference for both sexes of models consisting of two classes.

Table 4.9: Model fit indices for latent class cluster models summarizing internalizing symptoms (men)

Number of classes	AIC	BIC	ssaBIC	aLRT p value	Entropy
Men					
Two	129810.73	129942.67	129882.29	<0.001	0.874
Three	128242.26	128408.92	128332.66	<0.001	0.834
Four	126983.32	127184.72	127092.56	<0.001	0.824
Five	125855.00	126091.11	125983.07	<0.001	0.820
Six	125280.45	125551.29	125427.35	0.019	0.828
Seven	124793.05	125098.61	124958.79	0.011	0.820
Eight		**Did not converge[1]**			
Women					
Two	126167.09	126298.09	126237.72	<0.001	0.904
Three	124561.30	124726.78	124650.51	<0.001	0.888
Four	123432.13	123632.08	123539.92	<0.001	0.862
Five	122695.81	122930.24	122822.19	0.032	0.871
Six	121987.09	122255.99	122132.06	0.028	0.862
Seven	121458.65	121762.02	121622.20	0.009	0.866
Eight	121102.36	121440.20	121284.49	0.535	0.865

[1]Satisfactory convergence was not achieved due to a non positive definite Fisher information matrix

All the models generated using the fuller sample for men added distinctive trajectories (see table 4.10). All models of K classes for the fuller sample were comparable to the models of the complete cases sample with the same value of K. For the models with 6 or 7 classes some of the sample sizes fell to below 200 and on this basis a five-class model was selected as being the best summary for men.

For women all the trajectories of internalizing symptoms in models of up to 5 classes were distinctive (see table 4.11). The 6-class model would seem to divide those with a peak of internalizing symptoms at age 7 into two separate groups. A small class, below 200, was added in the five-class model, and it would be more constructive to

Table 4.10: Mean internalizing symptoms scores for each class in models of K classes: complete cases and fuller sample (men)

Number of classes	Complete cases					Fuller sample				
	Age 7	Age 11	Age 16	Age 23	n[1] in class	Age 7	Age 11	Age 16	Age 23	n[1] in class
Two										
Class 1	13.2	6.6	2.4	2.4	452	13.5	6.8	2.6	2.4	962
Class 2	2.6	3.2	1.5	1.9	3274	2.7	3.4	1.6	2.0	6704
Three										
Class 1	3.8	4.4	2.3	7.8	312	4.2	4.7	2.7	8.0	523
Class 2	13.5	6.5	2.4	2.0	423	13.7	6.8	2.6	2.0	917
Class 3	2.5	3.2	1.4	1.4	2991	2.6	3.3	1.5	1.4	6226
Four										
Class 1	4.6	4.5	7.2	2.4	230	5.1	5.3	7.3	2.4	374
Class 2	3.8	4.3	2.0	8.0	292	4.2	4.5	2.1	8.1	488
Class 3	13.7	6.7	1.9	2.0	391	14.0	6.7	2.0	2.0	840
Class 4	2.5	3.1	1.1	1.4	2813	2.6	3.3	1.1	1.4	5964
Five										
Class 1	6.5	14.2	1.9	1.9	225	6.2	13.9	1.9	1.9	498
Class 2	4.6	4.4	7.1	2.4	239	4.9	4.7	7.3	2.4	361
Class 3	3.7	3.9	2.0	8.1	281	4.1	4.0	2.1	8.2	475
Class 4	14.2	5.2	1.8	2.0	294	14.4	5.4	1.9	2.0	662
Class 5	2.5	2.5	1.0	1.4	2687	2.5	2.5	1.1	1.4	5670
Six										
Class 1	15.5	16.0	3.8	3.2	87	15.8	15.7	4.4	3.0	179
Class 2	4.4	11.9	1.6	1.7	276	4.7	12.2	1.6	1.8	587
Class 3	4.5	4.2	7.2	2.4	220	4.7	4.5	7.2	2.4	352
Class 4	3.7	3.8	2.0	8.1	252	4.1	4.0	2.1	8.3	416
Class 5	13.0	4.0	1.6	1.8	298	13.5	4.3	1.7	1.8	659
Class 6	2.3	2.2	1.0	1.4	2593	2.4	2.3	1.1	1.4	5473
Seven										
Class 1	10.3	6.4	11.2	3.9	37	5.8	7.4	4.6	11.5	126
Class 2	15.3	16.1	3.7	3.1	84	15.9	15.4	4.1	3.0	168
Class 3	4.5	12.0	1.5	1.7	273	4.7	12.4	1.6	1.7	549
Class 4	3.5	4.0	5.7	2.1	275	4.8	4.3	7.2	2.2	330
Class 5	3.7	3.8	2.0	8.3	220	3.4	3.2	1.6	6.3	585
Class 6	13.0	4.0	1.7	1.8	305	13.5	4.2	1.7	1.7	648
Class 7	2.3	2.2	0.9	1.4	2532	2.4	2.3	1.1	1.2	5260
Eight										
Class 1	3.3	3.1	1.4	6.5	329					
Class 2	13.1	4.0	1.7	1.7	304					
Class 3	2.3	2.2	0.9	1.2	2407					
Class 4	3.5	3.9	5.7	2.0	258					
Class 5	4.6	6.8	4.8	11.3	57					
Class 6	4.5	12.2	1.5	1.7	257					
Class 7	15.5	15.9	3.7	2.9	81					
Class 8	11.0	6.4	11.1	3.1	33					

1 Based on the most likely class of membership.

Table 4.11: Mean internalizing symptoms scores for each class in models of K classes: complete cases and fuller sample (women)

Number of classes	Complete cases					Fuller sample				
	Age 7	Age 11	Age 16	Age 23	n[1] in class	Age 7	Age 11	Age 16	Age 23	n[1] in class
Two										
Class 1	12.6	5.8	2.3	4.1	298	12.8	6.4	2.6	4.3	802
Class 2	1.9	2.6	1.6	3.3	3369	2.0	2.9	1.7	3.3	6492
Three										
Class 1	3.3	5.0	7.0	5.1	284	4.8	12.9	3.1	4.2	575
Class 2	13.0	5.6	2.0	4.1	357	13.2	5.1	2.4	4.2	693
Class 3	1.8	2.5	1.2	3.1	3126	1.9	2.0	1.6	3.3	6026
Four										
Class 1	4.5	12.1	2.0	3.7	277	4.9	13.3	2.5	4.0	500
Class 2	3.1	4.0	7.4	5.1	192	3.4	4.2	7.7	5.4	340
Class 3	13.2	4.8	2.1	4.1	328	13.4	5.1	2.1	4.2	665
Class 4	1.8	1.8	1.2	3.1	2970	1.9	2.0	1.2	3.1	5789
Five										
Class 1	16.9	11.8	2.7	4.7	91	15.6	15.1	4.7	5.5	146
Class 2	3.9	11.4	2.0	3.7	307	3.8	11.8	2.1	3.8	546
Class 3	2.8	3.8	7.5	5.1	181	3.3	3.9	7.7	5.4	331
Class 4	10.9	3.2	1.8	3.9	334	12.3	4.0	1.8	4.0	602
Class 5	1.6	1.7	1.2	3.1	2854	1.8	1.8	1.2	3.1	5669
Six										
Class 1	16.1	4.8	2.6	4.2	148	8.3	3.4	1.7	3.8	884
Class 2	11.3	14.1	3.5	4.5	97	12.6	15.4	4.3	4.5	166
Class 3	2.3	10.8	1.7	3.4	265	2.9	11.9	2.1	3.9	482
Class 4	2.7	3.6	7.6	5.1	169	2.7	3.8	8.0	5.7	295
Class 5	8.1	3.1	1.6	3.8	431	16.3	5.1	2.6	4.5	290
Class 6	1.3	1.6	1.2	3.1	2657	1.4	1.8	1.2	3.1	5177
Seven										
Class 1	18.1	11.3	3.0	5.1	75	18.3	9.5	3.0	5.1	177
Class 2	13.1	3.1	2.0	4.1	167	12.4	3.6	2.2	4.2	407
Class 3	9.0	12.5	3.4	4.4	109	9.6	14.0	4.2	4.5	204
Class 4	2.0	10.9	1.7	3.2	237	2.2	12.1	2.0	3.5	353
Class 5	2.1	3.6	7.8	5.3	151	2.2	3.9	8.2	5.9	223
Class 6	6.6	2.9	1.6	3.9	499	6.3	3.2	1.7	3.8	969
Class 7	1.1	1.5	1.2	3.0	2529	1.1	1.7	1.2	3.0	4961
Eight										
Class 1	2.5	3.2	1.9	10.9	157	1.8	3.2	7.3	5.6	259
Class 2	12.4	3.0	1.8	3.6	259	18.5	9.5	3.2	5.2	164
Class 3	2.9	2.6	6.7	4.4	238	12.6	3.5	1.9	4.1	383
Class 4	15.5	12.7	3.0	4.8	77	10.4	15.4	2.6	4.5	128
Class 5	3.7	15.5	1.8	3.6	82	2.3	12.0	1.9	3.5	362
Class 6	2.9	7.9	1.5	3.2	399	8.6	9.0	8.0	4.8	158
Class 7	5.2	12.9	8.5	7.0	50	6.4	3.1	1.5	3.8	927
Class 8	1.6	1.2	1.1	2.6	2505	1.1	1.7	1.2	3.0	4913

1 Based on the most likely class of membership.

Figure 4.4: Internalizing developmental trajectories (men)

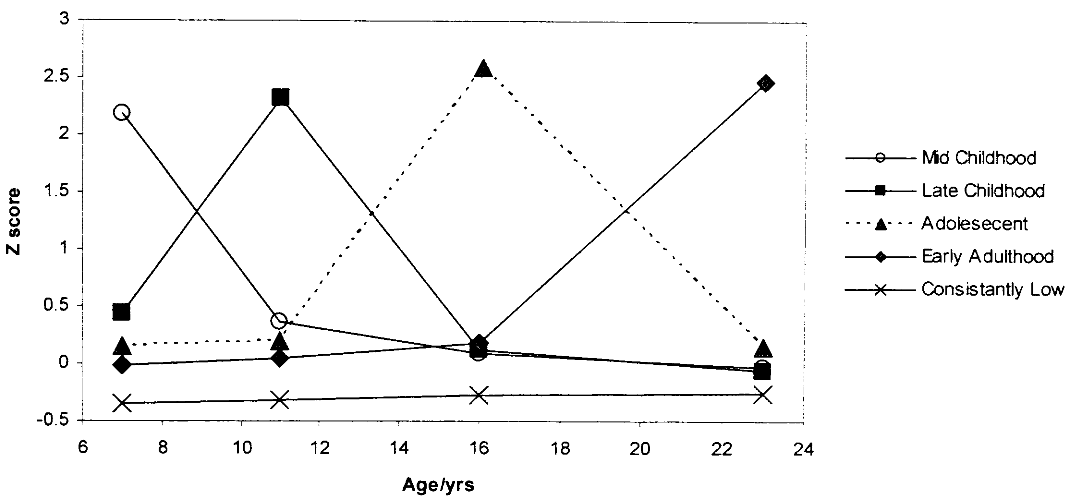
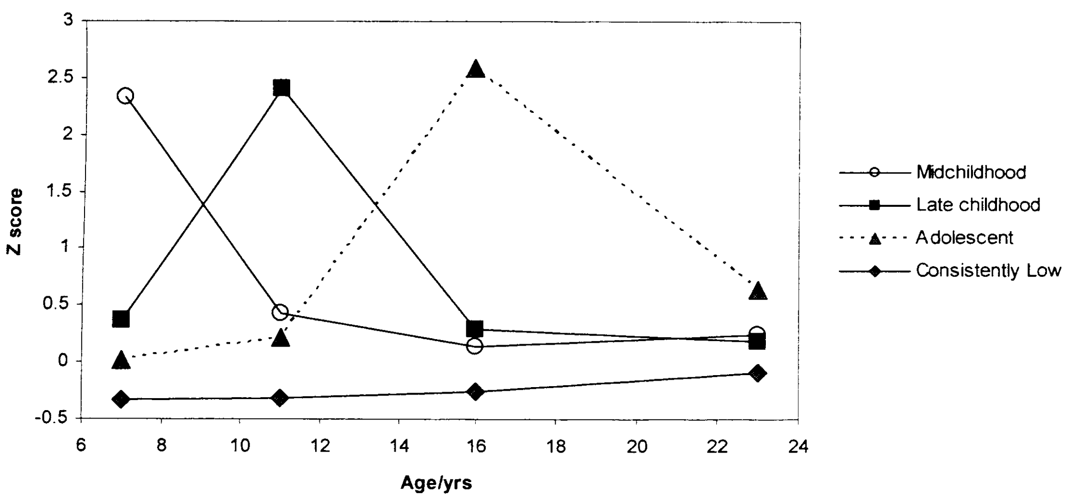


Figure 4.5: Internalizing developmental trajectories (women)



utilise 7 classes for which the smallest class is larger than the smallest class in the 5-class model. When comparing the models generated by the fuller sample with those generated by the complete cases sample, the 2, 4, 6 and 7, were more comparable than the 3, 5, and 8 class models (see table 4.11). Overall, on the basis of the balance of the pragmatic criteria, a 4-class model was chosen.

Standardized scores are again used in figures 4.4 and 4.5. The 5 classes for men are described in table 4.12 and figure 4.4. The largest class was termed the "consistently low" trajectory and contains 74% of the subjects. The other classes have marginally

Table 4.12: Developmental trajectories for internalizing symptoms: names, means for each indicator, n and proportions in each class

Class name	Age 7	Age 11	Age 16	Age 23	N in class	% in Class
Men						
Mid childhood	14.4	5.4	1.9	2.0	662	8.6
Late Childhood	6.2	13.9	1.9	1.9	498	6.5
Adolescent	4.9	4.7	7.3	2.4	361	4.7
Early adulthood	4.1	4.0	2.1	8.2	475	6.2
Consistently Low	2.5	2.5	1.1	1.4	5670	74.0
Women						
Mid childhood	13.4	5.1	2.1	4.2	665	9.1
Late Childhood	4.9	13.3	2.5	4.0	500	6.9
Adolescent	3.4	4.2	7.7	5.4	340	4.7
Consistently Low	1.9	2.0	1.2	3.1	5789	79.4

raised internalizing symptoms at all ages, and a peak at one age which gives that class its name. The "mid childhood" trajectory contains 8.6% of men, the "late childhood" trajectory 6.5%, the "adolescent" trajectory 4.7% and the "early adulthood" trajectory 6.2%.

The 4 classes for women are described in table 4.12 and figure 4.5. The classes are similar to those produced for men, with the exception that "early adulthood" is omitted. The "mid childhood" trajectory contains 9.1% of women, the "late childhood" trajectory 6.9%, the "adolescent" trajectory 4.7% and the "consistently low" trajectory 79.4%.

4.3.2. Prediction of the trajectories

Externalizing symptoms

Being born lighter than 2.51 kg was associated with increased odds of membership of the "decreasers" externalizing trajectory for both boys (see tables 4.13 and 4.14) and girls (see tables 4.15 and 4.16) in analyses adjusting for birth weight, gestational age and parental social class, and unadjusted analyses. The lightest boys were also at increased odds of membership of the "late childhood" externalizing trajectory,

Table 4.13: Unadjusted odds ratios for membership of externalizing trajectories (men)

	High increasers V Consistently low			Late childhood V Consistently low			Decreasers V Consistently low			Moderate increasers V Consistently low		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight												
<2.51 kg	1.18	0.60	2.34	1.97	1.24	3.13	1.66	1.06	2.61	1.35	0.87	2.10
2.51-3.00 kg	1.38	0.95	2.02	1.25	0.90	1.74	1.32	0.97	1.80	1.23	0.93	1.63
3.01-3.50 kg	1.17	0.85	1.61	0.78	0.58	1.05	1.06	0.81	1.38	1.11	0.87	1.40
3.51-4.00 kg	1	-	-	1	-	-	1	-	-	1	-	-
>4.01 kg	1.21	0.78	1.88	0.88	0.58	1.32	1.05	0.73	1.53	1.22	0.89	1.68
Gestational age												
Term birth	1	-	-	1	-	-	1	-	-	1	-	-
Preterm	1.16	0.59	2.28	2.37	1.56	3.60	1.07	0.64	1.79	0.60	0.31	1.16
Parental social class												
SC I and II	1	-	-	1	-	-	1	-	-	1	-	-
SC3NM	1.86	0.83	4.18	1.66	1.01	2.73	1.82	1.21	2.74	2.17	1.37	3.43
SC3MAN	3.65	1.97	6.76	1.83	1.25	2.68	1.78	1.29	2.45	2.84	1.97	4.09
SC4	5.73	2.95	11.13	2.66	1.70	4.16	1.67	1.09	2.54	4.24	2.81	6.40
SC5	11.53	6.01	22.11	4.78	3.07	7.45	2.78	1.83	4.23	6.87	4.52	10.43

Table 4.14: Adjusted[1] odds ratios for membership of externalizing trajectories (men)

	High increasers V Consistently low			Late childhood V Consistently low			Decreasers V Consistently low			Moderate increasers V Consistently low		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight												
<2.51 kg	0.87	0.35	2.16	1.66	0.99	2.80	1.71	1.00	2.95	1.24	0.71	2.14
2.51-3.00 kg	1.16	0.77	1.75	1.15	0.80	1.63	1.31	0.95	1.81	1.14	0.83	1.57
3.01-3.50 kg	1.05	0.74	1.49	0.70	0.51	0.97	1.05	0.79	1.39	1.14	0.88	1.47
3.51-4.00 kg	1	-	-	1	-	-	1	-	-	1	-	-
>4.01 kg	1.08	0.67	1.76	0.91	0.59	1.40	1.11	0.75	1.64	1.24	0.88	1.74
Gestational age												
Term birth	1	-	-	1	-	-	1	-	-	1	-	-
Preterm	0.81	0.35	1.91	1.80	1.11	2.93	0.79	0.43	1.46	0.52	0.27	1.00
Parental social class												
SC I and II	1	-	-	1	-	-	1	-	-	1	-	-
SC3NM	1.96	0.79	4.85	1.67	0.97	2.87	2.00	1.30	3.10	2.01	1.24	3.27
SC3MAN	3.66	1.82	7.35	1.86	1.23	2.81	1.80	1.27	2.54	2.51	1.72	3.67
SC4	7.06	3.36	14.85	2.70	1.66	4.41	1.62	1.02	2.59	4.20	2.73	6.46
SC5	13.65	6.56	28.42	4.26	2.60	6.99	2.73	1.72	4.34	6.54	4.21	10.16

1 Adjusting for birthweight, gestational age and parental social class.

Table 4.15: Unadjusted odds ratios for membership of externalizing trajectories (women)

	High increasers V Consistently low			Late childhood V Consistently low			Decreasers V Consistently low			Moderate increasers V Consistently low		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight												
<2.51 kg	1.52	0.80	2.87	1.40	0.88	2.25	1.86	1.15	3.03	0.99	0.61	1.59
2.51-3.00 kg	1.51	0.97	2.33	0.76	0.52	1.12	1.50	1.04	2.14	1.03	0.76	1.40
3.01-3.50 kg	1.19	0.78	1.81	1.01	0.74	1.38	1.11	0.79	1.57	0.83	0.62	1.10
3.51-4.00 kg	1	-	-	1	-	-	1	-	-	1	-	-
>4.01 kg	1.79	1.01	3.17	0.60	0.31	1.18	1.04	0.59	1.84	1.33	0.88	2.01
Gestational age												
Term birth	1	-	-	1	-	-	1	-	-	1	-	-
Preterm	1.54	0.76	3.13	1.41	0.78	2.55	0.88	0.41	1.90	1.30	0.75	2.26
Parental social class												
SC I and II	1	-	-	1	-	-	1	-	-	1	-	-
SC3NM	1.06	0.28	3.99	0.79	0.43	1.44	1.62	0.97	2.72	2.56	1.48	4.43
SC3MAN	5.41	2.22	13.20	1.48	1.01	2.17	2.02	1.35	3.03	3.57	2.29	5.57
SC4	8.22	3.26	20.78	2.31	1.49	3.60	1.93	1.18	3.15	4.55	2.78	7.48
SC5	16.12	6.44	40.33	2.68	1.66	4.32	1.96	1.13	3.39	6.17	3.71	10.27

Table 4.16: Adjusted[1] odds ratios for membership of externalizing trajectories (women)

	High increasers V Consistently low			Late childhood V Consistently low			Decreasers V Consistently low			Moderate increasers V Consistently low		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight												
<2.51 kg	1.65	0.78	3.48	1.11	0.61	2.02	1.96	1.12	3.45	0.73	0.42	1.27
2.51-3.00 kg	1.25	0.75	2.09	0.68	0.45	1.04	1.52	1.04	2.24	0.95	0.68	1.33
3.01-3.50 kg	1.23	0.77	1.97	0.95	0.68	1.33	1.03	0.71	1.49	0.75	0.55	1.02
3.51-4.00 kg	1	-	-	1	-	-	1	-	-	1	-	-
>4.01 kg	1.65	0.86	3.17	0.59	0.28	1.22	1.08	0.59	1.97	1.24	0.79	1.94
Gestational age												
Term birth	1	-	-	1	-	-	1	-	-	1	-	-
Preterm	1.26	0.54	2.96	1.36	0.70	2.65	0.74	0.34	1.63	1.50	0.84	2.67
Parental social class												
SC I and II	1	-	-	1	-	-	1	-	-	1	-	-
SC3NM	0.87	0.22	3.45	0.77	0.39	1.54	1.46	0.84	2.55	2.36	1.34	4.17
SC3MAN	4.18	1.76	9.96	1.70	1.11	2.60	1.84	1.20	2.83	3.36	2.13	5.28
SC4	6.53	2.62	16.26	2.25	1.36	3.72	1.80	1.06	3.06	4.50	2.71	7.46
SC5	10.53	4.22	26.23	2.62	1.53	4.51	1.65	0.91	3.00	3.80	2.15	6.71

1 Adjusting for birthweight, gestational age and parental social class.

although the significance was marginal after adjusting for gestational age.

Girls with a birthweight greater than 4.01 kg had increased odds for membership of the "high increasers" externalizing trajectory (see table 4.15). This remained significant after adjusting for social class (O.R. 1.77 95% CI 1.00-3.14) but not gestational age (O.R. 1.70 95% CI 0.88-3.29).

Gestational age was significantly associated with raised odds of the "late childhood" externalizing trajectory relative to the "consistently low" trajectory for men (see tables 4.13 and 4.14) and the association remained significant after adjusting for birthweight and social class. Gestational age was not associated with increased chances of membership for any of the other trajectories for men or any of the trajectories for women (see tables 4.15 and 4.16).

Parental social class predicted increased chance of membership of all trajectories of externalizing symptoms relative to the "consistently low" class for both sexes after adjustment for both gestational age and birthweight (see tables 4.13 through 4.16). For both sexes, social class showed an increasing trend of odds of membership of the "high increasers", "late childhood" and "moderate increasers" trajectories relative to the "consistently low" symptoms trajectory. For boys, this occurred across the social classes, whilst for girls, those with parents in social class 3 non manual were only at raised risk of the "moderate increasers" class. It should be noted that relative to children from social class I/II those in the more disadvantaged social classes had relatively similar odds of membership for the "decreasers" trajectory.

Internalizing symptoms

Birthweight for boys was associated with both "mid childhood" and "early adulthood" internalizing symptoms (see table 4.17). The effects of birthweight on "mid-childhood" internalizing symptoms remained after adjusting for social class and gestational age, and showed a non-linear relationship with both the lightest and heaviest births being at increased risk relative to infants born with a weight of 3.51-4.00 kg (see table 4.18). The lowest birthweight category (<2.51 kg) infants

Table 4.17: Unadjusted odds ratios for membership of internalizing trajectories (men)

	Mid childhood V Consistently low			Late childhood V Consistently low			Adolescent V Consistently low			Early adulthood V Consistently low		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight												
<2.51 kg	2.43	1.65	3.57	1.07	0.62	1.85	1.29	0.73	2.26	1.94	1.19	3.17
2.51-3.00 kg	1.65	1.25	2.18	1.25	0.92	1.70	1.59	1.16	2.19	1.41	1.00	2.01
3.01-3.50 kg	1.38	1.09	1.75	1.02	0.78	1.32	0.95	0.71	1.27	1.17	0.87	1.58
3.51-4.00 kg	1	-	-	1	-	-	1	-	-	1	-	-
>4.01 kg	1.52	1.11	2.08	0.97	0.66	1.41	1.25	0.86	1.82	1.28	0.86	1.90
Gestational age												
Term birth	1	-	-	1	-	-	1	-	-	1	-	-
Preterm	1.32	0.84	2.08	1.59	1.01	2.51	1.25	0.71	2.19	1.96	1.21	3.20
Parental social class												
SC I and II	1	-	-	1	-	-	1	-	-	1	-	-
SC3NM	1.06	0.70	1.60	1.07	0.66	1.71	1.47	0.90	2.41	2.00	1.10	3.64
SC3MAN	1.63	1.23	2.17	1.70	1.23	2.35	1.92	1.32	2.79	2.90	1.80	4.69
SC4	2.06	1.45	2.92	2.32	1.57	3.44	2.91	1.87	4.51	5.53	3.29	9.29
SC5	3.14	2.19	4.50	2.85	1.87	4.36	4.85	3.13	7.53	8.07	4.76	13.68

Table 4.18: Adjusted[1] odds ratios for membership of internalizing trajectories (men)

	Mid childhood V Consistently low			Late childhood V Consistently low			Adolescent V Consistently low			Early adulthood V Consistently low		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight												
<2.51 kg	2.25	1.40	3.62	0.95	0.53	1.72	1.34	0.70	2.56	1.29	0.71	2.33
2.51-3.00 kg	1.49	1.10	2.02	1.13	0.81	1.57	1.49	1.05	2.11	1.25	0.85	1.82
3.01-3.50 kg	1.32	1.02	1.71	0.96	0.72	1.26	0.96	0.70	1.31	1.10	0.80	1.52
3.51-4.00 kg	1	-	-	1	-	-	1	-	-	1	-	-
>4.01 kg	1.46	1.04	2.04	0.96	0.65	1.44	1.18	0.77	1.79	1.35	0.89	2.06
Gestational age												
Term birth	1	-	-	1	-	-	1	-	-	1	-	-
Preterm	0.94	0.56	1.59	1.35	0.80	2.29	0.99	0.52	1.87	1.49	0.84	2.66
Parental social class												
SC I and II	1	-	-	1	-	-	1	-	-	1	-	-
SC3NM	1.04	0.67	1.61	1.11	0.66	1.87	1.15	0.65	2.06	1.94	1.01	3.73
SC3MAN	1.48	1.09	2.00	1.85	1.29	2.65	1.86	1.24	2.78	2.85	1.69	4.81
SC4	1.96	1.35	2.84	2.56	1.67	3.93	3.13	1.95	5.02	5.37	3.04	9.49
SC5	2.77	1.87	4.11	2.99	1.87	4.79	4.89	3.02	7.92	8.70	4.91	15.41

1 Adjusting for birthweight, gestational age and parental social class.

Table 4.19: Unadjusted odds ratios for membership of internalizing trajectories (women)

	Mid childhood V Consistently low			Late childhood V Consistently low			Adolescent V Consistently low		
	OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight									
<2.51 kg	2.13	1.50	3.03	1.74	1.15	2.63	1.33	0.82	2.17
2.51-3.00 kg	1.40	1.07	1.82	1.35	1.00	1.81	1.06	0.76	1.48
3.01-3.50 kg	1.17	0.92	1.50	1.06	0.80	1.39	0.73	0.53	1.00
3.51-4.00 kg	1	-	-	1	-	-	1	-	-
>4.01 kg	1.07	0.71	1.61	1.09	0.70	1.70	0.85	0.51	1.44
Gestational age									
Term birth	1	-	-	1	-	-	1	-	-
Preterm	1.54	1.01	2.34	0.98	0.56	1.71	1.06	0.52	2.17
Parental social class									
SC I and II	1	-	-	1	-	-	1	-	-
SC3NM	1.38	0.90	2.13	1.55	0.97	2.48	1.52	0.78	2.95
SC3MAN	2.30	1.68	3.15	2.30	1.62	3.29	2.85	1.77	4.60
SC4	2.34	1.60	3.41	2.88	1.92	4.33	4.99	2.97	8.41
SC5	4.40	3.04	6.39	2.65	1.66	4.22	7.29	4.32	12.29

Table 4.20: Adjusted[1] odds ratios for membership of internalizing trajectories (women)

	Mid childhood V Consistently low			Late childhood V Consistently low			Adolescent V Consistently low		
	OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight									
<2.51 kg	1.98	1.33	2.94	1.76	1.07	2.90	1.08	0.58	2.01
2.51-3.00 kg	1.39	1.04	1.85	1.49	1.09	2.04	1.00	0.69	1.45
3.01-3.50 kg	1.15	0.88	1.51	1.10	0.81	1.47	0.73	0.52	1.04
3.51-4.00 kg	1	-	-	1	-	-	1	-	-
>4.01 kg	1.09	0.70	1.70	1.28	0.81	2.02	0.85	0.48	1.50
Gestational age									
Term birth	1	-	-	1	-	-	1	-	-
Preterm	1.11	0.70	1.76	0.80	0.43	1.49	0.97	0.45	2.12
Parental social class									
SC I and II	1	-	-	1	-	-	1	-	-
SC3NM	1.51	0.96	2.37	1.37	0.83	2.24	1.82	0.90	3.72
SC3MAN	2.24	1.60	3.14	2.12	1.48	3.05	2.99	1.76	5.08
SC4	2.19	1.45	3.29	2.66	1.74	4.05	5.22	2.92	9.34
SC5	3.92	2.61	5.90	2.31	1.41	3.76	7.11	3.96	12.77

1 Adjusting for birthweight, gestational age and parental social class.

had increased odds for membership of the "early adulthood" trajectory after adjusting for parental social class (O.R. 1.69 95% CI 1.01-2.83) but not gestational age (O.R. 1.35 95% 0.74-2.45).

Girls with lower birthweights had increased odds for membership of both the "mid childhood" and "late childhood" trajectories relative to the "consistently low" trajectory (see table 4.19). This was independent of both gestational age and social class (see table 4.20).

For boys, those born preterm were at higher risk of "late childhood" and "early adult" internalizing symptoms (see table 4.17). After adjusting for social class, the odds that preterm birth had for membership for both the "late childhood" trajectory (O.R. 1.53 95% CI 0.96-2.42) and the "early adulthood" trajectory (O.R. 1.77 95% CI 1.21-3.20) is hardly altered. However, the association that preterm birth and the "late childhood" trajectory had was no longer significant. The effects of both gestational age and birthweight disappear when they are in the same model.

In unadjusted analyses girls born preterm were at an increased risk of membership for the "mid childhood" trajectory, although the effect was reduced slightly on the addition of social class to the model (O.R. 1.49 95% CI. 0.97-2.30) and disappears when birthweight was added to the model (O.R. 1.09 95% CI 0.69-1.73).

Parental social class was associated with increased risk of membership for all the trajectories of internalizing symptoms for both boys and girls (see tables 4.17 and 4.19), and was only slightly reduced by adjusting for gestational age and birthweight (see tables 4.18 and 4.20).

4.4. Discussion

4.4.1. Externalizing trajectories

Of the trajectories in the 5-class model for externalizing symptoms, three of the trajectories "consistently low", "moderate increasers" and "high increasers" were consistent with the trajectories that would be expected from the studies on aggression (Broidy et al., 2003; van Lier & Crijnen, 2005; Bongers et al., 2004; Schaeffer et al., 2006; van Lier et al., 2007). The numbers in the "high increasers" and "moderate increasers" trajectories are at the lower end of the range expected from previous studies. This is likely to be accounted for partly by the two additional trajectories identified: the "decreasers" and "late childhood" trajectories. Approximately 10% of both men and women were members of the latter 2 trajectories. Despite the identification of additional trajectories, the proportions of the samples in the "consistently low" trajectories are at the top of the range expected from previous studies. This is not surprising, the other studies tended to be conducted on cohorts that are younger than the NCDS, and younger cohorts have been shown to have more behavioural problems (Collishaw, Maughan, Goodman & Pickles, 2004).

The "high increasers" trajectory is consistent with Moffit's (1993) theory of life course persistent anti-social behaviour. Whether these results support the concept of Moffit's proposed adolescent limited antisocial behaviour trajectory is debateable. The "late childhood" trajectory indicates a peak of externalizing symptoms too early to be considered adolescent limited and a smaller proportion of the population than would be expected by Moffit's theory. The "moderate decreasers" do have relatively low levels of externalizing symptoms at ages 7 and 11 and peak at age 16, so possibly could be could considered a trajectory of adolescent limited antisocial behaviour, however, they make up a much smaller proportion of the population than would be expected if this behaviour was part of normal development. It should be noted that with the age gap between the data sweeps from 11 to 16 it is possible that an adolescent limited trajectory could have been missed.

The results in this study do support girls having similar patterns of externalizing symptoms to those for boys as suggested by Bongers et al. (2004). The means for the trajectory indicators do reflect slightly lower levels of symptoms and there are fewer individuals in the more problematic groups. The instrument used in the study may be biased towards measuring symptoms mainly exhibited by boys and the results may have been different using more gender specific items.

The similarities between boys and girls should be interpreted with some caution as the similarities were one of the reasons why the 5-class model was accepted in favour of a 6-class model for girls. However, it is likely that, for girls, the 5-class model would have been selected ahead of a 6-class model on the basis of the aLRT and sample size, if the model for girls had been selected without reference to the results for boys.

It should also be noted that the terms increasing and decreasing used in the names of the trajectories are relative. The BSAG has different meanings at ages 7 and 11, whilst an entirely different scale altogether is used at age 16. Ideally, the measures should have identical meaning over time, which is not necessarily represented by identical scores as the expression of externalizing symptoms changes over time (Bongers et al., 2004; Owens & Shaw, 2003). To determine what scores have identical meaning requires subjective judgments based on qualitative research and clinical experience. However, for secondary data analysis the use of standardized scores in figure 4.2 and figure 4.3 is the best solution available.

4.4.2. Internalizing trajectories

The most striking feature of the model for developmental trajectories of internalizing symptoms is that apart from the largest group which is the "consistently low", none of the groups identified by latent class clustering represent a constant or steadily growing level of internalizing symptoms. Instead, for both men and women there is a "consistently low" trajectory, and then the other groups reflect a peak of internalizing symptoms at one particular age. If this is substantively correct, it would suggest there are no large groups with characteristics or environments that predispose to sustained internalizing symptoms. However, there is some concern that the shape may be an artefact of the methods and data used. One noticeable difference between the sexes is that for men there is a trajectory with peak internalizing symptoms at age 23, but no such comparable group exists for women. This is potentially misleading, as women have both a higher mean Malaise inventory score at this age and are more likely to be a case (scoring 7 or above on the Malaise inventory) at age 23. Fifteen percent of women are Malaise case positive at age 23 compared to 6.2% of men, and this difference was significant at $p<0.001$. The probable explanation for this is that Malaise for women, despite being distinctly non normal, is relatively normally distributed in comparison to the other indicators so that it is relatively well described by one group.

Another possible reason why a trajectory indicating persistently raised symptoms for internalizing cannot be found is that the BSAG, Rutter "B" and Malaise inventory measure different aspects of internalizing disorders so that there is not a common problem being identified. In particular, it should be noted that the measure of internalizing symptoms used at age 23 was a self-report measure, whilst those used during childhood were reported by a teacher, and other developmental trajectories may have been developed if only indicators based on teacher report data were used.

As the latent class clustering methodology does not result in models that have meaningful developmental trajectories for internalizing symptoms across childhood, an alternative a priori method will be used to summarize internalizing symptoms across the life course in chapters 7 and 8. For each measure of internalizing symptoms at ages 7, 11, 16 and 23, individuals are considered to score high if they had scored 3 or more on internalizing symptoms. The total number of times subjects scored as being high are then summed and subjects are placed into one of 4 categories, which are in order: not scoring high at all, scoring high once, scoring high twice, and scoring high 3 or 4 times.

4.4.3. Prediction of the trajectories

Social background

Odds of membership for all of the trajectories of increased externalizing symptoms, relative to the "consistently low" trajectory, were raised in those born to parents with more disadvantaged social classes. The associations were strongest for the "high increaser" trajectory and the "moderate increaser" trajectories where a clear trend can be seen. There is no trend for odds of membership of the "decreasers" trajectory. This is possibly due to different processes underlying the "decreasers" trajectory, and the characteristics that raise the chances of having high symptoms initially are antagonistic towards subsequent recovery.

Similarly for the internalizing trajectories, those from the most disadvantaged social circumstances are at raised odds of membership of the "mid childhood", "late childhood" and "adolescent" trajectories (and for men the "early adult" trajectory) relative to the "consistently low" trajectory. The strongest association is for trajectories indicating raised symptoms at the older age groups; the "early adulthood" trajectory for men and the "adolescent" trajectory for women. This is consistent with the idea that the effects of social disadvantage accumulate over time, increasing risk of exposure to stresses that exacerbate behavioural problems, whilst restricting the opportunities for recovery and skills to manage the symptoms.

Some caution should be made when generalizing to other samples; the recession in the early 1980s would have hit manual workers hardest and those from disadvantaged social backgrounds would have faced the most strain and hence exaggerated internalizing symptoms at age 23. This cohort was also amongst the first group to stay on at school until they were aged 16, and those in the poorest schools may have been more frustrated at being held back by their inability to join the labour market. Under different social circumstances the disadvantages may be reduced. Conversely, there is some evidence that children in private schools are assessed more unfavourably by teachers (Douglas, 1964) potentially leading to an underestimate of the effects of social class.

It should also be noted that the teachers were not blind to the social class of the children. This may have influenced their attitude towards the children and hence introduced bias in their reports of behaviour. However, the same attitude is likely to have resulted in poorer teaching for the children and so would place the children at risk for lower achievement (Fronstin et al., 2005).

Gestational age and birthweight

Although the effects of foetal growth rate and gestational age are theoretically different, in practice operationalizing and discussing the concepts separately is difficult. Where one of preterm birth and low birthweight has shown an association with a particular trajectory but the other has not, it is difficult to tell whether the differences are the results of different processes or simply an artefact of measurement and chance.

High birthweight

Associations between high birthweight and trajectories of emotional well-being should be unconfounded by gestational age because those born with high birthweights are likely to be term births, and the growth rate flattens or declines post-term (Lubchenco, Hansman, Dresseler & Boyd, 1963; Yudkin, Aboualfa, Eyre, Redman & Wilkinson, 1987), although this is somewhat debated (see Wilcox et al. 1993). In contrast, high birthweight has been shown to be associated with parity (Ørskou, Henriksen, Kesmodel & Secher, 2006), a socially determined factor, and so one would expect some confounding with social class. However, the reverse has been found in this study, the associations between high birthweight and the "high increasers" trajectory of externalizing symptoms for men, and high birthweight and the "mid childhood" internalizing symptoms for women remain significant after adjusting for parental social class but not gestational age. The loss of significance between high birthweight and these trajectories when adding gestational age to the model may be the result of a loss of power: a relatively large proportion of cases had missing data for gestational age and were omitted from the model. There may also be a problem with bias because gestational age was not estimated for mothers who did not have husbands (Jefferis et al., 2002). However, it cannot be ruled out that these are chance findings because heavy birthweights are only associated with 2 trajectories. Other cut-off points may have produced different results.

Preterm birth

Associations between preterm birth and the developmental trajectories for men is limited to increased odds for membership of the "late childhood" trajectories for both internalizing and externalizing symptoms, increased odds for membership of the "early adult" trajectory for internalizing symptoms and reduced odds of membership of the "moderate increasers" trajectory.

Why preterm birth should be associated with increased risk of membership of "late childhood" trajectories but not the other trajectories in childhood and adolescence is difficult to explain. In theory this could be related to age specific developmental tasks, but this is not consistent with the literature which has shown preterm birth to be associated with early childhood behavioural problems (Delobel-Ayoub et al., 2006; Gardner et al., 2004). The association between preterm birth and "early adulthood" internalizing symptoms is consistent with other studies (Cheung, 2002; Fan & Eaton, 2001; Costello et al., 2007). The protective effect that preterm birth has towards membership of the "moderate increasers" trajectory for men is consistent with a study by Hack et al. (2002) that showed that those born preterm are at reduced risk for anti-social behaviour as young adults.

Low birthweight

The association that low birthweight has with the "late childhood" externalizing trajectory for men and the "decreasers" externalizing trajectories for men and women is consistent with studies that have shown that low birthweight is associated with conduct problems in younger children (Delobel-Ayoub et al., 2006) but reduced risk of anti-social behaviour as young adults (Hack et al., 2002). The most likely explanation for this is that low birthweight infants have increased risk for poorer emotional well-being in general. However, increased risk of neuroticism (Allin et al., 2006), social withdrawal and isolation, which are a consequence of internalizing disorders, leads to fewer opportunities to exhibit externalizing symptoms (Harrison, 2002).

The prediction of the trajectories of internalizing symptoms by low birthweight is difficult to interpret because of the unsatisfactory nature of the trajectories. For men there are associations with 3 of the 4 trajectories and for women 2 of the 3 trajectories. This would suggest that those with low birthweight are at raised risk for internalizing symptoms throughout life. Studies have shown that low birthweight (although not always consistently) has been associated with a variety of measures of internalizing symptoms in children (Bhutta et al., 2002), adolescents (Patton, Coffey, Carlin, Olsson & Morley, 2004; Dahl, Kaaresen, Tunby, Handegård, Kvernmo & Ronning, 2006; Gale & Martyn, 2004; Saigal, Pinelli, Hoult, Kim & Boyle, 2003; Costello et al., 2007) and adults (Cheung, 2002; Cheung et al., 2002; Gale & Martyn, 2004; Wiles et al., 2005).

Mechanisms

The terms low-birthweight and prematurity are often used synonymously. The mechanisms that have been suggested to explain associations between poorer emotional well-being and gestational age, and between poorer emotional well-being and birth-weight are often the same. The most commonly suggested mechanisms are neurological, cognitive (Bhutta et al., 2002; Kelly et al., 2001; Wiles et al., 2005;

Allin et al., 2006) or the hypothalamic-pituitary-adrenal axis (Cheung, Ma, Machin & Karlberg, 2004). These mechanisms may be directly linked to control and management of emotions or indirectly through poor success in key developmental areas such as school or sport which in turn lead to frustration and emotional problems.

There are alternative mechanisms that suggest that birthweight and gestational age may be markers of social circumstances (Bartley, Power, Blane, Smith & Shipley, 1994). Maternal stress has been shown to be associated with increased risk of low-birthweight and preterm birth (Rondó, Ferreira, Nogueira, Ribeiro, Lobert & Artes, 2003). Accordingly, birthweight is potentially an indicator of social circumstances and stresses that could be prolonged beyond pregnancy and would affect the care the child receives and the environment to which the child is exposed.

That parental social class, birthweight and gestational age are associated with the developmental trajectories in a theoretically consistent way does provide some validity to the concept that the trajectories are measuring some meaningful aspect of emotional well-being.

4.4.4. Strengths and weaknesses

The study sample

Based on the observable data, the fuller sample used in the core of the analyses is reasonably representative of the population. There were some small significant differences for those deleted from analyses and it is unlikely that MCAR assumptions can be upheld. Emotional well-being is potentially a determinant of whether cases will be willing to participate in the study. However, the variables used to indicate emotional well-being were based on teacher report measures. This, combined with the fact that study participants were traced through schools (Fogelman, 1983), suggests that it may be better to focus on the characteristics of teachers and schools to explain the missing data. Future solutions to missingness should consider school characteristics to insure that assumptions of MAR are attainable. Overall the observable differences between the fuller sample and those excluded from the fuller samples suggest that the sample used to model the emotional well-being trajectories should be considered reasonably representative of the surviving births in the late 1950's/early 1960's. Whether this study is appropriate to make generalizations from is a matter of debate as there have been shown to be secular trends of increasing conduct problems for adolescents (Collishaw et al., 2004).

The data for the trajectories span a period of 16 years for internalizing symptoms and 9 years for externalizing symptoms. These are relatively long periods covered by only 3 indicators for the externalizing symptoms trajectory model and 4 for the internalizing symptoms trajectory model. An atypical period of poor emotional well-being could dramatically alter the shape of a trajectory for an individual. Having extra indicators across the course of the study would have helped determine whether the trajectories were a result of gradual developmental changes, or the product of extreme events occurring in a short period of time.

The statistical methodology

The key focus of this chapter has been identifying developmental trajectories of emotional well-being, and testing for relationships between these trajectories and commonly employed indicators of biological and social endowment. This prevented assumptions about the relationships between exogenous variables and the trajectories being used to aid analysis. Had these assumptions been made alternative approaches to analyses would have been permitted and the pros and cons of such methods are discussed in chapter 9, in the context of the developmental trajectories for all the resources.

Determining the models used for further analysis was perhaps the least satisfactory aspect of the methodology. Although there are fit statistics for selecting the number of classes they are not appropriate for deciding how to code the variables or deciding which distributions should be used to describe the mixture components. This is particularly problematic for the emotional well-being trajectories. The distributions for the indicator variables were very skewed and not readily summarized into normally distributed sub-groups. Alternatives to the methodology were tried. However, the resulting models had mean scores for the trajectory indicators that were harder to interpret and marginally poorer entropies.

When using the criteria to select how many trajectories the model for further analysis has, an extra emphasis was placed on pragmatic criteria because the trajectories are also used in analyses in chapters 7 and 8. For externalizing behaviour the greatest emphasis was placed on sample size. This did not conflict with the statistical criteria as 5-class models for both sexes were also suggested by the aLRT, and a 5-class model was consistent with the entropy scores.

Selecting an appropriate model for internalizing symptoms was in practice much harder. The statistical criteria would suggest that 7 classes fitted the data. However, on the basis of sample size a 4-class model for women and a 5-class model for men were selected. The real problem lay with the distinctiveness of the trajectories. Although each trajectory identified had a distinct shape, the peak of symptoms at each age suggested that perhaps the trajectories were just describing extreme scores on one indicator. A particular problem was the absence of an "early adulthood" trajectory for women. This was misleading as it suggests that there was not a group of women with high levels of internalizing symptoms at age 23, when in reality women at this age were more likely to have higher levels of internalizing symptoms than men. Adding extra classes did not resolve this, and it is likely that for women, internalizing symptoms at age 23, when compared to the other indicators of internalizing symptoms, are reasonably summarized using a single normal distribution. Thus the indicators of internalizing symptoms, used to generate the trajectories, indicate groups of individuals who have high symptoms at one time point, rather than discrete groups of individuals who are more vulnerable to exhibiting internalizing symptoms across childhood. This information would be better presented using traditional analysis treating each indicator of internalizing symptoms as a variable in its own right.

Alternative approaches to analysis

One alternate way of identifying developmental trajectories of internalizing symptoms using NCDS data would be to use measures of behaviour reported by the mothers, as it has been suggested that measures reported by teachers are relatively insensitive to internalizing behaviour (Macmillan et al., 1980; Kraatz Keiley et al., 2000). Internalizing symptoms are relatively subtle, and mothers may have more opportunity to observe situations in which these behaviours occur and which teachers may overlook (Kraatz Keiley et al., 2000). Studies have compared ratings of behaviour generated by parents and teachers and found that the numbers of psychiatrically disturbed children were similar in size for each rating method but of very different compositions (Rutter et al., 1970). This suggests that parent and teacher methods identify slightly different but equally disturbed children (Rutter et al., 1970). The NCDS data also posed an additional problem in that the behaviour questionnaires completed by the mothers did not have all the items required for the parental scales, making composition of sub-scales of internalizing and externalizing more difficult.

The handling of the internalizing and externalizing dimensions was potentially too simplistic, and alternative structures for the behaviour data could have been used, such as structures based on 3 empirical factors of: internalizing, opposition defiant/conduct disorder and attention-deficit/hyperactivity disorder. However, the most likely 3-factor structure would have split the externalizing symptoms into two different dimensions rather than the internalizing symptoms for which an appropriate model could not be identified. Another alternative to summarize the data would be to use multi-dimensional trajectories which could contain indicators of both internalizing and externalizing. However, this would have divided groups on more dimensions, potentially resulting in smaller samples sizes for use in the analyses in chapters 7 and 8.

The results for birthweight, gestational age and parental social class were consistent with what we know about these commonly researched factors, and added to our understanding of how they influence the development of emotional well-being over time. However, birthweight, gestational age and parental social class only represent a small proportion of the environmental, social, biological and genetic factors that will alter the development of emotional well-being, and alternative determinants of the developmental trajectories will need to be investigated in future studies. In addition, the methodology used was primarily to investigate how emotional well-being develops over time. Alternative methods could have been used, had the main aim of the thesis been to investigate how birthweight, gestational age and parental social class influence subsequent development.

4.5. Conclusions

For both sexes 5-class models summarized the data on externalizing symptoms: these trajectories were termed "high increasers," "late childhood", "decreasers," "moderate increasers" and "consistently low".

To summarize the internalizing data a 4-class model was selected for women. These trajectories were termed "mid childhood", "late childhood", "adolescent" and "consistently low". For men a 5-class model was selected to best summarize the data for internalizing symptoms; four of the classes were given the same names as applied to the women's trajectories and an additional trajectory termed "early adulthood" was found. However, the appropriateness of the internalizing developmental trajectories is questioned.

All the trajectories were associated with parental social class at birth, with the strongest association being with trajectories indicating high levels of symptoms at older ages. Birthweight was relatively weakly associated with trajectories that indicated raised externalizing symptoms early in childhood. Birthweight may also be associated with episodic internalizing symptoms throughout life, although the developmental trajectories were a less satisfactory way of summarizing internalizing symptoms. Being born preterm had limited associations with the trajectories; only being associated with, for men, the "late childhood" internalizing and externalizing trajectories and the "early adulthood" internalizing trajectory, and for women, preterm birth was only associated with the "mid childhood" internalizing symptoms.

The externalizing trajectories were thought to be a satisfactory summary of how resources develop across the life course. However, the episodic nature of the internalizing trajectories suggested that it may not be an appropriate way of summarizing the data in other analyses.

Chapter 5: Development of cognitive ability

5.1. Introduction

Cognitive ability, which is used interchangeably with the term intelligence (Singh-Manoux, Ferrie, Lynch & Marmot, 2005), has been defined as "a very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience" (Gottfredson, 1997). Some authors, such as Fergusson et al. (2005a), Gottfredson (2004), Deary (2000) and Lubinski (2004) place the emphasis on intelligence being best summarised by one general ability, whilst others such as Detterman (2000), Whiten (2000) and Nesse (2000) have emphasized the need to understand multiple factors underlying cognitive processes. How intelligence should be measured has been greatly debated (Gould, 1981; Cianciolo & Sternberg, 2004).

Cognitive ability has consistently been shown to be associated with childhood social background (Feinstein & Bynner, 2004; Jefferis et al., 2002; Bradley & Corwyn, 2002; Schoon, Bynner, Joshi, Parsons, Wiggins & Sacker, 2002; Power, Jefferis, Manor & Hertzman, 2006). The environment may also have an effect on cognitive development prenatally. Birthweight and gestational age have been shown to be associated with cognitive ability (Bhutta et al., 2002; Jefferis et al., 2002; Shenkin, Starr, Pattie, Rush, Whalley, Deary et al. 2001; McCormick et al., 1992; Richards et al., 2001; Richards, Hardy, Kuh & Wadsworth, 2002; Hack et al., 2002; Lawrence & Blair, 2003; Power et al., 2006; Corbett et al., 2007). The focus of analyses has typically been on the very lowest birthweights, but a systematic review of 6 studies did find some evidence for an association between birthweight and cognitive ability throughout the entire range of birthweights (Shenkin et al., 2004). This relationship may not be completely linear as there is some indication that the heaviest birthweights had disadvantaged cognitive development (Shenkin et al., 2004).

In this thesis cognitive ability will be operationalized through measures of reading and mathematics, which are what Spearman would call specific tests rather than measures of general intelligence (Cianciolo & Sternberg, 2004). Both reading and mathematics have been associated with birthweight (Jefferis et al., 2002; Saigal et al., 2000; Goldstein & Peckham, 1976) and socio-economic circumstances (McNiece, Bidgood & Soan, 2004; Jefferis et al., 2002; Saigal et al., 2000). However, there is some evidence that birthweight may be more strongly associated with mathematics than reading (Breslau et al., 2001; Taylor et al., 2002; Hutton et al., 1997). Mathematical ability is believed to be heavily dependent on nonverbal skills, which are more vulnerable to pathological neurological development indicated by low birthweight and preterm birth. Reading skills are believed to be dependent on verbal skills which are more strongly determined by social factors (Hutton et al., 1997; Taylor et al., 2002).

5.1.1. Development of cognitive ability

Levels of cognitive development are relatively stable over time (Masten et al., 2005; Bornstein et al., 2006). For example in the NCDS, age 11 scores for reading and mathematics are highly predictive of reading and mathematics at age 16 (R^2 for reading is 0.6 and R^2 mathematics 0.5 Hutchison, Prosser & Wedge, 1979). This is also reflected in studies which have investigated the impact of birthweight on cognitive development and found that birthweight is associated with initial levels of cognitive development, but once this has been accounted for, birthweight has limited association with subsequent cognitive development (Jefferis et al., 2002; Richards et al., 2001).

However, there is some variability in cognitive development and whether a particular level of cognitive ability is maintained over time is partly dependent on social circumstances. Feinstein and Bynner (2004), using a cohort study born in 1970, divided children into quartiles of cognitive ability at ages 5 and 10. Of children who were in the highest quartile of cognitive ability at age 5, those from more advantaged socio-economic backgrounds had a 65% chance of being in the highest quartile at age 10, whilst those who were from more disadvantaged backgrounds had only a 34% chance of remaining in the highest quartile. Conversely for children in the bottom quartile of cognitive ability at age 5, those from advantaged socio-economic backgrounds had only a 34% chance of remaining in the bottom quartile, whilst for children from disadvantaged backgrounds, the chances of persisting in the bottom quartile at age 10 was 67% (Feinstein & Bynner, 2004). Children from disadvantaged backgrounds, when compared to those from more advantaged circumstances, are increasingly likely to have relatively poorer cognitive ability as they age (Goldstein, 1979; Douglas et al., 1968; Fogelman et al., 1978; Jefferis et al., 2002; McNiece et al., 2004; Power et al., 2006)

A number of studies using NCDS data have already investigated developmental patterns of cognitive ability over time: for example, Essen, Fogelman and Ghodsian, (1978) identified patterns of development of mathematics and reading separately. Allocation to the patterns was based on which tertile of mathematics or reading individuals were in at ages 7, 11 and 16. The focus of the analyses was on individuals who either consistently remained in one tertile throughout or those that changed from being at one extreme of cognitive ability at age 7 to another extreme at age 16. Those who did not fit these patterns, 56% of the participants, were ignored in the analyses. Participants with consistently high cognitive ability or those who moved to the high cognitive ability tertile by age 11 were more likely to have a father who was in a non-manual social class. However, the numbers included in many of the patterns were very low, some containing as few as 20 children, and the large number of individuals excluded from analyses suggests that alternative person-based methods of summarizing cognitive development are needed.

5.1.2. Trajectories of cognitive ability

One approach to summarizing the development of cognitive ability over time is to use group-based developmental trajectories. However, the number of studies using group-based developmental trajectories so far has been limited. Duchesne et al. (2005) identified three trajectories, based on mothers' subjective ratings of academic achievement, performance and motivation, in children aged 10 to 13 years: 63% of participants were in a high stable trajectory, 14% in a trajectory of declining academic functioning and 23% in a low stable trajectory (Duchesne et al., 2005). This study suggests that for the majority of individuals, academic performance remains stable over time, and that there is a small group of individuals whose ability declines. However, caution has to be used when making inferences from this study. Trajectories based on objective measures of achieved academic ability, as used in this thesis, may be very different from trajectories based on subjective measures as used in the Duchesne et al. (2005) study.

The only study to use group-based methods to model trajectories of objectively measured cognitive ability was conducted by Muthén (2004a). Muthén, in a population studied from grade 7 through to grade 10, identified 3 approximately parallel trajectories of mathematical ability. A high trajectory contained 52% of the population, a middle trajectory contained 28% and a low trajectory contained 19% (Muthén, 2004a). On this basis, relatively stable trajectories of cognitive development would be expected, but without further studies the analyses should be considered highly exploratory.

5.1.3. Gender differences in development

In general, boys have been found to perform better at mathematics, whilst girls tend to be better at reading (Halpern & LaMay, 2000). The trend of boys having better mathematical ability is confirmed in the NCDS (McNiece et al., 2004). The gap between genders increases as children age with fewer boys than girls being found to have relative decreases in mathematical ability (Essen et al., 1978). At younger ages the NCDS supports the idea that girls have higher initial reading ability (Fogelman & Goldstein, 1976). However, by age 16 boys were found to have higher reading ability (McNiece et al., 2004) and boys have been shown to be more likely to improve from initially low reading levels (Essen et al., 1978): the relative improvement in reading for boys is predominately restricted to those from non-manual social backgrounds. Overall, boys and girls are likely to have different developmental trajectories for reading and mathematics: whether this is due to physiological or sociological explanations is disputed (Cianciolo & Sternberg, 2004).

5.2. Methods

5.2.1. Data

The mathematics and reading trajectories used in this chapter are generated from the data collected in the NCDS sweeps at age 7, 11 and 16. Data collected during the Perinatal Mortality Survey are used to indicate birthweight, gestational age and parental social class.

The focus of the analyses is the fuller sample. For this chapter the same fuller sample was used for identifying both the reading and mathematics trajectories. The fuller sample contains all cases which had data for at least 4 of the education indicator variables, and contains 7232 men and 6854 women. All these cases had valid data for at least 2 time points for both the reading and mathematics trajectories.

In addition, samples of complete cases (cases which have complete data on all indicators for that trajectory) are used to help identify the model to be used in further analysis. The complete cases sample for reading contains 4689 men and 4506 women. The complete cases sample for the mathematics trajectory contains 4647 men and 4470 women.

5.2.2. Variables

Reading at age 7 was measured using the Southgate reading test (Southgate, 1962). At the ages of 11 and 16 reading was measured using a reading comprehension test constructed by the National Foundation for Educational Research in England and Wales (NFER) specifically for use in this study (Fogelman & Goldstein, 1976).

Mathematics was assessed at age 7 using the Problem Arithmetic test (Pringle et al., 1966), and at age 11 using a mathematics test specifically constructed for use in the study by the NFER (Fogelman, 1983). At age 16 mathematics was assessed using a comprehension test, which was originally developed at the University of Manchester for NFER for a study of comprehensive schools (Fogelman, 1983).

The exogenous variables used in the analyses are: birthweight, gestational age and parental social class.

Birthweight in ounces has been converted into kilograms and is in 5 categories: <2.51 kg, 2.51-3.00 kg, 3.01-3.50 kg, 3.51-4.00 kg and >4.01 kg. 3.51-4.00 kg is used as the reference category.

Gestational age is dichotomised; those babies born before completing 37 weeks of pregnancy being considered preterm births.

Parental social class was based on Registrar General's Social Classification. If the mother was married, the mother's husband's occupation was used to indicate social class. If for whatever reason a husband's social class was not available, the mother's own or the mother's father's social class was used instead. Classes I and II were merged to create a reference category, while the remaining classes; III non-manual, III manual, IV and V, were left as independent categories.

5.2.3. Statistical analyses

Prior to conducting the main statistical analyses the samples to be used were tested for significant biases. The mean scores for the cognitive ability variables for the fuller samples and complete cases samples were compared with those of cases excluded from the respective samples using t-tests. Chi-square tests were also conducted to investigate if there were any significant biases in membership of the fuller samples predicted by social class, birthweight and gestational age.

The main statistical analyses in this chapter are presented in two stages. Firstly, exploratory analyses are conducted to identify the developmental trajectories. Secondly, a hypothesis testing stage is conducted to determine whether the identified trajectories are associated with social class, birthweight and gestational age.

In the exploratory stage, latent class clustering is used to identify a series of models with k number classes for both the fuller sample and the complete cases sample.

The statistical criteria used to help decide the number of classes that the best summary model has are: the AIC, BIC, ssaBIC, entropy Index and Lo Mendel Rubin Likelihood Ratio Test (aLRT). The pragmatic criteria used to decide the best models are: 1. that each developmental trajectory is reasonably distinct; 2. that the classes contain sufficiently large samples to be of use in future analyses, and 3. that the trajectories identified using the fuller samples have similar shapes to trajectories identified using complete cases.

Having established the best models to summarize both reading and mathematics, the next stage of the analysis is to regress the developmental trajectories identified in these models on to the exogenous variables birthweight, gestational age and social class using multinomial logistic regression. Cases that have missing data for an exogenous variable are excluded from the analyses involving that variable.

5.3. Results

5.3.1. Missing data

The means and standard deviations for indicators of reading and mathematics are presented in tables 5.1 and 5.2. Those excluded from the fuller samples when compared to those in the fuller sample have significantly (at $p<0.01$) lower scores for all indicators, with the exception of reading at age 11 for boys and mathematics at age 7 for girls. When the mean scores for reading and mathematics were compared between the complete cases sample and those excluded from the complete cases sample all results were significant at $p<0.01$.

Table 5.1: Reading at age 7, 11 and 16: numbers, proportions, means and standard deviations for cases included and excluded from the fuller sample and complete cases (men and women)

	Fuller sample			Excluded from fuller sample			Complete cases			Excluded from complete cases		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
	Men											
Age 7	6863	22.52	7.37	538	21.41**	8.07	4689	22.96	7.10	2712	21.53***	7.90
Age 11	6704	15.98	6.49	201	15.10	6.91	4689	16.28	6.48	2216	15.25***	6.49
Age 16	5586	25.57	7.18	155	22.62***	8.62	4689	25.70	7.09	1052	24.52***	7.75
Total	7232						4689			3861		
	Women											
Age 7	6504	24.43	6.55	506	23.02***	7.79	4506	24.66	6.36	2504	23.73***	7.13
Age 11	6347	16.12	5.94	184	15.00**	6.06	4506	16.33	5.95	2025	15.56***	5.91
Age 16	5363	25.46	6.64	149	23.03***	7.46	4506	25.52	6.61	1006	24.82**	6.94
Total	6854						4506			3541		

* $p < 0.05$, ** $p < 0.01$, *** $p < .001$

Table 5.2: Mathematics at age 7, 11 and 16: numbers, proportions, means and standard deviations for cases included and excluded from the fuller sample and complete cases (men and women)

	Fuller sample			Excluded fuller from sample			Complete cases			Excluded complete from cases		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
	Men											
Age 7	6843	5.23	2.49	528	4.94**	2.63	4647	5.32	2.46	2724	5.02***	2.56
Age 11	6704	16.90	10.56	199	14.50**	10.11	4647	17.51	10.53	2256	15.44***	10.48
Age 16	5564	13.47	7.23	153	11.75**	7.20	4647	13.62	7.22	1070	12.55***	7.23
Total	7232						4657			3903		
	Women											
Age 7	6494	5.02	2.46	513	4.82	2.64	4470	5.09	2.44	2537	4.87***	2.52
Age 11	6346	16.62	10.03	183	13.44**	9.47	4470	17.12	9.96	2059	15.25***	10.05
Age 16	5338	12.13	6.61	137	10.40***	5.91	4470	12.24	6.66	1005	11.40***	6.30
Total	6854						4470			3577		

* p <0.05, ** p<0.01, ***p<.001

Table 5.3: Numbers and proportions for birthweight, gestational age and social class: for those included and excluded from the fuller samples (men)

	Fuller sample		Excluded from fuller sample	
	N	%	N	%
Birthweight				
<2.51 kg	343	4.9	70	5.5
2.51-3.00 kg	1211	17.4	226	17.8
3.01-3.5 kg	2358	33.9	423	33.3
3.51-4.00 kg	2251	32.3	397	31.3
>4.01 kg	802	11.5	154	12.1
Total	6965	100.0	1270	100.0
Missing	267		48	
Gestational age				
Term birth	6207	95.4	1112	95.7
Preterm baby	296	4.6	50	4.3
Total	6503	100.0	1162	100.0
Missing	729		156	
Parental social class				
I an II	1204	16.7	270	20.7
III non-manual	756	10.5	128	9.8
III manual	3589	49.9	623	47.7
IV	920	12.8	147	11.3
V	720	10.0	138	10.6
Total	7189	100.0	1306	100.0
Missing	43		12	

The distributions of birthweight, gestational age and social class for those included and excluded from the fuller samples and all cases are presented in tables 5.3 and 5.4. Those cases that had too much missing data to be included in the fuller samples are little different; the one exception being that males born in social class I and II are significantly under represented ($p<0.01$). 81.6% of social class I and II males are in the fuller samples compared to 84.6% of all males.

Table 5.4: Numbers and proportions for birthweight, gestational age and social class: for those included and excluded from the fuller samples (women)

	Fuller sample		Excluded fuller sample	
	N	%	N	%
Birthweight				
<2.51 kg	444	6.7	79	6.8
2.51-3.00 kg	1540	23.2	294	25.3
3.01-3.5 kg	2537	38.2	449	38.6
3.51-4.00 kg	1671	25.1	256	22.0
>4.01 kg	455	6.8	86	7.4
Total	6647	100.0	1164	100.0
Missing	207		29	
Gestational age				
Term birth	5885	96.1	997	95.0
Preterm baby	239	3.9	53	5.0
Total	6124	100.0	1050	100.0
Missing	730		143	
Parental social class				
I an II	1167	17.1	228	19.2
III non-manual	725	10.6	111	9.4
III manual	3352	49.2	569	48.0
IV	927	13.6	156	13.2
V	644	9.4	121	10.2
Total	6815	100.0	1185	100.0
Missing	39		8	

5.3.2. Selection of the developmental trajectories

Reading trajectories

To identify the trajectories summarizing reading development, models containing up to 8 classes were successfully generated for both men and women. For both sexes the information criteria measures (AIC, BIC, ssaBIC) suggested that as the number of classes increased better fitting models were produced (see table 5.5).

Table 5.5: Model fit indices for latent class cluster models summarizing reading scores

Number of classes	AIC	BIC	ssaBIC	aLRT p value	Entropy
			Men		
Two	117533.16	117622.68	117581.37	<0.001	0.849
Three	116569.33	116686.39	116632.37	<0.001	0.851
Four	116077.29	116221.90	116155.17	0.104	0.853
Five	115670.24	115842.40	115762.95	0.281	0.838
Six	115288.47	115488.17	115396.02	0.010	0.836
Seven	115067.31	115294.56	115189.69	0.012	0.829
Eight	115029.68	115284.48	115166.90	0.193	0.816
			Women		
Two	107892.80	107981.62	107940.31	<0.001	0.902
Three	106633.06	106749.21	106695.19	<0.001	0.895
Four	105920.45	106063.93	105997.20	<0.001	0.889
Five	105445.47	105616.29	105536.84	<0.003	0.875
Six	105356.45	105554.60	105462.44	<0.001	0.779
Seven	104813.98	105039.45	104934.59	0.064	0.891
Eight	104726.80	104979.61	104862.03	<0.001	0.808

Men

For men, the aLRT suggested a 3-class model, whilst the entropy scores were all acceptable with a marginal preference for a 4-class model (see table 5.5). The sample sizes for all classes in models up to and including 7 classes were larger than 200 (see table 5.6). The most comparable trajectories between the fuller sample and the complete case sample were for the 2-class model, of the remaining models the 3,4, and 5 class models are reasonably comparable (see table 5.6) with the 4- and 5-class models being slightly more comparable than the 3-class model. Overall, on the basis of all criteria, a 4-class model has been selected as it was felt that a 4-class model was the best compromise between all criteria. However, a case could also be made for selecting models containing 2, 3 or 5 classes.

Table 5.6: Mean reading scores for each class in models of K classes: complete cases and fuller sample (men)

Number of classes	Complete cases				Fuller sample			
	Age 7	Age 11	Age 16	N[1] in class	Age 7	Age 11	Age 16	N[1] in class
Two								
Class 1	12.6	11.0	19.8	1173	12.1	10.6	19.3	1903
Class 2	26.5	18.1	27.7	3516	26.3	17.9	27.5	5329
Three								
Class 1	13.1	8.3	12.0	502	9.2	9.6	17.6	1111
Class 2	12.8	12.6	24.1	733	18.1	12.9	22.4	1566
Class 3	26.6	18.2	28.0	3454	27.5	18.6	28.3	4555
Four								
Class 1	18.6	13.1	22.5	996	20.1	13.8	23.4	1428
Class 2	9.3	7.3	10.6	290	6.7	8.2	14.7	519
Class 3	10.4	11.8	23.2	420	13.0	11.0	20.3	1054
Class 4	27.6	18.9	28.6	2983	27.8	18.9	28.6	4231
Five								
Class 1	18.7	10.2	15.0	363	16.4	9.5	13.4	452
Class 2	18.7	14.5	26.0	655	19.8	14.3	25.1	1191
Class 3	8.8	7.1	10.4	265	6.4	6.7	10.2	342
Class 4	10.4	11.8	23.0	430	11.1	11.5	22.6	873
Class 5	27.6	18.9	28.8	2976	27.7	18.9	28.6	4374
Six								
Class 1	28.3	23.8	31.3	588	22.9	11.9	17.0	331
Class 2	18.7	10.1	15.1	375	14.3	8.8	13.6	498
Class 3	18.6	14.6	26.1	657	19.3	14.6	25.9	1154
Class 4	8.8	7.0	10.5	269	6.0	6.4	9.7	308
Class 5	10.4	11.8	23.1	424	10.6	11.6	23.2	711
Class 6	27.3	17.2	27.9	2376	27.9	19.2	29.1	4230
Seven								
Class 1	13.3	8.4	13.7	267	16.7	13.4	24.8	763
Class 2	26.0	13.0	20.3	287	20.5	10.9	15.0	270
Class 3	19.7	10.4	15.4	240	12.8	8.5	12.9	403
Class 4	19.1	15.0	26.4	704	22.3	15.5	26.4	997
Class 5	6.6	6.5	9.5	165	5.3	6.4	9.7	245
Class 6	10.4	12.2	23.9	383	9.7	11.1	22.7	620
Class 7	27.9	19.7	29.8	2643	28.2	19.2	28.9	3934
Eight								
Class 1	27.5	25.9	6.9	3	26.1	24.4	7.0	6
Class 2	13.2	8.3	13.3	258	26.2	13.2	20.4	399
Class 3	26.1	13.0	20.1	283	19.6	10.6	16.3	361
Class 4	19.4	10.4	16.1	268	13.1	8.3	13.1	450
Class 5	19.2	15.1	26.7	671	10.5	11.9	23.5	688
Class 6	6.5	6.5	9.5	159	5.7	6.2	9.3	289
Class 7	10.5	12.1	23.8	397	19.2	14.9	26.6	1061
Class 8	27.9	19.7	29.8	2650	27.9	19.7	29.8	3978

1 Based on the most likely class of membership

Table 5.7: Mean reading scores for each class in models of K classes: complete cases and fuller sample (women)

Number of classes	Complete cases Age 7	Age 11	Age 16	N[1] in class	Fuller sample Age 7	Age 11	Age 16	N[1] in class
Two								
Class 1	12.8	10.6	18.7	751	12.4	10.5	18.4	1142
Class 2	27.1	17.5	26.9	3755	27.0	17.3	26.8	5712
Three								
Class 1	9.5	9.3	16.8	403	9.0	9.2	16.5	633
Class 2	18.9	12.6	21.8	798	18.6	12.5	21.7	1176
Class 3	28.0	18.1	27.5	3305	27.9	17.9	27.3	5045
Four								
Class 1	14.5	11.1	20.0	438	14.3	11.0	19.8	660
Class 2	7.4	8.5	14.9	231	7.1	8.5	14.7	392
Class 3	21.5	13.3	22.9	849	21.4	13.4	23.0	1196
Class 4	28.4	18.5	27.9	2988	28.3	18.3	27.7	4606
Five								
Class 1	19.0	12.8	21.9	490	18.7	12.7	21.7	710
Class 2	13.3	10.4	19.2	349	13.0	10.3	19.0	507
Class 3	7.0	8.3	14.6	211	6.6	8.2	14.3	354
Class 4	23.9	14.2	24.1	686	23.7	14.2	24.1	1103
Class 5	28.8	19.0	28.3	2770	28.7	18.8	28.1	4180
Six								
Class 1	10.7	9.3	17.7	225	29.1	24.1	30.6	409
Class 2	19.9	13.1	22.3	479	18.7	12.7	21.7	713
Class 3	15.3	11.4	20.1	294	13.0	10.3	19.0	512
Class 4	5.9	8.1	14.3	133	6.6	8.2	14.3	350
Class 5	24.4	14.6	24.5	832	23.7	14.1	24.1	1096
Class 6	28.9	19.1	28.3	2543	28.6	17.6	27.5	3774
Seven								
Class 1	29.2	24.5	31.0	318	3.2	7.2	10.8	80
Class 2	10.7	9.3	17.7	225	11.7	9.9	18.9	294
Class 3	19.9	13.1	22.3	480	20.1	13.1	22.5	703
Class 4	15.3	11.4	20.1	290	15.7	11.5	19.9	414
Class 5	5.9	8.1	14.3	133	7.6	8.5	15.3	271
Class 6	24.4	14.6	24.5	833	24.5	14.6	24.5	1265
Class 7	28.8	17.8	27.7	2227	28.9	18.9	28.2	3827
Eight								
Class 1	23.9	11.9	17.5	151	3.3	7.4	10.9	84
Class 2	29.2	24.5	31.0	355	29.2	24.1	30.7	386
Class 3	14.1	9.2	13.5	141	11.7	9.9	19.0	292
Class 4	19.0	12.9	22.4	496	20.1	13.1	22.5	693
Class 5	12.8	11.2	22.8	200	15.8	11.5	19.9	419
Class 6	7.0	8.2	14.2	215	7.6	8.4	15.3	271
Class 7	23.8	14.8	25.8	550	24.5	14.6	24.5	1258
Class 8	28.7	17.7	27.7	2398	28.8	17.8	27.7	3451

1 Based on the most likely class of membership

Women

For women, the aLRT would suggest a 6-class model (see table 5.5). The entropies are all acceptably high. However, the entropies for the 6-class and 8-class models are lower than for models with other number of classes suggesting that the 6- and 8-class models were not appropriate. The sample sizes are all greater than 200 for models up to 6 classes (see table 5.7). The distinctiveness of trajectories is a matter of debate. Each additional trajectory is distinct, in that there is little confusion between it and other trajectories. However, there is a tendency for the same overall shape across time. When models generated using the complete cases sample and the fuller sample are compared, models containing up to 5 classes are reasonably comparable. Beyond this the models produced by the complete cases and fuller samples have dissimilar trajectories. On the balance of all criteria a 5-class model was selected as being the best summary of the data.

Shape of reading trajectories

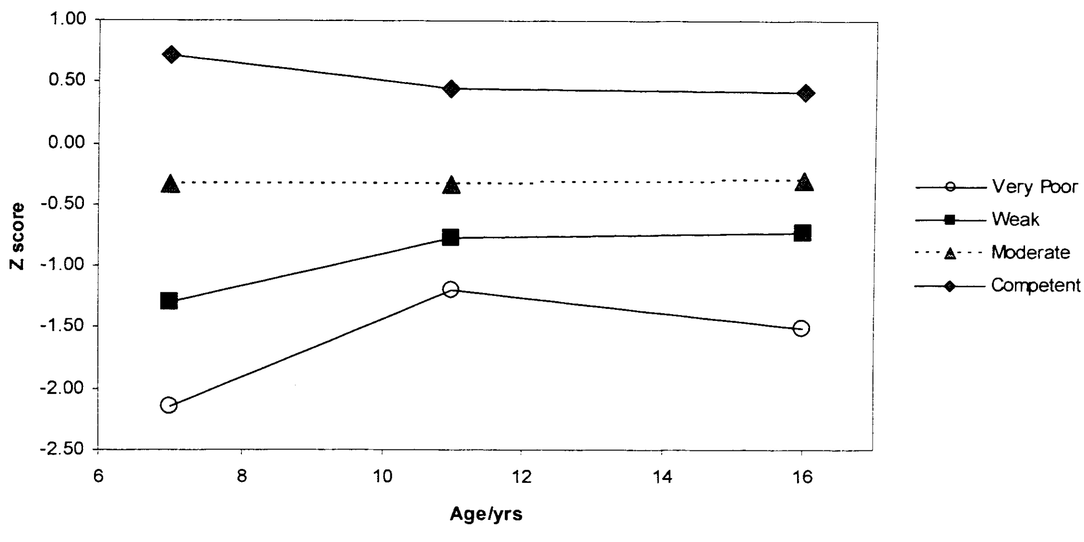
The trajectories in the selected models are described in table 5.8, figure 5.1 for men and figure 5.2 for women. As the Southgate reading test used to generate the indicators at age 7 was different from the reading comprehension test used at ages 7 and 11, z scores for each class have been generated by subtracting the population mean from the means for each indicator for each class and then dividing by the population standard deviations. The trajectories presented in the figures are comparisons of relative development rather than of absolute development.

The smallest class for men are the "very poor" readers consisting of 7.2% of the population, next is the "weak" readers of which 14.6% of men are members. The third trajectory is the "moderate" readers, containing 19.7% of the men. The final class is the "competent" readers' trajectory and 58.5% of men are members of this class.

Table 5.8: Developmental trajectories for reading: names, means for each indicator, n and proportions in each class

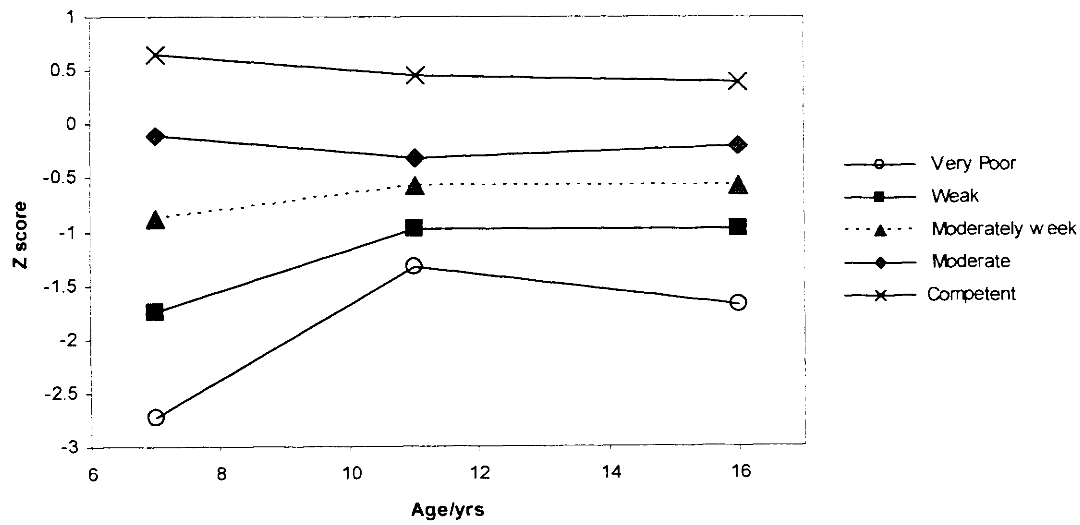
Class name	Age 7	Age 11	Age 16	N in class	% in class
Men					
Very poor	6.7	8.2	14.7	519	7.2
Weak	13.0	11.0	20.3	1054	14.6
Moderate	20.1	13.8	23.4	1428	19.7
Competent	27.8	18.9	28.6	4231	58.5
Women					
Very poor	6.6	8.2	14.3	354	5.2
Weak	13.0	10.3	19.0	507	7.4
Moderately weak	18.7	12.7	21.7	710	10.4
Moderate	23.7	14.2	24.1	1103	16.1
Competent	28.7	18.8	28.1	4180	61.0

Figure 5.1: Reading developmental trajectories (men)



For women the smallest class is the "very poor" readers' trajectory of which 5.2% of women are members. 7.4% of women are members of "weak" trajectory; 10.4% are members of the "moderately weak" trajectory; 16.1% are members of the "moderate" trajectory; and 61% are members of the "competent" trajectory. It should be noted that relative to the other trajectories those who are "very poor" or "weak" readers improve between the ages of 7 and 11.

Figure 5.2: Reading developmental trajectories (women)



Mathematics trajectories

Models with at least 8 classes could be identified for both men and women. The information criteria measures (AIC, BIC, ssaBIC) suggest that, of all models that converged, the ones with the largest number of classes fitted the data best (see table 5.9).

Men

For men the aLRT would suggest that a 5-class model should be selected. The entropy scores for the models were not good, with the entropies for the 5-, 6- and 8-class models falling below 0.7, suggesting that these models may not acceptably fit the data (see table 5.9). Sample sizes would suggest that models up to 6 classes would be useful for further analysis (see table 5.10). The trajectories added reasonably distinct shapes and the fuller samples and complete cases are reasonably comparable for most models up to the 6-class model (see table 5.10). On the balance of all criteria, a 4-class model was selected, although on the basis of entropy a 2-class model might be preferable.

Table 5.9: Model fit indices for latent class cluster models summarizing mathematics scores

Number of classes	AIC	BIC	ssaBIC	aLRT p value	Entropy
Men					
Two	111621.62	111711.14	111669.83	<0.001	0.763
Three	111209.17	111326.23	111272.21	<0.001	0.724
Four	110980.70	111125.31	111058.57	<0.001	0.705
Five	110860.19	111032.35	110952.90	<0.001	0.677
Six	110819.29	111018.99	110926.84	0.055	0.651
Seven	110708.28	110935.53	110830.66	0.081	0.710
Eight	110662.26	110917.05	110799.47	0.023	0.698
Women					
Two	105422.32	105511.15	105469.83	<0.001	0.721
Three	104972.75	105088.90	105034.88	<0.001	0.676
Four	104780.53	104924.01	104857.28	<0.001	0.704
Five	104684.81	104855.62	104776.18	0.007	0.710
Six	104591.42	104789.56	104697.41	0.023	0.696
Seven	104530.98	104756.46	104651.59	0.233	0.667
Eight	104438.78	104691.58	104574.01	0.032	0.659

Women

For women the aLRT would suggest that a 6-class model should be selected (see table 5.9). The entropy scores for the models were again not good, with the entropies for the 3-, 6-, 7- and 8-class models falling below 0.7. Sample size would suggest that the number of classes included should be limited to 4 (see table 5.11): within models containing 5 or more classes the sample sizes falls below 200. All the models produce reasonably distinct trajectories and models of up to 6 classes generated by the complete cases and the fuller samples are reasonably comparable. On the balance of entropy and sample size a 4-class model was selected for women.

Table 5.10: Mean mathematics scores for each class in models of K classes: complete cases and fuller sample (men)

Number of classes	Complete cases				Fuller sample			
	Age 7	Age 11	Age 16	N[1] in class	Age 7	Age 11	Age 16	N[1] in class
Two								
Class 1	6.5	27.9	19.7	1906	6.5	27.7	19.8	2785
Class 2	4.5	10.2	9.3	2741	4.4	9.9	9.1	4447
Three								
Class 1	6.0	24.1	11.4	481	6.0	23.7	11.3	579
Class 2	6.7	28.2	21.8	1566	6.6	28.2	21.8	2368
Class 3	4.4	9.6	9.2	2600	4.3	9.2	9.0	4285
Four								
Class 1	5.6	18.4	17.8	521	5.8	18.6	18.0	782
Class 2	5.9	23.6	11.7	669	5.9	23.0	11.6	1043
Class 3	6.9	30.5	22.9	1181	6.9	30.7	22.9	1679
Class 4	4.2	8.5	8.2	2276	4.1	8.1	8.1	3728
Five								
Class 1	5.6	16.3	9.8	718	5.6	15.9	9.8	1177
Class 2	5.5	19.2	18.4	606	5.7	19.9	18.9	915
Class 3	6.1	26.7	12.7	401	6.2	26.3	12.7	576
Class 4	7.0	31.1	23.0	1097	7.0	31.4	23.1	1536
Class 5	3.9	7.0	8.1	1825	3.8	6.7	8.0	3028
Six								
Class 1	6.2	24.1	19.7	637	6.8	9.9	8.9	230
Class 2	5.4	15.7	9.9	935	5.5	17.0	10.1	1124
Class 3	5.1	14.7	17.0	262	5.6	19.7	18.9	871
Class 4	6.2	27.0	12.6	380	6.2	26.8	12.8	479
Class 5	7.2	32.6	23.7	825	7.0	31.3	23.0	1591
Class 6	3.8	6.3	7.6	1608	3.5	6.6	7.9	2937
Seven								
Class 1	6.4	31.8	11.7	64	6.4	31.8	11.6	66
Class 2	6.2	24.0	20.5	593	6.2	23.7	20.5	929
Class 3	5.3	14.4	9.7	1000	5.3	14.3	9.7	1618
Class 4	5.1	14.7	17.5	224	5.1	14.5	17.7	222
Class 5	6.0	24.1	12.2	459	6.1	24.0	12.3	597
Class 6	7.2	32.6	23.3	850	7.1	32.6	23.3	1278
Class 7	3.7	5.8	7.7	1457	3.6	5.6	7.6	2522
Eight								
Class 1	6.5	31.7	11.6	73	6.2	32.9	10.7	39
Class 2	6.4	24.6	21.2	529	6.4	24.7	20.9	929
Class 3	4.9	16.0	15.6	377	5.6	19.1	10.5	739
Class 4	5.4	14.1	9.0	807	5.0	12.1	9.2	1389
Class 5	5.4	12.0	20.7	40	5.1	15.5	17.5	317
Class 6	6.0	24.0	12.3	511	6.3	26.8	13.9	466
Class 7	7.2	32.7	23.3	830	7.2	33.3	23.7	1098
Class 8	3.7	5.9	7.8	1480	3.5	5.0	7.4	2255

1 Based on the most likely class of membership

Table 5.11: Mean mathematics scores for each class in models of K classes: complete cases and fuller sample (women)

Number of classes	Complete cases Age 7	Age 11	Age 16	N[1] in class	Fuller sample Age 7	Age 11	Age 16	N[1] in class
Two								
Class 1	6.5	27.1	20.4	1300	6.2	26.8	17.3	2635
Class 2	4.5	12.9	8.8	3170	4.3	10.1	8.5	4219
Three								
Class 1	5.4	23.0	11.4	809	5.5	22.9	11.4	1134
Class 2	6.7	28.1	21.0	1179	6.6	28.2	20.9	1705
Class 3	4.2	9.7	8.4	2482	4.2	9.3	8.3	4015
Four								
Class 1	6.1	18.0	18.2	245	6.1	18.2	17.8	349
Class 2	5.4	22.4	11.6	1070	5.4	22.3	11.5	1594
Class 3	6.7	29.0	21.6	954	6.7	30.3	21.6	1352
Class 4	4.1	8.9	7.7	2201	4.0	8.4	7.6	3559
Five								
Class 1	5.1	28.1	11.4	141	5.2	28.1	11.6	191
Class 2	6.2	17.6	19.0	198	6.2	17.6	18.3	238
Class 3	5.3	19.7	11.1	1150	5.3	19.4	11.0	1769
Class 4	6.8	29.9	21.4	997	6.8	30.1	21.4	1461
Class 5	4.0	8.1	7.6	1984	3.9	7.7	7.5	3195
Six								
Class 1	6.3	24.7	18.4	619	6.3	24.3	18.1	948
Class 2	5.5	26.3	11.7	394	5.5	26.2	11.6	505
Class 3	6.0	15.0	19.1	98	6.0	15.1	19.0	114
Class 4	5.1	16.5	10.0	1148	5.0	16.2	9.8	1731
Class 5	7.0	32.4	22.8	581	7.0	32.4	22.7	880
Class 6	3.8	6.9	7.2	1630	3.7	6.6	7.1	2676
Seven								
Class 1	4.9	31.4	12.0	68	6.9	9.0	7.8	229
Class 2	6.2	23.2	19.0	455	6.5	25.0	17.8	979
Class 3	5.6	23.9	11.7	635	5.1	26.7	11.6	404
Class 4	5.8	13.1	19.8	54	6.2	15.9	18.9	155
Class 5	4.9	14.9	9.6	1096	5.0	16.8	9.9	1724
Class 6	7.0	31.9	22.2	686	6.9	32.3	22.9	850
Class 7	3.7	6.4	7.3	1476	3.3	6.6	7.1	2513
Eight								
Class 1	4.9	10.4	20.4	30	4.6	27.6	20.0	409
Class 2	5.3	21.9	10.9	613	6.7	10.2	8.2	795
Class 3	6.5	27.1	19.3	631	7.4	23.6	12.4	609
Class 4	5.5	30.1	12.3	143	4.3	28.4	11.5	151
Class 5	6.0	19.3	18.1	251	6.9	18.5	18.9	243
Class 6	4.9	13.9	9.2	1032	4.1	17.9	10.7	1240
Class 7	7.2	33.7	23.4	408	7.7	31.3	22.2	992
Class 8	3.6	5.9	7.0	1362	2.9	6.9	7.3	2415

1 Based on the most likely class of membership

Table 5.12: Developmental trajectories for mathematics: names, means for each indicator, n and proportions in each class

Class name	Age 7	Age 11	Age 16	N in class	% in class
Men					
High performers	6.9	30.7	22.9	1679	23.2
Late developers	5.8	18.6	18.0	782	10.8
Moderate decreasing	5.9	23.0	11.6	1043	14.4
General population	4.1	8.1	8.1	3728	51.5
Women					
High performers	6.7	30.3	21.6	1352	19.7
Transient lapse	6.1	18.2	17.8	349	5.1
Moderate decreasing	5.4	22.3	11.5	1594	23.3
General population	4.0	8.4	7.6	3559	51.9

Shape of mathematics trajectories

The overall shapes of the mathematics trajectories for both sexes are similar, and are described in table 5.12, and for men, figure 5.3, and for women, figure 5.4. For 3 of trajectories the means are slightly lower for women. The first of these trajectories is the "high performers" for which 23.2% of men and 19.7% of women are members. This trajectory starts with the highest mean mathematics score at age 7 which increases relative to the other trajectories. The second trajectory is the "moderate decreasing" for which 14.4% of men and 23.3% of women are members. The mean for this trajectory is moderately raised initially but relative scores decrease over time. The third trajectory "general population" contains the 51.5% of men and the 51.9% of women who start with low mean mathematical ability at age 7 which then deteriorates relative to the other trajectories at age 11, before a slight recovery at age 16.

The fourth trajectory is similar in shape for both men and women but the means for the women's trajectory are consistently higher than for men. For women the fourth trajectory is termed "the transient lapse". This reflects that women on this trajectory

Figure 5.3: Mathematics developmental trajectories (men)

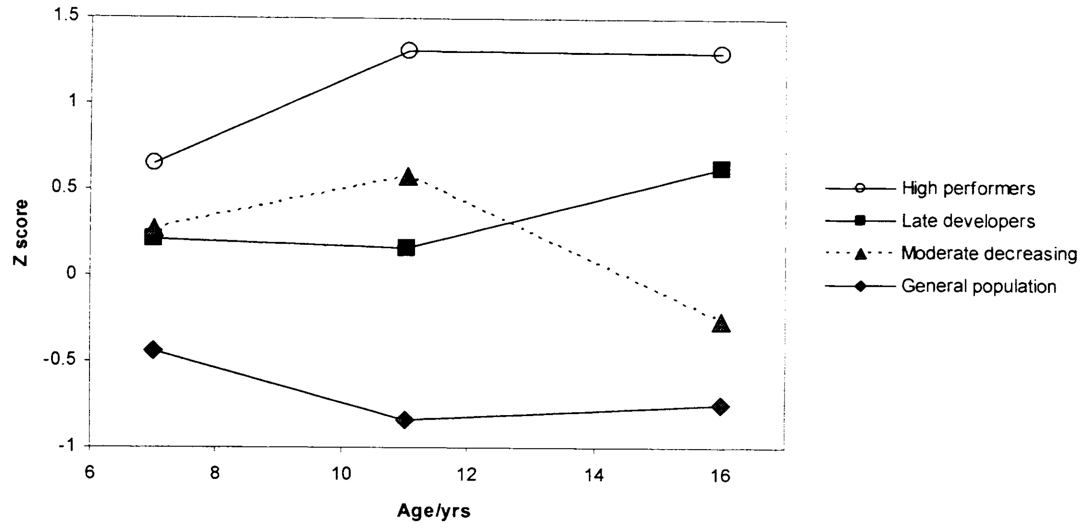
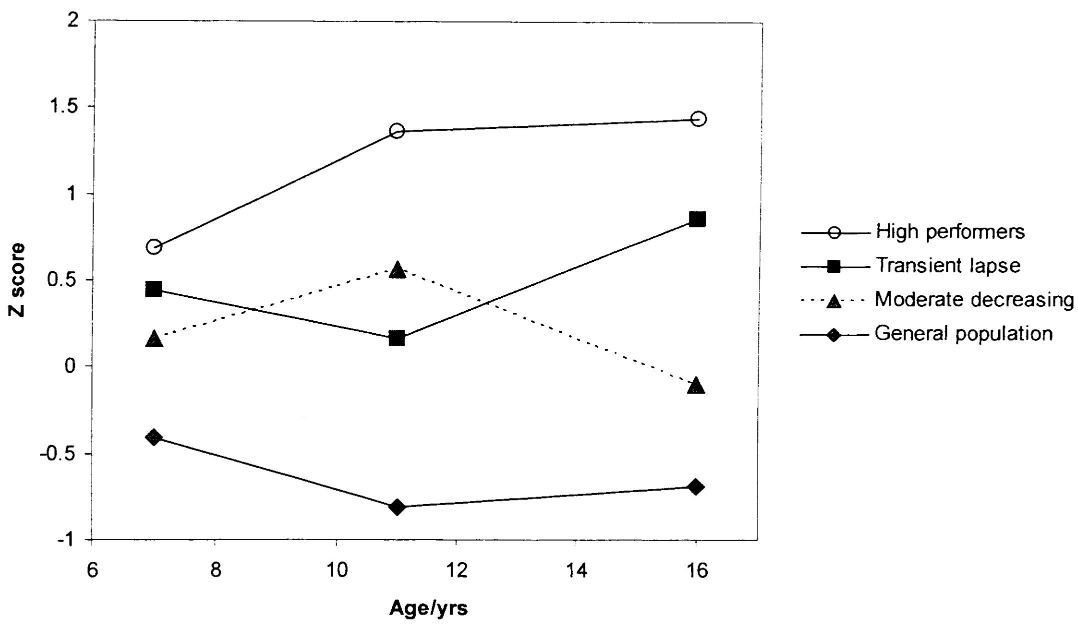


Figure 5.4: Mathematics developmental trajectories (women)



initially perform fairly well and only drops below the "moderate decreasing" trajectory at age 11. The "transient lapse" trajectory contains 5.1% of women. For men the fourth trajectory is termed "late developers". This trajectory starts with above average mathematical ability which improves relative to other trajectories between the ages 11 and 16 and contains 10.8% of men.

5.3.3. Prediction of trajectories

Reading

The "competent" trajectory was used as the reference category for the multinomial logistic regression analyses.

Low birthweight was associated with significantly raised odds of all the poorer reading trajectories for both boys and girls in both analyses adjusting for parental social class and gestational age and unadjusted analyses. However, there was no association between heavier birthweights and any of the trajectories (see tables 5.13-5.16.)

For boys, being born preterm was associated with the "weak" and the "moderate" reading trajectories (see table 5.13). After adjusting for parental social class or birthweight only the association between preterm birth and the "weak" readers' trajectory remained significant (see table 5.14).

For girls, in unadjusted analyses, being born preterm is associated with raised odds of membership of 3 of the trajectories for reading; "very poor," "weak," and "moderate" readers, but not the "moderately weak" readers' trajectory (see table 5.15). The association is only slightly reduced after adjusting for social class ("very poor" O.R. 2.02 95% CI 1.17-3.47; "weak" O.R. 1.86 95% CI 1.15-3.00; "moderate" O.R. 1.85 95%CI 1.24-2.67), but after adjusting for birthweight, being born preterm did not have a significant association ($p<0.05$) with any of the trajectories.

Parental social class was associated with increased risk of membership for all the trajectories of disadvantaged reading development for both boys and girls in analyses adjusting for birthweight and gestational age and unadjusted analyses (see table 5.13-5.16). The strongest association was with the "very poor" readers' trajectory.

Table 5.13: Unadjusted odds ratios for membership of reading trajectories (men)

	Very poor V Competent			Weak V Competent			Moderate V Competent		
	OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight									
<2.51 kg	2.76	1.80	4.23	1.96	1.36	2.84	2.36	1.71	3.25
2.51-3.00 kg	1.74	1.29	2.33	1.55	1.24	1.93	1.37	1.11	1.68
3.01-3.50 kg	1.12	0.86	1.47	1.20	0.99	1.45	1.16	0.97	1.38
3.51-4.00 kg	1	-	-	1	-	-	1	-	-
>4.01 kg	1.07	0.74	1.53	0.79	0.59	1.05	0.96	0.75	1.23
Gestational age									
Term birth	1	-	-	1	-	-	1	-	-
Preterm	1.10	0.60	2.01	2.25	1.63	3.12	1.42	1.00	2.01
Parental social class									
I and II	1	-	-	1	-	-	1	-	-
III non-manual	2.55	1.42	4.57	1.45	1.01	2.09	1.46	1.09	1.97
III manual	4.38	2.75	6.98	2.63	2.03	3.41	2.18	1.76	2.71
IV	8.28	5.01	13.67	3.36	2.45	4.61	2.93	2.24	3.83
V	16.56	10.00	27.41	6.32	4.57	8.76	4.37	3.26	5.85

Table 5.14: Adjusted[1] odds ratios for membership of reading trajectories (men)

	Very poor V Competent			Weak V Competent			Moderate V Competent		
	OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight									
<2.51 kg	2.80	1.65	4.75	1.58	1.05	2.37	1.89	1.28	2.79
2.51-3.00 kg	1.58	1.13	2.20	1.39	1.09	1.77	1.26	1.01	1.57
3.01-3.50 kg	1.01	0.74	1.38	1.14	0.92	1.40	1.10	0.92	1.33
3.51-4.00 kg	1	-	-	1	-	-	1	-	-
>4.01 kg	1.20	0.82	1.77	0.76	0.56	1.05	0.94	0.73	1.23
Gestational age									
Term birth	1	-	-	1	-	-	1	-	-
Preterm	0.59	0.29	1.19	1.51	1.05	2.17	1.00	0.67	1.48
Parental social class									
I and II	1	-	-	1	-	-	1	-	-
III non-manual	2.37	1.27	4.40	1.36	0.92	2.02	1.26	0.92	1.73
III manual	3.82	2.34	6.25	2.63	1.99	3.47	1.97	1.58	2.47
IV	7.00	4.10	11.93	3.16	2.25	4.45	2.66	2.00	3.52
V	14.22	8.33	24.29	6.00	4.22	8.54	4.03	2.96	5.50

1 Adjusting for birthweight, gestational age and parental social class.

Table 5.15: Unadjusted odds ratios for membership of reading trajectories (women)

	Very poor V Competent			Weak V Competent			Moderately weak V Competent			Moderate V Competent		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight												
<2.51 kg	3.60	2.33	5.55	3.24	2.21	4.77	2.42	1.64	3.58	2.53	1.82	3.51
2.51-3.00 kg	1.66	1.19	2.33	1.57	1.17	2.09	1.67	1.28	2.17	1.20	0.95	1.51
3.01-3.50 kg	1.00	0.71	1.39	1.14	0.87	1.49	1.39	1.09	1.78	1.21	0.99	1.49
3.51-4.00 kg	1	-	-	1	-	-	1	-	-	1	-	-
>4.01 kg	1.05	0.63	1.78	0.84	0.52	1.37	0.96	0.63	1.46	0.99	0.70	1.40
Gestational age												
Term birth	1	-	-	1	-	-	1	-	-	1	-	-
Preterm	2.09	1.24	3.53	1.98	1.25	3.15	1.12	0.66	1.89	1.82	1.24	2.67
Parental social class												
I and II	1	-	-	1	-	-	1	-	-	1	-	-
III non-manual	2.43	1.14	5.18	2.38	1.33	4.29	1.06	0.71	1.58	1.91	1.36	2.68
III manual	5.70	3.14	10.36	5.70	3.58	9.06	2.02	1.54	2.65	2.78	2.13	3.63
IV	11.27	6.00	21.16	8.02	4.83	13.32	3.22	2.34	4.44	3.30	2.40	4.54
V	16.56	8.71	31.50	11.26	6.68	18.97	3.68	2.58	5.26	4.66	3.31	6.57

Table 5.16: Adjusted[1] odds ratios for membership of reading trajectories (women)

	Very poor V Competent			Weak V Competent			Moderately weak V Competent			Moderate V Competent		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight												
<2.51 kg	3.12	1.86	5.24	2.77	1.73	4.41	2.55	1.64	3.97	2.33	1.58	3.43
2.51-3.00 kg	1.46	1.00	2.13	1.59	1.15	2.19	1.55	1.17	2.06	1.21	0.95	1.55
3.01-3.50 kg	1.05	0.73	1.50	1.20	0.88	1.63	1.42	1.10	1.83	1.16	0.93	1.44
3.51-4.00 kg	1	-	-	1	-	-	1	-	-	1	-	-
>4.01 kg	0.95	0.53	1.69	0.87	0.51	1.47	0.81	0.51	1.30	1.01	0.71	1.43
Gestational age												
Term birth	1	-	-	1	-	-	1	-	-	1	-	-
Preterm	1.36	0.75	2.45	1.32	0.79	2.20	0.78	0.43	1.41	1.48	0.97	2.25
Parental social class												
I and II	1	-	-	1	-	-	1	-	-	1	-	-
III non-manual	2.17	1.00	4.73	2.08	1.12	3.87	1.04	0.68	1.59	1.82	1.25	2.63
III manual	4.86	2.65	8.94	4.77	2.96	7.69	1.99	1.50	2.65	2.86	2.15	3.81
IV	10.02	5.26	19.09	7.05	4.16	11.95	3.04	2.15	4.31	3.36	2.38	4.73
V	13.38	6.88	26.08	9.23	5.34	15.94	3.17	2.14	4.69	4.59	3.17	6.65

1 Adjusting for birthweight, gestational age and parental social class.

Mathematics

Unless otherwise stated the "general population" trajectory for mathematics is used as the reference category in the multinomial logistic regression analyses.

Those born with lower birthweights have reduced chance of membership of the more advantaged trajectories of mathematics development, for both boys and girls, after adjusting for gestational age and social class (see tables 5.17-5.20). Women with high birthweights have reduced chance of membership of "moderate decreasing" trajectory (see table 5.19).

For boys, preterm birth predicts reduced chance of membership of the "high performers" trajectory and the "moderate decreasing" trajectory but not the "late developers" trajectory (see table 5.17). This relationship is unaltered by adjustment for social class but does not remain significant after adjusting for birthweight. Preterm birth for girls is associated with reduced chance of membership of the "high performers" trajectory (see table 5.19). This association remains significant after adjusting for parental social class, but does not remain significant after adjusting for birth weight.

The disadvantaged social classes have reduced chance of membership of all the mathematically more able trajectories. The association is strongest with the "high performers" trajectory for both sexes in both analyses adjusting for birthweight and gestational age and unadjusted analyses (see table 5.17-5.20).

Additional analyses were conducted to test if birthweight, preterm birth and parental social class differentiated between the membership of the "moderate decreasing" and the "late developers" trajectories for boys and "the transient lapse" and "moderate decreasing" trajectories for girls. These analyses were unadjusted and neither birthweight nor preterm birth predicted differing odds of membership for these two classes, but those from more disadvantaged social backgrounds were more likely to be members of the "moderate decreasing" trajectory than the "late developer" for boys (see table 5.17) and "transient lapse" trajectory for girls (see tables 5.19).

Table 5.17: Unadjusted odds ratios for membership of mathematics trajectories (men)

	High performers V General population			Late developers V General population			Moderate decreasing V General population			Late developers V Moderate decreasing		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight												
<2.51 kg	0.30	0.20	0.44	0.54	0.30	0.98	0.58	0.36	0.94	0.93	0.42	2.03
2.51-3.00 kg	0.44	0.36	0.55	0.64	0.44	0.91	0.73	0.55	0.96	0.88	0.55	1.39
3.01-3.50 kg	0.72	0.62	0.85	0.99	0.75	1.30	0.94	0.75	1.19	1.04	0.73	1.49
3.51-4.00 kg	1	-	-	1	-	-	1	-	-	1	-	-
>4.01 kg	1.12	0.90	1.39	1.14	0.78	1.68	1.21	0.89	1.65	0.58	0.94	1.52
Gestational age												
Term birth	1	-	-	1	-	-	1	-	-	1	-	-
Preterm	0.37	0.24	0.57	0.73	0.42	1.26	0.57	0.34	0.98	1.26	0.57	2.82
Parental social class												
I and II	1	-	-	1	-	-	1	-	-			
III non-manual	0.34	0.26	0.43	0.46	0.30	0.71	1.09	0.73	1.63	0.42	0.25	0.72
III manual	0.15	0.12	0.18	0.29	0.22	0.39	0.64	0.46	0.89	0.46	0.31	0.69
IV	0.08	0.06	0.11	0.20	0.13	0.30	0.48	0.32	0.71	0.42	0.24	0.72
V	0.03	0.02	0.05	0.08	0.04	0.14	0.35	0.23	0.54	0.22	0.10	0.46

Table 5.18: Adjusted[1] odds ratios for membership of mathematics trajectories (men)

	High performers V General population			Steady moderate V General population			Moderate decreasing V General population		
	OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight									
<2.51 kg	0.38	0.23	0.62	0.63	0.33	1.19	0.68	0.38	1.19
2.51-3.00 kg	0.48	0.38	0.61	0.70	0.49	1.01	0.74	0.55	1.00
3.01-3.50 kg	0.75	0.62	0.89	0.99	0.75	1.32	0.97	0.76	1.23
3.51-4.00 kg	1	-	-	1	-	-	1	-	-
>4.01 kg	1.17	0.91	1.51	1.11	0.74	1.67	1.20	0.86	1.66
Gestational age									
Term birth	1	-	-	1	-	-	1	-	-
Preterm	0.73	0.45	1.20	0.90	0.47	1.74	0.71	0.37	1.35
Parental social class									
I and II	1	-	-	1	-	-	1	-	-
III non-manual	0.36	0.27	0.47	0.49	0.32	0.77	1.15	0.74	1.77
III manual	0.15	0.13	0.19	0.29	0.21	0.40	0.67	0.47	0.96
IV	0.09	0.06	0.12	0.19	0.12	0.30	0.53	0.35	0.81
V	0.04	0.02	0.06	0.08	0.04	0.16	0.41	0.26	0.64

1 Adjusting for birthweight, gestational age and parental social class.

Table 5.19: Unadjusted odds ratios for membership of mathematics trajectories (women)

	High performers V General population			Transient lapse V General population			Moderate decreasing V General population			Transient lapse V Moderate decreasing		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight												
<2.51 kg	0.26	0.17	0.38	0.25	0.10	0.66	0.34	0.23	0.49	0.75	0.26	2.13
2.51-3.00 kg	0.56	0.46	0.70	0.57	0.36	0.89	0.65	0.52	0.81	0.87	0.53	1.43
3.01-3.50 kg	0.75	0.63	0.90	1.01	0.71	1.45	0.73	0.60	0.90	1.39	0.93	2.06
3.51-4.00 kg	1	-	-	1	-	-	1	-	-	1	-	-
>4.01 kg	0.97	0.73	1.29	0.70	0.34	1.43	0.64	0.45	0.92	1.09	0.49	2.42
Gestational age												
Term birth	1	-	-	1	-	-	1	-	-	1	-	-
Preterm	0.55	0.35	0.86	0.55	0.22	1.41	0.76	0.49	1.18	1.26	0.57	2.82
Parental social class												
I and II	1	-	-	1	-	-	1	-	-	1	-	-
III non-manual	0.29	0.22	0.38	0.45	0.28	0.73	0.56	0.39	0.79	0.42	0.25	0.72
III manual	0.10	0.08	0.13	0.18	0.13	0.27	0.39	0.30	0.50	0.46	0.31	0.69
IV	0.05	0.04	0.08	0.10	0.06	0.18	0.26	0.19	0.36	0.42	0.24	0.72
V	0.04	0.03	0.06	0.06	0.02	0.13	0.14	0.10	0.21	0.22	0.10	0.46

Table 5.20: Adjusted[1] odds ratios for membership of mathematics trajectories (women)

	High performers V General population			Transient lapse V General population			Moderate decreasing V General population		
	OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight									
<2.51 kg	0.26	0.16	0.41	0.38	0.16	0.91	0.30	0.19	0.47
2.51-3.00 kg	0.60	0.47	0.75	0.55	0.34	0.88	0.58	0.45	0.74
3.01-3.50 kg	0.76	0.61	0.93	1.04	0.72	1.52	0.69	0.56	0.85
3.51-4.00 kg	1	-	-	1	-	-	1	-	-
>4.01 kg	1.06	0.76	1.47	0.81	0.40	1.65	0.71	0.49	1.03
Gestational age									
Term birth	1	-	-	1	-	-	1	-	-
Preterm	0.87	0.52	1.46	0.90	0.33	2.47	1.13	0.69	1.85
Parental social class									
I and II	1	-	-	1	-	-	1	-	-
III non-manual	0.32	0.24	0.43	0.50	0.30	0.81	0.63	0.43	0.92
III manual	0.11	0.09	0.14	0.18	0.12	0.26	0.41	0.31	0.54
IV	0.06	0.04	0.08	0.12	0.07	0.21	0.28	0.20	0.40
V	0.04	0.03	0.07	0.09	0.04	0.18	0.17	0.11	0.26

1 Adjusting for birthweight, gestational age and parental social class

5.4. Discussion

5.4.1. Reading trajectories

The 5 reading trajectories identified for women and the 4 reading trajectories identified for men emphasize the stability of reading ability across time with none of the trajectories crossing. This emphasis on stability is partly an artefact of the models that were selected. For men, the selection of a 5-class model would have led to 2 trajectories crossing. However, for women even if an 8-class model were used to summarize their reading development none of the trajectories would have crossed.

There are, however, some relative changes. Between the ages of 7 and 11 the "very poor" and the "weak" readers' relative reading ability improves considerably when compared to the other trajectories. It is possible that going to school enables rapid development of unfulfilled potential for children who had received inadequate pre-school tuition. However, this recovery has to be interpreted with caution. The Southgate reading test, which was used to measure reading at age 7, was designed to identify the poorest readers (Southgate, 1962) and the apparently more rapid development between the ages 7 and 11 of the poorest readers may be a consequence of using instruments with different properties between the ages of 7 and 11.

The mean reading ability for boys changes from being lower than girls' reading ability at age 7 to being relatively higher at age 16. However, when the population is broken down into different trajectories, the relative improvement is restricted to competent readers. Previous studies on the NCDS have shown that the relative improvement is restricted to those from non-manual social classes (Essen et al., 1978). Boys from more disadvantaged backgrounds would have expected to be employed in manual jobs, and the perceived benefits of school work are likely to be less, resulting in lower motivation and unfulfilled potential. In contrast, girls had less emphasis placed on careers for their future roles, and therefore girls from all classes may have been less motivated or had less support to improve their reading ability.

However, drawing conclusions about sex differences in development based on these trajectories is somewhat speculative as different models are used for each sex.

5.4.2. Mathematics trajectories

The 4 trajectories of mathematics identified for men and women demonstrate a high degree of stability. However, there are some changes in relative abilities. Firstly, the "high performers" advantage over the "general population" trajectory increases between the ages of 7 and 11, for both sexes. This should be interpreted with caution as the more limited number of items to produce the age 7 score may simply mean that it is less possible to measure variability at this age.

Secondly, for both sexes there are two groups with similar abilities at age 7 whose ability diverges by age 16. The "moderate decreasing" trajectory initially progress well, with their relative ability improving from age 7 to 11, before falling relative to the other trajectories between the ages of 11 and 16. In contrast, the members of the "transient lapse" and "late developers" trajectories struggle somewhat up to the age of 11 before improving between the ages of 11 and 16. Many key developments occur between the ages of 11 and 16 and the effect could be explained by either biological factors, such as the age of puberty, or social factors. One possible social factor, changing school, could act as a turning point which changes the quality of teaching and the motivation of the child to learn. For children in a good school environment up to the age 11, a turning point could act as a set back, whilst for children in poor schools a turning point would provide new chances. A comparison of the proportions of the "moderate decreasing" trajectories for boys and girls would suggest that the forces leading to a decrease in relative mathematical ability are more prevalent for girls than they are for boys, a likely reason is that girls are socially programmed to believe it unfeminine to be good at maths.

5.4.3. Prediction of the trajectories

Social background

Social background is consistently associated with the more disadvantaged trajectories for the development of both reading and mathematics. This is consistent with the results of other studies (Schoon, Parsons & Sacker, 2004; Feinstein & Bynner, 2004; Jefferis et al., 2002; Bradley & Corwyn, 2002). In addition, it should be of little surprise that those from more disadvantaged social backgrounds have reduced chance of membership, relative to the "moderate decreasing" trajectory, of the "transient lapse" and "late developers" trajectories, suggesting that social circumstances play a role in the poorer subsequent development of mathematics.

It has been argued on the basis of heritability studies that the intergenerational transmission of both social class and intelligence is via the same genes (Gottfredson, 2004; Scarr & McCartney, 1983). However, the ability of complex traits to be transmitted genetically has been disputed (Holtzman, 2002; Huisman, Kunst & Mackenbach, 2005). In addition, at population levels IQs have been shown to change by nearly a standard deviation in a decade (Angoff, 1988) and IQ scores have on average increased by 3 points for every decade for recent decades (Flynn, 1987). These changes clearly occur at a rate faster than genetics could explain (Holtzman, 2002) and have coincided with educational and social changes (Angoff, 1988). Thus the socio-economic environment must play a role in cognitive development.

Individuals from more privileged homes have more educational opportunities, and better access to books, role models and informal kin networks (Schoon et al., 2004), and there is evidence that children who were of borderline ability for grammar school selection (I.Q. 110-120) were selected on the basis of social circumstances (Douglas, 1964). In addition, biases in the tests themselves may hinder the performance of children from disadvantaged social backgrounds (Currie & Thomas, 1999). Thus socio-economic circumstances could alter cognitive ability test scores in many ways.

Gestational age

Preterm birth's association with the trajectories does indicate that problems linked to preterm birth do undermine the development of cognitive ability. This association disappears after adjusting for birthweight, suggesting that to some extent birthweight and preterm birth are measuring the same thing.

Birthweight

Decreasing birthweight shows a trend of increasing risk of membership of the more disadvantaged cognitive ability trajectories for both reading and mathematics. Thus this study does not provide any evidence that birthweight is less important for the development of reading than it is for mathematics.

The strongest association is between the lightest babies and the most disadvantaged trajectories. However, even individuals with a birthweight in the 3.01-3.5 kg category relative to those with a birthweight of between 3.51-4.0 kg have reduced chance of membership of the best performing trajectory for mathematics. Differences between the 3.01-3.5 kg and 3.51-4.0 kg categories are unlikely to be solely attributable to preterm birth, suggesting that other mechanisms play a role.

Birthweight is a crude measure of both biological endowment and the prenatal environment and will be the product of many factors not all of which will have an effect on cognitive development. The most important of these, length of gestation, clearly plays a role. However, it is unlikely that preterm birth is the only mechanism. One potential alternative mechanism is that birthweight is a predictor of future body size. However, the effects of birthweight on cognitive growth have been shown to be independent of subsequent postnatal growth (Richards et al., 2002). Another possible mechanism is that birthweight could be a marker for biological factors such as insulin-like growth factors which promote both neurological development and physical growth (Richards et al., 2002). Alternatively, as discussed in chapter 4, birthweight could be a marker for social disadvantage. Finally, birthweight and preterm birth have been associated with maternal rejection and poorer relationships with parents (Keren, Feldman, Eidelman, Sirota & Lester, 2003), which could have a disruptive effect across development.

It should be noted that, with one exception, the heaviest birthweight category was not associated with any of the trajectories, suggesting that either the benefits of increasing birthweight balance out the disadvantages, or that beyond a certain level increasing growth provides no extra benefit to cognitive development. The exception for the heaviest births is a reduced chance of membership of the moderate decreasing mathematics trajectory relative to both the "general population" and the "high performers" (O.R. 0.66 95% CI 0.44-1.00) for girls. Potentially high birthweight girls have a heavier build throughout life, which may cause some form of social stigma and result in these girls placing more emphasis on academic achievement and in particular non-stereotypical disciplines such as mathematics. The extent to which heavy birthweights are associated with developing larger body size throughout childhood will partially be addressed in the next chapter. However, there needs to be some caution as there was no significant difference in the chance of membership of the "moderate decreasing" trajectory relative to the "transient lapse" trajectory.

The trajectories are predicted by parental social class, birthweight and gestational age. These associations are consistent with theory, providing some external validity that the trajectories are measuring a real underlying process.

5.4.4. Strengths and weaknesses

Some of the strengths and weaknesses that applied to the identification of the emotional well-being trajectories apply to the cognitive development trajectories, particularly the balance between the exploratory and hypothesis testing methods used and these will be discussed further in chapter 9. However, there are some differences. A period of 7 to 16 years is a relatively long period to be covered by only 3 indicators for development and it makes identifying the timing of changes in trajectories difficult. However, because the developmental trajectories for cognitive ability appear to be relatively stable, changes in the degree of development are unlikely to be missed, so the infrequency of the indicators for cognitive ability does not pose the same problems as it did for emotional well-being.

The cognitive ability trajectories do fare somewhat worse for missing data than the emotional well-being trajectories. Those excluded from the analyses consistently had poorer scores for both reading and mathematics, indicating a distinct bias and it cannot be assumed that the data is MCAR. Apart from a slight under representation of social class I and II males, the probability of missing data was not associated with the exogenous variables, thus it would be quite difficult to enable MAR assumptions to be attained. As tracing of individuals was carried out through schools (Fogelman, 1983), it is possible that the characteristics of the school that made it difficult to trace individuals also creates a less effective academic environment. If future analyses are to produce unbiased models, school characteristics need to be utilized in any method of estimating missing data.

Possible changes in modelling

Developing the trajectories separately for the sexes has enabled better fitting models to be identified for each sex but does have the drawback that it does make formal comparisons of the sexes harder, particularly because different numbers of classes were selected for each sex. More exploratory analyses modelling the development for both sexes combined would have made comparing the sexes easier, but would not have fitted the data as well, which would potentially have been a problem for the models described in chapters 7 and 8.

Identification of reading trajectories

Deciding on the number of classes that best summarize reading development for women was relatively easy. The aLRT indicated 6 classes. However, the 6-class model had a considerably worse entropy score than the 5-class model, suggesting that the 5-class model was a better fit. A case could be made that trajectories were not sufficiently distinct for a 5-class model. The actual numerical indicators for each trajectory were clearly different. However, the developmental trajectories all had similar gradients with the main distinguishing feature being the initial values.

Deciding on the number of classes of reading trajectory for men was much harder: a good case could be made for any of the models from 2 to 5 classes. The 2-class models for the complete cases and fuller samples were the most comparable. A 3-class model was indicated by the aLRT, while a 5-class model was of interest because it contained trajectories that crossed, and may have enabled more complex hypotheses to be tested. In the end the 4-class model was chosen as a compromise, but a case could be made for all the other models and more research on the selection criteria to decide on the final model would be helpful.

Identification of mathematics trajectories

The entropies played a key role in determining the number of classes used to summarize mathematics, with the entropies for many of the models dropping below a cut-off 0.7, although this cut-off is admittedly somewhat arbitrary. One reason why the entropies would have been poor is that the "moderate decreasing", "transient lapse" and "late developers", although different shaped trajectories, did have relatively similar indicators scores, making it difficult to distinguish statistically between the trajectories. Higher entropy scores may have been obtained if a more exploratory approach to the analyses had been taken. Exogenous variables could have been used to help allocate individuals to the trajectories. However, this would have prevented some of the hypotheses from being tested. Some alternative methods for analysis are discussed in chapter 9.

Improving measurement of cognitive ability

One problem interpreting the results is to distinguish between results that are a true reflection of the development of cognitive ability and those that are an artefact of the data used. The results of this study suggest that the majority of individuals are competent at reading and relatively poor at mathematics, the latter finding being inconsistent with the results of Muthén (2004a) which found that the largest group was those with the highest performance for mathematics. However, at age 7 and 16 for reading (see figure 5.5) the upper limit of the scales did not allow for much variation amongst the best readers, whilst at age 11 for mathematics (see table 5.6) ability to identify variation amongst the poorest readers is limited.

Although latent class clustering is more forgiving of using instruments with different scales than some other modelling techniques, such as growth mixture modelling, there are finite limits to what can be done once data has been collected. Ideally this type of problems needs to be resolved before collecting data. Recent advances, such as the computer assisted data collection used to collect the age 41/42 sweep, could be combined with computerized adaptive testing which enables tests to be automatically scaled appropriately for the individual completing the tests (Cianciolo & Sternberg, 2004). This would allow tests to be conducted that would enable people varying widely in ability to be assessed without them having to complete numerous time-consuming questionnaires, many of which would not be appropriate for a specific individual.

Caution should also be exercised when interpreting the results in relation to more recent cohorts. The nature of teaching has changed since the NCDS study members left school; currently the focus is on continuous assessment and group work which may promote different skills. In addition, the skills identified, reading and mathematics, reflect only relatively narrow bands of cognitive development (Fogelman, 1983). Furthermore, birthweight, gestational age and parental social class reflect only a small proportion of the biological and social factors that could alter cognitive development. There is great scope for these ideas to be developed in the future. Of particular interest are factors that could explain why some individuals' relative mathematical ability improved more than others between the ages of 11 and 16.

Figure 5.5: Distribution of reading variables

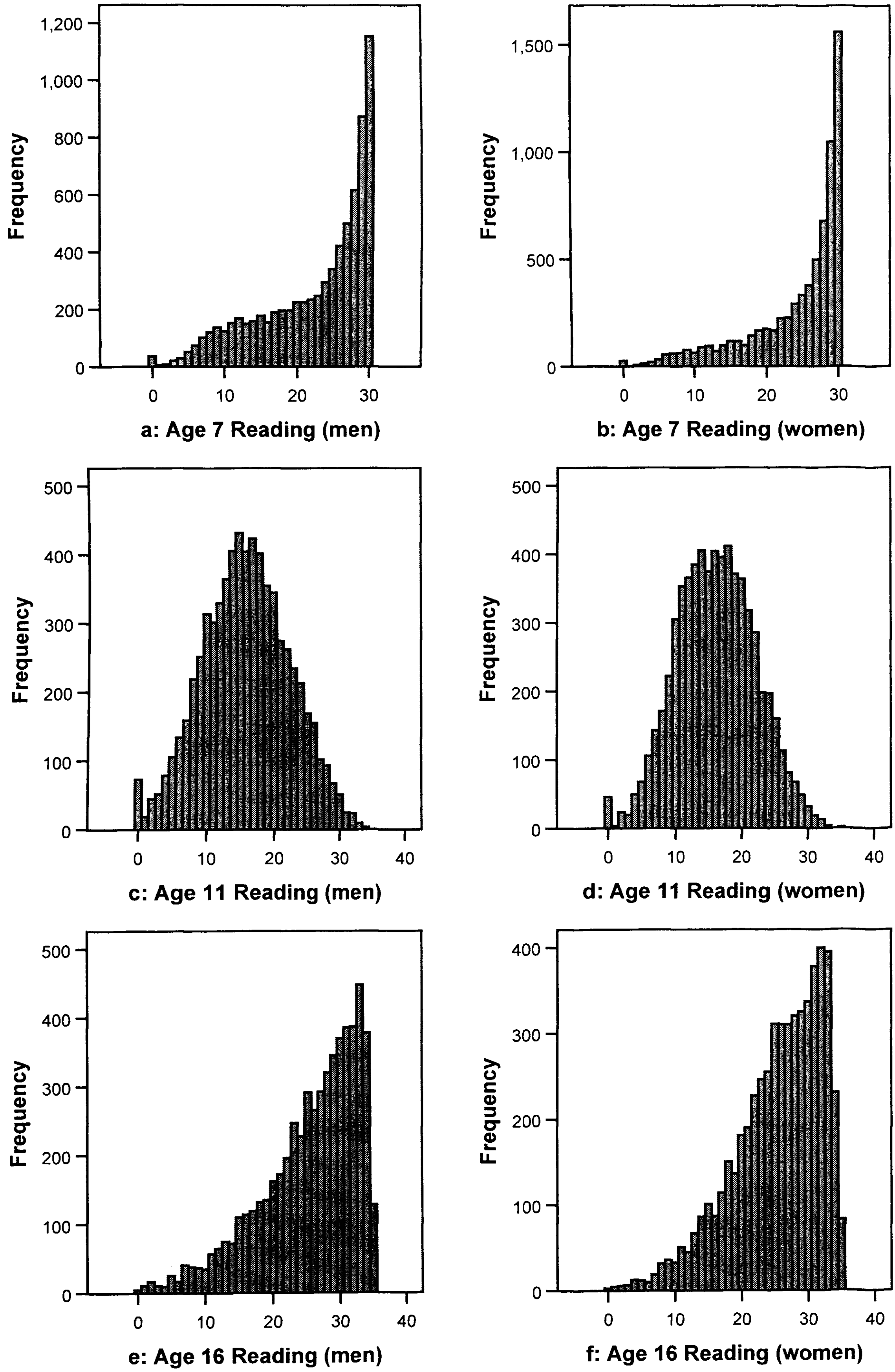
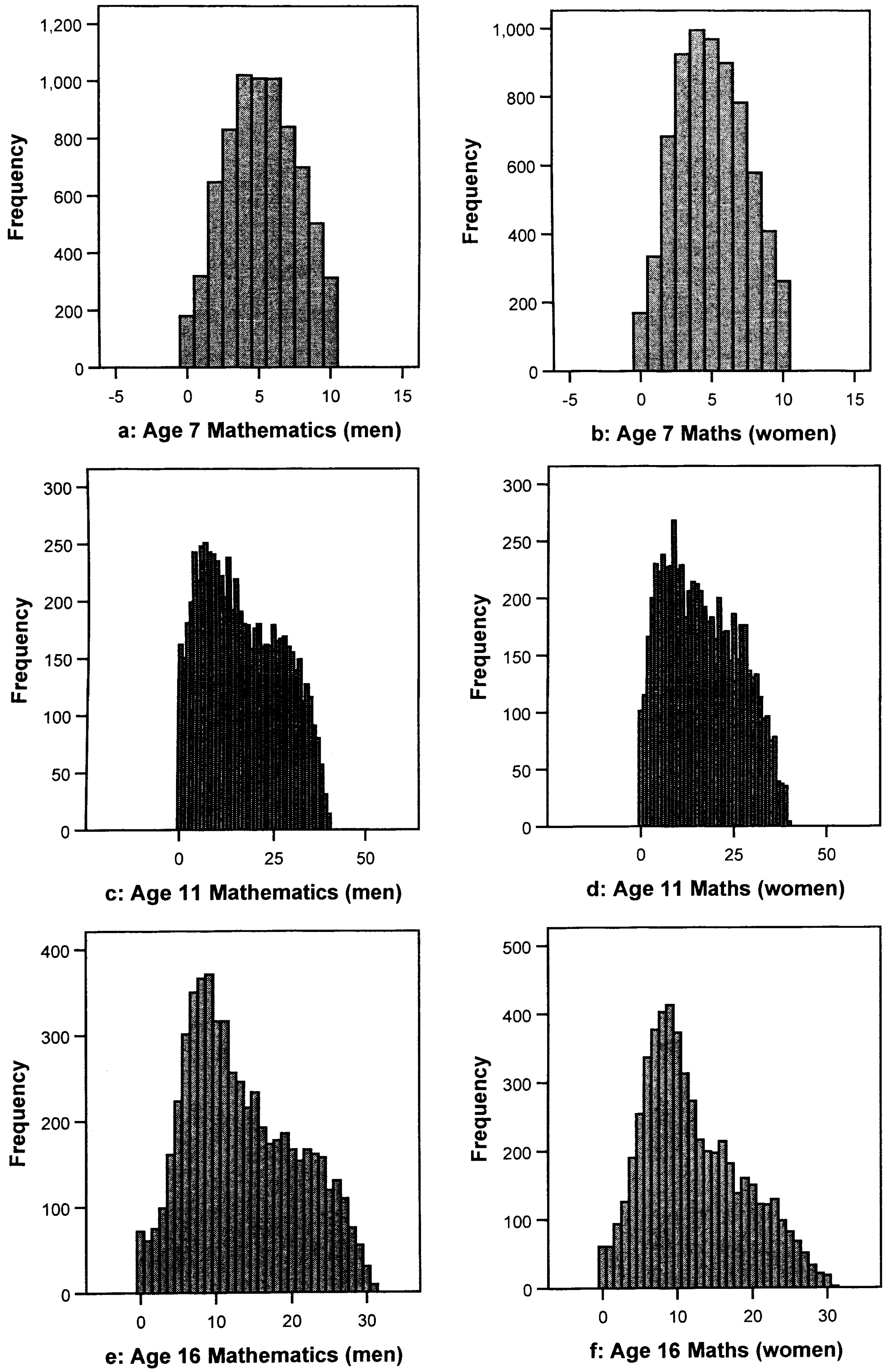


Figure 5.6: Distribution of mathematics variables



5.5. Conclusions

For men a 4-class model for reading was selected. The trajectories were approximately parallel, and termed "very poor", "weak", "moderate" and "competent". For women a 5-class model for reading was selected. The trajectories were approximately parallel and were termed "very poor", "weak", "moderately weak", "moderate" and "competent". A case could be made that between the ages of 7 and age 11 the poorest readers recovered somewhat relative to other readers in the population. However, this could equally well be explained by the properties of the instruments used to measure reading.

For both sexes, models containing 4 trajectories of mathematics were identified. Three of the trajectories were very similar for both sexes. These trajectories were called "high performers", "moderate decreasing" and "general population." The fourth trajectory for men was called the "late developers", whilst the fourth trajectory for women was called "transient lapse."

The results of the trajectories would suggest that overall cognitive ability is stable across time, although for mathematics there were identifiable groups of individuals whose relative ability declined. Membership of all trajectories was predicted by low birthweight and social class in the expected direction, and the majority of trajectories were predicted by gestational age. The associations with heavy birthweights were extremely limited, but did suggest that girls born heavy were less likely to have a decline in mathematical ability.

Chapter 6: Development of Body Mass

6.1. Introduction

Body mass is operationalized in this thesis using the Body Mass Index, which is a measure of weight independent of height, and it is relatively simple to measure BMI quite accurately (Oken & Gillman, 2003). However, BMI is not without its flaws. BMI does have a small correlation with height (Power & Jefferis, 2002). Weight divided by $Height^3$ is considered a better measure of relative weight during puberty, but BMI is the best measure of relative weight to use at a population level across time (Power et al., 1997b). At a population level BMI can be used as an indicator of the degree of adiposity (Power et al., 1997b; Hall & Cole, 2006) and as BMI increases its accuracy as an indicator for adiposity improves (Freedman, Khan, Serdula, Dietz, Srinivasan & Berensen, 2005). However, for any particular BMI score there is a wide range of percentage body fat (Eriksson et al., 2001), and BMI is both a measure of fat mass and lean body mass (Thorogood et al., 2003; Prentice & Jebb, 2001; Sayer et al., 2004a). This thesis will not be able to differentiate between fat mass and lean body mass but will allow the identification of separate groups with different patterns of BMI development over time.

6.1.1. Development of BMI

It is regularly proposed that BMI tracks across time into adulthood (Wardle et al., 2006; Hardy et al., 2000; Eriksson et al., 2001; Trudeau, Shephard, Bouchard & Laurencelle, 2003). A systematic review of 15 studies by Serdula, Ivery, Coates , Freedman, Williamson and Byers (1993) found that about one third of obese pre-school children and one half of obese school-age children became obese adults. Continuity of weight increases if overweight or obesity is used as the outcome. For example, Eriksson et al. (2001), who defined obesity as being in the top 10% of the BMI distribution, found that those who were obese at the ages of 7, 11 and 15 years had a 55%, 58% and 57% chance respectively of being classified as obese (BMI

>30) at some point in adult life. When overweight or obesity was used as the outcome (BMI >25) those obese at the ages of 7, 11 and 15 had a 93%, 94% and 93% chance respectively of becoming overweight or obese (Eriksson et al., 2001).

This has been used to foster the widespread belief that fatness begins during childhood (Ball, Crawford & Kenardy, 2004). However, a large proportion of those who are classified as obese as children do not go on to be obese as adults (Viner & Cole, 2005). Partly this is because using percentiles erroneously over estimates the numbers of obese children (Cole, Bellizzi, Flegal & Dietz, 2000). In addition, continuity may reflect continuity of body frame, rather than adiposity (Wright, Parker, Lamont & Craft, 2001; Power et al., 1997b). Wright et al. (2001), following a population born in 1947, showed that BMI at age 9 years was significantly correlated with BMI at age 50 but not with percentage body fat.

Another challenge to the concept of BMI tracking is that the majority of obese adults were not obese as children (Power et al., 1997a; Reilly et al., 2003; Serdula et al., 1993). For example, in the NCDS 75% of those obese at 33 years of age were below the 91 percentile at the age of 7 (Power et al., 1997a). Thus lean children have a considerable chance of becoming obese. In reality, the association between childhood and adult BMI should best be described as moderate (Freedman et al., 2005; Lake, Power & Cole, 1997; Wright et al., 2001).

One reason why childhood BMI is likely to have only a moderate association with adult BMI is that at a single point in time two individuals may have the same BMI, but their BMIs may be the result of very different processes, reflected in very different trajectories both in the past and the future.

6.1.2. Trajectories of BMI

Currently no studies of group-based developmental trajectories of BMI have been identified. Mustillo et al. (2003) have modelled trajectories of obesity, but their study treated obesity as a bipolar state so that little can be inferred about a subject's BMI before or after they became obese. Thus, in order to make predictions about which

Figure 6.1: Median BMI

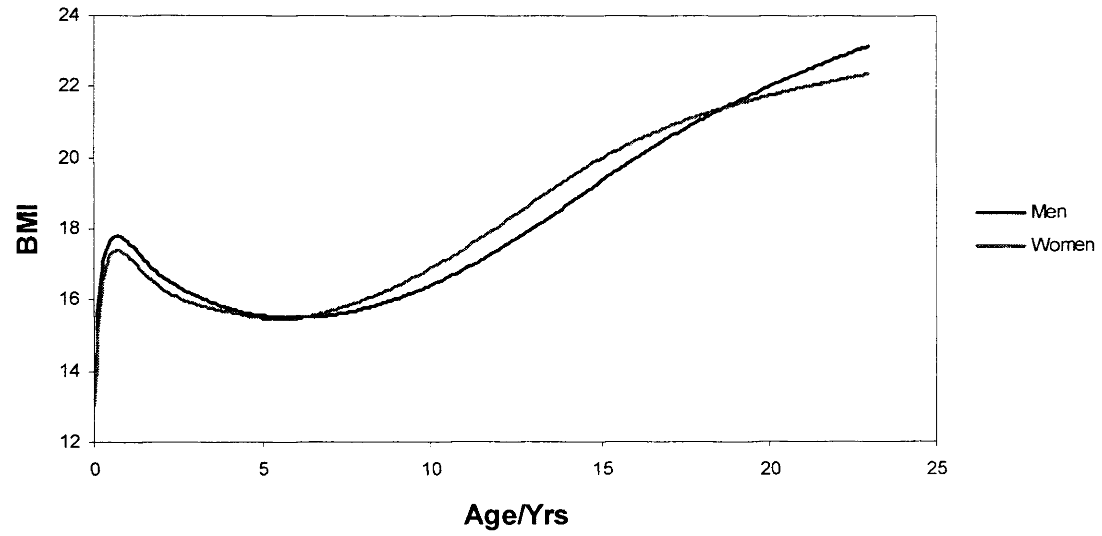


Figure based on data collected by Cole, Freeman and Preece (1995), and provided by the Child Growth Foundation.

trajectories of BMI development might be found, inferences have to be based on studies that either have looked at overall population BMI trends or have used variable-based methods to show how external factors might affect BMI development.

Median BMI changes with age (see figure 6.1). In early infancy there is an initial period of rapid growth of BMI (Cole et al., 2000; Wells, 2003). Then, from the age of 1 year until 6 or 7 BMI decreases (Dietz, 2004; Cole et al., 2000; Wells, 2003) (this period is known as the adiposity rebound.) After the age of 7 BMI increases for both sexes; for girls the increase in BMI is initially more rapid but starts to slow around the age of 16, whilst for boys BMI increases steadily for longer, resulting in higher average BMI for men as adults (Cole et al., 2000). High variability in childhood BMI growth rates has been found, with higher initial BMI at baseline being associated with greater rates of increase in BMI using multi-level models (Rzehak & Heinrich, 2006). There are clearly groups within each sex deviating from the median, as despite the average BMI for women being less than for men higher proportions of women are obese as adults (Hardy et al., 2000). These deviating groups could well have been on different trajectories originating from critical periods in childhood.

Critical periods for the development of obesity have been proposed (Dietz, 2004) and these critical periods may be the times during which people are set on to specific trajectories. Suggested periods include; the pre-natal period (Rogers, 2003; Sandhu, Ben-Shlomo, Cole, Holly & Davey Smith, 2006; Ekelund, Ong, Linné, Neovius, Brage, Dunger et al. 2006), the adiposity rebound and puberty (Eriksson et al., 2001; Dietz, 2004). The NCDS has sufficient data to track BMI from the end of the adiposity rebound, preceding puberty, to early adulthood when pubertal development has been completed.

Early puberty is associated with high BMI in both girls (Anderson, Dallal & Must, 2003; Coall & Chisholm, 2003; Parsons et al., 1999; Lee, Appugliese, Kaciroti, Corwyn, Bradley & Lumeng, 2007) and boys (Sandhu et al., 2006; Parsons et al., 1999; Power et al., 1997a). Early puberty is likely to be reflected in trajectories which have a higher initial BMI and initially faster rates of growth. However once puberty is completed growth in lean tissue is limited (Sandhu et al., 2006). This process may result in trajectories with very different initial BMIs converging by early adulthood. This prediction has to be made cautiously. Earlier puberty has been found to be associated with higher adult BMI with only partial mediation by earlier BMI (Power et al., 1997a; Parsons et al., 1999; Pierce & Leon, 2005). Thus early mass is likely to accumulate through processes that are not halted by puberty.

Although the NCDS lacks data to describe BMI in infancy and early childhood, the pre-natal origins of BMI trajectories can be examined by looking for associations between the developmental trajectories and early life factors such as birthweight and parental social class.

6.1.3. Birthweight and BMI

Higher birthweights are associated with higher BMIs (Dietz, 2004; Rogers, 2003; Baird et al., 2005; Pietiläinen et al., 2002; Parsons et al., 1999). The relationship may not be entirely linear, as there is evidence that the association between birthweight and BMI may be U or J shaped (Rogers, 2003; Oken & Gillman, 2003), implying that both low and high birthweights are associated with an increased risk of high

BMI. Parsons, Power and Manor (2001) using NCDS data found that the shape of the relationship between birthweight and BMI changes over time. Birthweight had a linear relationship with BMI at age 7. However, by age 33 the relationship had become J shaped for women and tended to J shape for men. It is possible that the J shaped association between birthweight and BMI is due to uncontrolled social factors (Rogers, 2003).

Studies that have attempted to look at the pathways through which heavier birthweights have their effect have tended to find that the association between high birthweight and BMI disappears when BMI at an earlier age is included in the analysis (Hardy et al., 2000). This would suggest that higher birthweights are associated with trajectories that are heavier throughout life and remain fixed: conversely, low birthweights may be associated with trajectories that have low BMIs throughout life. Alternatively, the change in the shape of the relationship between BMI and birthweight (from a linear to a J shape) found in variable-based approaches may be reflected in a person-based approach by low birthweight individuals being on trajectories that start with a low BMI which steadily increases, resulting in a high BMI during adult life.

6.1.4. Social background and BMI

Socio-economic circumstances have been associated with BMI across developed nations (Power, Graham, Due, Hallqvist, Joung, Kuh et al. 2005; Ball & Mishra, 2006). There is a great deal of evidence pointing to socio-economic circumstances during childhood predicting adult BMI (Brunner, Shipley, Blane, Davey Smith & Marmot, 1999; Parsons et al., 1999; Langenberg, Hardy, Kuh, Brunner & Wadsworth, 2003), but the prediction of childhood obesity by social class has been inconsistent (Parsons et al., 1999). Disadvantaged social circumstances could predispose to lifestyles that are set throughout life, leading to a gradual accumulation of fat which only reaches obesity during adulthood, hence explaining the lack of consistent relationship between childhood socio-economic circumstances and obesity during childhood. Alternatively, childhood socio-economic circumstances may show no association with childhood BMI and the effects of childhood SES on adult obesity are brought about due to social disadvantage in adult life.

In summary, there have been few if any studies identifying group-based developmental trajectories of BMI. Existing evidence would suggest that there are key periods during which the direction of trajectories is potentially altered. Studies looking at puberty's influence on BMI would suggest that there may be individuals who have a higher fat mass and high BMI earlier who undergo puberty at a younger age, resulting in a decrease in subsequent growth rates for BMI. The results from high birthweight would suggest that there will initially be heavy individuals for whom growth remains steady. Studies investigating the associations that BMI has with childhood social class and birthweight are inconclusive. There may be trajectories of initially thin individuals who have a steadily increasing BMI, or alternatively, the development of high BMI may not occur until adult life.

6.2. Methods

6.2.1. Data

BMI is based on the anthropometric data collected during the medical examinations at the ages of 7, 11 and 16, and self reported weight and height at age 23. Data collected during the perinatal mortality survey at birth are used to indicate birthweight, gestational age and parental social class.

The focus of the analyses is the BMI fuller sample which contains cases that have valid data for at least 2 of the indicators used to identify each of the BMI trajectories. There were 7150 men and 6777 women in the fuller sample. In addition, there is the complete cases sample which consists of cases which have valid data for all the BMI indicators. There were 2996 men and 3020 women in the complete cases sample.

6.2.2. Variables

At the ages of 7, 11 and 16 the heights and weights of the cohort members in their underclothes were recorded by trained medical personnel. The age 23 measure was a self report measure. The anthropometric measures were then used to calculate BMI as follows

BMI = Weight (kg) / Height $(m)^2$ (Sadler et al. 1999).

The BMI raw scores were used to identify the trajectories.

The exogenous variables used in the analyses are birthweight, gestational age and parental social class.

Birthweight in ounces has been converted into kilograms and is in 5 categories: <2.51 kg, 2.51-3.00 kg, 3.01-3.50 kg, 3.51-4.00 kg and >4.01 kg. The 3.51-4.00 kg category is used as the reference.

Gestational age is dichotomized; those babies born before completing 37 weeks of pregnancy are considered preterm births.

Parental social class was based on Registrar General's Social Classification. If the mother was married, the mother's husband's occupation was used to indicate social class. If for whatever reason a husband's social class was not available, the mother's own or the mother's father's social class was used instead. Classes I and II were merged to create a reference category, while the remaining classes; III non-manual, III manual, IV and V, were left as independent categories.

6.2.3. Statistical analyses

Prior to conducting the main statistical analyses, the samples used in the analyses were tested for possible significant biases. The mean scores for BMI at age 7, 11, 16 and 23 for the fuller sample and complete cases samples were compared with those of cases excluded from the respective samples using t-tests. Chi-square tests were also conducted to investigate if there were any significant biases in membership of the fuller samples predicted by social class, birthweight and gestational age.

As the same measure, BMI, was used at each age, several methods could be used to identify trajectories. Preliminary analyses were conducted to summarize the data using latent growth curves and growth mixture models in addition to latent class clustering, and a brief description is provided in the appendix 1. However, it was concluded that latent class clustering provides the best summary of the data and was used for both the exploratory and hypothesis testing stages presented in this chapter.

In the exploratory stage, latent class clustering is used to identify a series of models with k number classes for both the fuller sample and the complete cases sample. The statistical criteria, used to help decide the number of classes that the model for further analysis has are: the AIC, BIC, ssaBIC, entropy Index, and Lo Mendel Rubin Likelihood Ratio Test (aLRT). The pragmatic criteria used to select models are: 1. that each developmental trajectory is reasonably distinct; 2. that the classes contain sufficiently large samples to be of use in future analyses; and 3. that the trajectories identified using the fuller samples have similar shapes to trajectories identified using complete cases.

Having established the best models to summarize the BMI trajectories, the next stage of the analysis is to regress the developmental trajectories identified in these models on to the exogenous variables - birthweight, gestational age and social class - using multinomial logistic regression. Cases that have missing data for an exogenous variable are excluded from the analyses involving that variable.

6.3. Results

The mean BMIs for those included and excluded from both the fuller sample and the complete case sample are presented in table 6.1. When those excluded from the fuller sample were compared to those included, the only significant difference for

Table 6.1: BMI at age 7, 11, 16 and 23: numbers, proportions, means and standard deviations for cases included and excluded from the fuller sample and complete cases (men and women)

Variable	Fuller sample			Excluded from fuller sample			Complete cases			Excluded from complete cases		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
	Men											
Age 7	6194	15.96	1.59	408	16.08	1.73	2996	15.94	1.54	3606	16.00	1.64
Age 11	5907	17.29	2.39	132	17.27	2.68	2996	17.29	2.37	3043	17.29	2.43
Age 16	5184	20.24	2.69	82	20.67	3.28	2996	20.25	2.65	2270	20.24	2.77
Age 23	5591	23.14	2.91	188	22.98	2.59	2996	23.04	2.88	2783	23.24**	2.91
Total	7150			1400			2996			5554		
	Women											
Age 7	5826	15.90	1.86	339	16.14*	2.10	3020	15.85	1.77	3145	15.97**	1.97
Age 11	5646	17.65	2.72	131	17.62	2.52	3020	17.62	2.64	2757	17.67	2.78
Age 16	4886	21.02	2.97	83	20.88	2.89	3020	21.03	2.96	1949	21.00	2.99
Age 23	5624	22.12	3.25	201	22.28	3.55	3020	22.08	3.16	2805	22.18	3.36
Total	6777			1270			3020			5027		

* $p < 0.05$, ** $p < 0.01$

Table 6.2: Numbers and proportions in each category for birthweight, gestational age and social class for those included and excluded from the fuller samples

	Men				Women			
	Fuller sample		Excluded from fuller sample		Fuller sample		Excluded from fuller sample	
	N	%	N	%	N	%	N	%
Birthweight								
<2.51 kg	337	4.9	76	5.7	429	6.5	94	7.6
2.51-3.00 kg	1187	17.2	250	18.6	1542	23.4	292	23.6
3.01-3.5 kg	2340	33.9	441	32.9	2517	38.3	469	38.0
3.51-4.00 kg	2230	32.4	418	31.1	1641	25.0	286	23.2
>4.01 kg	799	11.6	157	11.7	447	6.8	94	7.6
Total	6893	100.0	1342	100.0	6576	100.0	1235	100.0
Missing	257		58		201		35	
Gestational age								
Term birth	6147	86.0	1172	96.1	5839	96.1	1043	94.9
Preterm baby	298	4.2	48	3.9	236	3.9	56	5.1
Total	6445	90.1	1220	100.0	6075	100.0	1099	100.0
Missing	705	9.9	180		702		171	
Parental social class								
I an II	1226	17.3	248	17.9	1175	17.4	220	17.4
III Non-manual	746	10.5	138	9.9	721	10.7	115	9.1
III Manual	3532	49.7	680	49.0	3300	49.0	621	49.2
IV	912	12.8	155	11.2	921	13.7	162	12.8
V	691	9.7	167	12.0	622	9.2	143	11.3
Total	7107	100.0	1388	100.0	6739	100.0	1261	100.0
Missing	43		12		38		9	

either sex was that women who were excluded from the fuller sample had significantly higher BMIs at age 7 ($p<0.05$). When the complete cases sample was compared to those excluded from the complete cases sample, for men the only significant difference was that those excluded from the complete case sample had a slightly higher BMI at age 23 ($p=0.008$), whilst for women, the only significant difference was that those excluded had a slightly higher BMI at age 7 ($p=0.009$).

The distributions of birthweight, gestational age and social class for those in the fuller sample and those excluded from the fuller sample are presented in table 6.2. Those cases that had too many missing data to be included in the fuller samples were little different from those in the fuller sample. However, some results approached significance. Social class approached significance ($p=0.052$) for men and preterm birth approached significance for women ($p=0.068$). Overall, 83.7% of boys who were reported not to have died by age 7 were represented in the fuller sample. There was a slight under-representation of those in social class V, of whom only 80.5% were included in the fuller sample and a slight over-representation of those in social class IV of whom 85.5% were included. Only 80.8% of women born preterm were represented in the fuller sample, compared to 84.7% for the entire population.

6.3.1. Selecting the developmental trajectories

For both sexes the information criteria showed that increasing the number of classes produced better fitting models for BMI (see tables 6.3).

Men

For men the aLRT suggested using a 2-class model (see table 6.3). The Entropies were all good, with a slightly preference for 3- or 4-class models. Sample size and comparability of the samples both supported a 2-class model (see table 6.4). However, more classes would be suggested on the basis of distinctiveness of trajectories, as the 2-class model does not distinguish between men who were consistently slightly overweight and a group of men who initially have normal

Table 6.3: Model fit indices for latent class cluster models summarizing BMI scores

Number of classes	AIC	BIC	ssaBIC	aLRT p value	Entropy
Men					
Two	92151.63	92282.25	92221.87	<0.001	0.933
Three	91499.01	91664.01	91587.74	0.218	0.951
Four	91060.32	91259.69	91167.53	0.115	0.949
Five	90718.71	90952.45	90844.41	0.133	0.944
Six	90445.90	90714.02	90590.09	0.069	0.939
Seven	90236.52	90539.01	90399.19	0.527	0.934
Eight	90057.04	90393.91	90238.20	0.537	0.928
Women					
Two	94017.93	94147.54	94087.16	<0.001	0.937
Three	93038.09	93201.80	93125.53	<0.001	0.925
Four	92513.56	92711.38	92619.22	0.011	0.890
Five	92160.85	92392.78	92284.73	0.338	0.896
Six	91911.89	92177.92	92053.99	0.242	0.891
Seven	91666.65	91966.78	91826.96	0.229	0.890
Eight	91514.44	91848.69	91692.98	0.470	0.885

weights but gradually accumulate extra weight and go on to be obese. Thus, partly supported by the number of classes identified for women, a 4-class model was chosen for men.

Women

For women the aLRT suggested a 4-class model (see table 6.3). The Entropies were all acceptable, although there was a slight preference for a 2-class model. In terms of the pragmatic criteria; sample size would suggest a limit of 4 classes (see table 6.5). The trajectories start to lose their distinctiveness in a 6-class model where there are two "constant increasing" trajectories roughly parallel but differing on initial values at age 7. When the models for the fuller sample were compared with those for the complete cases sample 3- 4- and 5-class models were deemed the most comparable. Overall it was decided that a 4-class model provided the best summary of data.

Table 6.4: Mean BMI scores for each class in models of K classes: complete cases and fuller sample (men)

Number of classes	Complete cases					Fuller sample				
	Age 7	Age 11	Age 16	Age 23	N[1] in class	Age 7	Age 11	Age 16	Age 23	N[1] in class
Two										
Class 1	18.0	23.5	25.1	26.5	183	18.5	23.7	25.5	26.7	430
Class 2	15.8	16.9	19.9	22.8	2813	15.8	16.8	19.9	22.9	6720
Three										
Class 1	17.8	23.1	28.4	29.9	88	21.0	24.4	24.1	25.8	164
Class 2	17.9	23.2	23.2	24.7	126	17.0	23.1	26.4	27.4	281
Class 3	15.8	16.8	19.9	22.7	2782	15.8	16.8	19.9	22.8	6705
Four										
Class 1	17.5	22.2	28.2	29.1	75	17.1	20.8	25.9	32.8	125
Class 2	21.3	24.9	25.7	28.3	50	21.1	24.3	24.3	25.9	156
Class 3	16.5	22.7	23.0	24.1	95	16.8	23.5	25.6	25.6	208
Class 4	15.8	16.8	19.8	22.7	2776	15.8	16.8	19.9	22.7	6661
Five										
Class 1	17.7	22.1	25.3	33.9	34	17.0	20.5	23.9	33.4	79
Class 2	17.6	21.9	28.6	27.9	54	17.7	22.2	29.2	28.4	132
Class 3	21.1	24.3	25.0	26.3	46	21.6	24.5	24.7	25.9	130
Class 4	16.5	22.9	23.2	24.4	93	16.7	23.0	23.3	24.5	190
Class 5	15.8	16.8	19.8	22.7	2769	15.8	16.8	19.8	22.7	6619
Six										
Class 1	19.9	26.2	29.2	36.8	15	19.8	17.2	20.1	22.4	83
Class 2	16.1	18.0	21.3	28.6	92	16.9	20.5	23.9	33.4	81
Class 3	17.6	22.0	28.5	28.0	64	17.5	22.0	29.2	28.4	128
Class 4	21.0	24.0	24.5	25.8	41	21.4	25.0	25.4	26.4	128
Class 5	16.5	22.8	23.1	24.2	89	16.4	22.9	23.3	24.6	175
Class 6	15.8	16.8	19.8	22.5	2695	15.7	16.8	19.8	22.7	6555
Seven										
Class 1	19.9	26.2	29.3	36.9	15	17.2	27.3	35.0	29.8	17
Class 2	19.6	17.2	20.6	22.5	35	19.8	17.3	20.0	22.4	85
Class 3	16.1	18.0	21.3	28.6	92	17.0	20.6	24.0	33.6	75
Class 4	17.6	22.0	28.5	28.0	61	17.2	20.6	27.4	27.7	157
Class 5	20.5	24.0	24.1	25.5	48	21.4	25.1	25.8	26.6	119
Class 6	16.2	22.9	23.3	24.5	80	16.5	22.6	23.0	24.4	197
Class 7	15.7	16.8	19.8	22.5	2665	15.7	16.8	19.8	22.7	6500
Eight										
Class 1	16.4	17.5	25.7	25.3	38	15.7	27.6	35.9	30.4	9
Class 2	20.0	26.3	29.3	37.1	15	19.7	27.3	26.8	45.5	7
Class 3	16.1	18.0	21.3	28.7	86	16.2	18.8	22.6	30.3	135
Class 4	19.7	17.2	20.4	22.5	34	19.8	17.2	20.1	22.4	89
Class 5	17.9	23.6	28.5	27.6	61	17.6	21.4	28.1	28.0	167
Class 6	20.6	23.9	23.8	25.6	41	21.5	25.1	25.4	26.6	113
Class 7	16.1	22.4	22.3	23.9	76	16.4	22.6	23.0	24.4	193
Class 8	15.7	16.8	19.7	22.5	2645	15.7	16.8	19.8	22.6	6437

1 Based on the most likely class of membership

Table 6.5: Mean BMI scores for each class in models of K classes: complete cases and fuller sample (women)

Number of classes	Complete cases					Fuller sample				
	Age 7	Age 11	Age 16	Age 23	N[1] in class	Age 7	Age 11	Age 16	Age 23	N[1] in class
Two										
Class 1	17.6	20.7	25.3	30.8	140	20.8	24.0	25.5	26.2	320
Class 2	15.8	17.5	20.8	21.6	2880	15.6	17.3	20.8	21.9	6457
Three										
Class 1	16.8	19.6	24.5	31.2	103	16.9	20.6	26.0	31.4	247
Class 2	21.2	24.1	25.8	25.6	95	20.8	23.9	24.8	25.0	285
Class 3	15.6	17.3	20.7	21.6	2822	15.6	17.2	20.7	21.6	6245
Four										
Class 1	16.3	21.8	23.3	23.3	205	16.3	22.4	23.8	23.5	332
Class 2	16.8	19.6	24.5	31.2	102	16.9	19.9	25.4	31.5	206
Class 3	21.6	24.7	26.5	26.2	81	21.5	24.4	25.9	26.0	215
Class 4	15.6	16.9	20.5	21.5	2632	15.6	17.0	20.5	21.5	6024
Five										
Class 1	18.2	22.9	29.7	25.4	56	20.8	26.3	34.0	32.6	77
Class 2	16.2	21.7	22.5	23.1	182	16.2	22.3	24.4	23.6	334
Class 3	16.7	19.6	24.5	31.3	94	16.4	19.2	24.1	30.4	230
Class 4	21.7	24.5	25.5	25.7	69	21.0	23.2	23.7	24.4	206
Class 5	15.6	16.9	20.4	21.4	2619	15.6	16.9	20.4	21.4	5930
Six										
Class 1	22.8	28.4	33.1	31.6	21	18.3	22.9	32.4	39.3	31
Class 2	16.5	21.4	27.2	24.4	111	21.7	26.7	31.8	30.6	81
Class 3	16.6	21.9	22.0	23.1	154	16.2	22.3	24.5	23.6	319
Class 4	16.6	19.5	24.4	31.1	99	16.3	19.0	23.6	28.5	349
Class 5	20.9	22.3	23.4	24.1	68	20.7	22.8	22.9	23.4	188
Class 6	15.5	16.8	20.4	21.4	2567	15.5	16.9	20.4	21.3	5809
Seven										
Class 1	16.6	22.0	21.9	22.7	144	18.2	22.7	22.2	22.5	244
Class 2	17.6	20.8	28.5	37.6	18	18.4	22.7	32.4	39.2	30
Class 3	22.5	27.9	32.3	30.8	22	21.7	27.0	31.5	30.7	76
Class 4	16.4	21.4	27.3	24.4	99	15.7	22.1	25.9	24.4	213
Class 5	16.4	19.2	23.3	28.4	148	16.3	18.9	23.6	28.6	333
Class 6	21.0	22.4	23.2	23.8	60	21.5	20.9	23.1	24.0	115
Class 7	15.5	16.8	20.3	21.3	2529	15.5	16.9	20.4	21.3	5766
Eight										
Class 1	16.9	21.1	28.1	24.7	79	16.9	20.7	27.7	24.9	151
Class 2	19.9	18.2	22.1	22.5	31	19.3	22.7	22.2	22.7	221
Class 3	17.6	20.8	28.5	37.6	18	18.4	23.2	32.8	39.4	28
Class 4	22.6	27.8	32.3	30.8	22	21.8	27.5	31.6	31.1	68
Class 5	15.9	21.7	22.6	22.9	144	15.7	22.3	23.6	23.5	215
Class 6	16.4	19.2	23.3	28.4	149	16.2	18.9	23.4	28.8	303
Class 7	20.5	23.4	22.9	23.8	59	22.1	20.9	24.0	25.3	69
Class 8	15.5	16.8	20.3	21.3	2518	15.5	16.8	20.3	21.2	5722

1 Based on the most likely class of membership

Table 6.6: Developmental trajectories for BMI: names, means for each indicator, n and proportions in each class

Class name	Age 7	Age 11	Age 16	Age 23	N in class	% in class
Men						
Constant increasing	17.1	20.8	25.9	32.8	125	1.7
Consistently heavy	21.1	24.3	24.3	25.9	156	2.2
Early developers	16.8	23.5	25.6	25.6	208	2.9
Typical development	15.8	16.8	19.9	22.7	6661	93.2
Women						
Constant increasing	16.9	19.9	25.4	31.5	206	3.0
Consistently heavy	21.5	24.4	25.9	26.0	215	3.2
Early developers	16.3	22.4	23.8	23.5	332	4.9
Typical development	15.6	17.0	20.5	21.5	6024	88.9

Shapes of BMI trajectories

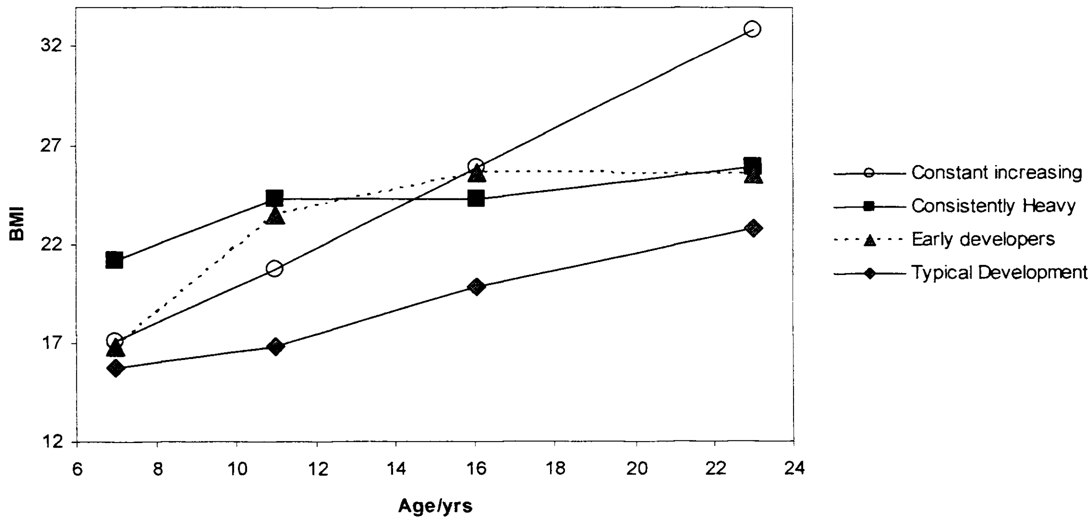
In summary, 4 trajectories were identified for both men and women. The shapes of the trajectories for both genders were relatively similar and the same names have been used to label the trajectories for both genders.

The trajectories for men are described in table 6.6 and figure 6.2. The "constant increasing" trajectory contained 1.7% of men. The mean BMIs for this trajectory rise steadily from 17.1 kg/m^2 at age 7, to 32.8 kg/m^2 at age 23.

The "consistently heavy" trajectory contained 2.2% of men. Mean BMI for this trajectory is initially very high (21.1 kg/m^2) at age 7, rises moderately up to age 11 and then remains relatively flat, having a mean BMI that is only slightly overweight at age 23 (25.9 kg/m^2).

The "early developers" trajectory contained 4.9% of the men. This trajectory had a mean BMI that is only slightly raised at age 7 (16.8 kg/m^2), increases dramatically at

Figure 6.2: BMI trajectories (men)



age 11 and then remains relatively unchanged at a similar level to the "consistently heavy" trajectory.

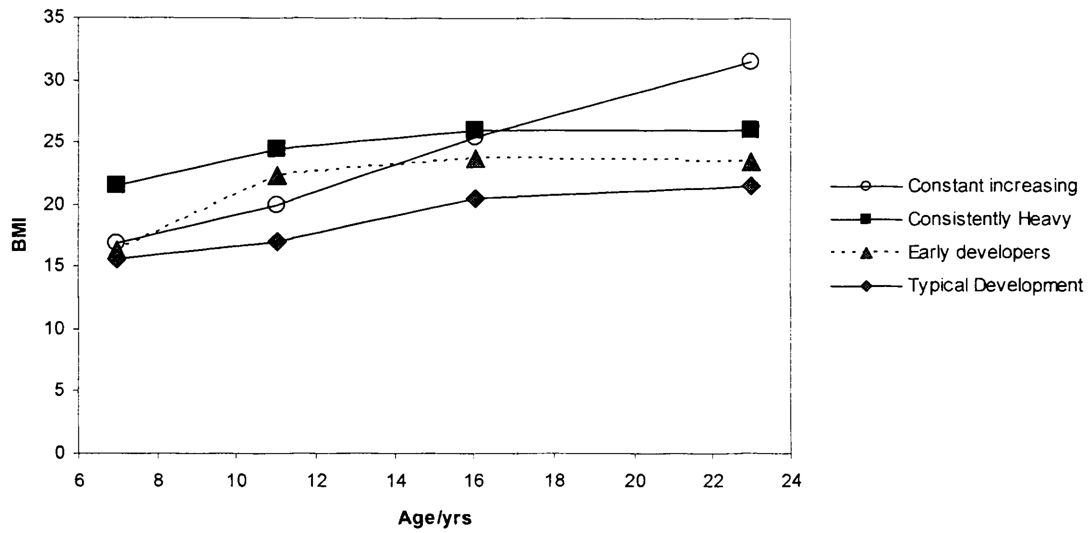
Finally there is a "typical development" trajectory containing 93.2% of men. This trajectory has the lowest initial mean (15.6 kg/m^2). There is a small rise in BMI for this trajectory between the ages 7 and 11, after which there is then a steady linear growth up until age 23.

The trajectories for women are described in table 6.6 and figure 6.3. The "constant increasing" trajectory contains 3% of the population. The mean BMI for this trajectory is initially slightly elevated at age 7 (16.9 kg/m^2). BMI then increases almost linearly up to the age of 23, for which there is a mean BMI (31.5 kg/m^2) above the cut-off for obesity. In the process the "constant increasing" trajectory crosses the paths of the "early developers" and the "consistently heavy" trajectories.

Next was the "consistently heavy" trajectory which contained approximately 3.2% of the women. This trajectory started with a mean BMI of 21.5 kg/m^2 which rises slightly until age 16 and does not change between the ages of 16 and 23.

The "early developers" trajectory contains 4.9% of the women. This trajectory has a mean BMI that is only slightly raised at age 7 (16.3 kg/m^2), rises sharply up to age 11, and then remains relatively unchanged at age 16 and 23.

Figure 6.3: BMI trajectories (women)



Finally there was the "typical development" trajectory which contains 88.9% of the women. This trajectory starts with a low mean BMI (15.6 kg/m^2), which rises steadily up to the age of 16, and has a slight increase between the ages of 16 and 23, resulting in a BMI of 21.5 kg/m^2 at age 23.

6.3.2. Prediction of the trajectories

Birthweight was not associated with increased odds of membership of the constant increasing trajectory for either sex, in both analyses adjusting for social class and gestational age and unadjusted analyses (see tables 6.7 through 6.10). However, birthweight was associated with increased odds for membership of the "consistently heavy" trajectory for both sexes. For men it was only the heaviest group (birthweights greater than 4.01 kg) that had raised odds relative to the reference category; whilst for women all those with birthweights below 3.5 kg had roughly half the chance of being a member of the "consistently heavy" trajectory.

Finally for birthweight, although not significant for men, heavier births had an increased chance of membership of the "early developers" trajectory. For men, post

Table 6.7: Unadjusted odds ratios for membership of BMI trajectories (men)

	Constant increasing V Typical development			Consistently heavy V Typical development			Early developers V Typical development		
	OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight									
<2.51 kg	0.44	0.09	2.15	0.54	0.17	1.69	0.65	0.24	1.75
2.51-3.00 kg	1.14	0.65	2.01	0.75	0.41	1.34	0.64	0.38	1.08
3.01-3.50 kg	0.75	0.44	1.25	0.95	0.60	1.51	0.79	0.53	1.17
3.51-4.00 kg	1	-	-	1	-	-	1	-	-
>4.01 kg	1.32	0.71	2.45	2.14	1.30	3.52	1.52	0.96	2.40
Gestational age									
Term birth	na[1]			1	-	-	1	-	-
Preterm	na[1]			0.69	0.25	1.87	1.36	0.68	2.69
Parental social class									
I and II	1	-	-	1	-	-	1	-	-
III Non-manual	1.04	0.20	5.34	0.79	0.41	1.54	0.54	0.25	1.18
III Manual	5.00	1.74	14.34	0.89	0.56	1.40	1.02	0.66	1.56
IV	7.16	2.37	21.56	1.07	0.60	1.92	0.97	0.54	1.73
V	7.70	2.51	23.59	0.26	0.08	0.81	1.17	0.66	2.09

1. Odds ratios could not be calculated

Table 6.8: Adjusted[1] odds ratios for membership of BMI trajectories (men)

	Constant increasing V Typical development			Consistently heavy V Typical development			Early developers V Typical development		
	OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight									
<2.51 kg	0.47	0.11	1.93	0.56	0.18	1.73	0.59	0.21	1.65
2.51-3.00 kg	1.00	0.57	1.75	0.75	0.42	1.34	0.64	0.38	1.07
3.01-3.50 kg	0.69	0.42	1.15	0.95	0.60	1.50	0.78	0.53	1.16
3.51-4.00 kg	1	-	-	1	-	-	1	-	-
>4.01 kg	1.32	0.72	2.44	2.05	1.24	3.38	1.53	0.97	2.41
Parental social class									
I and II	1	-	-	1	-	-	1	-	-
III Non-manual	1.03	0.21	5.16	0.81	0.41	1.61	0.60	0.28	1.29
III Manual	4.64	1.67	12.92	0.86	0.54	1.38	1.09	0.70	1.70
IV	6.65	2.26	19.59	1.16	0.64	2.09	1.07	0.59	1.93
V	6.64	2.18	20.17	0.32	0.11	0.95	1.04	0.56	1.94

1 Adjusting for birthweight, gestational age and parental social class.

Table 6.9: Unadjusted odds ratios for membership of BMI trajectories (women)

	Constant increasing V Typical development			Consistently heavy V Typical development			Early developers V Typical development		
	OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight									
<2.51 kg	0.91	0.45	1.83	0.44	0.21	0.91	0.41	0.19	0.86
2.51-3.00 kg	1.33	0.87	2.04	0.55	0.36	0.84	0.62	0.42	0.93
3.01-3.50 kg	0.87	0.57	1.32	0.45	0.30	0.67	0.79	0.57	1.09
3.51-4.00 kg	1	-	-	1	-	-	1	-	-
>4.01 kg	1.25	0.66	2.37	1.27	0.76	2.13	1.51	0.95	2.41
Gestational age									
Term birth	1	-	-	1	-	-	1	-	-
Preterm	0.80	0.31	2.09	1.72	0.94	3.16	0.42	0.12	1.46
Parental social class									
I and II	1	-	-	1	-	-	1	-	-
III Non-manual	2.69	1.17	6.19	0.89	0.50	1.58	0.82	0.47	1.44
III Manual	3.93	1.99	7.75	0.90	0.61	1.35	1.16	0.81	1.66
IV	4.58	2.17	9.66	0.94	0.54	1.61	0.84	0.50	1.41
V	5.06	2.36	10.87	0.89	0.49	1.63	0.73	0.40	1.34

Table 6.10: Adjusted[1] odds ratios for membership of BMI trajectories (women)

	Constant increasing V Typical development			Consistently heavy V Typical development			Early developers V Typical development		
	OR	95% CI		OR	95% CI		OR	95% CI	
Birthweight									
<2.51 kg	0.72	0.31	1.67	0.36	0.17	0.77	0.30	0.11	0.88
2.51-3.00 kg	1.33	0.85	2.08	0.46	0.29	0.73	0.64	0.42	0.97
3.01-3.50 kg	0.85	0.54	1.33	0.43	0.28	0.65	0.80	0.57	1.12
3.51-4.00 kg	1	-	-	1	-	-	1	-	-
>4.01 kg	1.00	0.49	2.06	1.08	0.63	1.86	1.34	0.81	2.21
Gestational age									
Term birth	1	-	-	1	-	-	1	-	-
Preterm	0.84	0.31	2.28	2.18	1.11	4.31	0.75	0.21	2.66
Parental social class									
I and II	1	-	-	1	-	-	1	-	-
III Non-manual	2.54	1.00	6.44	0.84	0.45	1.56	0.71	0.38	1.31
III Manual	4.11	1.95	8.67	0.91	0.60	1.38	1.13	0.78	1.64
IV	5.40	2.40	12.16	0.92	0.52	1.64	0.92	0.54	1.57
V	5.73	2.48	13.24	0.91	0.48	1.73	0.81	0.43	1.53

1 Adjusting for birthweight, gestational age and parental social class.

hoc analyses found that if the 2.51-3.00 kg category was used as the reference category the highest birthweights (greater than 4.01 kg) had significantly raised odds (O.R. 2.36 95% CI 1.33-4.21) of membership of the "early developers" trajectory.

For men the prediction of the trajectories by gestational age was somewhat problematic as there were too few preterm births in the "constant increasing" trajectory from which to calculate an odds ratio. Being born preterm was not significantly associated with increased odds of membership for the other trajectories (see tables 6.7 and 6.8).

For women in unadjusted analysis preterm birth approaches significance for membership of the "consistently heavy" trajectory (see table 6.9). This becomes significant when adjusted for birthweight. Those born early were more likely to have a relatively high BMI throughout childhood (see table 6.10).

Social class is strongly associated with odds of the "constant increasing" trajectory for both men and women, but not of the other trajectories in both unadjusted analyses and analyses adjusting for birthweight and gestational age (see tables 6.7- through 6.10).

6.4. Discussion

6.4.1. BMI trajectories

The vast majority of individuals, 93.2% of men and 88.9% of women, were included in the "typical development" trajectory. Thus in childhood very few of the NCDS members were on trajectories that indicated overweight or obesity. In addition, for both sexes only one trajectory, the "constant increasing", had a mean that indicated obesity at age 23. For men this was only achieved after selecting a 4-class model, which was not supported by all the selection criteria. For women, had a 5-class model been selected there would have been more than one class with a mean indicating obesity at age 23, and a few more women would have been allocated to a trajectory class that indicated obesity; but the overall conclusion from this cohort was that obesity was rare up to the age of 23.

The "consistently heavy" and the "early developers" trajectories are likely to be consistent with the concept that higher early BMI triggers earlier puberty and then results in a subsequent reduction in growth of BMI. However, to understand this relationship further the association with puberty needs to be tested.

The results for the "consistently heavy" trajectory also raise questions about inferring that childhood obesity leads to adult obesity. One way of identifying obesity in childhood is to assume that all children develop at the same rate. Using this assumption it is then possible to track back from adulthood to an age appropriate cut-off equivalent to the BMI cut-off of 30 kg/m^2 that is used to indicate obesity in adulthood (Chinn & Rona, 2004; Cole et al., 2000). Taking into account that the NCDS data for each sweep were collected over an extended period the most appropriate cut-offs to use are those for the mid-point of the age at which data was collected. The age 7.5 obesity cut-off for boys is 20.3 kg/m^2 and for girls is 21.2 kg/m^2, and the age 11.5 obesity cut-off for boys is 24.1 and girls is 25.2 (Chinn & Rona, 2004). Thus the only trajectory that indicates obesity at age 7 or 11 is the "consistently heavy", yet the mean for this trajectory no longer indicates obesity at age 23. On this basis, at least in the NCDS, being heavy during early childhood may just indicate a different developmental pattern, determined by a natural set point.

The concept of a set point is not without controversy. However, studies have found that if animals are overfed or underfed, they gain or lose weight, but when returned to ad libitum feeding will, after a week or so, return to their original weight (Sadler et al., 1999; Prentice & Stubbs, 1999). Thus those on the "consistently heavy" trajectory may simply have a high set point; for them the high BMI may not be pathological and does not lead to young adult obesity, and attempts to address their "obesity" may cause more harm than it solves.

Caution has to be made in extrapolating from these trajectories. Undoubtedly there are very small groups of individuals following different patterns but these groups are likely to be too small to be identified in the models. Some trajectories that were not identified, such as consistently low BMIs, may be accounted for in a normal distribution around the "typical development" trajectory, whilst others containing individuals with eating disorders are probably too rare to be identified.

6.4.2. Prediction of the trajectories

Social background

Social class is the only predictor of the "constant increasing" trajectory, suggesting that the primary origins of obesity in early adulthood are related to social disadvantage and that this is the result of gradual accumulation of excess weight across time. However, some caution is needed as it is possible that individuals who had a sharp rise in BMI between the ages of 16 and 23 were allocated to this trajectory.

Mechanisms typically used to explain the association between social disadvantage and high BMI are that those from disadvantaged backgrounds are more likely to eat low cost high energy foods and perform less physical activity (Stamatakis, Primatesta, Chinn, Rona & Falascheti, 2005). This is based on the assumption that obesity develops because of a simple energy imbalance. During early childhood there is little evidence of differences in physical activity by social background (Kelly, Reilly, Fisher, Montgomery, Williamson, McColl et al. 2006), suggesting that it is either changes in physical activity during adolescence or diet that is playing the key role in the development of obesity. However, those from disadvantaged backgrounds are likely to experience more stress, and stress can lead to metabolic changes that increase the likelihood of obesity (Kyrou, Chrousos & Tsigos, 2006). One possible mechanism through which stress could have an effect is that of a growth restriction. When children from disadvantaged social backgrounds have been compared to more advantaged children, the disadvantaged children have been found to have the same weight, however, they have a higher BMI indicating that the problems may lie with changed growth processes (Cecil, Murrie, Wrieden, Wallis, Hetherington, Bolton-Smith et al. 2005) possibly caused by psycho-social stress which has been associated with slower growth (Montgomery, Bartley & Wilkinson, 1997). Whatever the mechanism, the results of this chapter would suggest that the development of obesity as a young adult is closely linked to the social environment in which a child develops.

Gestational age

There are too few preterm men in the "constant increasing" trajectory to calculate an odds ratio. This is likely to be because of the very limited numbers of men in both the preterm and "constant increasing" trajectories rather than a protective effect. Gestational age did not show a significant association with the other BMI trajectories.

For women, the association between gestational age and the "consistently heavy" trajectory approaches significance in unadjusted analysis and becomes significant when adjusting for birthweight. This may be supportable as extremely premature births have been found to have higher rates of BMI growth (Farooqi, Hägglöf, Sedin, Gothefors & Serenius, 2006). Alternatively, there may a survival bias: preterm births that do survive will tend to be those that grew faster and were more fully developed at the time of birth. However, adjusting analyses of gestational age for birthweight should be interpreted carefully. If preterm and full term births are the same weight, the preterm birth will have had to have grown faster to achieve that weight, and thus the preterm birth variable becomes an indicator of faster foetal growth and it is of little surprise if this foetal growth predisposes infants to being heavier as children.

Birthweight

Low birthweight is not associated with increased chance of membership of any of the trajectories. This suggests that if low birthweight is associated with increased odds of obesity for adults, as intimated by some studies (Rogers, 2003; Oken & Gillman, 2003; Parsons et al., 2001; Rogers, 2003), then it is due to factors that do not act until adulthood and it is more likely to be mediated through other factors, possibly arising as a consequence of poorer emotional or cognitive development.

For both sexes, high birthweight, when the "typical development" trajectory is used as the reference trajectory, is associated with increased odds of membership for 2 of the developmental trajectories, with the association being slightly greater for the "consistently heavy" than for "early developers" trajectory. Thus there is some evidence that high birthweight does predispose individuals to being heavier throughout childhood. The question then arises, why is birthweight associated with both of these trajectories?

One explanation is that the "consistently heavy" and "early developer" trajectories are in reality not very different. An alternative is that heavier birthweight does not differentiate between infants who are heavy for their size at birth and infants who are simply of greater stature. The former group would just be generally heavy throughout development, whilst those with a greater stature may be developing faster overall and at age 7 have a normal relative weight, but the faster development may also indicate earlier puberty resulting in a rapid increase in BMI post age 7. However, associating high birthweight with early puberty would be controversial since it is currently assumed that small babies tend to have earlier puberty (Coall & Chisholm, 2003; Labayen, Moren, Blay, Blay, Mesana, Bueno et al. 2006). Testing whether the trajectories are associated with a number of other factors, including puberty and height, may help to clarify these issues.

In general, it would seem that being heavy at birth does predispose to having a higher relative weight throughout childhood. This may be due to increased development of lean tissue and there is evidence that birthweight is associated with increased development of muscle (Phillips, 1995; Gale et al., 2001; Kuh et al., 2002; Sayer et al., 2004b) bone (Sayer et al., 2003); (Sayer et al., 2004a; Labayen et al., 2006) and other organs (Latini et al., 2004; McMillen & Robinson, 2005; Martin et al., 2004). Alternatively, the association between birthweight and high BMI could be due to adiposity with pre-natal nutrition determining the number of fat cells (Oken & Gillman, 2003), and some studies have found that birthweight or foetal growth is associated with increased risk of adiposity (Hediger et al., 1999; Rogers, Ness, Steer, Wells, Emmett, Reilly et al. 2006; Oken & Gillman, 2003; Coall & Chisholm, 2003). However, the majority of studies associating obesity with higher birthweights have used BMI to indicate obesity. Those studies using measures better able to distinguish between fat and lean body mass have tended to show that birthweight is more strongly associated with increased lean body mass than fat mass (Hediger, Overpeck, Kuzmarski, McGlynn, Maurer & Davis, 1998; Kensara, Wootton, Phillips, Patel, Jackson, Marinos et al. 2005; Labayen et al., 2006; Rogers, 2003; Sayer et al., 2004a), resulting in lower levels of relative adiposity (Rogers, 2003).

Studies have shown that the association between birthweight and BMI is reduced when adjusting for parental body mass (Oken & Gillman, 2003; Parsons et al., 2001), suggesting an inter-generational transmission mechanism affects both birthweight and BMI (be it due to fat mass or lean body mass). This mechanism could be partly genetic (Hardy et al., 2000), epigenetic (Canoy & Buchan, 2007) (studies in rats have shown that dietary changes in one generation can have consequences on subsequent generations' metabolisms, transmitted through non-genetic mechanisms; Ismail-Beigi, Catalano & Hanson, 2006), or alternatively, due to family life style (Canoy & Buchan, 2007). The latter would promote parental obesity and determine nutrition during pregnancy and childhood.

6.4.3. Strengths and weaknesses

The use of latent class clustering has enabled empirically determined group-based trajectories to be modelled. The models allow for non-linear relationships, and identify groups of individuals whose distinct developmental trajectories have not been identified before. The data covers the full period of puberty. However, this age range is covered by only 4 indicators and some subtleties of timing may be missed. In particular, it is not possible to distinguish if the growth in BMI in the "constant increasing" trajectory reflects a large spurt at the end of puberty or is actually sustained steady growth that is maintained from the age of 16 to 23. However, as the rate of increase of the trajectory for "constant increasing" is linear at earlier ages, it is possible that this reflects constant growth.

The association between the trajectories and the exogenous variables does provide some external validity for the trajectories identified as it is reasonably consistent with theoretical predictions. However, these predictions were made on the basis of literature which was not entirely consistent about the relationship that childhood BMI has with socio-economic circumstances and low birthweight.

Deciding on the number of classes used to model the data for women was relatively easy. In contrast, for men many of the criteria for selecting models were ignored. Selecting a 2-class model for men would have resulted in groups of individuals on very different trajectories being merged. A 3-class model would have effectively merged the "early developers" with the "constant increasing" trajectories. Theoretically, the "consistently heavy" and "early developers" trajectories are likely to be very different from the "constant increasing" trajectory. Support for using 4 classes for men was provided by parental social class only being associated with the "constant increasing" trajectory whilst higher birthweights were only associated with the "consistently heavy" and the "early developers" trajectories.

Missing data

There was only one significant difference between those included and excluded from the fuller sample. This was for BMI at age 7 for women. Being excluded from the fuller sample due to having insufficient BMI data was only associated with the exogenous variables at a marginal levels of significance, and in the cases of parental social class in a manner not consistent with the operationalization of social class. These associations could have easily occurred by chance. Based on observable data violations of MCAR assumptions are relatively limited and estimated parameters are likely to be reasonably reliable.

Alternative measures of BMI

The BMI measures used in this chapter did not have the problematic distributions that were apparent for some of the indicators of the emotional well-being and cognitive ability trajectories. The main limitation of using BMI as an indicator of development is that it is only a general indicator of relative weight, thus making distinctions between fat and lean body mass impossible. Ideally, future studies would collect data which would provide a way of evaluating differences in the compositions of fat and lean mass. Bio-electrical impedance would be one method appropriate for a study the size of the NCDS (Wells, Williams, Fewtrell, Singhal, Lucas & Cole, 2006). However, this would not entirely resolve the issue. The debate would probably then move on to whether body composition needs to be separated further into separate masses for fat, water, protein and minerals (Wells, 2003).

Generalization to current children

The key limitation with this study is that the rates of obesity have changed in the last 2 decades, suggesting that the environment is very different from what it was in the 50's, 60's and 70's when the NCDS children were growing up. Using UK specific cut-offs, it is apparent that the proportion of obese children aged 5-10 has increased over the last 3 decades. For girls, the proportions who were obese have consistently risen since 1974: 1.3% of girls were obese in 1974, 1.8% in 1984, 4.5% in 1996-97, and 6.6% in 2002-03 (Stamatakis et al., 2005). For boys the proportions of obese have also generally risen over the same period, from 1.8% in 1974, 1.2% in 1984, and 3.4% in 1996-7 to 6.0% in 2002-3 (Stamatakis et al., 2005). As a comparison using the cut-offs produced by Chinn & Rona (2004), in the NCDS 1.8% of boys and 1.9% of girls can be considered obese at age 7 and 2.4% of boys and 1.9% of girls were obese at age 11. (The cut-offs actually used were for age 7.5 and 11.5, as the medical surveys used to collect the data were carried out over an extended period). Thus the NCDS population is not comparable to children growing up today, and potentially for today's children there are trajectories of BMI development that could not be identified using NCDS data.

The general rise in obesity may explain why only moderate associations between childhood and adult BMI have been found in past studies (Freedman et al., 2005; Lake et al., 1997; Wright et al., 2001). Older generations during childhood would have been exposed to an environment that did not promote obesity, but then, as adults, been exposed to conditions that promoted obesity. This changing environment means that more of the variation in BMI development will be explained by the environment than inherent biological characteristics such as genes. One consequence of environmental changes is that there is evidence of increased social inequalities in childhood (Aznar & Moreno, 2007; Law, Power, Graham & Merrick, 2007). However, to attribute the entire rise in childhood "obesity" to environmental and social changes in childhood may be a mistake. During the period in which obesity rates have risen there have also been secular trends of increasing birthweight over a comparable period (Wen, Kramer, Platt, Demissie, Liu & Sauve, 2003). For example, in Scotland the proportions of infants over 4 kg have risen from 6.79% in 1975 to 9.93 % in 1992 (Power, 1994). Thus the increase in childhood relative weights may in part be caused by factors that are developing pre-natally and not the result simply of poor diets and lack of physical activity in children.

6.5. Conclusions

The latent class clustering methodology identified 4 different trajectories to describe the development of BMI for men and women.

The largest trajectory for both sexes; 93.2% of men and 88.9% of women, is a "typical development" trajectory, highlighting how rare a raised relative weight is in this cohort.

In addition, there was a "constant increasing" trajectory containing 1.7% of men and 3.0% of women. This trajectory had a BMI at age 7 close to the population average, but had gradually risen and had a mean indicating obesity at age 23.

The "consistently heavy" trajectory contained 2.2% of men and 3.2% of women. The mean BMI for this trajectory is initially very high at age 7 (representing obesity if the cut-offs produced by Chinn & Rona (2004) are applied), rises moderately at age 11, and then remains relatively flat, having a mean BMI that is only slightly overweight at age 23. This trajectory suggests that early childhood obesity does not necessarily lead to adult obesity.

The final trajectory, the "early developers", had a mean BMI that is only slightly raised at age 7, increases dramatically to age 11, and then remains relatively level until age 23. This trajectory contained 2.9% of men and 4.9% of women.

Both the "early developers" and "consistently heavy" trajectories were associated with higher birthweights and suggest that high birthweight may be an indication of being heavy throughout life. The "constant increasing" trajectory was associated with parental social class, suggesting that the association of social class during childhood with adult obesity is due to the gradual accumulation of mass rather than a tendency to be obese throughout childhood.

These results would suggest that the current childhood obesity epidemic may to some extent be programmed at birth and that the consequences of current childhood obesity may not necessarily be adult obesity. However, as overall levels of childhood obesity are very different now from those when the NCDS cohort were growing up it may not be appropriate to generalize from the NCDS population to today's children.

Chapter 7: Unemployment

7.1. Introduction

This chapter, chapter 7, is the first of two chapters that bring together the concepts developed in chapter 2 with the developmental trajectories identified in chapters 4, 5 and 6. There are 3 themes in this chapter. The first theme is that unemployment has an impact on health. The second theme is that resources protect people from experiencing unemployment. The third theme is that developmental trajectories will aid understanding of how resources develop and protect people from experiencing unemployment.

7.1.1. Unemployment and health

It has been established that unemployment is associated with poorer health (Whitehead et al., 2005; McKee-Ryan et al., 2005; Thomas et al., 2007; Montgomery et al., 1999) and that this is at least in part causal. However, unemployment is one of many activity states into which an individual could be allocated. Other activity states include: employment (both full- and part-time); being in education and out of the labour force for a number of reasons, including illness, caring for a relative and looking after the home. In practice, it is also possible for some activity states to co-occur, such as working full-time and being in education. Thus this chapter includes tests to determine whether a simple measure that indicates whether somebody experienced a period of unemployment is associated with health and thus could be an indicator of challenges to which people will need to respond.

7.1.2. Protection against unemployment

The second theme, which is that resources protect against unemployment, and the third theme, which is that developmental trajectories will help improve understanding of this relationship, are linked. There is evidence that emotional well-being (Caspi et al., 1998; Fronstin et al., 2005; Virtanen et al., 2005a; Feinstein, 2000; Bildt & Michelsen, 2003), cognitive ability (Caspi et al., 1998; Fergusson et al., 2005a) and BMI (Montgomery et al., 1998; Sarlio-Lähteenkorva & Lahelma, 1999) are associated with increased risk of unemployment. However, with few exceptions, these results have been found using measures which have summarized data using variables collected at a single time point and assume that it does not matter how a particular value at that time was achieved.

Group-based developmental trajectories have advantages over methods in that they enable data collected across the life course to be summarized based on relatively few assumptions. However, group based developmental trajectories can have a disadvantage. They may not identify all possible patterns of development that are of substantive interest. Some of the other patterns of development may be better indicated by categories generated from a single time point measures and this thesis aims to compare to the two methodologies.

In order to compare the two methods, analyses assessing the relationship between resources and unemployment will be conducted using both the developmental trajectories and the single time point measures. The results and conclusions of both methods will be compared to ascertain if different conclusions are drawn depending on the methods used. The theoretical and pragmatic reasons used to allocate individuals to categories needs to be stated because the cut-off points selected to summarize the data could influence the observed results. In the next section the expected relationships between unemployment and resources, as indicated by both the developmental trajectories (identified in chapters 4, 5 and 6), and the single time point measures, will be proposed starting with externalizing symptoms.

Externalizing symptoms

Externalizing symptoms have been associated with increased risk of unemployment (Dubow et al., 2006; Kokko & Pulkkinen, 2000; Montgomery et al., 1996; Caspi et al., 1998; Virtanen et al., 2005a; Fergusson et al., 2005b; Fronstin et al., 2005). Thus it would be expected that the categories exhibiting more externalizing symptoms would be more likely to be unemployed.

The single time point measure of externalizing symptoms is derived from the antisocial subscale of the Rutter "B" scale at age 16. The scale has been divided into 3 categories. The first category is "no symptoms". This was chosen as these individuals were potentially the most resilient because they did not express any adverse symptoms, indicating that they may have the ability to respond to stressful events. The remaining participants were divided, with those scoring 1 to 3 symptoms assigned to a "low symptoms" category and those scoring 4 or more symptoms to a "high symptoms". A cut-off of 4 is suggested by Macmillan et al. (1980) as being an indicator of antisocial behaviour.

The trajectories established in chapter 4, for both sexes, were the "high increasers", "late childhood", "decreasers", "moderate increasers" and "consistently low" (see table 4.8). The "high increasers" trajectory is likely to reflect Moffit's life course persistent antisocial behaviour group (Moffit, 1993), which has been found to have raised odds of experiencing unemployment (Moffit et al., 2002) and thus is likely to have the highest odds of unemployment in this thesis. However, it is less clear what the relationship between the other trajectories and unemployment should be.

One mechanism through which externalizing symptoms could be associated with unemployment is that externalizing symptoms indicate the degree to which individuals are able to control their emotions in difficult situations. If this is the main mechanism it may not matter when the ability to control emotions is gained but simply that this developmental milestone is achieved. Assuming this, the odds of unemployment for each trajectory are likely to be ranked in the same order as the mean for the indicator of externalizing symptoms used at age 16. Thus the chances of experiencing unemployment would be, from highest to lowest, "high increasers", "moderate increasers", "late childhood", "decreasers" and "consistently low".

Alternatively if externalizing symptoms are a marker for more general development, for example, schooling during a critical period, the odds of unemployment may be higher for a trajectory reflecting raised symptoms during early childhood. It is possible that brief periods of emotional problems could result in a child being streamed into lower ability school sets or not forming friendships or social connections that are advantageous for future career prospects. The results are likely to be the same for both genders but aggressive women have been found to have higher wages (Feinstein, 2000) and being aggressive may affect other employment characteristics of women.

Internalizing symptoms

The single time point measure of internalizing symptoms is based on the Malaise scale at age 23. The scale has been divided into "no symptoms", "low symptoms" and "high symptoms". The "no symptoms" category was selected as these individuals are likely to be the most resilient to internalizing disorders, whilst the "low symptoms" and "high symptoms" groups were separated using a cut-off of 7 which is used to indicate depression (Rutter et al., 1976; Richman, 1978; Power & Manor, 1992). There is evidence from the literature that raised levels of internalizing symptoms are associated with increased risk of unemployment. (Claussen et al., 1993; Virtanen et al., 2005a; Bildt & Michelsen, 2003) and it would be expected that this is reflected in the single time point measure.

The life course measure of internalizing symptoms, rather than using the developmental trajectories which did not adequately summarize the data, uses a simple measure recording how often individuals had moderately elevated internalizing symptoms. For each of the measures at the ages of 7, 11, 16 and 23, individuals scored 1 point if they had a score of 3 or more for that scale. The total number of points was summed. Individuals were then divided into 4 groups based on their score. The groups were "never", elevated symptoms "once", elevated symptoms "twice" and elevated "3 or 4" times. The cut-off of 3 was chosen as it resulted in 4 groups of reasonably comparable size. Those with more frequently elevated levels of internalizing symptoms are either likely to have an inherent disposition towards internalizing disorders or have more disadvantaged childhood leading to increased problems and those with more frequently raised levels of internalizing symptoms are more likely to experience unemployment.

Reading

The reading comprehension scale at age 16 was used to generate the single time point measure of reading. The single time point measure divided the participants into 3 categories, using pragmatic criteria. The best and worst readers, those in the top and bottom 20% of the population based on reading comprehension scores, were placed into categories representing “good” readers and “poor” readers. A large group of “moderate” readers was selected as employment prospects may be determined by a critical threshold of reading ability, and using a large “moderate” reader group would minimise the chances that the threshold fell within the “poor” or “good” reader categories. Identifying the exact cut-off for any threshold would have to be done using exploratory analysis which would reduce the validity of any hypothesis tests.

Better reading ability has been associated with a reduced chance of unemployment (Caspi et al., 1998). In terms of the single time point measures, this would suggest that the moderate and good readers will be less likely to be unemployed.

For men the developmental trajectories identified in chapter 5 are “competent”, “moderate”, “weak”, and “very poor”; whilst for women the developmental trajectories identified are “competent”, “moderate”, “moderately weak”, “weak” and “very poor” (see table 5.8). None of these trajectories cross so that the “competent” readers would be the least likely to be unemployed and the “very poor” readers the most likely to be unemployed.

Mathematics

The single time point measure for mathematics was distributed into categories using the same principles as used for the reading trajectory, with the mathematics comprehension test being used instead. As the distribution of the data for girls was different to boys different cut points were used for each sex. Those best at mathematics (top 20%) were placed in a “good” category, an intermediate group were placed in a “medium” category and those scoring lowest (bottom 20%) were placed in a "poor" category. Mathematics is an indicator of cognitive ability and so is likely to be an indicator of resources that reduce the chances of unemployment.

The developmental trajectories summarizing mathematical ability across time for men are "general population", "late developer", "moderate decreasing" and "high performers". The developmental trajectories for women are "general population", "moderate decreasing", "transient lapse" and "high performers" (see table 5.12).

For both men and women the "general population" trajectory is likely to have either the poorest cognitive ability or the greatest social disadvantage and so the highest chance of experiencing unemployment. In contrast, the "high performers" consistently have the highest ability and so are likely to have the lowest chance of unemployment.

The intermediate trajectories are slightly more complicated. They are likely to have a risk of unemployment that falls somewhere between the "general population" trajectory and the "high performer" trajectory. However, the intermediate trajectories may be different from each other. Boys who are members of the "moderate decreasing" trajectory have higher mean mathematical ability at age 7 and 11 than boys who are members of the "late developer" trajectory. If mathematics at age 7 or 11 is critical for development, for example if it determines subsequent quality of teaching or is a better indicator of innate ability, then one would expect members of the "moderate decreasing" trajectory to have a lower risk of unemployment. However, at age 16 the mean for the "late developer" trajectory is higher than the moderate decreasing trajectory. If employment prospects are determined by achieved mathematical ability or social forces underlying decline or improvements in mathematical ability are important, then members of the "late developer" trajectory would be expected to have a lower risk of unemployment.

For girls, the members of the "transient lapse" trajectory had better mathematical ability at age 7 and age 11 than members of the "moderate decreasing" trajectory. Thus, unless age 11 is a critical period, members of the "transient lapse" trajectory would be expected to have better employment prospects than members of the "moderate decreasing" trajectory.

Body Mass

To produce the single time point measure of BMI, the age 23 measure of BMI was used to allocate study participants to different categories using standard cut-offs: underweight (BMI < 18.5), normal weight (18.5 ≤ BMI < 25), overweight (BMI 25 ≤ 30) and obese (BMI ≥ 30) (NHBLI, 2000). Those with the highest BMIs are likely to have the highest risk of unemployment because obesity has been associated with increased risk of unemployment for both men and women (Tunceli et al., 2006). The effects of being thin are likely to be different for each sex. Thin men have been shown to be at increased risk of experiencing unemployment (Sarlio-Lähteenkorva & Lahelma, 1999; Montgomery et al., 1998); however, thinness for women has been equated with beauty (Rothblum et al., 1988) so thin women are unlikely to be at increased risk. Overweight individuals may be of higher risk of unemployment although if there are any effects they are likely to be small for men.

The developmental trajectories identified for both men and women are "constant increasing", "consistently heavy", "early developers" and "typical development" (see table 6.6). The "typical development" trajectory is likely to have the lowest odds of unemployment, as it consists mostly of people who have a normal weight. The "constant increasing" trajectory has a mean BMI at age 23 that indicates obesity and is therefore likely to be at high risk of unemployment.

Predictions for the "consistently heavy" and "early developers" trajectories are more speculative. Members of the "consistently heavy" and "early developers" trajectory may be heavier because of increased muscle mass which could indicate increased capacity for physical work and better employment prospects. Alternatively, the larger body size during childhood may have lead to ridicule and possible emotional problems, leading to poorer employment prospects. The benefits of any increased muscle mass are more likely to be experienced by men whilst the social disadvantage of larger body size is more likely to be experienced by women.

7.1.3. Women and employment

Employment has traditionally been considered less important for women than it has for men (Arber, 1997) and it could be considered that it is not representative of challenges that women need to be protected against. However, the NCDS cohort will have been members of the first generation of women to benefit from many important legal changes regarding discrimination in the work place (Joshi, Macran & Dex, 1996). Firstly, the equal pay act of 1970, which prohibited employers from discriminating between women and men, who are doing the same or similar work of equal value (Dex, Ward & Joshi, 2006). Secondly, maternity leave was established in 1973 offering, those who qualified, the right to return to the same job and employer with some maternity pay, and the length and entitlements of maternity leave have subsequently been expanded (Dex et al., 2006). Thirdly, the sex discrimination act of 1975, which prohibited any direct or indirect discrimination, victimisation on the grounds of sex, and has subsequently been extended to prevent the discrimination on grounds of pregnancy and maternity leave (Dex et al., 2006).

This has meant that employment has become much more important for women. The proportion of women economically inactive has fallen from 41% in 1971 to 25% in 2003 (Lindsay & Doyle, 2003) and women in the NCDS returned to work following birth faster than earlier generations. The median time of returning to work following first birth for NCDS women was 29 months compared to 70 months for the 1946 cohort (Dex, Joshi, Macran & McCulloch, 1998), and 84% of women in the NCDS had made at least one entry to a paid job within 10 years of first giving birth (Dex et al., 1998). Overall, women have been increasingly likely to return to work following childbirth and are more likely to return to work between births (Paull, 2006). In total, 44.7% of NCDS women spent less than a year out of the labour force for first childbirth (Dex et al., 2006). This compares 12.6 % for women born between 1922 and 1936.

Women have also been able to develop more successful careers. The number of women in managerial jobs doubled between 1980 and 2001 (Dex et al., 2006) and the percentage of women in professional jobs in 2001 was comparable to men (Dex et al., 2006). During the careers of NCDS women, women have experienced an increase in upward occupational mobility and reduction in downward mobility (Dex et al., 2006). However, women's employment opportunities can still be vulnerable to the economic climate. Women's employment has been shown to decrease at the same times as employment decreases for men (Dex et al., 1998).

Overall, the changes to the labour market that have occurred at the start of NCDS women's careers, mean that unemployment potentially has much greater impact on NCDS women than previous generations.

7.2. Methods

7.2.1. Data

The analyses in this chapter are focused on the 4177 men and 4145 women for whom there were sufficient economic activity data, from the age of 24 until the time subjects were interviewed at age 41/42, so that missing data were unlikely to obscure whether unemployment had been experienced or not. This is approximately half the sample selected for use in this thesis. The sample is initially reduced from 8550 men and 8047 women to 4519 men and 4853 women because of individuals who do not have data for one or both of sweeps 5 and 6. This number is reduced further because of the exclusion of cases who had periods of unallocated economic activity data that exceeded 18 months (325 males and 543 females) and/or were economically active for less than 12 months (40 men and 177 women). However, the total used for any of the analyses is likely to be less, as not all cases that had employment data had complete data for the health outcomes (see table 7.1) or the resources (see table 7.2)

Table 7.1: Sample sizes for analyses testing for associations between unemployment and health

Health outcome	Men	Women
Self rated health	4174	4144
Limiting longstanding illness	4174	4143
Malaise	4134	4128
GHQ	4135	4126
Weight change	3532	3535

Table 7.2: Samples sizes used in analyses testing for associations between unemployment and resources

Resource	Men		Women	
	Trajectory	Single	Trajectory	Single
Externalizing	3853	3138	3849	3209
Internalizing[1]	2348	3622	2420	3678
Reading	3853	3193	3851	3217
Mathematics	3853	3186	3851	3205
BMI	3925	3586	3888	3649

1 The internalizing life course measure was produced using different methodology.

7.2.2. Variables

Unemployment

Subjects were considered to have experienced unemployment if they had experienced a period of 3 months or more in which they defined themselves as being either unemployed and seeking work or in a government training scheme. Analysis of recall bias has shown that periods of unemployment less than three months in this cohort were poorly remembered (Montgomery et al., 1998). Numbers and percent unemployed are presented in table 7.3.

Health outcomes

There are 5 health outcomes used in this chapter. Self rated health, limiting longstanding illness, Malaise and GHQ were derived from data collected during the

Table 7.3: Numbers and proportions for unemployment, self rated health, limiting longstanding illness, Malaise, GHQ and weight change

Categories	Men		Women	
	N	%	N	%
Unemployment status				
Any	1134	27.1	774	18.7
None	3043	72.9	3371	81.3
(Missing)	(4373)		(3902)	
Self rated health				
Excellent or good	4356	82.1	4478	81.8
Fair or poor	951	17.9	994	18.2
Limiting longstanding illness				
No	4502	84.8	4546	83.1
Yes	806	15.2	925	16.9
Malaise				
Without	4509	86.0	4296	78.9
Malaise	733	14.0	1148	21.1
GHQ				
Not a case	4410	84.1	4261	78.4
Case	832	15.9	1177	21.6
Weigh Change				
Moderate gain	2314	53.8	2386	52.6
Lost weight	378	8.8	625	13.8
High gain	1606	37.4	1524	33.6

age 41/42 interview. Weight change was based on data collected during both the age 23 and age 41/42 interviews. Numbers and percentages in the categories for all health outcomes are presented in table 7.3.

Self rated health

Study participants were asked to rate their general health in one of 4 categories: those responding that their health was "excellent" or "good" were placed in one category and those responding "fair" or "poor" in the other.

Limiting longstanding illness

Individuals were considered to have a limiting longstanding illness if they had an illness, disability or infirmity that study participants believed would affect their ability to perform paid work or daily activities.

Malaise

The Malaise inventory is used to indicate depression at age 41/42. A score of 7 or more is indicative of depression (Rutter et al., 1976; Richman, 1978; Power & Manor, 1992) and is used in this thesis to generate a dichotomous variable.

General Health Questionnaire

The 12 item version of the GHQ (Goldberg et al., 1997) was also used to assess mental health. Each item is rated on a four-point scale (less than usual, no more than usual, rather more than usual, or much more than usual - items in table 3.3). Those scoring above 4 using the bimodal scoring style are considered a case.

Weight change

In this thesis weight change is calculated by subtracting BMI at age 23 from BMI at age 41/42. Individuals were then allocated into one of 3 categories: any fall in BMI; a moderate weight gain category with a BMI rise of 0 to 4; and a high weight gain category reflecting a rise in BMI of greater than 4.

Table 7.4: Descriptive statistics for resources as indicated by life course measures and indicators at a single time point (men)

Life course measure			Single time point		
Class name	N	%	Category	N	%
		Externalizing			
High increasers	310	4.3	High symptoms	1159	20.2
Late childhood	404	5.6	Low symptoms	1390	24.3
Decreasers	507	7.0	No symptoms	3177	55.5
Moderate increasers	548	7.5			
Consistently low	5505	75.7			
		Internalizing			
3 or 4	728	19.5	High symptoms	246	4.2
Twice	1037	27.8	Low symptoms	3648	61.9
Once	1147	30.8	No symptoms	1996	33.9
Never	814	21.8			
		Reading			
Very poor	519	7.2	Poor	1289	22.5
Weak	1054	14.6	Moderate	3111	54.2
Moderate	1428	19.7	Good	1341	23.4
Competent	4231	58.5			
		Mathematics			
High performers	1679	23.2	Good	1164	20.4
Late developers	782	10.8	Medium	3211	56.2
Moderate decreasing	1043	14.4	Poor	1342	23.5
General population	3728	51.5			
		BMI			
Constant increasing	125	1.7	Obese	133	2.3
Consistently heavy	156	2.2	Overweight	1042	17.9
Early developers	208	2.9	Medium	4513	77.6
Typical development	6661	93.2	Thin	127	2.2

Resources

The resources, which have already been described in section 7.1.2. are repeated here for reference. For each resource domain two types of indicator are used: an indicator at one time point and a life course measure represented by the trajectories identified in chapters 4, 5, and 6. Numbers in each trajectory or category for the entire population are summarized in table 7.4 for men and 7.5 for women.

Table 7.5: Descriptive statistics for resources as indicated by trajectories and indicators at a single time point (women)

Life course measure			Single time point		
Class name	N	%	Category	N	%
		Externalizing			
High increasers	223	3.2	High symptoms	632	11.4
Late childhood	314	4.6	Low symptoms	1107	20.0
Decreasers	324	4.7	No symptoms	3871	68.6
Moderate increasers	371	5.4			
Consistently low	5660	82.1			
		Internalizing			
3 or 4	810	21.5	High symptoms	643	10.8
Twice	958	25.4	Low symptoms	4206	70.9
Once	1180	31.3	No symptoms	1084	18.3
Never	819	21.7			
		Reading			
Very poor	354	5.2	Poor	1194	21.7
Weak	507	7.4	Moderate	3209	58.2
Moderately weak	710	10.4	Good	1109	20.1
Moderate	1103	16.1			
Competent	4180	61.0			
		Mathematics			
High performers	1352	19.7	Good	1193	21.8
Transient lapse	349	5.1	Medium	3160	57.7
Moderate decreasing	1594	23.3	Poor	1122	20.5
General population	3559	51.9			
		BMI			
Constant increasing	206	3.0	Obese	182	3.1
Consistently heavy	215	3.2	Overweight	674	11.5
Early developers	332	4.9	Normal	4615	78.7
Typical development	6024	88.9	Thin	391	6.7

Emotional well-being

Externalizing symptoms

The 5 trajectories of externalizing symptoms identified in chapter 4 have the same names for both men and women. They are “high increasers”, “late childhood”, “decreasers”, “moderate increasers” and “consistently low”.

To indicate externalizing symptoms at a single time point the Rutter “B” scale at age 16 is used. The scale is divided into 3 categories, those exhibiting, no externalizing symptoms as potentially the most resilient are placed in one category “no symptoms”, those scoring 1 - 3 symptoms in the next category “low symptoms”, whilst those scoring 4 or more (a cut-off suggested by Macmillan et al., 1980 as indicating antisocial behaviour) were considered to be exhibiting “high symptoms.

Internalizing symptoms

The developmental trajectories for internalizing symptoms did not adequately summarize the development of internalizing symptoms across time, so an alternative approach to summarizing internalizing symptoms across the life course was used. For each measure of internalizing symptoms at ages 7, 11, 16 and 23, individuals are considered to score high if they had scored 3 or more on internalizing symptoms. The total number of times subjects were scored as high are then summed and subjects are placed in one of 4 categories, which are in order; “never” scoring high at all, scoring high “once”, scoring high “twice” and scoring high “3 or 4” times.

The single time point measure of internalizing is based on the Malaise inventory (Rutter et al., 1970) recorded at age 23. Those scoring 0 are placed in a “no symptoms” category, 1 through 6 placed in “low symptoms” and 7 or more in “high symptoms”.

Cognitive ability

Reading

The reading developmental trajectories identified in chapter 5 are used to indicate resources as exemplified by the reading trajectories. The 4 trajectories for men are: "very poor", "weak", "moderate" and "competent". For women the 5 trajectories are: "very poor", "weak", "moderately weak", "moderate" and "competent".

The single time point measure of reading used is the age 16 comprehension test (Fogelman & Goldstein, 1976). Categories were generated using cut-off points corresponding to approximately the 20^{th} and 80^{th} percentiles, resulting in 3 categories. For reading, the cut-off points were the same for boys and girls: "poor readers" are considered to score 0 to 20, "moderate readers" 21 to 31 and "good readers" 32 to 35.

Mathematics

The mathematics trajectories identified in chapter 5 are used to indicate the mathematics life course measures. The trajectories identified for men are "high performers", "late developers", "moderate decreasing" and "general population"; whilst the 4 trajectories for women are "high performers", "transient lapse", "moderate decreasing" and "general population".

The Mathematical Comprehension Test at age 16 was used as the indicator of mathematical ability recorded at one time point and the implied resources. Cut-offs were generated that corresponded approximately to the 20^{th} and 80^{th} percentiles, resulting in 3 categories. The distribution of mathematics scores was slightly different for the 2 genders, leading to different categories being used. For boys, those scoring 0 to 7 are in the "poor" category, 8 to 20 in the "medium" category and 21 to 31 in the "good" category. For girls, those scoring 0 to 6 are in the "poor" category, 7 to 17 in the "medium" category and 18 to 31 in the "good" category.

BMI

The developmental trajectories identified in chapter 6 are used to indicate BMI across the life course. For both sexes, the trajectories were given the same names: "constant increasing", "consistently heavy", "early developers" and "typical development".

Body Mass at age 23 is used to generate the single time point measure using standard cut-offs with <18.5 kg/m^2 indicating thin, 18.5-25 kg/m^2 normal , 25-30 kg/m^2 overweight and >30 kg/m^2 obesity (NHBLI, 2000).

7.2.3. Statistical methodology

In this chapter the analyses are in three sections. The first set of analyses assesses any biases caused by attrition. The second tests if unemployment, as operationalized, is associated with health outcomes. The third tests if the indicators of resources are associated with unemployment and thus potentially indicate factors that protect people from unemployment. As the resources and unemployment have potentially different meaning between the genders, the analyses were conducted separately by sex.

Missing data

Two sets of analyses are used to test if missing data has any influence on the results. Firstly, a relatively large proportion of those with missing economic activity data have health data. Approximately 1130 men (26%) and 1320 (34%) women have health data and 766 (17.5%) men and 1000 women (25.6%) have weight change data. Thus it is possible to test to if missing economic activity data and health are associated using logistic regression. Secondly, it is possible to test if the resources are associated with probability of having missing data for economic activity status to see if missing data can be predicted.

Unemployment and health

The association between unemployment and health is tested by using logistic regression for self rated health, limiting longstanding illness, Malaise and GHQ, and multinomial logistic regression for weight change. In addition for men, the association between unemployment, self rated health, Malaise and weight change, was conducted adjusting for the appropriate health measure at age 23. For self rated health the measure used is self rated health recorded at age 23, for Malaise the analyses were adjusted for the single time point measure for internalizing symptoms, and for weight change, the indicator was the single time point measure for BMI.

The GHQ was not available at age 23; however, because the GHQ is a pure state measure responding to how much a subject feels that their present state over the past few weeks differs from their normal state (Bynner et al., 2002), adjusting for GHQ would not have been appropriate. Only 3.4% of the population had a longstanding illness at age 23 and thus it was decided that it was unnecessary to adjust for limiting longstanding illness.

Resources and unemployment

Associations between resources and unemployment were tested for both resources as indicated by developmental trajectories and indicators based on a single time point.

To test the association between the trajectories and unemployment, the trajectory indicators (represented by Y in figure 3.4) are fixed to the means found for each trajectory found in chapters 4, 5 and 6, for externalizing, cognitive ability and BMI. Unemployment status is added as an extra endogenous variable (U in figure 3.4.) Thus the odds of scoring on U for each latent class can be identified and odds ratios calculated. Analyses were conducted using Mplus 3.12 (Muthén & Muthén, 2004).

Table 7.6: Odds of poor health for those coded missing for economic activity data compared to those with adequate economic activity data

Health outcome	Men			Women		
	OR	95% CI		OR	95% CI	
Self rated health	1.86	1.59	2.18	1.88	1.62	2.18
Limiting illness	1.84	1.56	2.17	1.68	1.44	1.96
Malaise	1.56	1.31	1.87	1.69	1.47	1.95
GHQ	1.43	1.20	1.69	1.37	1.18	1.58
Lost weight	1.44	1.10	1.87	1.19	0.96	1.46
High weight gain	1.06	0.89	1.25	1.06	0.90	1.23

The association between each single time point measure of resources and unemployment are tested for using logistic regression for self rated health, limiting longstanding illness, Malaise and GHQ, whilst multinomial logistic regression will be used for weight change.

The results and conclusions obtained using developmental trajectories and single time point measures are compared in order to ascertain if different conclusions are drawn using the different methods.

7.3. Results

7.3.1. Missing data

Those cases, both men and women, which had insufficient economic activity data to be included in analyses had poorer health, with the exception of high weight gain for men and both weight loss and high weight gain for women (see table 7.6).

Those with insufficient economic activity data for analysis were also more likely to be disadvantaged in terms of resources during childhood and early adulthood for all resources measured using both developmental trajectories and single time point measures for both genders with the exception of BMI (see table 7.7 and 7.8). For BMI for men, the only trajectory with significantly raised odds of having missing

Table 7.7: Odds ratios of missing economic activity data by resources (men)

Class name	OR	95CI%		Category	OR	95CI%	
			Externalizing				
High increasers	4.13	3.11	5.49	High sympt.	2.93	2.55	3.37
Late childhood	1.74	1.39	2.19	Low sympt.	1.50	1.32	1.70
Decreasers	1.88	1.53	2.31	No sympt.	1	-	-
Mod. increasers	2.92	2.40	3.55				
Consist. low	1	-	-				
			Internalizing				
3 or 4 times	2.53	2.05	3.12	High sympt.	2.15	1.65	2.81
2 times	1.77	1.46	2.16	Low sympt.	1.31	1.17	1.46
Once	1.23	1.01	1.49	No sympt.	1	-	-
Never	1	-	-				
			Reading				
Very poor	3.10	2.49	3.86	Poor	2.36	2.01	2.76
Weak	1.64	1.41	1.91	Moderate	1.25	1.10	1.43
Moderate	1.40	1.22	1.61	Good	1	-	-
Competent	1	-	-				
			Mathematics				
High perform.	0.43	0.37	0.49	Good	0.35	0.30	0.41
Late developer	0.34	0.27	0.44	Medium	0.49	0.43	0.55
Mod. decreas.	0.62	0.52	0.75	Poor	1	-	-
Gen. pop.	1	-	-				
			BMI				
Const. increas.	1.38	0.92	2.01	Obese	1.23	0.87	1.74
Consist. heavy	1.41	1.00	2.01	Overweight	1.06	0.93	1.22
Early dev.	0.95	0.70	1.31	Normal	1	-	-
Typical dev.	1	-	-	Thin	1.06	0.74	1.52

data was the "consistently heavy" trajectory, whilst for women the only group with raised odds of missing data were those that were thin.

7.3.2. Unemployment's association with health

For men, there is a modest association between unemployment and all the health outcomes; self rated health (OR 1.62 95% CI 1.36-193), limiting longstanding illness (OR 1.72 95% CI 1.43-2.08), Malaise (OR 1.58 95% CI 1.30-1.91), GHQ (OR 1.54

Table 7.8: Odds ratios of missing economic activity data by resources (women)

Class name	OR	95CI%		Category	OR	95CI%	
				Externalizing			
High increasers	3.13	2.30	4.25	High sympt.	2.50	2.11	2,97
Late childhood	1.97	1.53	2.53	Low sympt.	1.74	1.52	1.99
Decreasers	1.71	1.34	2.19	No sympt.	1	-	-
Mod. increasers	2.03	1.63	2.53				
Consist. low	1	-	-				
				Internalizing			
3 or 4 times	1.91	1.56	2.34	High sympt.	1.98	1.63	2.42
2 times	1.40	1.15	1.70	Low sympt.	1.24	1.08	1.43
Once	0.97	0.80	1.18	No sympt.	1	-	-
Never	1	-	-				
				Reading			
Very poor	3.15	2.46	4.03	Poor	2.64	2.23	3.12
Weak	1.95	1.59	2.38	Moderate	1.15	1.00	1.33
Mod. weak	1.89	1.58	2.25	Good	1	-	-
Moderate	1.29	1.10	1.51				
Competent	1	-	-				
				Mathematics			
High perform.	0.43	0.37	0.50	Good	0.39	0.33	0.47
Transient lapse	0.33	0.23	0.46	Medium	0.69	0.60	0.79
Mod. decreas.	0.48	0.41	0.57	Poor	1	-	-
Gen. pop.	1	-	-				
				BMI			
Const. increas.	0.91	0.66	1.25	Obese	0.85	0.62	1.16
Consist. heavy	0.88	0.65	1.19	Overweight	1.03	0.88	1.22
Early dev.	0.72	0.55	0.95	Normal	1	-	-
Typical dev.	1	-	-	Thin	1.32	1.07	1.62

95% CI 1.28-1.85), losing weight (OR 1.50 95% CI 1.15-1.95), but not high weight gain (OR 1.01 95% CI 0.86-1.19). Additional analyses were conducted for men. These analyses tested if associations between unemployment and self rated health, Malaise and weight change were significant after adjusting for the equivalent health measure at age 23. The results of these analyses remained significant: self rated health (OR 1.43 95% CI 1.17-175), Malaise (OR 1.34 95% CI 1.07-1.67) and losing weight (OR 1.47 95% CI 1.12-1.91).

For women, only self rated health was significantly associated with experiencing unemployment (OR 1.24 95% CI 1.01-1.52). Malaise (OR 1.17 95% CI 0.97-1.43) and GHQ (OR 1.19 95% CI 0.99-1.44) had associations with unemployment that approached significance, whilst for limiting longstanding illness (OR 1.10 95% CI 0.89-1.37) weight loss (OR 1.15 95% CI 0.89-1.49) and high weight gain (OR 1.13 95% CI 0.93-1.36) there was no evidence of an association with unemployment.

7.3.3. Protection against unemployment

Emotional well-being

Externalizing symptoms

Externalizing symptoms as summarised by both the developmental trajectories and by a measure indicated at a single time point were associated with experiencing unemployment for men (see table 7.9) but not for women (see table 7.10).

For men, the single time point measure demonstrated that those exhibiting more externalizing symptoms were more likely to experience unemployment. Of the trajectories, relative to the "consistently low" trajectory, the "high increasers" had the highest odds of becoming unemployed (OR 3.15 95% CI 1.97-5.05). The other trajectories had modestly raised odds of unemployment in order from highest to lowest: "moderate increasers" (OR 1.90 95% CI 1.39-2.60), "decreasers" (OR 1.67 95% CI 1.22-2.27) and "late childhood" (OR 1.60 95% CI 1.14-2.25). The two trajectories with the highest odds of unemployment, "high increasers" and "moderate increasers", also had the highest mean scores for externalizing symptoms at age 16 (see table 4.8).

Table 7.9: Association between unemployment and resources (men)

Class name	OR	95CI%		Category	OR	95CI%	
				Externalizing			
High increasers	3.15	1.97	5.05	High sympt.	1.91	1.53	2.39
Late childhood	1.60	1.14	2.25	Low sympt.	1.26	1.04	1.52
Decreasers	1.67	1.22	2.27	No sympt.	1	-	-
Mod. increasers	1.90	1.39	2.60				
Consist. low	1	-	-				
				Internalizing			
3 or 4 times	2.85	2.12	3.84	High sympt.	2.23	1.51	3.31
2 times	2.05	1.56	2.69	Low sympt.	1.30	1.11	1.53
Once	1.44	1.10	1.88	No sympt.	1	-	-
Never	1	-	-				
				Reading			
Very poor	1.99	1.39	2.86	Poor	1.71	1.35	2.17
Weak	1.47	1.16	1.85	Moderate	1.10	0.91	1.33
Moderate	1.20	0.97	1.48	Good	1	-	-
Competent	1	-	-				
				Mathematics			
High perform.	0.58	0.47	0.70	Good	0.57	0.44	0.73
Late developer	0.51	0.37	0.70	Medium	0.73	0.59	0.89
Mod. decreas.	0.74	0.57	0.98	Poor	1	-	-
Gen. pop.	1	-	-				
				BMI			
Const. increas.	2.79	1.59	4.88	Obese	2.40	1.52	3.81
Consist. heavy	1.08	0.61	1.90	Overweight	0.97	0.80	1.19
Early devel.	0.81	0.49	1.32	Normal	1	-	-
Typical dev.	1	-	-	Thin	1.79	1.12	2.87

Internalizing symptoms

Internalizing symptoms were the only indicator of resources for which both the life course and the single time point measures were associated with unemployment for both sexes. The associations were stronger for men (see table 7.9) in comparison to women (see table 7.10). For the single time point measure, for men, the odds ratio of unemployment for those exhibiting high symptoms was 2.23 (95% CI 1.51-3.31) whilst for women the odds ratio was 1.38 (95% CI 1.00-1.91). Whilst for the life

Table 7.10: Association between unemployment and resources (women)

Class name	OR	95CI%		Category	OR	95CI%	
				Externalizing			
High increasers	0.85	0.43	1.67	High sympt.	1.16	0.85	1.59
Late childhood	1.22	0.77	1.93	Low sympt.	1.12	0.89	1.41
Decreasers	0.97	0.62	1.53	No sympt.	1	-	-
Mod. increasers	1.30	0.89	1.89				
Consist.low	1	-	-				
				Internalizing			
3 or 4 times	1.83	1.33	2.50	High sympt.	1.38	1.00	1.91
2 times	1.36	1.00	1.85	Low sympt.	1.11	0.89	1.38
Once	1.32	0.99	1.76	No sympt.	1	-	-
Never	1	-	-				
				Reading			
Very poor	1.30	0.82	2.07	Poor	0.98	0.73	1.30
Weak	0.84	0.57	1.24	Moderate	0.86	0.70	1.07
Mod. weak	0.96	0.70	1.34	Good	1	-	-
Moderate	0.98	0.76	1.26				
Competent	1	-	-				
				Mathematics			
High perform.	1.17	0.93	1.48	Good	1.03	0.77	1.36
Transient lapse	0.84	0.52	1.34	Medium	0.89	0.69	1.13
Mod. decreas.	1.04	0.80	1.36	Poor	1	-	-
Gen. pop.	1	-	-				
				BMI			
Const. increas.	1.33	0.84	2.09	Obese	1.21	0.94	1.56
Consist. heavy	1.00	0.61	1.64	Overweight	1.01	0.71	1.44
Early dev.	0.89	0.57	1.40	Normal	1	-	-
Typical dev.	1	-	-	Thin	0.95	0.59	1.53

course measure for men the odds ratio of unemployment for those exhibiting raised internalizing symptoms 3 or 4 times was 2.85 (95% CI 2.12-3.84) whilst for women the odds ratio was 1.83 (95% CI 1.33-2.50). For the single time measures the strongest association with unemployment was for those who had high levels of internalizing symptoms at age 23. For the life course measure those who had raised internalizing symptoms for 3 or 4 measurement occasions had the highest odds of unemployment.

Cognitive ability

Reading

For men, both the developmental trajectories and the single time point measures of reading were associated with experiencing unemployment (see table 7.9). Whichever way reading was measured, the poorest readers had the highest odds of unemployment (the poor single time point category, O.R. 1.71, 95% CI 1.35-2.17; the "very poor" developmental trajectory, O.R. 1.99, 95% CI 1.39-2.86; the "weak" developmental trajectory O.R. 1.99, 95% CI 1.39-2.86). However, for the "moderate" developmental trajectory (OR 1.20 95% CI 1.16-1.85), or the moderate category as indicated by the single time point measure (OR 1.10 95% CI 0.91-1.33) there was not a significantly increased risk of unemployment in comparison to those in the appropriate reference group. For women, neither the developmental trajectories nor the single time point measure of reading were associated with unemployment risk (see table 7.10).

Mathematics

Mathematics ability as summarised by the developmental trajectories and the single time point measures was associated with unemployment for men (see table 7.9) but not for women (see table 7.10). For men, those better at maths as indicated by both the single time point measure (good O.R. 0.57 95% CI 0.44-0.73; medium O.R. 0.73, 95% CI 0.59-0.89) and the developmental trajectories generally ("high performers" O.R. 0.58 95% CI 0.47-0.70; "late developer" O.R. 0.51 95% CI 0.37-0.70; "moderate decreasing" O.R. 0.74 95% CI 0.57-0.98) had lower odds of experiencing unemployment. However, the "late developer" trajectory had the lowest odds of unemployment. The "high performers" trajectory was not significantly disadvantaged relative to the "late developer" trajectory (OR 1.13 95% CI 0.80-1.59), but the "moderate decreasing" trajectory's association with unemployment relative to the "late developer" trajectory did approach significance (OR 1.46 95% CI 0.97- 2.19).

Body Mass

Body mass was not associated with the chance of experiencing unemployment for women (see table 7.10), but was for men (see table 7.9). For men, relative to those with a normal BMI, both those who were obese (OR 2.40 95% CI 1.52-3.81) and thin (OR 1.79 95% CI 1.12-2.87) had raised odds of experiencing unemployment, but not those who were overweight (OR 0.97 95% CI 0.80-1.19). The only developmental trajectory to have raised odds of unemployment relative to the "typical development" trajectory was the "constant increasing" trajectory (OR 2.79 95% CI 1.59-4.88).

7.4. Discussion

7.4.1. Impact of unemployment on health

For men, unemployment was associated with all health outcomes except high weight gain. Thus unemployment is likely to be an indicator of challenges towards health. In the cases of self rated health, Malaise and weight loss the associations remained significant after adjusting for the appropriate indicators of health at age 23. This provides evidence that that the relationship between unemployment and health was not entirely due to health selection.

For women, the odds ratios for the associations between unemployment and health are all in the expected direction, but the associations are weak. The only significant association was between unemployment and self rated health. The relative lack of associations between unemployment and health for women may be due to how economic activity data has been coded or because unemployment is only a relatively minor challenge for women. The effects of unemployment may be hidden because some groups of women, particularly mothers, may only be able to work outside of the home if they enjoy good health (Fokkema, 2002). It is also possible that there is only a weak association between unemployment and health because the majority of women have access to resources that protect against the stresses caused by unemployment.

7.4.2. The association between resources and unemployment

All the indicators of resources are associated with unemployment for men. However, for women, the only indicator that is significantly associated with unemployment is internalizing symptoms and thus it has to be questioned whether unemployment, as operationalized, has any meaning for women. In the next section, the discussion of any associations between resources and unemployment relates to men unless otherwise stated.

Emotional well-being

Externalizing symptoms

Both the single time point measures and developmental trajectories demonstrated that those who exhibited the highest levels of externalizing symptoms had the highest risk of unemployment. As such, externalizing symptoms are likely to indicate the absence of resources that protect people from experiencing unemployment or indicate that such an individual's behaviour places them at greater risk of unemployment. Development of the ability to control emotions by age 16 is likely to be critical, as the two trajectories that have the highest levels of externalizing symptoms at age 16, "high increasers" and "moderate increasers", have the highest odds of "unemployment." However, the "late childhood" and the "decreasers" trajectories are also associated with increased risk of unemployment. This relationship is likely to be because these trajectories having mean externalizing scores at age 16 which are slightly higher than the "consistently low" trajectory. However, it may also indicate that the problems underlying externalizing symptoms earlier in childhood may continue to exert an influence into adult life.

Internalizing symptoms

Internalizing symptoms are the only potential indicator of resources to show an association with unemployment for both men and women. The association with unemployment was found for internalizing symptoms as indicated by both the life course and the single time point measures. For men, this is likely to be because internalizing symptoms indicate factors that affect employability. However, for women the association between internalizing symptoms and unemployment may be because internalizing symptoms alter which type of non-employment activity women will be allocated to: for example, amongst non-working women, those who have a tendency towards internalizing disorders may be less likely to define themselves as in positive role outside the labour force as opposed to being unemployed.

Comparing the results for the life course measure of internalizing symptoms with the results for the single time point measure of internalizing symptoms raises an important point. The most disadvantaged category of the single time point measure of internalizing symptoms for both men and women only contains a small proportion of men and women (4% of men and 10.8% of women). This "high" symptoms group should represent individuals who were exposed to relatively extreme disadvantage and have relatively high odds of unemployment. In comparison the most disadvantaged category for the life course measure, those exhibiting raised levels of internalizing symptoms "3 or 4" times contains 19.5% of men and 21.5% of women. This "3 or 4" times group contained a relatively large proportion of the sample and would be expected to represent a moderate level of disadvantage and have only a moderately elevated risk of unemployment. Yet the life course measure had a stronger association with unemployment than the measure recorded at a single time point, suggesting that having moderate levels of internalizing symptoms that are consistently elevated across the life course has more impact on the chances of employment than highly elevated levels of symptoms in early adulthood.

One relatively formal way of testing this is to include both the life course measures and single time point measures of internalizing in the same model to predict unemployment. This was done for both men and women and the results are presented

Table 7.11: Association between unemployment and internalizing symptoms, when both the life course and single time point measures are included in the same model

Class name	OR	95CI%		Category	OR	95CI%	
Men							
3 or 4 times	2.67	1.95	3.65	High sympt.	1.53	0.91	2.54
2 times	1.98	1.50	2.61	Low sympt.	1.08	0.88	1.33
Once	1.42	1.08	1.86	No sympt.	1	-	-
Never	1	-	-				
Women							
3 or 4 times	1.83	1.30	2.57	High sympt.	1.00	0.65	1.54
2 times	1.36	0.99	1.87	Low sympt.	1.00	0.75	1.31
Once	1.32	0.98	1.77	No sympt.	1	-	-
Never	1	-	-				

in table 7.11. In this model the life course measure is still significantly associated with unemployment but the single time point measure is not. This suggests that the life course measure which identifies the frequency of moderate levels of internalizing is a better indicator of resources to protect against unemployment than a measure indicating more extreme levels of symptoms at only one age. Although some caution is perhaps needed as for men "high symptoms' did show a moderate although statistically insignificant association with unemployment.

Cognitive ability

Reading

Poorer reading was associated with increased odds of unemployment for men as indicated by the single time point measure and the development trajectory. For the single time point measure only those in the "poor" group were significantly more likely to experience unemployment, whilst for the developmental trajectories only those in the "very poor" and "weak" trajectories were at increased risk of unemployment. This suggests that employment prospects are improved by having a

Table 7.12: Association between unemployment and reading, assessed using 10 groups (men)

Reading Percentile	OR	95% CI	
		Lower	Upper
0 - 10	1.89	1.31	2.72
10 - 20	1.34	0.95	1.89
20 - 30	1.30	0.92	1.83
30 - 40	0.99	0.69	1.42
40 - 50	0.89	0.62	1.27
50 - 60	0.91	0.65	1.27
60 - 70	0.96	0.69	1.32
70 - 80	1.03	0.70	1.51
80 - 90	0.72	0.49	1.05
90 - 100	1	-	-

reading ability above a critical threshold. Greatly exceeding this threshold does not enhance the chances of finding or maintaining employment. Exploratory analyses using the single time point measure were conducted to examine whether a critical threshold could be identified for reading.

The men were divided into 10 approximately equal sized groups based on reading scores at age 16. The best readers were used as the reference category. Those in the bottom 10% on reading were significantly more likely to experience unemployment (see table 7.12). Those from the 10^{th} to 30^{th} percentiles had increased odds of unemployment that was not significant. The remaining groups of men had odds ratios that are little different from one, suggesting that, in terms of job security, having reading ability a little above the 30^{th} percentile provided little extra protection. (There is one anomaly in that those in between the 80^{th} -90^{th} percentiles are relatively protected compared to the best readers; however, this is not significant and may be a chance finding). The benefits of higher reading ability may however play an important role in terms of earnings, a subject that is not examined in this thesis.

Mathematics

The single time point measure would suggest that protection against unemployment improves with improving mathematical ability. The results are similar for the developmental trajectories. However, the lowest rates of unemployment are found amongst members of the "late developers" trajectory. This has two implications. Firstly, as the "late developer" trajectory had odds that approached significance relative to the "moderate decreasing" trajectory it would suggest that achieving high ability in mathematics at age 16 outweighs having high ability at age 7 and 11. Secondly, the "high performers" are not as well protected against unemployment as they would be expected to be. As the difference between the "high performers" and the "late developer" is not significant this may be a chance finding, however, in conjunction with the results for reading, these results suggest that those with the highest academic ability may choose professions with a high risk of unemployment. Mathematical self efficacy has been shown to influence whether students aspire to a career in science and engineering (Mau, 2003), and with the decline of the manufacturing sector in the UK engineers may have been more likely to experience unemployment.

BMI

Members of the "constant increasing" trajectory indicated by the developmental trajectory, and those indicated as obese by the single time point measure, had increased odds of experiencing unemployment. This is consistent with the idea that obese individuals may experience prejudice in the labour market, although other underlying problems cannot be ruled out. Thin men were also at increased risk of unemployment. Further research is needed to determine whether thin men encounter prejudice in terms of employment, suffer from poor health, or come from more disadvantaged backgrounds.

There were no associations between unemployment and the "consistently heavy" trajectory or the "early developers" trajectories. This would suggest that having a high BMI in early childhood, due to either fat or lean mass, does not affect subsequent chances of becoming unemployed and that indicators of BMI closer to adult life were a more relevant indicator for future employment prospects.

Underlying mechanisms for all resources

The indicators of resources are associated with unemployment for men, but the analyses only provide limited glimpses into the processes involved. The association between the resources and the outcomes could be because of the underlying socio-economic circumstances which are associated with the trajectories. In addition, the individual resources are likely to be interlinked. Cognitive ability may indicate fewer externalizing problems as higher levels of academic performance have been associated with desistance from law-breaking behaviour (Lerkkanen et al., 2004; Dubow et al., 2006). Cognitive ability also influences health behaviours such as diet and exercise (Chandola et al., 2006) which in turn will influence BMI. Emotional well-being has been shown to influence academic performance (Lerkkanen et al., 2004) and both high and low BMI's have been associated with internalizing and externalizing behaviour (ter Bogt, van Dorsselaer, Monshouwer, Verdurmen, Engels & Vollebergh, 2006). This is likely to be result of bi-directional processes. Obese children are at increased risk of developing educational (Falkner, Neumark-Szrainer, Story, Jeffery, Beuhring & Resnick, 2001), emotional and social problems (Sadler et al., 1999; Garrow, 1999; Falkner et al., 2001), whilst obesity itself may be a product of comfort eating brought about by emotional problems (Korkeila et al., 1998; Laitinen et al., 2002). Thus all the resources effects are interlinked and the effects of any one may be difficult to separate out.

7.4.3. The pros and cons of using life course measures

In comparison to the single time point measures, there were advantages and disadvantages in using life course measures to test associations between resources and unemployment and these varied for each of the indicators of resources.

The results for externalizing symptoms would suggest that of those ages for which externalizing symptoms data are available, age 16 is most critical indictor of risk of unemployment. However, the results are somewhat equivocal about whether earlier externalizing symptoms episodes continue to exert an influence on future employment prospects. The "late childhood" and "decreaser" trajectories are moderately associated with unemployment. However, this association may be because these trajectories have elevated externalizing symptoms at age 16 rather than the indicated elevated externalizing symptoms at an earlier age. For externalizing symptoms, it would appear that having few emotional problems at age 16, either due to innate control or due to fewer social stressors, is key for predicting future employment prospects, and that a single time point measure at age 16 is adequate for measuring this.

The internalizing symptoms life course measure provides the clearest indication that the life course approach is required to understand future employment prospects. The methodology used to generate the internalizing symptoms life course measure, and the very different conceptual principles underlying the life course and single time point measures, enabled formal testing of whether the life course or single time point measures for internalizing symptoms better predicted chances of unemployment. The conclusion to be drawn from these results is that consistent moderate levels of disadvantage are a better predictor of subsequent unemployment than acute levels of symptoms at a single time point. This also suggests that unlike externalizing symptoms, exhibiting internalizing symptoms across childhood indicates problems which may have a lasting influence across the life course.

The relative stability of reading development, found in chapter 5, meant that the prospective advantages of using developmental trajectories over single time measures in predicting future consequences were always going to be limited. The method used to identify trajectories did not identify the critical threshold of reading ability that was necessary to determine future employment prospects. This threshold may have been identified if a more exploratory approach to the analysis had been conducted. However, such an approach would have limited the ability to test hypotheses relating developmental trajectories to exogenous variables. The pros and cons of using other methods to identify trajectories are discussed in chapter 9. In this thesis the main benefit of using developmental trajectories to summarize reading was that it enabled individuals with missing data at age 16 to be included in analyses, however, there are other alternative solutions to missing data such as multiple imputation (Schafer, 1997). The parallel nature of the developmental trajectories meant that for practical purposes a single time point measure of reading is an adequate summary of a child's ability as there is little change in relative ability across childhood. This would also suggest that a child's reading ability is set in early childhood and there is potentially little scope for subsequent intervention.

The mathematics trajectories provided a limited opportunity to identify which ages were more important for the prediction of future employment prospects. Although it may be of little surprise that ability at age 16 is more important than measures at age 7 and 11, the study did enable this to be formally tested. The fact that mathematics at age 16 is more important than at earlier ages would suggest that a single time point measure at age 16 is a good indicator of employment prospects, and measures of mathematics at earlier ages are slightly misleading. The results also suggest that the development of mathematical ability can be influenced by social factors, and all children need a supportive environment to fulfil their potential, otherwise the benefits of gains shown in early childhood may subsequently be lost.

The BMI trajectories managed to identify one substantive result that would not have been found using a single time point measure. The developmental trajectories suggest that childhood "obesity" that does not progress to adult obesity does not have implications for future employment and that it is only BMI close to the relevant period of labour market activity that is relevant. This is reinforced by the results for the single time point measures. The developmental trajectories failed to identify a group of thin individuals who were disadvantaged in terms of employment prospects, and that developmental trajectories of BMI may be a useful way to describe development, but a single time point measure in early adulthood is a better indicator of future prospects.

Overall, externalizing symptoms, mathematics and BMI trajectories emphasize that the underlying resources for unemployment are best summarized by measures closest to adult life. They also suggest that a single time point measures close to the adult exposure may be adequate to summarize the data, and that a single measure earlier in childhood may be misleading. In contrast, the internalizing life course measure would suggest that a life course approach may be critical to understanding the development of unemployment. The BMI results suggest that the sole use of developmental trajectories is not appropriate as they failed to identify a group of thin men who were at greater risk of unemployment.

7.4.4. Strengths and weaknesses

The critical areas of concern in this study relate to how unemployment is operationalized and the effects of attrition.

Measurement of unemployment

The way in which unemployment is operationalized does not take into account two important dimensions. Firstly, that unemployment is one of many states that an individual could be participating in at any one time. Secondly, the relatively simplistic measure used, does not take into account the effects of unemployment across the life course.

Activity states

The way in which the measure of unemployment is operationalized assumes that those who did not experience unemployment are relatively homogenous. This is unlikely to be true, especially for women who are less likely to describe themselves as unemployed for a number of reasons (McGinnity, 2004). Firstly, women are more likely to be ineligible for unemployment benefit and so may not consider themselves unemployed. Secondly, women job seekers may not label themselves as unemployed due to domestic responsibilities. Thirdly, women may not describe themselves as unemployed as they are only looking for part-time work. Thus women and to a lesser extent men may be allocated to one of many activities that are alternatives to unemployment. These activities include; employment, being in education or caring for a child, the home or a sick relative. The circumstances of these activities may also vary widely.

Those employed, particularly women, may be working part time only for a few hours or be in full time employment working 70 hours a week. Working hours will not be the only variation. Some individuals will be in jobs that are richly rewarding emotionally, intellectually and financially, whilst others will be in jobs that provide very little reward apart from a minimal wage that barely meets the needs for survival. The consequences of losing an ideal job and the poorest jobs are likely to be different. Potentially, those who experience the most adverse effects of unemployment are those in what could be termed moderate quality jobs. This type of job would provide adequate finances and support so that the jobs are beneficial whilst people are working in them but fail to provide sufficient financial rewards or skills to allow people to save for periods of unemployment or find re-employment elsewhere.

Equally, there may be differences amongst those out of the labour force. Some women caring for children, home or relatives may be well supported by a partner. Others however may want to work but simply can not find a job or at least a job that will pay enough to provide for the care needed to look after children in their absence at work.

One method to tackle activity states would be to merge those considered unemployed with those out of the labour force, although it has been demonstrated that these states are not equivalent (Flinn & Heckman, 1983). Another way of addressing the issue of multiple activities would be to select one month and allocate individuals on the basis of their economic activity during that month. However, the numbers allocated to some economic activities at any one time may be very low. For example, in April 1996, one month picked at random, of those who had valid economic activity data 91.2% of men and 43.1% of women were in full time employment; 1.5% of men and 33.3% of women were in part time employment, 0.1% men and 0% of women were in a government training scheme; 4.0% of men and 20.9% of women were out of the labour force, 2.6% of men and 1.2% of women were unemployed and 0.6% of men and 1.5% of women were in full time education. Selecting the most appropriate month would also be difficult. Using the month corresponding to the age 41/42 interview would result in analyses that were cross-sectional making the determination of the direction of causality impossible. More importantly, activity states are not static. People potentially experience a variety of activity states and so will be exposed to different challenges. Furthermore, transitions between different activities both within employment and within non-employment have been shown to be associated with health (Thomas, Benzeval & Stansfeld, 2005). Thus a life course approach to unemployment needs to be taken into account.

Unemployment through the life course

The unemployment measure used has limitations in describing employment status across the life course. First, unemployment as operationalized, refers to periods of unemployment of at least 3 months or more, due to periods of unemployment of less than 3 months being unreliably reported (Montgomery et al., 1998). This has meant that individuals, who have characteristics that may not protect against unemployment but allow finding new employment quickly, will not have been identified. This means mean that the measure of unemployment used is less focused on indicating the challenges and stresses represented by the event of losing a job and more to medium and long term effects of unemployment. There are many sub challenges indicated by unemployment. They will vary depending on an individual's socio-economic circumstance. Examples will include negotiating the benefit or insurance systems, obtaining training, obtaining goods or services with a limited income, identifying sources of social support and finding new employment.

Obtaining new employment is a good illustration of the complex nature of one of the many sub challenges generated by unemployment. It is not just finding work that has an impact on future health, but also the nature and quality of that work which is important. The quality of jobs held by the employed will vary dramatically. At one end of the spectrum there will be high quality jobs with decent pay and conditions with opportunities for advancement and training, at the other end there will be poorly paid, low skilled, possibly part-time work with few opportunities for advancement.

Many of individuals employed at the latter extreme may have skills but simply can not find the opportunities to make use of them, a state which has been termed under-employment (Dooley, 2003). Thus, amongst the employed, there will be those who have highly beneficial and skilful employment and those who have been forced to accept underemployment to minimise their exposure to destitution.

Conversely amongst the unemployed there will be a wide variety of individuals. Low skilled workers, who simply live in an area where there are no jobs, and do not have a realistic option of being able to afford a home in an area where there are jobs, are a one end of the spectrum. Such individuals will have little option but to experience destitution. At the other extreme, will be highly skilled individuals who have sufficient wealth or alternate sources of income which enable these individuals to remain out of the labour force to retrain or wait until an ideal job opportunity presents itself. Particularly disadvantaged are likely to be mothers. Many mothers may want to work but do not, because it is impossible to find jobs that pay enough to cover the costs of childcare and lost benefit payments.

The heterogeneous nature of both employment and unemployment will make interpretation of resilience in the next chapter much harder.

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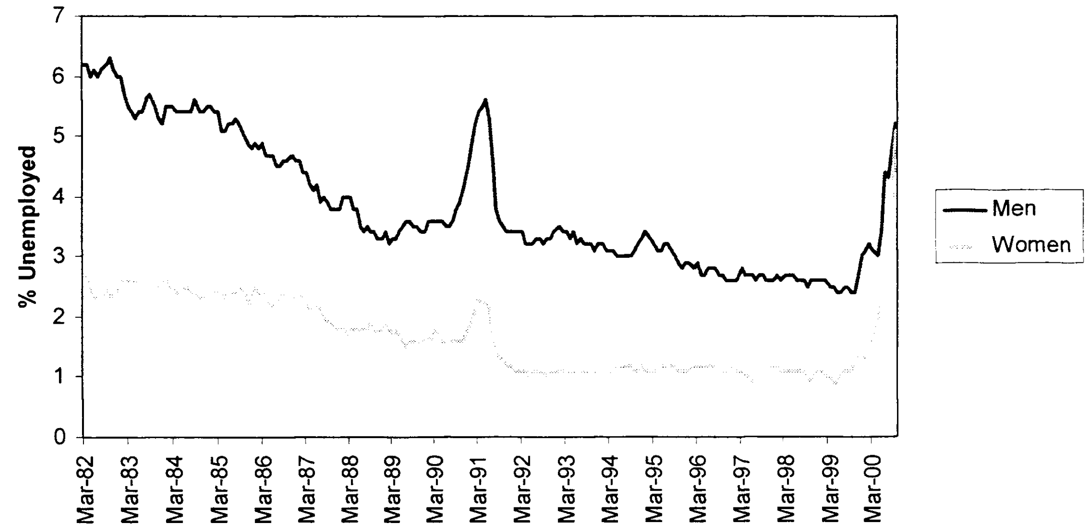
Secondly, the measure of unemployment used does not take into account that people may experience different numbers of unemployment periods. Those experiencing more periods of unemployment potentially have the worse health. However, Gallo, Bradley, Teng and Kasl (2006) have demonstrated that as the number of episodes of employment increases the effects of each additional unemployment episode is diminished.

Thirdly, the simple measure of unemployment used does not take into account the timing of unemployment in peoples' lives, and potentially unemployment could have different effects depending on when it occurs in people's careers. Figure 7.1 shows the percentage of men and women who were unemployed or in a government

Figure 7.1: Percentage unemployed from March 1982 to September 2000



training scheme at any one time from March 1982 to September 2000. The data used to generate figure 7.1 was based on the percentage of all NCDS cases that had economic activity data for any one month rather than just those used in the analyses. Thus the data used to generate figure 7.1 does have higher rates of unemployment and more exaggerated peaks than the sample used for the analyses but these data better illustrate potential biases.

As shown in the figure 7.1 for both genders there is a general decrease in the proportion of those unemployed. Thus if an individual did experience a period of unemployment it is more likely to have occurred in the early and mid 1980's. This is a long time before the health measures were recorded and because of this the challenge represented by unemployment is probably best conceived of as the consequences of coping with a life that includes less secure employment rather than just the challenges of unemployment itself. Disadvantages in social and material circumstances have been shown to persist for at least 6 years after returning to work (Wadsworth, Montgomery & Bartley, 1999). In addition, concerns about the causal direction between unemployment and resources measured at age 23 need to be raised.

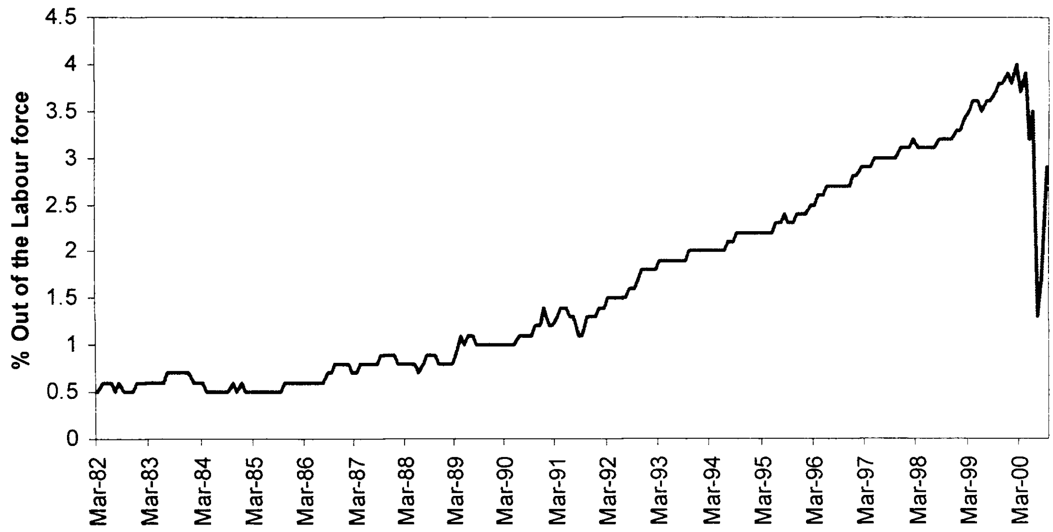
The road leading to unemployment after age 24 may have been set before that age and this road may lead to both unemployment and to poorer health. Without health data collected at very short intervals it is always theoretically possible that poor health preceded unemployment. Thus the causal direction between unemployment and health is difficult to determine. However, NCDS data may provide one resolution to this. For each longstanding illness the age of onset is recorded. For those individuals who experienced unemployment and had a longstanding illness it may be possible to determine whether the illness or the unemployment came first.

Potential biases in unemployment data

Although figure 7.1 suggests a general decline in unemployment, there are two additional peaks. The first peak is in the early 1990's. The second is in 1999/2000. These peaks coincide with the collection of the data for sweeps 5 and 6, and are unlikely to be explained solely by actually experienced unemployment. National unemployment did rise in 1991 but it was not until 1996 that unemployment fell back to its 1990 level (HMSO, 2001). This is not consistent with the short peak in figure 7.1, whilst official figures for national unemployment in 1999-2000 suggest that unemployment was falling (HMSO, 2001) rather than rising as figure 7.1 suggests. Thus it is likely that participants' responses to questions on economic activity in the period immediately prior to the interviews used to collect the data. generate different response patterns to those questions attempting to investigate the participants more distant past.

Recall bias is potentially a serious cause for concern. One possible cause of bias is that some of those seeking employment may have been described as being out of the labour force. Figure 7.2 shows the percentage of men out of the labour force. This increases with a steady linear gradient without a peak corresponding to the recession in 1991. This would suggest that being out of the labour force is a product of health effects due to aging. However, there is a drop in numbers out of the labour force in 1999 coinciding with collection of data for sweep 6 (see figure 7.2). At the same time the numbers unemployed increases dramatically (see figure 7.1), supporting the concept that the participants past circumstances may be described differently from their present circumstances. This is somewhat contradictory to Flinn and Heckman (1983), who suggest that it is inappropriate to treat being out of the labour force and

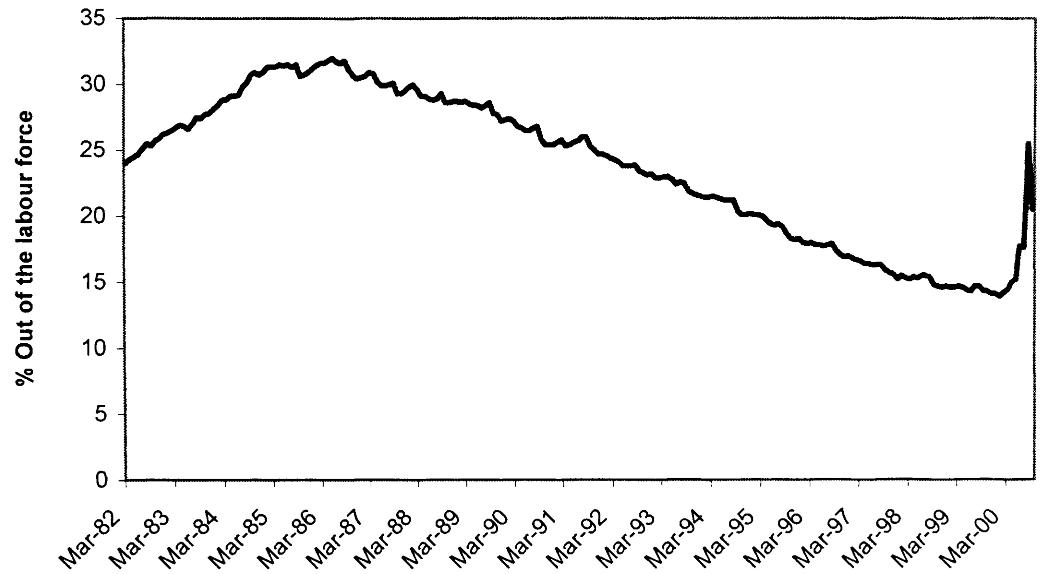
Figure 7.2: Percentage out of the labour force from March 1982 to September 2000 (men)



unemployment as equivalent states. If the unemployment and out of labour force figures are combined the results would suggest that there is a relatively constant "unemployment" rate. In March 1982 just over 6% of men were unemployed and 0.5% out of the labour force, while in March 1999 3 % of men were unemployed and 3.5 % of men out of the labour force. The combined out of the labour force and unemployment rate is comparable to an unemployment rate of 6%, which has been proposed as being the natural unemployment rate in a market economy by Tobin (1972).

For women, the pattern of being out of the labour force is different, and is likely to be dominated by child rearing. The number of individuals out of the labour force increases until women are in their late 20's (see figure 7.3) with the only subsequent rise, occurring in late 1999, coinciding with a rise in unemployment. The employment data does suggest one possible bias. In March 1990 1.8% of women were unemployed, a figure which falls to 1.1% in 1992 and remains relatively flat until just before data collection in 1999-2000. The 1990 data was collected when the women were aged 33 and based on a period very close to when the data for sweep 5 was collected. In contrast, March 1992 data was collected when the women were 41/42, and a long time before the interview for sweep 6. The fall in unemployment between 1990 and 1992 is likely to be due to either recall bias, or to different

Figure 7.3: Percentage out of the labour force from March 1982 to September 2000 (women)



approaches being taken to collect data for the different sweeps.

Overall, there are a number of problems with the unemployment data. Those due to recall bias and changing interpretation of lives are not easily solved. However, the problem of adequately summarizing multiple activities that change across time may in the future be solvable. One such method is optimal matching which can be used to identify common patterns of behaviour across time and then work out which pattern individuals are best allocated to(Martin, Schoon & Ross, 2007; Schoon, McCulloch, Joshi, Wiggins & Bynner, 2001; Wiggins, Erzberger, Hyde, Higgs & Blane, 2007).

Missing data

The other critical weakness of the study was missing data. Those who had missing economic activity data had poorer health and were more disadvantaged in terms of resources. This is likely to have lead to an underestimation of the effects of unemployment as the most disadvantaged individuals are more likely to be unemployed. The data clearly does not meet the assumption of MCAR. For the MAR assumption to be attainable, firstly, all variables that are conceptually independently associated with both the chance of missingness and the chances of being unemployed need to be included to model the data, secondly, there is no residual chance of being missing dependent on the measure used to indicate unemployment. Ensuring that all missing data is MAR is thus unlikely. However, assuming the data is MAR may lead to greater reductions in bias than the violations of the MAR assumptions introduce and research investigating the impact of missing data techniques on the parameters estimating the effects of unemployment should be conducted.

7.5. Conclusions

Despite the many concerns with the unemployment data, for men, unemployment does indicate challenges towards health. However, there is a weaker association for women; this may in part be due to how resources have interacted with unemployment, masking the association of unemployment and health. It important to note that as unemployment may have occurred a long time before the health outcome it may be better to consider unemployment as a detrimental turning point in the course of people's lives rather than the unemployment itself directly contributing to poor health.

For women, only one of the indicators of resources, internalizing symptoms, was associated with unemployment. However, for men all the indicators of resources were associated with unemployment, thus indicating protective factors. For externalizing symptoms, reading, mathematics and BMI, the developmental trajectories would suggest that the oldest age at which the resource indicator was measured was the most critical, and for resources indicated by these domains single time point measures may be an adequate summary of the underlying resources. However, the results for internalizing symptoms would suggest that taking a life course approach for some dimensions is critical, as repeated measurements of moderately raised internalizing symptoms were better at predicting unemployment than relatively acute symptoms at one time point.

Chapter 8: Resilience

8.1. Introduction

As illustrated in chapter 7, evidence would suggest that unemployment is detrimental to health. Chapter 7 also provided evidence that there are factors which protect people from experiencing unemployment. However, there may be limits to the protection that these factors provide. It is unlikely that improving protective factors within the population will prevent all unemployment, and protective factors may simply determine which individuals become unemployed. Thus there will always be unemployed individuals whose health will be at risk. This has moral and economic implications.

The moral debate over how power allocates resources and its impact on health is beyond the scope of this thesis, but it can not be forgotten entirely. Those most at risk of experiencing unemployment are also likely to be those most at risk of other forms of social exclusion and have the least influence over the economy and decisions surrounding who is employed. This discord between those with power and those who experience the consequences of that power can potentially lead to injustice, which even if justice is not valued itself, is likely to lead to conflict which itself will have economic costs. The economic costs of unemployment will be more direct if the health consequences of unemployment (and unregulated employment) are allowed to develop to such extent that morbidity and mortality force unemployed people out of the labour force.

Mechanisms to prevent the health consequences of unemployment have traditionally relied on welfare. There are a number of different types of welfare which can be based on earned entitlements or means tested provision of basic needs (McGinnity, 2004). However, the provision of welfare in the UK falls well below the minimum income for healthy living (Morris, Donkin, Wonderling, Wilkinson & Dowler, 2000) and political restrictions are unlikely to lead to an entirely satisfactory solution. In this chapter, indicators of emotional well-being, cognitive ability and physical development will be investigated as potential indicators of resources that could provide people with greater resilience to experienced unemployment.

8.1.1. Defining resilience

The definition of resilience that is used in this thesis is:

"Resilience is the capacity of the individual to meet a challenge and use it for growth or maintenance."

The challenge in this chapter is unemployment which has already been established as being an indicator of conditions that challenge health for men and to lesser extent for women. One possible explanation for the lesser association for women may be due to the way in which resources have interacted with unemployment.

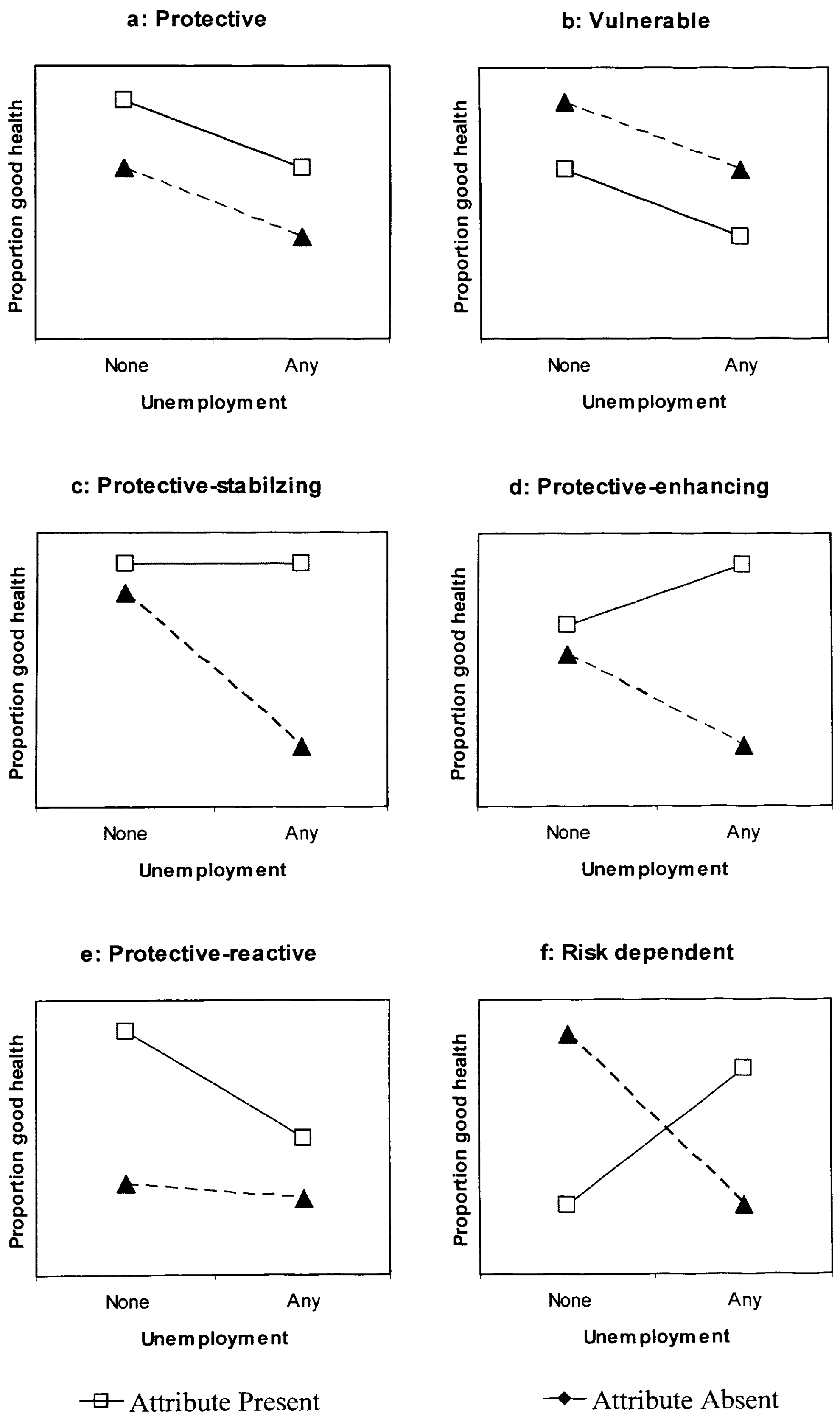
The capacity to meet unemployment is provided by resources which are indicated by measures of emotional well-being, cognitive ability and BMI. It has been established that these measures indicate resources that protect people against experiencing unemployment and in this chapter it will be tested if these measures also indicate protection that is specific to unemployment that is experienced. This will be operationalized using a test for statistical interactions; however, interactions can take many forms and some of them may be difficult to interpret as resilience.

8.1.2. Typologies of statistical interactions.

There are many different types of statistical interactions and in this section a modified version of a system developed by Luthar et al. (2000) will be used to illustrate the possible variations.

The attribute indicated as being present in figure 8.1a represents a protective factor which enhances an individual's chance of good health irrespective of their unemployment status. In figure 8.1b the attribute indicated as being present

Figure 8.1: Illustrative effects of moderator variables in interaction with unemployment



represents what could be termed a vulnerability factor which decreases an individual's chance of good health irrespective of their unemployment status. Figures 8.1a and 8.1b, are produced using the same data, with the difference being simply to apply different labels. Ideally, differentiation between protection and vulnerability should be based on prior theory. The attributes in figures 8.1a and 8.1b represent states that protect against poor health generally but do not alter unemployment's relationship with health and so do not protect against unemployment's effects on health. For a factor to provide resilience to the health consequences of unemployment it needs to alter unemployment's relationship with health.

Examples of different types of factors which alter unemployment's relation with health are presented in figures 8.1c to 8.1f. In figure 8.1c the attribute indicates a factor which results in unemployment having no association with health. This factor is termed "protective stabilizing" (Luthar et al., 2000). In Figure 8.1d the presence of an attribute leads to a different set of circumstances. In one set of circumstances individuals health improves on exposure to unemployment, whilst in the other set of circumstances health deteriorates in the face of unemployment. This has been termed by Luthar et al. (2000) as "protective enhancing". In Figure 8.1e, the attribute represents a quality or circumstance that generally has better health. However, the effects are reduced in the face of unemployment and this has been termed "protective reactive" by Luthar et al. (2000). A final type of factor is presented in figure 8.1f, whether the attribute represented indicates protection or vulnerability is entirely dependent on whether the individual is exposed to unemployment and such a relationship can be described as risk dependent. In the case of a risk dependent attribute the nature of unemployment itself has to be questioned, as for some individuals it is an adversity and for others it would indicate an opportunity.

Collectively, figures 8.1a to 8.1f demonstrate some of the many ways in which an attribute may interact with unemployment in the prediction of health and illustrate two key points. Firstly, each attribute will determine the type of association that unemployment has with health. If unemployment has no association with health for people with an attribute, that attribute would be labelled by Luthar et al. (2000) as being "stabilizing." If unemployment has a detrimental effect on health for people with an attribute that attribute would be labelled as being "reactive" (Luthar et al., 2000), and if unemployment leads to an improvement in health for people with an attribute, the attribute would be labelled as "enhancing" (Luthar et al., 2000). Those factors indicating stabilizing or enhancing effects could be considered resilience, whilst it is harder to classify reactive traits. Secondly, for an attribute there may be a main effect independent of unemployment which indicates general vulnerability or protection. This general protection is not the focus of this study, as it does not meet the criteria of resilience specific to the effects of unemployment; however, it is possible that an attribute has a main effect that is at odds with the effect of unemployment for that attribute. For example, the main effect for an attribute could be so strongly detrimental that the enhancing effect that occurs if exposed to unemployment does little to outweigh the main effect of the attribute. Thus if there is a significant interaction the main effect needs to considered before determining if a factor indicates resilience.

The resources: emotional well-being, cognitive ability and BMI

Emotional well-being and cognitive ability (Bender & Castro, 2000; Werner, 1993; Vaillant & Davis, 2000; Masten, 2001; Luthar & Cicchetti, 2000) have been identified as being critical for the development of resilience during childhood. The work of Barker et al. (2001, 2005) suggests that certain patterns of physical development are indicative of factors better able to withstand social disadvantage and thus protect against heart disease. However, the evidence that these factors might have protective effects specific to unemployment is extremely limited.

Interactions between unemployment and one aspect of externalizing symptoms, hostility, have been found. Kivimäki et al. (2003) conducted two studies on men. The first was a cross-sectional study which found that hostile men benefited less from employment than non hostile men did. In this case, hostility could be considered to be a stable vulnerability attribute, or non hostility to be an example of a protective reactive attribute, an effect similar to figure 8.1e. The second study was a follow up study using hostility recorded during childhood. In this study there was no main effect for hostility and health. However, unemployed men who were hostile as children were less likely to have good health than employed people and those unemployed men who were not hostile as children had better health than employed men (Kivimäki et al., 2003). In this study the absence of hostility could be said to be protective enhancing, whilst hostility could be said to indicate reactive vulnerability. This is an effect similar to that shown in figure 8.1d. The contrasting interactions between unemployment and hostility in these studies may be because childhood hostility and adult hostility are indicating different resources in relation to unemployment. Alternatively, the contradictory results may suggest that the interactions are type I statistical errors. It is thus difficult to predict what type of interaction a variable indicating externalizing symptoms would have. Predicting the type of interaction to be found is equally difficult for the other resources for which there is limited research.

Individuals with high levels of internalizing symptoms are likely to be more vulnerable to unemployment. Depressed people suffer from diminished interest in most daily activities and a lack of energy (Caspi et al., 1998; Breslin et al., 2006). This is likely to lead to poorer social relationships and an inability to structure time constructively, both of which have been associated with poorer mental health amongst unemployed individuals (McKee-Ryan et al., 2005). Those with high internalizing symptoms are also likely to be less motivated to search for a job (Fronstin et al., 2005) and thus be exposed to longer periods of unemployment, potentially with greater consequences.

Those with poorer cognitive ability have poorer chances of employment. This is likely to make circumstances appear more stressful and result in more desperate job seeking activity (Ferrie et al., 1995; McKee-Ryan et al., 2005; Taris, 2002). Cognitive ability is also likely to be associated with greater wealth and those with better financial resources and lower financial strain have better health when unemployed (McKee-Ryan et al., 2005). In particular, the combination of lack of confidence in finding future employment and more financial strain may force individuals of poor cognitive ability to accept low quality employment which potentially will have more adverse effects on health. Thus in general those with poorer cognitive ability are likely to be more vulnerable.

Although there is enough evidence to suggest that emotional well-being and cognitive ability may interact with unemployment, the form of these interactions is at best speculative and there are many possible options. However, for BMI there are some indications of how people may react to the challenge presented by unemployment.

There is evidence that individuals of differing body mass may respond differently to unemployment for both the single time point measure and for the developmental trajectory. Men with a high BMI tend to gain weight in response to stress (Kivimäki et al., 2006), possibly due to stress related eating (Laitinen et al., 2002), whilst thin men have been shown to lose weight (Kivimäki et al., 2006). Although this most strongly suggests that there will be an interaction for weight change, factors such as diet, exercise and emotional well-being which underpin weight change are also likely to have an effect on health. Thus thin and heavy individuals are likely to respond differently in the face of unemployment when compared to individuals of normal weight.

There is also evidence suggesting that developmental trajectories may interact with unemployment in the prediction of health. Those who are initially thin at birth and then go on to be obese have the greatest risk of heart disease (Barker et al., 2005). In particular, people who were not thin at birth have been found to be resilient to the effects that social class has on heart disease (Barker et al., 2001). The "constant increaser" trajectory potentially reflects those that are initially thin and then dramatically increase in weight and this trajectory is likely to be more vulnerable to stress. The "consistently heavy" and the "early developers" are potentially indicative of development of higher levels of lean tissue which potentially make individuals less vulnerable to unemployment.

Overall, it is highly plausible that resources will provide the means to cope with challenges. However, research so far has been extremely limited. This is especially true from a life course perspective, for which indicators of resources have tended to be indicators restricted to discrete period or events in early childhood such as birthweight (Barker et al., 2001) or breastfeeding (Montgomery et al., 2006). When studies have used group based developmental trajectories in the context of resilience, the developmental trajectories have been primarily used as outcomes rather than resources. Thus developmental trajectories provide a new way of assessing when resilience develops across the life course.

8.2. Methods

8.2.1. Data

The analyses in this chapter use the same data as in chapter 7 but the data are used differently. When resources are indicated using single time point measures cases are only included if they have complete data for unemployment. The sample sizes for these analyses vary depending on the resource and the health outcome used in the analysis. Sample sizes for analyses ranged from 2712 men and 2780 women included for testing interactions between unemployment and externalizing symptoms with weight change as the outcome, to 3619 men and 3677 women included in the analyses testing for an interaction between internalizing symptoms and unemployment for self rated health.

The methodology used to test for interactions using the developmental trajectories allows for cases that have missing data for the health outcome to be included. This means that the sample sizes are based on having adequate employment data and being a member of the fuller sample for the appropriate resource. Sample sizes are as presented in table 7.2. (The method used to analyse the life course measure of internalizing symptoms does require that all cases have health data; however, virtually all cases that had data for both the life course measure and unemployment had complete health data.) This does mean that some cases that are included have missing data. However, the numbers with missing data included in the analyses are low. The analyses for which cases have the most missing data are those testing for an interaction between externalizing symptoms and unemployment in the prediction of weight change, for which 14.5% of men and 14.1% of women having missing weight change data. At the other extreme are analyses testing interactions for the prediction of self rated health: for example, only 0.1% of men and none of the women have missing health data for the interaction between unemployment and externalizing symptoms in the prediction of self rated health.

8.2.2. Variables

As the variables in this chapter are the same as those used in chapter 7 only a brief recap will be provided here. The variable used to indicate the challenge to which resilience is being tested is unemployment. The resources will be indicated by single time point measures and developmental trajectories of externalizing and internalizing symptoms, reading, mathematics and BMI. Health outcomes at age 42 will be assessed using self rated health, limiting longstanding illness, Malaise, GHQ and weight change. The latter has three categories, weight loss, moderate weight gain and high weight gain, with moderate weight gain used as the reference category.

8.2.3. Statistical analyses

The analyses in this chapter are aimed at identifying statistically significant interactions and describing those that are found.

To identify significant interactions for the prediction of health between unemployment and the resources, indicated by a single time point, a likelihood ratio test is conducted using Stata 9 (Statacorp, 2005). A standard multivariate logistic regression model (multinomial when weight change is the health outcome) is considered to be nested within a model where additional parameters are generated for unemployed*resource status. If removal of the unemployed*resource status indicators does not result in a significant reduction in model fit there is no evidence of an interaction as measured by the likelihood ratio test.

To identify significant interactions for the prediction of health between unemployment and resources as indicated by developmental trajectories a likelihood ratio test was conducted using data produced by Mplus version 4 (Muthén &

Muthén, 2006). Two models are generated. In the first, the odd ratios for the prediction of health by the developmental trajectories classes are allowed to differ depending on unemployment status. In the second, a nested model, the odds ratios for the prediction of health are constrained to be the same for those who experience unemployment and those who do not.

As statistical interactions are rare and hard to find, a relatively relaxed criterion for statistical significance, $p \leq 0.1$, is used. Should a significant interaction be found between unemployment and a resource for a particular health outcome, the interactions for all health outcomes for that gender, indicator (developmental trajectory or single time point measure) and resource combination are presented graphically along with odds ratios with 95% confidence intervals for association of unemployment within each resource strata. As there is a danger that the large number of statistical tests may lead to chance findings being counted as significant, in the discussion section the plausibility of mechanisms for any interactions that are found are discussed.

8.3. Results

Many analyses were conducted. In order to present the results as simply and succinctly as possible, the results are presented in two steps. Initially, the p values for interactions between resources, as indicated by both development trajectories and single time point measures, and unemployment in the prediction of each health outcome are presented in table 8.1 for both men and women. The second step is to focus on the resources, methodology and gender combinations for which there was strongest evidence of interactions. If there is a significant interaction in the prediction of health for a single gender, resource and methodology combination (methodology refers to single time or developmental trajectory as indicator of resource), then all interactions for that combination are graphically presented. The results are presented for each resource intern.

8.3.1. Externalizing symptoms

For men there were no significant interactions between unemployment and externalizing symptoms as indicated by the developmental trajectories or the single time point measure (see table 8.1).

For women there was one significant interaction between externalizing symptoms and unemployment. This was for the interaction between the single time point measure of externalizing symptoms with unemployment in the prediction of weight change. The relationship between unemployment and externalizing symptoms for the other health outcomes did not follow a similar pattern (see figure 8.2).

When the association between unemployment and weight change is broken down by each resource category, amongst those with "no symptoms" unemployment had no association with weight loss (OR 1.26 95% CI 0.90-1.76), but does have an association with high weight gain (OR 1.33 95% CI 1.04-1.70). In contrast, for those in the "low symptoms" category unemployment had protective effects that approached significance for both weight loss (OR 0.57 95% CI 0.28-1.17) and high weight gain (0.63 95% CI 0.38-1.05). The p value for weight loss was 0.13 and the p value for weight gain 0.08. Finally, amongst those with "high symptoms" unemployment was associated with increased odds of weight loss (OR 2.49 95% CI 1.01- 6.16) but not with high weight gain (OR 1.59 95% CI 0.77-3.31).

8.3.2. Internalizing symptoms

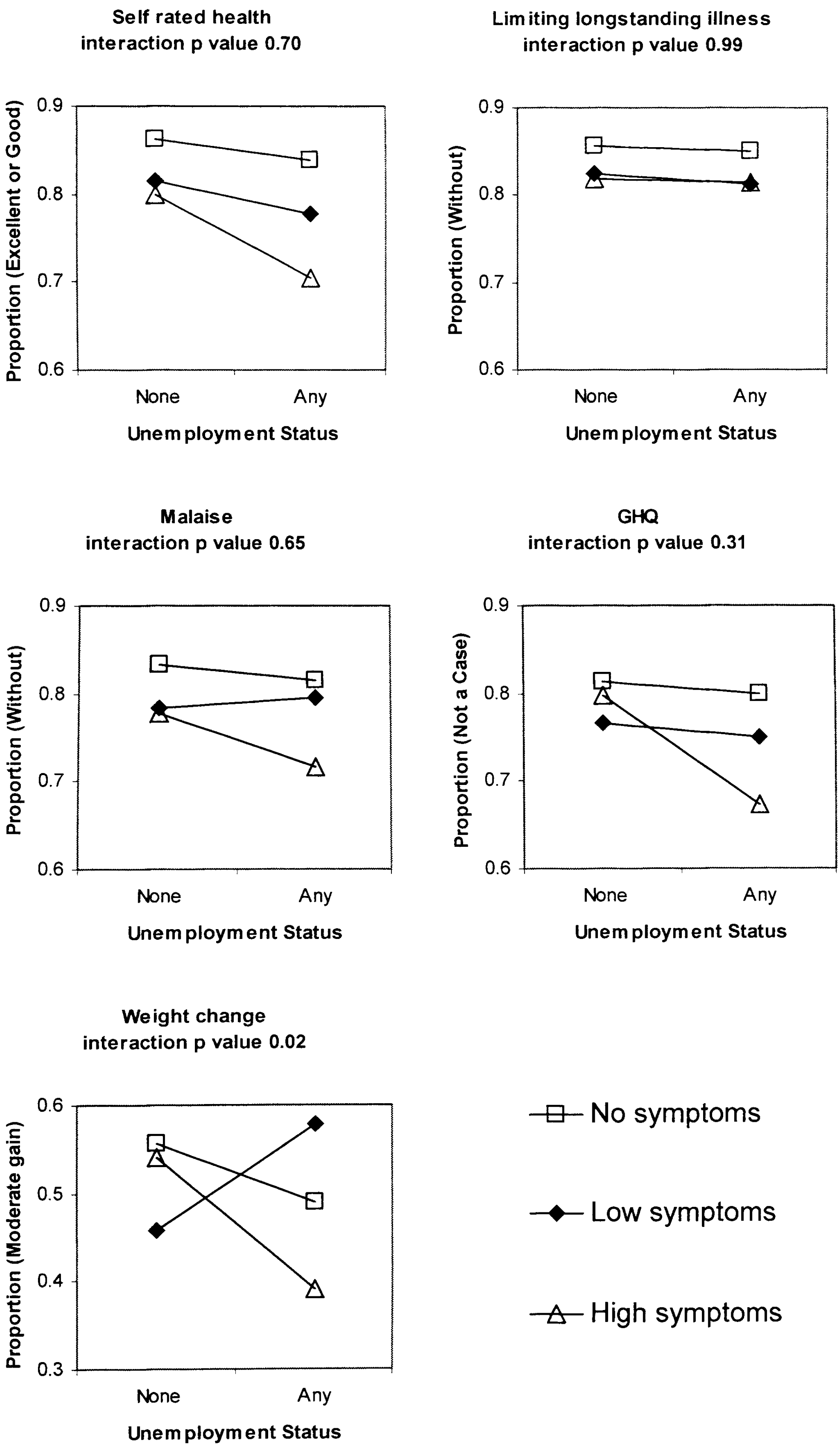
For internalizing symptoms there were significant interactions for both sexes. For men the only significant interaction was between unemployment and the single time point measure of internalizing symptoms for self rated health (see table 8.1). For men with "no symptoms", unemployment was not associated with poor self rated health (OR 1.03 95% CI 0.66-1.60). For men with "low symptoms", there was a moderate association between unemployment and poor self rated health (OR 1.60 95% CI 1.27-2.02), whilst for men with high symptoms unemployment had a

Table 8.1: p values for interactions between resources and unemployment

Health outcome	Men		Women	
	Trajectory	Single time point	Trajectory	Single time point
		Externalizing		
General health	0.42	0.89	0.19	0.70
Limiting illness	0.15	0.33	0.13	0.99
Malaise	0.92	0.97	0.65	0.65
GHQ	0.38	0.65	0.61	0.31
BMI Change	0.75	0.71	0.17	**0.02**
		Internalizing		
General health	0.17	**0.05**	**0.10**	0.14
Limiting illness	0.46	0.23	0.42	**0.07**
Malaise	0.89	0.85	0.87	**0.08**
GHQ	0.33	0.62	**0.09**	0.29
BMI Change	0.87	0.34	0.69	0.27
		Reading		
General health	0.74	**0.08**	0.94	0.69
Limiting illness	0.34	0.30	0.55	0.26
Malaise	0.44	0.49	0.60	0.82
GHQ	0.23	**0.03**	0.12	0.65
BMI Change	0.26	**0.05**	0.28	0.44
		Mathematics		
General health	0.30	0.63	0.13	0.32
Limiting illness	0.75	0.69	**0.03**	0.24
Malaise	0.60	0.25	0.78	0.78
GHQ	0.85	0.45	0.44	0.11
BMI Change	0.29	0.17	0.94	0.73
		BMI		
General health	**0.06**	0.68	0.61	0.43
Limiting illness	**0.08**	0.99	0.40	**0.05**
Malaise	0.50	0.55	0.84	0.53
GHQ	0.20	0.12	0.33	**0.07**
BMI Change	0.92	0.61	0.86	0.56

relatively strong association with self rated health (OR 2.90 95% CI 1.34-6.25). Having "no symptoms" at age 23 could be considered as having an attribute that provides a protective stabilizing effect. For the other health outcomes, with the exception of weight change, the non significant interactions are weakly supportive of the concept that having no internalizing symptoms indicates factors that provide a

Figure 8.2: Interactions between unemployment and the externalizing single time point measure (women)



protective effect that is stable in the face of unemployment (see figure 8.3).

For women, using a significance level of p of ≤ 0.1, both the life course and the single time point measure of internalizing symptoms showed significant interactions. The first significant interaction between the life course measure of internalizing symptoms and unemployment was for self rated health. For those that "never" had elevated internalizing symptoms unemployment was associated with poor self rated health (OR 2.03 95% CI 1.01-4.10). Unemployment did not have a significant association with health for those who had elevated symptoms "once" (OR 0.66 95% CI 0.37-1.18) "twice," (OR 1.06 95% CI 0.63-1.80) of those who had elevated symptoms "3 or 4" times (OR 1.25 95% CI 0.77- 2.00) (see also figure 8.4).

The other significant interaction between unemployment and the life course measure of internalizing symptoms was for GHQ. For those that "never" had elevated symptoms, or had elevated symptoms "twice" or "3 or 4 times", unemployment did not have an association with being a case as indicated by GHQ. (The odds ratios and 95% confidence intervals for "never" are OR 1.27 95% CI 0.66-2.43, "twice" OR 1.32 95% CI 0.84-2.10 and "3 or 4 times" OR 0.96 95% CI 0.59-1.56). However, for those who had elevated symptoms "once" unemployment was associated with a lower odds of being a case as indicated by GHQ (OR 0.57 95% CI 0.33-0.98).

For women, there were also significant interactions between unemployment and the internalizing single time point measure for limiting longstanding illness and Malaise (see table 8.1 and figure 8.5). Unemployment was not associated with limiting longstanding illness for those with "no symptoms" (OR 1.33 95% CI 0.70-2.53) or "low symptoms" (OR. 1.08 95% CI 0.82-1.41). However, amongst those who had "high" symptoms, experiencing unemployment is associated with a reduced chance of having a limiting longstanding illness (OR 0.51 95% CI 0.26-1.00).

In addition, for those with "no symptoms" unemployment was associated with high Malaise (OR 2.58 95% CI 1.17-5.65); however, amongst those with "low symptoms" (OR 1.06 95% CI 0.82-1.37) or "high symptoms" (OR. 0.84 95% CI 0.49 -1.43) there was no association between unemployment and high Malaise scores.

Figure 8.3: Interactions between unemployment and the internalizing single time point measure (men)

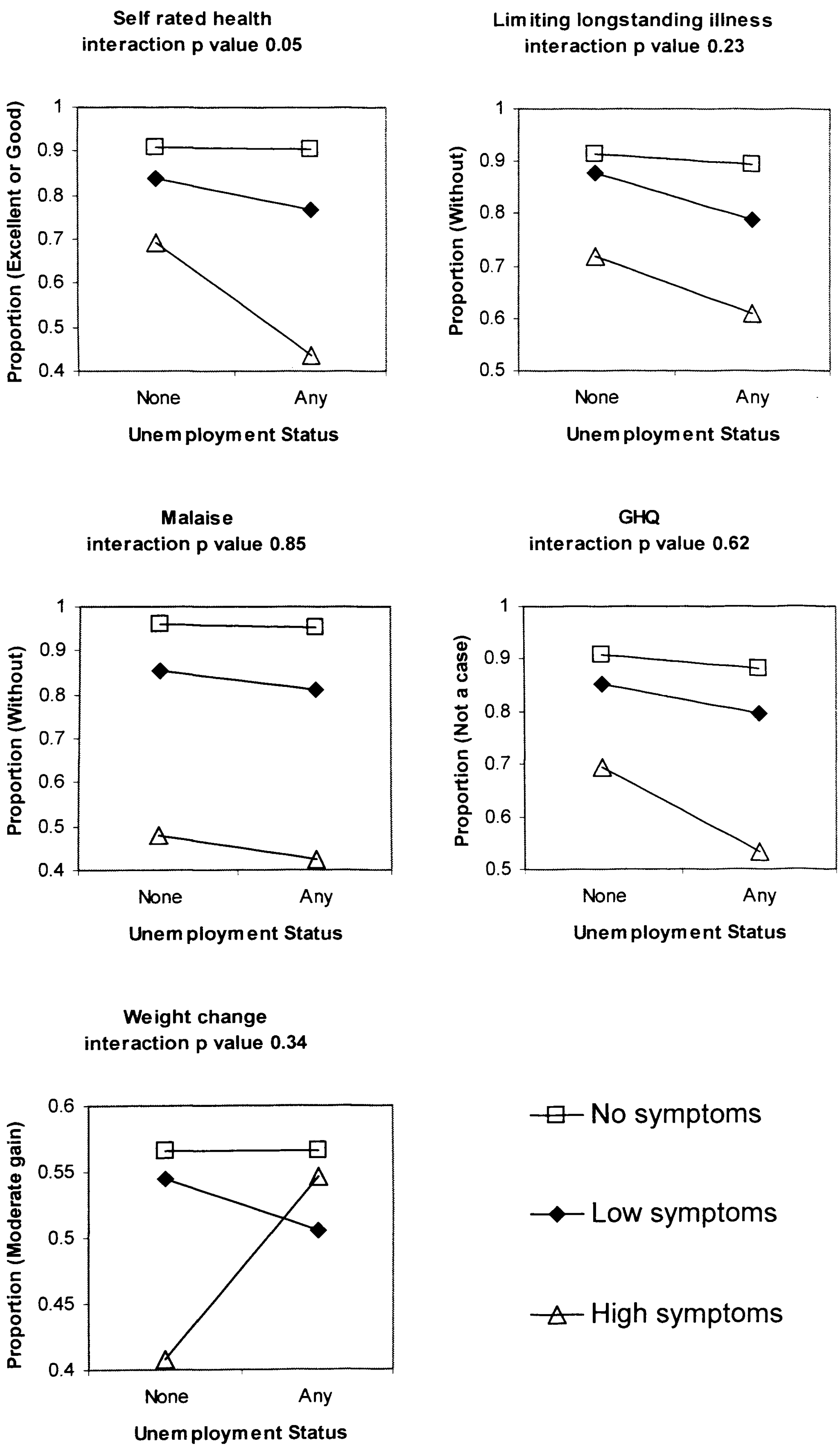
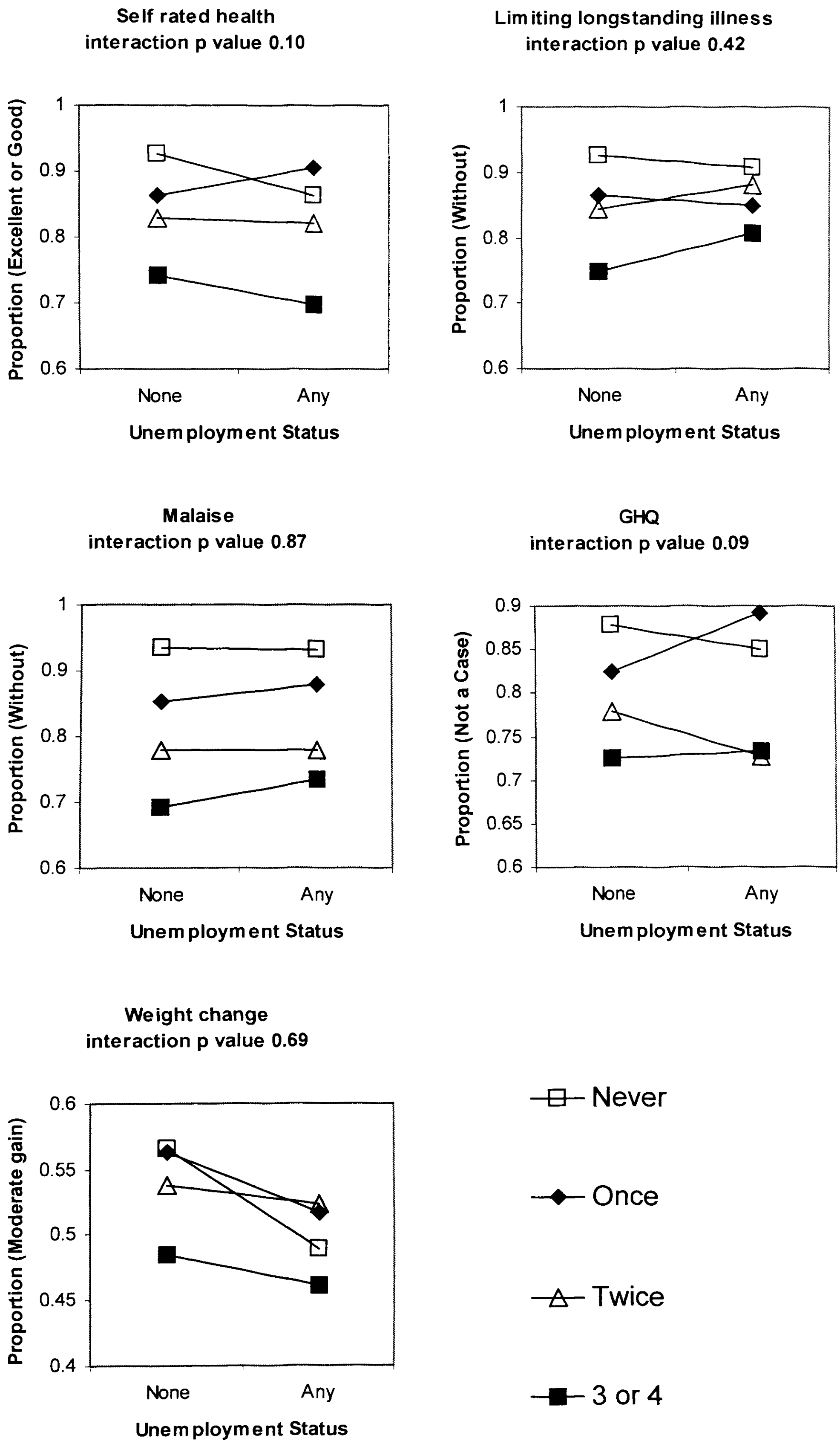


Figure 8.4: Interactions between unemployment and the internalizing life course measure (women)



Overall, those women who have "high symptoms" had their chances of poor health reduced if they experienced unemployment for all health outcomes (see figure 8.5), although the protective effect was only significant for the aforementioned limiting longstanding illness.

8.3.3. Reading

In the prediction of the health outcomes there were significant interactions between unemployment and reading as measured by the single time point measure for men. However, there were no significant interactions between reading and unemployment for women, and when reading was operationalized using the development trajectories for men (see table 8.1).

The significant interactions between unemployment and the single time point measure were for self rated health, GHQ and weight change, and are presented in figure 8.6.

Amongst those of moderate reading ability unemployment was associated with increased odds of poorer self rated health (OR. 1.79 95% CI 1.37-2.34); however, this was not the case for good readers (OR 0.98 95% CI 0.57-1.69), or for the poor readers (OR 1.23 95% CI 0.82-1.84).

For GHQ, amongst those who were of moderate reading ability unemployment was again associated with increased odds of poorer health (OR 1.93 95% CI 1.47-2.54), and again this was not the case for poor readers (OR 1.25 95% CI 0.74-2.10) or for good readers (OR 1.01 95% 0.66-1.55).

For weight change, amongst the poorest readers unemployment approached significance ($p = 0.07$) with high weight gain (OR 1.47 95% CI 0.97-2.22), but poorest readers were not more likely to lose weight (OR 1.07 95% CI 0.55-2.07). On the other hand, moderate readers who experienced unemployment were more likely to lose weight (OR 1.75 95% CI 1.17-2.62,) but were no more likely to be at increased risk of high weight gain (OR 0.84 95% CI 0.65-1.07). For the best readers,

Figure 8.5: Interactions between unemployment and the internalizing single time point measure (women)

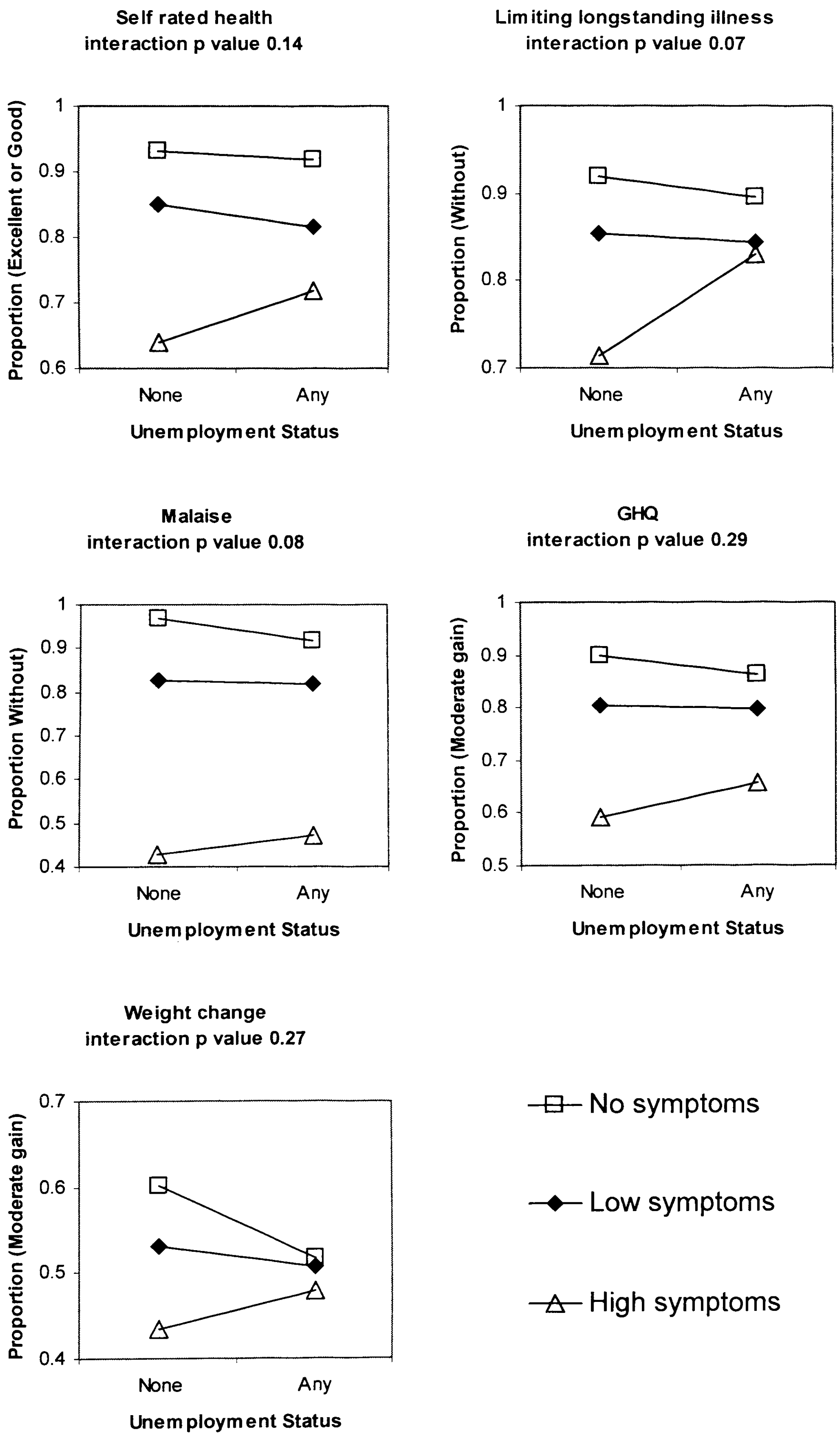
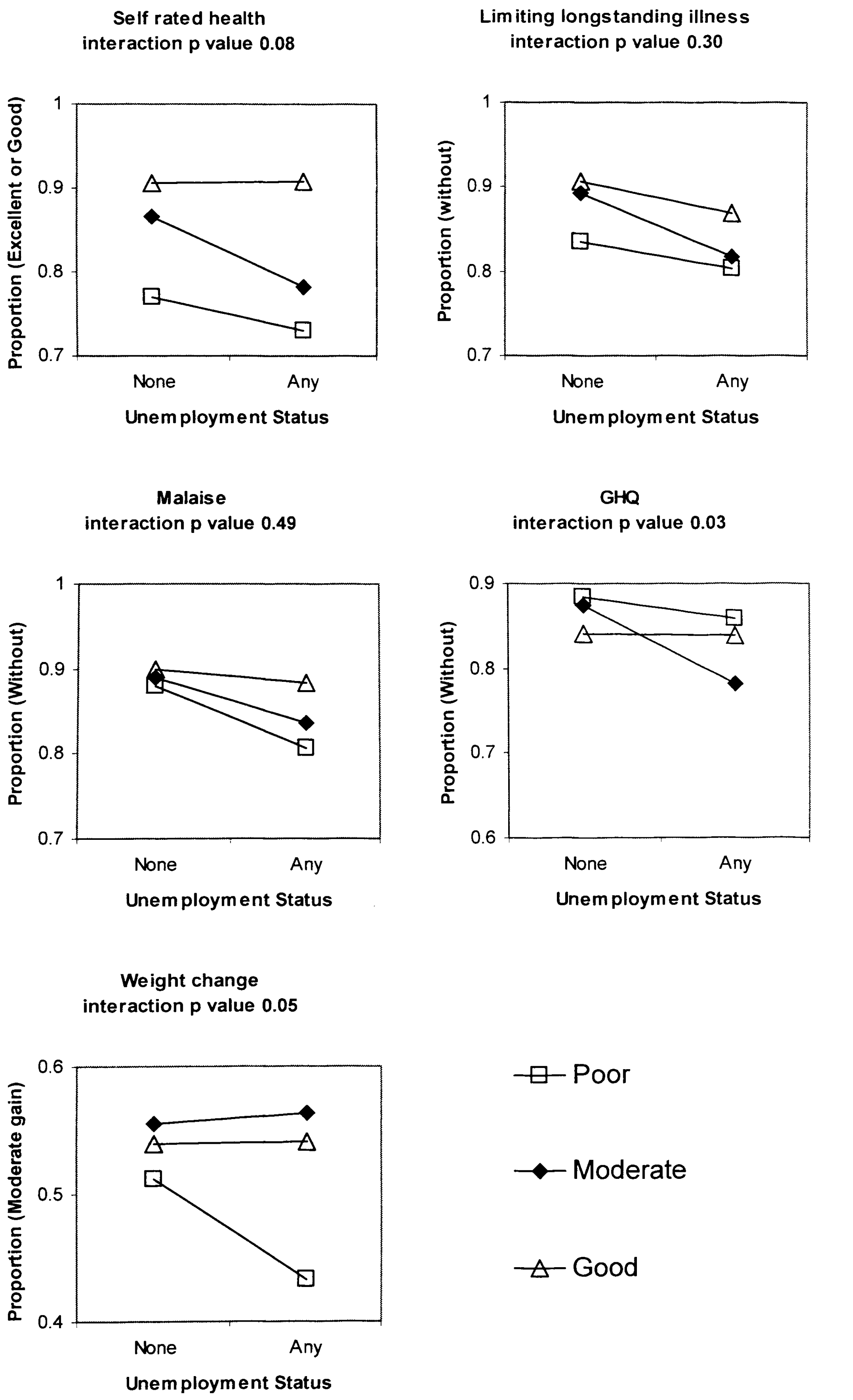


Figure 8.6: Interactions between unemployment and the reading single time point measure (men)



there were no significant associations between unemployment and high weight gain (OR 0.91 95% CI 0.64-1.31) or weight loss (OR 1.60 95% CI 0.84-3.03).

The non significant interactions for limiting longstanding illness and Malaise suggest that being a good reader has a protective stabilizing effect, whilst those of moderate reading ability react poorly to unemployment (see figure 8.6).

8.3.4. Mathematics

For men, there were no interactions between unemployment and mathematics in the prediction of health (see table 8.1). However, for women there was a significant interaction between unemployment and the developmental trajectory of mathematics in the prediction of limiting longstanding illness (see figure 8.7). For the "general population" trajectory unemployment was associated with increased odds of limiting longstanding illness but unemployment was not associated with limiting longstanding illness for any of the other trajectories: "high performers" (OR 0.75 95% CI 0.38-1.48), "transient lapse" (OR 0.49 95% CI 0.07-3.45), "moderate decreasing" (OR 0.76 95% CI 0.42-1.36).

8.3.5. BMI

There are interactions, which are significant at the 0.1 level, between unemployment and BMI for both men and women. For men the interactions were operationalized using the BMI developmental trajectories, whilst for women the interactions were operationalized using BMI as indicated by a measure at a single time point.

For men the two significant interactions are for the prediction of self rated health and limiting longstanding illness (see table 8.1 and figure 8.8). Members of both the "early developers" and the "constant increasing" trajectories were less likely to have poor self rated health if they become unemployed; however, for neither trajectory was this significant ("constant increasing" trajectory OR 0.52 95% CI 0.17-1.62, "early developers" trajectory OR 0.52 95% CI 0.11-2.40). In contrast, members of

Figure 8.7: Interactions between unemployment and the mathematics trajectories (women)

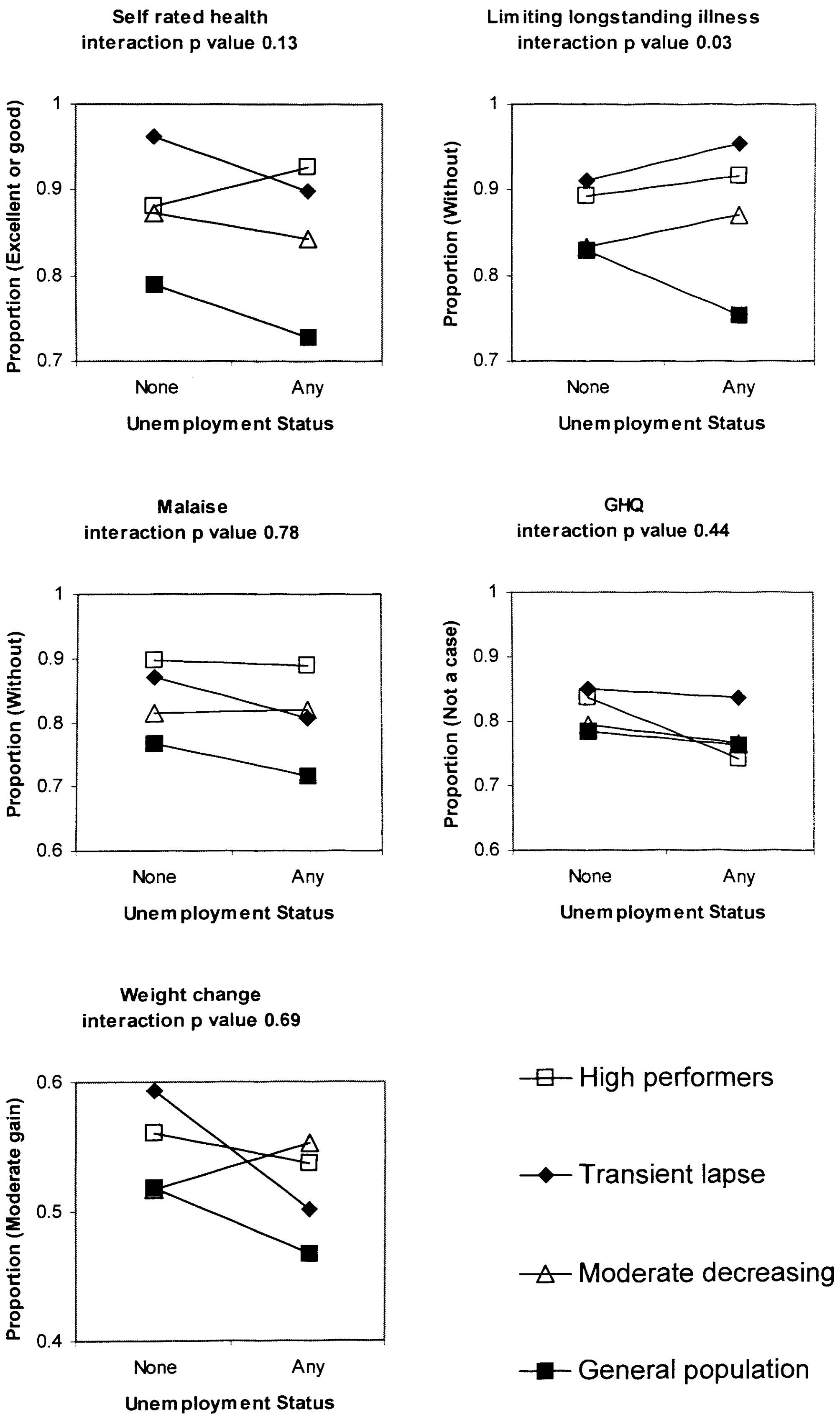
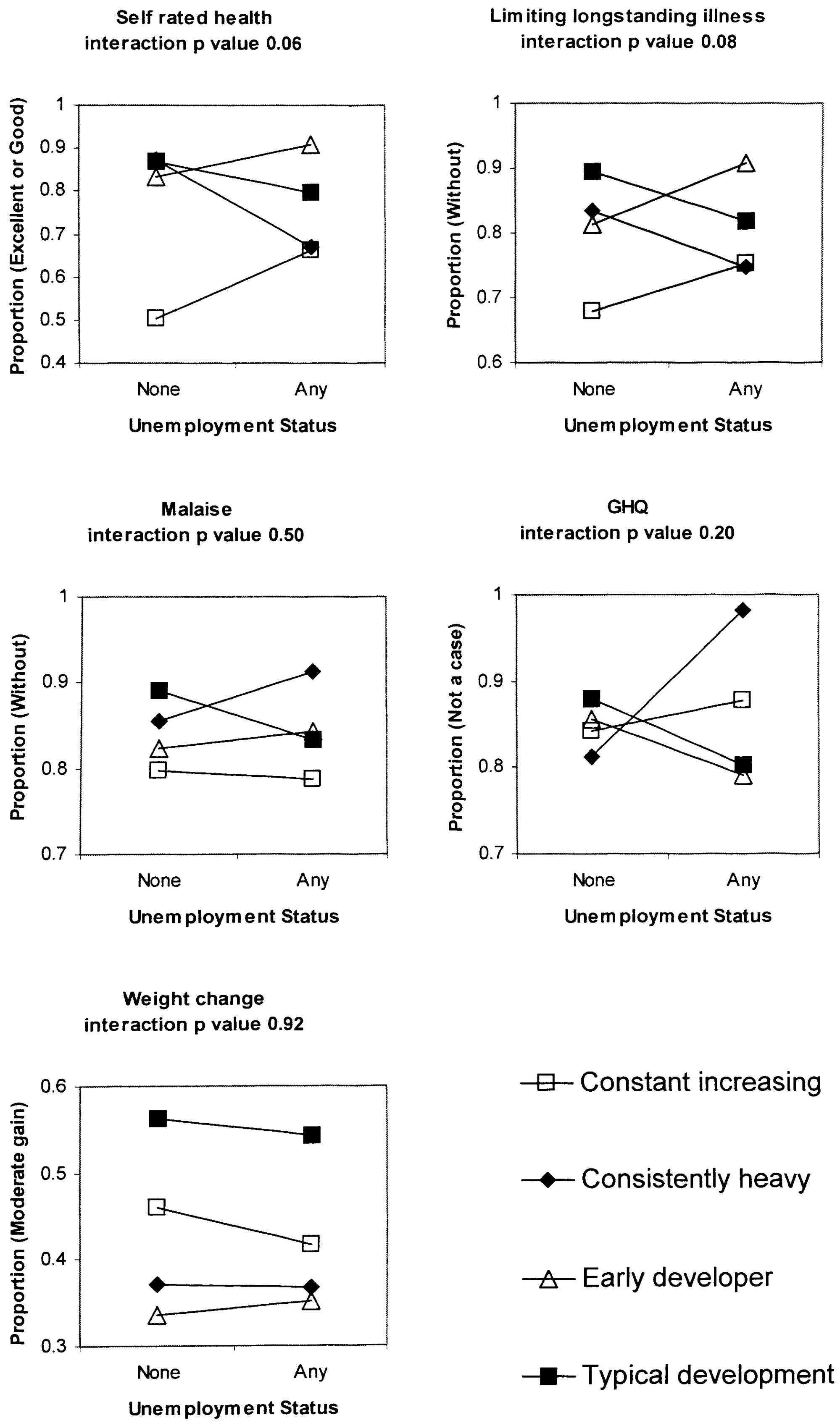


Figure 8.8: Interactions between unemployment and the BMI trajectories (men)

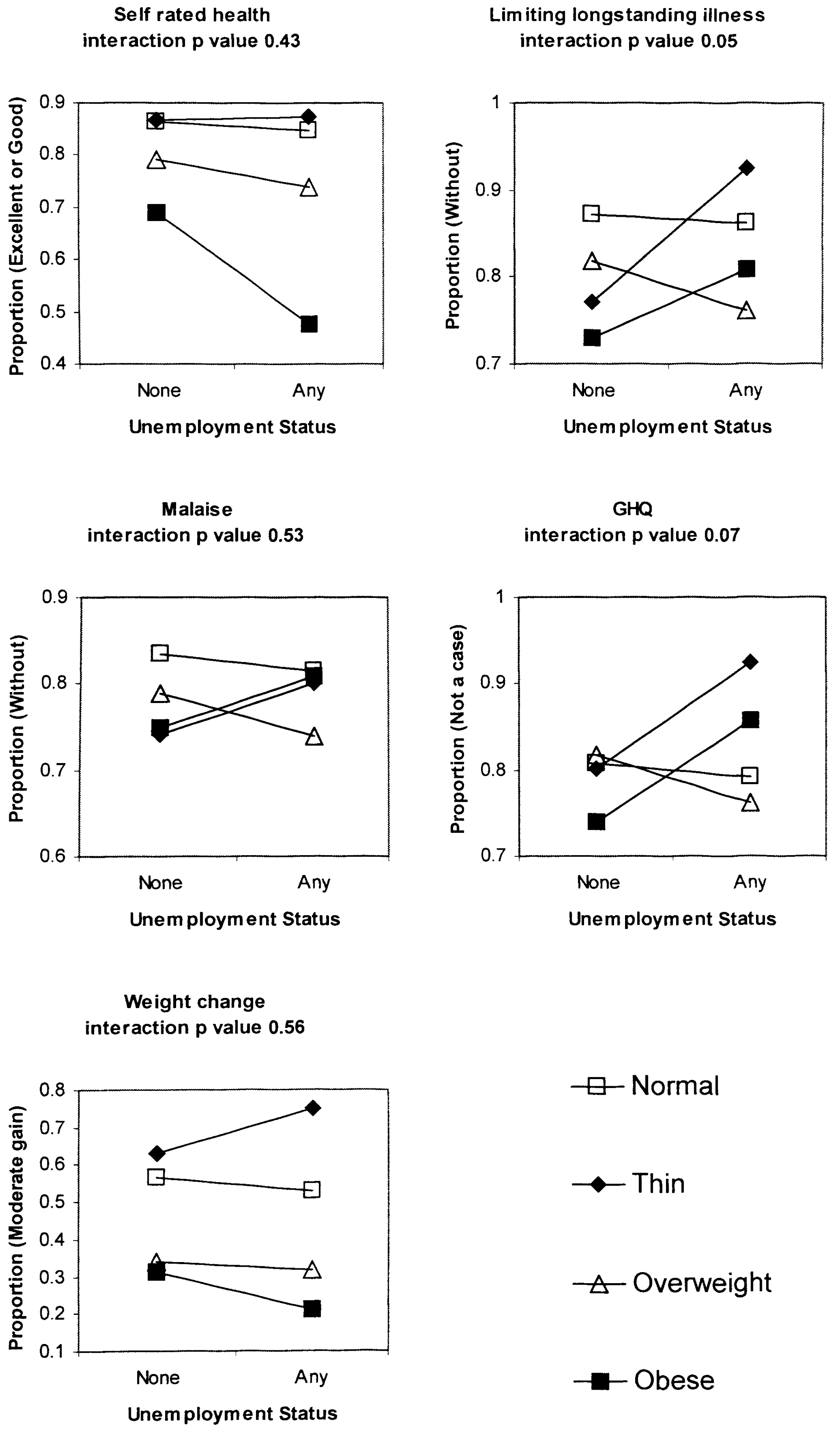


the "consistently heavy" trajectory and the "typical development" trajectory were more likely to have poor self rated health if they became unemployed. This association was not significant for the "consistently heavy" trajectory (OR 3.35 95% CI 0.85-13.15) but was for the "typical development" trajectory (OR 1.70 95% CI 1.40-2.06).

For men there was also a significant interaction between unemployment and the BMI trajectories for limiting longstanding illness. Unemployment was associated with reduced risk of limiting longstanding illness for the "constant increasing" (OR 0.70 95% CI 0.20-2.39) and the "early developers" (OR 0.43 95% CI 0.09-2.16) trajectories but for neither trajectory was this significant.. Unemployment had a non significant adverse effect for the "consistently heavy" trajectory (OR 1.71 95% CI 0.43-6.80) and unemployment was associated with increased odds of limiting longstanding illness for the typical development trajectory (OR 1.86 95% CI 1.52-2.29).

For women there were significant interactions between BMI measured at a single time point and unemployment for limiting longstanding illness and GHQ (see figure 8.9). For women with a normal BMI there was no association between unemployment and either limiting longstanding illness (OR 1.08 95 % CI 0.82-1.42), or GHQ (OR 1.10 95% CI 0.87-1.39). For women who were overweight there was again no association between unemployment and limiting longstanding illness (OR 1.41 95% CI 0.80-2.47) or GHQ (OR 1.40 95% CI 0.80-2.46). For obese women there was a non significant reduction in the association between unemployment and limiting longstanding illness (OR 0.64 95% CI 0.20-2.06) and GHQ (OR 0.47 95% CI 0.13-1.74). However, for thin women unemployment was associated with significantly reduced risk of limiting longstanding illness (OR 0.27 95% CI 0.08-0.93) and a reduction in risk for GHQ caseness that approached significance (0.33 95% CI 0.10-1.13 $p = 0.08$).

Figure 8.9: Interactions between unemployment and the BMI single time point measures (women)



8.4. Discussion

8.4.1. Externalizing symptoms

The lack of significant interactions for men would suggest that more general externalizing symptoms do not indicate (a lack of) resources that provide resilience to unemployment. This is not surprising. Although Kivimäki et al. (2003) found two significant interactions between unemployment and hostility the interactions demonstrated contradictory effects, suggesting that Kivimäki et al.'s results were chance findings.

For women, there was a significant interaction with weight change; this is not supported in any way by the non significant interactions for other health outcomes. The relationship is complex due to weight change having three outcomes. This relationship does not indicate an ordered trend, and it would require a complex mechanism to explain why those with no symptoms and high symptoms are more similar to each other than the intervening category. Unless other studies replicate these results it may be better to ignore this interaction.

8.4.2. Internalizing symptoms

For men and women the interactions found between unemployment and internalizing symptoms are very different. The results for men would suggest that increasing levels of internalizing symptoms is indicative of reduced resilience to the effects of unemployment. Weich & Lewis (1998) have proposed a valid non statistically distinguishable alternative hypothesis that internalizing symptoms at the age of 23 indicate poor health, and unemployment rather than causing poor health has prevented recovery amongst this group. Either way, the combination of high levels of internalizing symptoms and unemployment together indicates worse health for men than would be expected from having high levels of internalizing symptoms and unemployment alone. The absence of internalizing symptoms for men could indicate resilience to unemployment.

In contrast, for women, the type of interaction between internalizing symptoms and unemployment was very different. Amongst those with the highest levels of internalizing symptoms, as indicated by the single time point measure, unemployment effectively enhanced a women's chance of having good health. For limiting longstanding illness this led to a considerable improvement, but for the other outcomes there was a lesser effect. For those with no internalizing symptoms unemployment had a detrimental effect.

The women's life course measure of internalizing symptoms had a significant interaction which indicated that unemployment enhances health for those with raised symptoms at one time point. It is difficult to explain why having elevated symptoms at only one time would lead to enhanced health if that individual becomes unemployed. Those who have high internalizing symptoms at age 23 may constitute a large proportion of those in the "once" category for the life course measure. An additional life course measure was generated using data measured at ages 7, 11 and 16. This measure did not show a significant interaction with unemployment for the prediction of self rated health and GHQ; reinforcing the idea that internalizing symptoms at age 23 may be driving the interaction for the life course measure.

Several mechanisms could explain why experiencing unemployment may lead to improved health for those with high internalizing symptoms. Firstly, although women with multiple roles generally have good health (McMunn, Bartley, Hardy & Kuh, 2006), it is possible that women with high internalizing symptoms lack the resources to cope with the challenges and opportunities that multiple roles present. By being made unemployed these women have fewer challenges so their resources can more easily cope and have improvement in health. A second possible explanation is that, women with high levels of internalizing symptoms may, on being made unemployed, re-evaluate their lives and make changes. Thus unemployment may act as a turning point. A third explanation is that many women with high levels of internalizing symptoms may simply be prepared to drift out of the labour force, and experiencing unemployment could indicate resilient women who are trying to remain economically active. Distinguishing between these mechanisms is important. The first mechanism would suggest that for distressed women abandoning work is good for their health, whilst the third mechanism would suggest that remaining in the work force would be critical for good health. Current evidence would most strongly support the third mechanism, as women with good health are more likely to work outside the home (Fokkema, 2002). However, further research would help to clarify the issue. Whatever the mechanism, the strength of the main effect of internalizing on health is much stronger than any reduction in risk of poor health for the unemployed, and so women with high levels of internalizing symptoms should not be said to be more resilient.

8.4.3. Reading

Only the single time point measure of reading for men interacts with unemployment in the prediction of health, and this interaction does not take the form of the simple relationships suggested by Luthar et al. (2000). For self rated health, being good at reading indicates a protective stabilizing attribute which means that unemployment has no impact and is thus an example of resilience; whilst being poor at reading would indicate a general vulnerability to poor health and the stresses provided by unemployment are lost among all the other stresses. Thus for poor readers unemployment could be said to have no effect, but it would be difficult to attribute resilience to these individuals as they have poor health generally. In contrast, those of moderate reading ability would seem to be vulnerable to unemployment.

For GHQ, as for self rated health, the good and bad readers are resilient to the effects of unemployment whilst those of moderate reading ability are vulnerable. This is despite GHQ not being associated with reading (see appendix 2). The lack of association between GHQ and measures in adolescence is not surprising as GHQ is only intended to identify recent health problems and health effects caused by factors experienced during adolescence are more likely to be due to long-term health problems.

There are at least three possible explanations for why good and bad readers are not affected by unemployment whilst those of intermediate ability are. One explanation is that reading indicates resources, be they financial or social. Good readers have high levels of resources and thus the extra capacity to absorb the consequences of unemployment. Poor readers have such a lack of resources or are exposed to such a high number of adversities that they are effectively so saturated with problems that being made unemployed makes no difference. Those of intermediate reading ability have a level of resources that can cope with daily stresses if the individual is employed; however, on becoming unemployed either through the absence of resources provided by employment or because of increased stresses, those of intermediate reading ability no longer have the resources to cope with every day life. This leads to deterioration in health.

An alternative mechanism which could explain the interactions relates to the changing labour market. In the 1970's those with limited education still had good employment prospects (Bynner et al., 1996b) and it is possible that only the poorest readers were forced into a low quality jobs. The impact of the loss of these jobs is likely to have been limited and similar replacement jobs are likely to be readily available. However, following the restructuring of the manufacturing sector there would have been a loss of good quality jobs for those of intermediate reading ability. If a person of intermediate reading ability stayed in employment or found a job of comparable quality there is unlikely to be adverse health consequences; but failure to find a good quality job may have forced individuals of moderate reading ability into lower quality employment, which would have had a detrimental impact on health. Those of the highest reading ability are likely to have the most skills and would if made unemployed have been able to find a comparable white collar job as a replacement.

The final reason to explain why poor readers who experience unemployment are not at increased risk of poor health is due to health selection. Poor readers may require good health to participate in the labour force and those who have both poor reading ability and poor health may be less likely to be economically active.

There is also a significant interaction between unemployment and reading for weight change. If only significant associations ($p<0.05$) between unemployment and weight change within each reading trajectory are considered, the interaction could be described as follows. Good readers would be considered resilient to the effects of unemployment as for this group unemployment is not significantly associated with either weight gain or weight loss. Moderate readers are vulnerable to the health effects of unemployment reflected by the increase in weight loss. The poorest readers are likely to be saturated with stresses that might lead to weight loss (see appendix 2) and thus unemployment confers no extra risk of weight loss. However, unemployment for these individuals may have led to the loss of a job requiring a high calorie diet. If these individuals did not change their diet on being made unemployed they would have been more likely to gain weight.

There are problems with this explanation. Although not significant, the association between unemployment and weight loss for good readers is of comparable strength to the association between unemployment and weight loss for moderate readers, and would suggest that good readers may not be immune to the effects of unemployment. In addition, other plausible mechanisms could explain why poor readers gain weight on being made unemployed; for example, living on benefit may restrict individual's ability to purchase any food other than the lowest quality, high calorie foods.

8.4.4. Mathematics

The only significant interaction that was found between mathematics and unemployment was for the developmental trajectories for women in the prediction of limiting longstanding illness. One possible explanation is that the "high performers", "transient lapse" and "moderate decreasers" have more resources, and thus are more resilient to the health effects of unemployment. An alternative explanation is that women with poorer mathematical ability only have access to low paid manual work for which a physical disability is likely to hinder employment chances and by definition a physical disability that affects employment chances is a long-term limiting illness. In contrast, women with better mathematical ability have access to a wider variety of jobs and disability is less likely to hinder employment prospects and therefore less likely to be described as a limiting illness. There is some support for this interpretation; men without formal qualifications have been found to be at greater risk of limiting longstanding illness (Bartley et al., 2005).

8.4.5. BMI

For only one of the men's developmental trajectories was there a significant association between unemployment and health. This was for the "typical development" trajectory, the largest developmental trajectory, and within this trajectory unemployment had an adverse effect. The lack of significance for the other trajectories may be due to them containing relatively few individuals. On the evidence available it is difficult to draw any conclusions about how BMI is implicated in altered relationships between unemployment and health.

In addition, it is hard to explain why thin women have better chances of good health if they experience unemployment. Thin women had increased risk of limiting longstanding illness (see appendix 2), so that unemployment could represent a disruption of women's lives that led to their putting on weight and thus experiencing better health. However, if this was the case there would also be a significant interaction in the prediction of weight change, but this was not found. Alternatively, unemployment could be an indicator of remaining economically active, for which there is a health selection effect. In this scenario, unhealthy thin women drop out of the labour force and are thus not exposed to the risk of unemployment, whilst healthy women would remain economically active and thus remain at risk of unemployment. Neither of these explanations suggests that unemployment is a challenge towards health and so using the term resilience would be inappropriate. It is highly likely that the interaction between BMI and unemployment was found by chance and that defining it as significant is committing a type I statistical error.

8.4.6. Resilience to the health consequences of unemployment

There were relatively few significant interactions despite using a somewhat generous significance level: 100 tests for interactions were conducted and only 14 were significant interactions at $p \leq 0.1$ level, so it cannot be ruled out that the majority were chance findings. This is likely to be the case for the interaction between the single time point measure for externalizing symptoms in the prediction of weight change for women and the interactions between BMI and unemployment for both men and women, for which possible mechanisms were speculative at best.

Those interactions which had associations that would most conveniently fit the definition of resilience are restricted to the single time point measures for internalizing and reading for men. Men who had no internalizing symptoms are likely to have attribute(s) that are "protective stabilizing", which indicates resources that improve health in general and make individuals resilient to the effects of unemployment. As the number of symptoms that men have increases, their vulnerability to poor health also increases: this increase is more rapid when they are exposed to unemployment. The form of the non significant interactions between internalizing and unemployment for the other outcomes (see figure 8.3) supports the concept that an absence of internalizing symptoms indicates resilience to unemployment.

Reading is indicative of resilience to some of the health effects of unemployment. Self rated health would suggest that good reading has a protective stabilizing effect and thus indicates resilience to unemployment. The circumstances of poor readers are so detrimental that unemployment cannot make matters worse. The result for the interaction between GHQ and unemployment supports the concept that only moderate readers are vulnerable to unemployment. The interaction between reading and unemployment in the prediction of weight change offers equivocal results concerning whether good reading ability indicates resilience, and suggests that poor and moderate readers have different types of vulnerability and that the processes leading to change amongst the unemployed needs further research.

For women there are interactions, but these should not be interpreted as resilience to the health consequences of unemployment. It is difficult to explain why women who have high internalizing symptoms have better health if they are unemployed. These women were also at greater risk of becoming unemployed, and this only emphasises the complexity of the relationship between health and women's roles.

For women, the interaction between unemployment and the mathematics trajectories for limiting longstanding illness may indicate a form of resilience, but this may not necessarily be resilience to the health effects of unemployment. The most likely explanation for the result is that mathematical ability indicates resources that help protect people with disabilities, which are also likely to be limiting longstanding illnesses, from being selected into unemployment, and thus mathematical ability provides resilience against the effects that disability has on employment prospects.

Mathematics for women aside, there were no meaningful interactions between unemployment and the developmental trajectories. This could be for two possible reasons. Firstly, developmental trajectories are a summary of a person's development throughout the life course and the accumulated affects across the life course may have a pre-determined impact on future health which will be little altered by subsequent challenges. Alternatively, it may simply be that the level of resources achieved is more important than how those resources developed. Thus a single time point measure recorded closer to the experienced challenge is a better indicator of resources that enable resilience.

8.4.7. Strengths and weaknesses

The variables used in this chapter are the same as those used in chapter 7, so many of the strengths and weaknesses that applied in chapter 7 also apply to this chapter. Two of these strengths and weaknesses need to be highlighted. Firstly, unemployment is likely to have occurred a long time prior to the health outcome, and therefore the resilience that has been identified may be better considered as resilience to the general life changes following unemployment rather than resilience to unemployment itself. Secondly, individuals with economic activity data have better health than the whole NCDS sample, so it is likely that the effects of resource variables were under-estimated.

Statistical interactions, which were used to operationalize resilience, lack statistical power. This was partly off set by using a more sensitive but less specific cut-off for statistical significance of $p \leq 0.1$. However, this did increase the risk that statistical type I errors would occur. Hopefully, this was off set by discussing the plausibility of the processes that could explain such interactions. Ideally, these results would be confirmed in other studies. Existing studies investigating interactions between unemployment and potential indicators of resources are mixed. The Kivimäki et al. (2003) studies would suggest that hostility can indicate both increased and decreased vulnerability. The Wiggins, Schofield, Sacker, Head and Bartley (2004) study would suggest that those with more advantaged social positions are more vulnerable to the effects that unemployment has on psychological distress, whilst other studies would suggest that it is those from manual rather than non manual backgrounds are more vulnerable to unemployment (Thomas et al., 2007; Wadsworth et al., 1999). Therefore further research is needed to clarify which factors protect against the effects that unemployment has on health.

As there were only limited associations between unemployment and health, it was not clear whether interactions between unemployment and resources for women should have been tested. However, at least for one health outcome, self rated health, there was a significant association with unemployment and the limited association between unemployment and health may be because women are largely resilient. The interactions that were found would reinforce the need for more research on the importance of unemployment for women. A simplistic interpretation of these results would suggest that being unemployed is better for some women's health. However, it can not be ruled out that unemployment is simply an indicator of being economically active, and this issue needs to be clarified before making decisions about policies encouraging mothers into work.

The interpretation of interactions was in some cases difficult. For example, the interaction between the BMI developmental trajectories and unemployment in the prediction of self rated health for men indicated that unemployment should have different associations with health depending on trajectory membership. However, deciding which trajectories had truly different effects for unemployment was impossible because the association between unemployment and health was only significant for one of the developmental trajectories. Matthews and Altman (1996) have suggested that effects sizes rather than p values should be used to interpret interactions. In this study the odds ratios are the measure of the effect size. Using this interpretation it could be argued that for men with high BMI growth rates (members of the "constant increaser" and "early developers" trajectories) employment enhances health, whilst for men with relatively stable BMI's (members of the "typical development" and "consistently heavy" trajectories) unemployment has a detrimental effect. This issue would be clarified if the summary measure for BMI focused more on growth rates rather than the overall development trajectory identified using latent class clustering.

8.5. Conclusions

There are indications that good reading ability and an absence of internalizing symptoms at age 23 represent resources that make men more resilient to the effects that unemployment has on health. These measures of reading and internalizing symptoms were both indicated by single time point measures, and this suggests that the health effects that are a consequence of developmental trajectories are little altered by subsequent circumstances, or alternatively that single time point measures are better indicators of resources to meet unemployment. Other interactions were found but there were no obvious mechanisms for them, and it can not be ruled out that the results were chance findings. The interactions between resources and unemployment for women were ambiguous: further research is required to understand what unemployment indicates for women.

Chapter 9: Discussion and Conclusions

9.1. Introduction

The themes developed across this thesis are drawn together in this chapter. The results, theories and methodological issues that have emerged are synthesized into 7 sections.

The first section focuses on the developmental trajectories and investigates the similarities and differences in their origins.

The second section focuses on unemployment. A brief description of the evidence that unemployment is a challenge and the nature of protection are covered as well as discussion of why unemployment was not a good indicator of challenges for women.

The third section focuses on resilience. There is a brief discussion of the results and there is an exploration of why some resources indicate resilience and other do not. In addition some other ways operationalizing resilience are described.

The fourth and fifth sections address methodological issues. The fourth compares the necessity of taking a life course approach to summarizing data as opposed to using a simpler measured based on a single time point. The fifth section, looks at how characteristics of the data and the selection criteria may have influenced the trajectories identified. In addition, there is a discussion on how the trajectories should be interpreted.

The sixth section takes a brief look at the implications of the results and discusses the extent to which the results can be generalized to younger cohorts.

The chapter ends with a brief statement of the conclusions.

9.2. Developmental trajectories

This is not the first study to identify group based developmental trajectories of emotional well-being, cognitive ability and BMI, but, earlier studies have not had the same focus.

Work on emotional well-being has focused primarily on narrow measures of behaviour or well-being such as physical aggression (Broidy et al., 2003) or depression (Brendgen et al., 2005). The studies modelling cognitive ability by Duchesne et al. (2005) and Muthén (2004a) covered a period of only 3 years, and the only study modelling BMI (Mustillo et al., 2003) chose to use a simple dichotomous indicator of obesity rather than treating BMI as a continuous measure. Thus the aspects of resources modelled in this thesis extend the literature.

The methodologies used in this thesis are different from those used in previous studies. The majority of existing studies use latent class growth analysis or growth mixture modelling and thus the use of latent class clustering provides a different way of summarizing the data.

Finally, prior to this thesis, mixture models had not been used to summarize data from British samples. Therefore, the NCDS data provided the opportunity to apply new methods in a different context and with each of the developmental domains different types of trajectories were identified.

9.2.1. Trajectories across the developmental domains

The trajectories identified across the domains indicated very different processes and patterns of development. However, within each domain the process for both genders were very similar, with the caveat that similarity between the sexes was one criterion used to determine the most useful models.

For, externalizing symptoms the 5 trajectories identified were so similar for both genders that the trajectories were given the same names (see table 4.8). There were two trajectories containing individuals whose elevated symptoms were greatly reduced by adolescence and were not constant problems across childhood. These trajectories were the "late childhood" and "decreasers" trajectories. Whilst there were 3 trajectories suggesting more stability of externalizing symptoms, which were termed "high increasers," "moderate increasers" and "consistently low".

The internalizing symptoms developmental trajectories indicated that that elevation of internalizing symptoms was limited to relatively discrete periods. For women, the most useful model consisted of 4 trajectories (see table 4.12). The trajectories were termed "mid childhood", "late childhood", "adolescent" and "consistently low". For men an additional trajectory was identified. This trajectory was termed "early adulthood". As all the trajectories indicated that internalizing symptoms were restricted to relatively discrete periods, it was concluded that group based developmental trajectories were not a useful way of summarizing internalizing symptoms across the life course and an alternate method was used.

In contrast to the emotional well-being trajectories, the reading trajectories emphasised stability of relative cognitive ability across time. The 4 trajectories for men were termed "very poor", "weak", "moderate" and "competent" and 5 trajectories for women were termed "very poor", "weak", "moderately weak", "moderate" and "competent" (see table 5.8).

For mathematics trajectories there was again an emphasis on stability of development. However, amongst those of above average ability there was some indication that relative position of trajectories could vary. Broadly the patterns were similar for both genders. Three of the trajectories for both genders were given the same name. Two of these trajectories indicated relatively stable development "high performers" and "general population" (see table 5.12). The third trajectory "moderate decreasing" for both genders indicated a relative decline in ability at age 16. The fourth trajectory for men was called the "late developers" and members of this trajectory had an improvement in relative mathematical ability between the ages of 11 and 16. The trajectory for women was called "transient lapse" and indicated individuals who had a decrease in relative ability between the age of 7 and 11 and then an improvement between 11 and 16.

The models for the BMI trajectories of both genders were relatively similar. The models selected for both genders had the same number of trajectories and the same names were used to label those trajectories. The "typical development" trajectory indicated a slow steady increase in BMI consistent with healthy development. The "consistently heavy" trajectory indicated very limited increases for individuals who initially had a high BMI. Using some criteria this trajectory would indicate obesity in early childhood. However, this trajectory does not progress to adult obesity. A third trajectory, the "early developers", indicated a surge between age 7 and 11 after which growth was steady. The final trajectory, "constant increasing", had a relatively healthy BMI at age 7 which then steadily increased and had mean BMI indicating obesity at age 23.

Overall, the trajectories for each of the resources had very different emphases. Stability for cognitive ability, gradual change for BMI, and both persistent and discrete problems identified for emotional well-being. However, the most disadvantaged trajectories did show common origins.

9.2.2. Associations with exogenous variables

One of the aims of the thesis was to test if the developmental trajectories were associated with indicators of both social and biological origins. This would suggest factors underlying the trajectories, and, if the associations were as predicted by theory, provide support for the trajectories being a useful summary of the data. The social origins were indicated by parental social class at birth and the biological origins by birthweight and gestational age.

Social class

Parental social class was associated with the trajectories for externalizing, internalizing, reading and mathematics, for both genders. Parental social class was even able to differentiate between the mathematics trajectories of intermediate ability. Parental social class had more limited associations with BMI; men and women with parents from more disadvantaged social backgrounds had a higher risk of membership of the "constant increasing" trajectory. This is the only trajectory for which there were disadvantaged outcomes in terms of unemployment (and health, see appendix 2). The only other association between social class and the BMI trajectories was that men in social class v (unskilled manual) were less likely to be members of the "consistently heavy" trajectory. There is little evidence that members of this trajectory experienced future disadvantage. Thus the roots of disadvantaged trajectories could be said to have their origins in disadvantaged social circumstances.

The literature predicted that social disadvantage would be associated with subsequently poorer development, and the results are consistent with this. Social class in this thesis is considered to be one of many social determinants (Regidor, 2006; Wilkinson & Marmot, 2003), including parenting, schooling and diet, that could explain the relationships between social class and the trajectories.

Biological factors may also explain the relationship between social class and the trajectories. It has been proposed that social class is an indicator for genetically determined intelligence (Gottfredson, 2004). However, although genetic influences may have played a part in shaping the developmental trajectories, they are unlikely to be the sole explanation for the associations between social class and the developmental trajectories. Secular changes have occurred in emotional well-being (Collishaw et al., 2004), cognitive ability (Flynn, 1987) and BMI (Canoy & Buchan, 2007; Stamatakis et al., 2005), at rates which are far too rapid to be explained by genetic changes.

Birthweight and gestational age

Birthweight and gestational age have to be considered together because birthweight is a product of foetal growth rate and gestational age (Leon et al., 2000). The analyses were conducted using categorical variables and broadly 3 different groups of individuals could be identified who were at risk of poor development. These groups were high birthweight infants, preterm births and low birthweight infants.

A high birthweight may be due to healthy development, but may also indicate macrocosmic babies who are at increased risk of diseases such as obesity and diabetes (Jolly, Sebire, Harris, Regan & Robinson, 2003). A preterm birth represents infants who are born before 37 weeks of completed pregnancy. In the NCDS, there were relatively few children born preterm and inaccuracies in measurement of gestational age may have lead to miscoded term births making up a relatively high proportion of the preterm category. Infants may have a low birthweight for a number of reasons, including a slow foetal growth rate, being born preterm, maternal smoking or being born as one infant of a multiple birth, and it cannot be assumed that all the mechanisms have the same consequences.

High birthweight had limited associations with the emotional well-being and cognitive ability developmental trajectories. High birthweight was associated with increased risk of membership of only one externalizing trajectory, "high increasers" for women, and one internalizing trajectory, "mid childhood" for men, and with reduced risk of membership of one trajectory of cognitive development, the "moderate decreasing" mathematics trajectory for women. These associations could have occurred by chance so it is unlikely that a high birthweight indicates increased risk of poor social and emotional development. However, for both genders higher birthweights were associated with increased chance of membership of the "consistently heavy" trajectory and to a lesser extent the "early developers" trajectory, but not the "constant increasing" trajectory. The latter trajectory contained individuals who on average were relatively thin at age 7, but went on to become obese by age 23. These results suggest that those heavy at birth have a predisposition to be heavy throughout life.

Being a preterm birth was not associated with any of the BMI trajectories and had mixed associations with the emotional well-being trajectories. The associations with emotional well-being were more consistent for men. For men, being born preterm was associated with one of the externalizing trajectories (increased risk for the "late childhood" trajectory), and of the two of the internalizing trajectories (increased risk for membership of the "late childhood" and "early adulthood" trajectories). For women, the only emotional well-being trajectory associated with preterm birth was the "mid childhood" internalizing trajectory. For both genders, preterm birth was associated with poorer cognitive development, as indicated by both maths and reading. Thus it can be concluded that this thesis provides evidence that preterm birth is associated with poorer emotional and cognitive development, but not with poorer physical development as indicated by BMI.

Low birthweight was associated with increased risk of membership of some of the disadvantaged emotional well-being and cognitive ability trajectories for both men and women. In particular, for both genders, low birthweight was associated with both the "decreasers" externalizing trajectory and the "mid childhood" internalizing trajectory, suggesting that low birthweight indicated poor development in early childhood, possibly due to developmental delay, rather than problems that persist throughout childhood.

The associations between the developmental trajectories and birthweight and gestational age, tended to be reduced when birthweight and gestational age were included in the same model; thus, it is likely that low birthweight does to some extent indicate the same problems as preterm birth. The developmental trajectories' relationship with low birthweight and preterm birth can be explained through a number of mechanisms.

One potential mechanism, birthweight as an indicator for social class (Bartley et al., 1994), can be ruled out because the associations between birthweight and the trajectories do not change after adjusting for social class. However, it is still possible that associations may be explained by other social factors. Maternal distress has been associated with birthweight and preterm birth (Rondó et al., 2003), and persistence of this distress into childhood is likely to cause developmental problems. In addition, it has been suggested that birthweight and preterm birth may trigger maternal rejection (Keren et al., 2003) which is likely to lead to poorer development. However, biological mechanisms are more commonly used to explain associations between poor development and birthweight and preterm birth.

Overall social class is implicated in the development of all the resources. A high birthweight is associated with being heavier throughout childhood but not the subsequent development of obesity, whilst low birhtweight and preterm birth are linked to cognitive and emotional development. Future research needs to investigate a myriad of other factors which could be shaping the developmental trajectories. Especially pertinent would be analyses testing for associations between the "early developers" BMI trajectory and pubertal development, and analyses testing for associations between the mathematics "moderate decreasing" trajectory and school characteristics. Genetic factors may also underpin some developmental trajectories.

9.3. Unemployment

Unemployment was proposed to indicate a challenge towards health. This was utilised to indicate circumstances that individuals could both be protected from experiencing, and be more resilient to if experienced.

9.3.1. Unemployment as a challenge towards health

The results for men would suggest that unemployment did indicate circumstances which had an adverse impact on health. Thus potentially unemployment does indicate challenges towards men's health. However, the associations were only of moderate strength; odds ratios ranged from 1.5 for weight loss to 1.7 for limiting longstanding illness. The associations between unemployment and health were expected but could not be assumed because increasing numbers of men are becoming economically inactive rather than unemployed.

For women, unemployment had very limited associations with the health outcomes. The only significant association was for self rated health and significance was approached for malaise and GHQ. Thus it should be questioned whether the measure of unemployment used was a good indicator circumstances that challenged health for women.

The health outcomes themselves were all self rated measures. Self rated measures have been shown to be related to morbidity and mortality (Idler & Benyamini, 1997; Manor et al., 2001), but it would be useful to know if the same results could be obtained using clinical measures and biomarkers for disease. In particular, having a weight change measure based on values measured by independent observers would help eliminate any biases caused by social desirability.

9.3.2. Protection from experiencing unemployment

For men all the indicators of resources were strongly associated with unemployment. Thus the resources are likely to be indicators of factors that protect people form experiencing unemployment. This is consistent with the literature and indicates that unemployment was related to disadvantaged circumstances.

In contrast, for women, unemployment was only associated with one of the indicators of resources, internalizing symptoms. The lack of associations with the other resources does again raise the question of whether the unemployment is a valid measure of circumstances for women.

9.3.3. Unemployment and women

Using data in this thesis it was possible to explore two possible explanations for why unemployment is not a good indicator of challenges for women. One possible reason was that too few women had experienced unemployment. This, however, was not the case. Fewer women than men experienced unemployment, but the number of women, 774, was still substantial. The other explanation is that there are sub-groups of women for whom unemployment has opposing effects. When the sub-groups are combined in one population the effects nullify each other. In part, this was explored by investigating which resources provided resilience to unemployment and the results provided little evidence to support this hypothesis. There are other reasons, which were not explored using data in this thesis, which would explain why unemployment may not be a good indicator of challenges for women. These reasons include gender specificity of skills, role conflict, gender differentials in the benefits of employment, the challenge of being out of the labour force, unemployment being less stressful for women and biases in reporting. Some of these explanations apply primarily to specific groups of women whilst others will apply to all women.

Gender specificity of skills

Unemployment may have had a smaller impact on the health of women because as the economy has changed skills have traditionally though as being female have become more important. The industries that declined most over the course of NCDS cohort members' lives were heavier industries such as mining. The jobs in these industries were dependent on skills typically considered male, for example tool use (Bynner, Morphy & Parsons, 1996a). In contrast, the greatest growth in jobs was for the service sector and access to these jobs would be easiest for skills that are traditionally thought of as being women's skills, for example, writing, care, keyboard skills and teaching (Bynner et al., 1996a). Thus the changes in the economy restricted the opportunities for men whilst generating more opportunities for women.

Role conflict

Women carry a greater burden of domestic responsibility and it is widely acknowledged that women have to tackle multiple roles (Arber, 1997). Women in multiple roles generally have the best health (McMunn, Bartley & Kuh, 2006), but these women also have the best jobs (McMunn et al., 2006) and so are likely to able to afford domestic help. When the burden of domestic and paid work has been considered, the combined burden has been an increased risk of poorer health (Blane, Berney & Montgomery, 2001). Thus the benefits of being employed may be reduced for women.

Gender differentials in the benefits of employment.

It is not just the stresses of role conflict which will affect women's health. Conflicting roles may limit a women's career development. Mothers' careers are more strongly affected. The difference between women without children and mothers is much greater than the gap between genders (Paull, 2006).

Very few men with children leave work to take on domestic responsibilities. In general, men with children tend to have more successful careers than men without children (Bynner et al., 1996a). However, despite considerable improvements for mothers' wanting careers, for example the introduction of maternity leave, becoming a mother still had a considerable impact on a woman's employment prospects.

The impact is primarily driven by the age of the youngest child (Dex et al., 1998), but every stage of a child's development will have an impact on a women's career (Paull, 2006). As a result, in the NCDS, mothers with a child under the age of 3 were most likely to be out of the labour force (Joshi et al., 1996) and thus not at risk of experiencing unemployment. Mothers with children between the ages of 3 and 10 were most likely to be in part time work, and mothers generally tend to return to full time work when their children had reached the age of 11 (Joshi et al., 1996). Some caution for these figures has to be applied as they would have been based on younger and generally less educated mothers.

The impact of taking a part-time job may be great. Part-time work can be particularly detrimental as part-time work has more negative characteristics than full time work (Matthews, Hertzman, Ostry & Power, 1998), provides fewer opportunities for training (Bynner et al., 1996a), and in general leads to reduction in chances for career advancement and an increased risk of downward career mobility (Dex et al., 2006).

Downward mobility is not just restricted to women working part-time. The difficulties of caring for children will also slow career progression for women working full time. Many women despite being enabled to return to their old jobs following maternity leave, subsequently find there career trajectory moving downward and moving into non supervisory roles (Dex et al., 2006). Overall mothers are less likely to be using their skills to their full potential (Bynner et al., 1996a)

It is not solely the conflict between domestic and paid work that inhibits a women's ability to gain from a career. The financial benefits of careers for women may be less for other reasons. Many women may want to work, but simply do not because working may leave women finically worse off when the costs of childcare and lost benefits are taken into account (Dex et al., 1998). This is particularly true of women with unemployed partners who are most likely to suffer from loss of benefits (Joshi et al., 1996). However, women married to men on high incomes are also less likely to work. In general, a woman's own potential earnings encourages them into the labour market whilst her partner's earnings discourages her from joining the labour market (Dex et al., 1998).

Thus despite the many gains for women in NCDS compared to previous generations, women when compared to men are less likely to have successful careers and receive fewer benefits from employment.

Challenges of being out of the labour force

As already indicated women may spend considerable periods either out of the labour force or in part time work. This has an impact beyond the effects it has on limiting careers. Looking after the home and family is associated with poorer health (Thomas et al., 2005) and this effect is likely to be confounded by childbearing. Women with more children are likely to have spent longer out of the labour force and be at increased risk of being overweight or obese (Gunderson & Abrams, 2000; Kim, Yount, Ramakrishnan & Martorell, 2007). Thus women who are at little or low risk of unemployment will be exposed to non-employment related challenges which could have a negative impact on health.

Unemployment being less stressful for women

Unemployment is likely to be less stressful for women. The idea of employment and being employed, is considered central to male identity (Bynner & Parsons, 2000) and loss of employment may have a dramatic impact on a man's self-esteem. In contrast, women have many other sources of identity (Bynner & Parsons, 2000). It is also more socially acceptable for women to be housewives (Kivimäki et al., 2003), thus women will be less stigmatised by unemployment. In addition, women are more likely to have social support outside work making women much less vulnerable (Kivimäki et al., 2003). Thus becoming unemployed is likely to be less stressful for women.

Biases in the reporting of unemployment

Biases in reporting are also likely to have led to an underestimation of the effects of unemployment for women. There are many reasons why women may be less likely to report unemployment (McGinnity, 2004). In this thesis, the best evidence of biased reporting of women's unemployment is that there is a sharp reduction in the proportion of women experiencing unemployment between the ages of 33 and 34. The age 33 data were collected in sweep 5 and the age 34 data were collected in sweep 6, suggesting that the data collection methods influenced the results.

It should also be noted that biases in reporting may have also underestimated the effects of unemployment for men. Within the NCDS there is a general trend of men being declared out of the labour force rather than being declared unemployed. However, for economic activities recorded immediately prior to the age 41/42 interview, there was an immediate fall in the proportion of men out of the labour force and a rise in the number of men unemployed. This suggests that the way in which the questions about unemployment were asked also influences the responses for men. The effects of this bias, in the age range measured in this thesis, may have been minimal for the NCDS cohort. Those declaring themselves out of the labour force in their late 30s/early 40s are likely to have declared themselves as being unemployed at an earlier age and thus are included in those experiencing unemployment. The bias is more likely to be a problem for future studies focusing on the NCDS sample in middle age onwards, and other studies for which economic activity has been collected more recently.

9.3.4. Concluding unemployment

Despite changes in womens' relationships with the labour market unemployment was not a good indicator of challenges for women. Methods such as optimal matching which can take into account when unemployment occurred in a women's career and other economic activities states across the life course (Martin et al., 2007; Schoon et al., 2001; Wiggins et al., 2007) may be a useful approach when operationalizing the challenge's women face. In contrast, for men, unemployment was an indicator of challenges and an area for which resilience needs to be investigated.

9.4. Resilience

There were significant interactions between unemployment and the indicators of resources for the prediction of health for both genders. For women, the significant interactions were not in a form that could be meaningfully described as resilience and the results highlighted the difficulty in operationalizing activity states for women. This suggests that other approaches are needed to operationalize resilience. For men, there were interactions that could be interpreted as indicating resilience with the relevant indicators of resources being internalizing symptoms and reading.

Absence of evidence for interactions does not conclusively prove that externalizing symptoms, mathematics and BMI do not provide resilience, but it is plausible that these measures do not indicate the presence or absence of the most relevant resources. Externalizing symptoms despite indicating disadvantage may also indicate people who will actively face challenges, even if the way they respond is not considered appropriate. In comparison, those exhibiting internalizing symptoms may respond more passively and thus are more helpless in the face of adversities. Finally, the skills represented by mathematical ability may be less critical than reading ability for coping with the challenges of unemployment.

There are many possible reasons why good readers and an absence of internalizing symptoms could provide the resources to be resilient to unemployment. However, the evidence is for resilience as indicated by the measure used in thesis, rather than a more generic concept of unemployment.

The unemployment measure used identifies individuals who experience a period of unemployment of at least 3 months. This is what could be considered median term unemployment and will represent numerous sub-challenges, many of which will be mutually exclusive. For some individuals median term unemployment could progress into long-term unemployment, or temporary employment punctuated by repeated episodes of unemployment. If this is the case, the resources that provide resilience are likely to be resources that are utilized to the face the challenges represented by deprivation. In this case the resources represented by reading ability may include alternative sources of income or the ability to use spare time constructively, and the resources represented by an absence of internalizing symptoms could include a strong social network, or a general tendency to tackle the stresses of deprivation rather than be paralyzed by anxiety.

For others median term unemployment may not develop into long term unemployment or repeated episodes of unemployment. This would result in a very different type of resilience. Individuals may not be resilient to the deprivations caused by unemployment, which they would not have experienced, but, instead would have the resources to indicate resilience to challenges such as job-seeking. In this case reading ability could indicate skills or the potential to develop skills required to obtain a job, whilst the absence of internalizing symptoms could indicate a wider social network that could help identify job opportunities or a positive approach to life that would help in jobs interviews.

Distinguishing between the different challenges that are generated by unemployment will require more complex coding of the data and additional information. One approach would be to take a more holistic view of how economic activities fit within the life course and other aspects of life. An alternative would be to focus on many of the challenges which may occur for the unemployed. Examples of such challenges include social and material deprivation, the event of job loss and the process of job seeking. Others areas could be investigated in the role of challenges. Other factors that are detrimental include specific events such as bereavement or divorce, and more general measures of adversity represented by scales of life events and daily hassles.

In addition to broadening the scope of challenges investigated, it should not be assumed that resources that provide resilience to health provide resilience to other outcomes, such as family formation, relationships and offspring behaviour. Furthermore, the resources utilized in this thesis were selected in part for their ability to modelled across the life course, other factors that could provide resilience include qualifications, finances, social support, membership of organisations, hobbies and personality types.

9.5. The use of life course measures to predict outcomes

One of the aims of the thesis was to evaluate the advantages and disadvantages of two methods of summarizing resources, namely group based developmental trajectories and single time point measures. Both methods were used to test hypotheses relating to protection and resilience. The results of each methodology were compared in order to evaluate the methods. The majority of the analyses did not produce significant results for women. Therefore, the majority of conclusions drawn about the methodologies relate to results for men.

The associations between the externalizing symptoms developmental trajectories and unemployment were strongest for trajectories with raised externalizing symptoms at age 16. The trajectories indicating elevated externalizing symptoms at 7 or 11 did have weak associations with unemployment, but these trajectories also had marginally elevated symptoms at age 16, and for these trajectories any associations may also have been explained by symptoms at age 16. For externalizing symptoms, it could be concluded that developmental trajectories helped to identify patterns of development that increased risk of unemployment. However, for general analyses a single time point measure at age 16 is likely to be a reasonable summary of the risk of unemployment.

An alternative a priori method was used to summarize internalizing symptoms across the life course because the developmental trajectories for internalizing symptoms provided a poor summary of the data. A comparison of the results for the life course measure and the single time point measure, and subsequent analyses including both measures in the same model, would suggest that the life course method is a better way of summarizing risk of unemployment. However, the only significant interaction between internalizing symptoms and unemployment for health was for the single time point measure. Internalizing symptoms in early life, represented by the life course measure, could indicate a variety of social and educational problems. These problems may lead to poor social development, which in turn leads to poorer employment prospects, but may not alter processes directly related to health and thus does not have an effect on health. However, there is an alternative explanation. The single time point measure was a self rated measure, whilst the life course measure included both self report and teacher report measures. It may be that external observer based measures are better indicators of social functioning and thus more relevant to unemployment, whilst the self rated measure is a better indicator of well-being and so a better indicator of protection against adverse effects on health.

The reading trajectory models supported the concept that reading is a stable trait. This stability means a single measurement across childhood is likely to be a good indicator for future employment prospects.

The mathematics trajectories provided an opportunity to identify which ages were more important for the prediction of future employment prospects. A comparison of the "moderate decreaser" and the "late developer" trajectories suggested that mathematics ability at age 16 was more important for future prospects than mathematics ability measured at earlier ages. Thus, a single time point measure of mathematics at age 16 is likely to be a reasonable summary of mathematics and better than measures recorded at earlier ages.

The use of BMI developmental trajectories demonstrated that childhood obesity, which does not progress to adult obesity, does not alter the chances of becoming unemployed. There was also weak evidence that unemployment had different consequences for individuals whose BMI was stable compared to those for whom BMI was increasing at a rapid rate. However, the use of developmental trajectories to model BMI also had a significant disadvantage. The trajectories failed to identify a thin group of men who had increased risk of unemployment. The single time point measure at age 23 was thus a better measure of future employment prospects. The main benefit in using developmental trajectories to summarize BMI was that the trajectories did raise questions about assuming that childhood obesity progresses into adult obesity.

Mathematics for women aside, there were no meaningful interactions between unemployment and the developmental trajectories. This could be for two possible reasons. Firstly, developmental trajectories are a summary of a person's development throughout the life course and the accumulated affects across the life course may have a set impact on the chances of poor health that is relatively unaltered by unemployment. If this is the case the single time point measure, being a point estimate, is less likely to indicate somebody on a fixed pathway and thence more susceptible to subsequent challenges. Alternatively, it may simply be that the level of resources achieved is more important than how those resources were constructed.

It can be concluded that, for the majority of resources, a single time point measure, recorded at a time close to the period of economic activity, is an adequate indicator of resources that protect against both experiencing unemployment and the health consequences of any unemployment that was experienced. However, these conclusions apply to protection against only one challenge, unemployment. Different conclusions may arise for other challenges. The advantages and disadvantages of using developmental trajectories may also have been different if the developmental trajectories had been operationalized using a different methodology.

9.6. The use of latent class clustering to model development

The latent class clustering approach used in this thesis is one of many possible ways of summarizing data and it has advantages and disadvantages. These advantages change depending on the methodology applied and the data utilized. This section starts with a discussion of how the characteristics of the data used would have determined the shape of the trajectories identified. Then moves on to how the different selection criteria were used to select models. The section finishes with a discussion of how trajectories should be interpreted.

9.6.1. The indicators of trajectories

Two key aspects of the data shape the trajectories. The time span covered by the trajectories and the properties of the scales used to measure the trajectories.

Time span covered by the trajectories

The time span covered by the trajectory indicators plays a key part in determining the trajectories that can be identified (Connell & Frye, 2006). Trajectories can only be identified for time periods covered by the data and differentiating between some trajectories is only possible if there is sufficient resolution in the data to identify when individual developmental changes occur. Thus the age range and the number of indicators covering that age range play a key role.

For externalizing symptoms, reading and mathematics, there were only 3 indicators across 9 years, whilst in the case of internalizing symptoms and BMI, 4 indicators spanned a period of 16 years.

The frequency of indicators was adequate for the cognitive ability trajectories. The trajectories modelling reading development suggested that reading ability was stable. So it is unlikely that having trajectory indicators measured at shorter intervals would have identified trajectories with different shapes. The development of mathematics was again relatively stable, with the exception that two of the trajectories crossed for both genders. Having more frequent indicators would help identify when changes in mathematical ability might occur and so give better clues to underlying causes.

The BMI developmental trajectories had relatively steady growth rates, so the frequency of indicators used to model the trajectories is likely to be adequate. However, having more indicators would help identify differences in the development of boys and girls. The indicators were measured at relatively long time intervals; a minimum of 4 years. This made it very difficult to distinguish between groups who have similar BMIs at the start and the end of an interval, but have BMI growth spurts occurring at different ages. In addition, more trajectory shapes may be identified in populations which contain a greater proportion of children with a high BMI.

The greatest benefits of having more frequent indicators are likely to occur for emotional well-being. For externalizing symptoms, having more indicators is unlikely to have changed the shape of the two trajectories of relatively stable symptoms, as indicated by "moderate increasers" and "high increasers." However, for the "late childhood" and "decreasers" trajectories, which are primarily driven by high levels of symptoms at one time point, extra information would be helpful. In both cases it would be useful to distinguish if the trajectories were the result of extreme levels of symptoms at one acute point in time or the product of a more gradual change in the number of symptoms.

Having more frequent indicators may also help explain why the internalizing trajectories modelled using latent class clustering did not identify groups of individuals with continuously elevated internalizing symptoms. It is possible that internalizing symptoms are the results of discrete events, which develop and recede over a relatively short period. However, it is also possible that the indicators of internalizing symptoms were measuring different concepts.

The properties of scales

Ideally, when tracking development the indicators should be measuring the same construct and distribute the populations in the same manner (Goldstein, 1979; Owens & Shaw, 2003). One method of doing this is to use the same scale at more than one age. For BMI, which is considered to be a good measure to track relative weight across time (Power et al., 1997b), the use of the same measure at each age is unlikely to have caused a problem, but, when modelling trajectories for the other resources some issues needed to be considered.

Externalizing and internalizing symptoms at both the ages of 7 and 11 were measured using the Bristol Social Adjustment Guide (BSAG) (Stott, 1969). However, a behaviour that is considered normal in a younger child might be considered to be pathological in an older child (Puura et al., 1998), so that identical scores at different ages are unlikely to indicate the same problems. The Reading Comprehension Test (Fogelman & Goldstein, 1976), which was used to assess reading at both the ages of 11 and 16, also posed problems. At age 11, the reading comprehension test was able to evaluate the full range of cognitive ability. In contrast at age 16, ceiling effects would have meant that variation amongst the best readers was not identified.

Where different scales are used to model trajectories, there are other considerations. Different scales are likely to be measured using different units. This can potentially be solved by standardizing the scales. However, the theoretical basis of the scales may be different. This could result in the variables having differently shaped distributions that make standardisation inappropriate. Alternatively the different theoretical basis may mean that the scales indicate very different constructs. The use of different scales is likely to have influenced the shape of the trajectories for all of the indicators of resources except BMI.

When the reading trajectories were investigated, a relative improvement in reading between the ages of 7 and 11 for members of the "very poor" and "weak" reading trajectories was suggested. However, the Southgate reading test (Southgate, 1962), used at age 7, was developed to identify problem readers. Thus the scores amongst the poorer readers were more widely distributed than the scores of average and good readers. In contrast, the reading comprehension test (Fogelman, 1983) was developed to assess more general ability and there is a more even distribution. Thus what appears to be an improvement in relatively ability is likely to be an artefact of the measures used.

For mathematics, the relative decrease in mathematical ability identified for the "moderate decreasing" trajectory may not reflect a decrease in relative ability. An alternative explanation is that the mathematics test used at age 11 and the mathematics comprehension test measured at age 16 require different skills. Thus the "moderate decreasing" trajectory could indicate individuals who have mixed mathematical abilities, rather than a relative decline in ability over time.

For externalizing symptoms the use of different scales posed few problems. However, in theory it is possible that the "high increasers" had the worst chances of employment, not because age 16 is the more critical period for employment prospects, but because the Rutter "B" questionnaire (Rutter, 1967) is a more appropriate measure of functioning than the BSAG (Stott, 1969).

The use of different scales to measure internalizing symptoms may have obscured any underlying developmental trajectories. One possible reason why trajectories of consistently elevated internalizing symptoms across time were not found is that at each age different problems are being measured. The Malaise scale at age 23 was a self rated measure. In contrast, the BSAG (Stott, 1969), used at the ages of 7 and 11, and the Rutter "B" (Rutter, 1967), used at age 16, were both based on responses made by teachers. It is entirely possible that the Malaise scale at age 23 indicates a sub-factor of internalizing symptoms relating to health, whilst the teacher report measures may measure a sub-factor of internalizing symptoms relating to social functioning.

For all of the resources, latent class clustering enables scales with differing properties to be combined to identify trajectories. However, if the theories underlying the scales are not sufficiently similar, the trajectories, instead of indicating patterns of overall development, may indicate groups of people with different skills and abilities. Thus features of the data can make the results ambiguous. There are also ambiguities in the statistical methods used.

9.6.2. Selection criteria

The modelling of latent class clustering requires subjective decisions to determine the selected models. These decisions include selecting the number of classes and fundamental decisions surrounding the purposes of the models.

The number of classes used to summarize the data has a critical role in determining the results of any analyses (Cudeck & Henly, 2003). In this thesis statistical and pragmatic criteria were used to select the number of classes. The statistical criteria consisted of: three information criteria measures, the Lo, Mendel, Rubin Likelihood Ratio Test (aLRT) and the entropy Index. The pragmatic criteria were sample size, the distinctiveness of the trajectories and the comparability of the complete cases sample to the fuller sample.

Statistical criteria

The information criteria measures

The three information criteria measures are: The Bayesian Information Criteria (BIC), Akaike's Information Criterion (AIC), and the sample size adjusted BIC (ssaBIC). None of these measures played a role in deciding the final model for any of the resources. All the other model selection criteria indicated that models containing fewer than 8 classes should be selected. In contrast, for every resource, the information criteria measures suggested that adding extra classes beyond the 8 limit used in this thesis would have improved model fit. (Preliminary models were run with up to 10 classes and the information criteria still suggested adding extra classes.) This may have led to models that more accurately summarized the data but would not have been practical for the further analysis required in this thesis. In other studies using large samples, information criteria measures have failed to help identify developmental trajectories (Loughran & Nagin, 2006) and studies investigating how the external validity compares between models selected on the basis of the BIC and other criteria would be useful.

Lo Mendel Rubin Likelihood Ratio Test

The aLRT uses a likelihood ratio test to compare models with K classes to a model containing one less class (Lo et al., 2001). The use of the aLRT was helpful in determining the number of classes in the models that were selected when used in conjunction with other selection criteria. However, use of the aLRT test has been disputed (Jeffries, 2003; Bauer & Curran, 2004; Connell & Frye, 2006) and in this thesis it did not always agree with the other criteria. For 4 of the final models, externalizing symptoms for both men and women, internalizing symptoms for men and BMI for women, the number of classes that the aLRT suggested as fitting the data best, agreed with the total number of classes in the final selected model. The aLRT suggested models that differed by 1 class from the final model in 2 cases, men's reading and men's mathematics. The aLRT suggested a model that differed by 2 or more classes from the model selected in the final analysis in 4 cases, women's internalizing, women's reading, women's mathematics and men's BMI. Overall, the aLRT did play a considerable role in determining the final number of classes of models used in this thesis but was not helpful in all cases.

Entropy index

The entropy index is a measure of the how accurately individuals can be allocated to a latent class and is an average of the highest posterior probability of class membership for each individual, with a higher score indicating a better model. When comparing different models to summarize a resource, the entropies were all similar to each other, with the exception being the reading trajectories for women. When modelling reading, a 6-class model had an entropy score substantially worse than the other models and so was rejected. The entropy index also played a role in determining the final model for mathematics for men. For the models summarizing mathematics, for both genders, the entropies were clustered around 0.70. A 5 class model for men was rejected on the basis that it had an entropy score of 0.677. This falls below a cut-off of 0.7 which has been suggested as indicating an acceptable level of fit (Loughran & Nagin, 2006). The entropy index had a role in selecting the final models. However, its role was primarily to rule out poorly fitting models rather than identifying the better models.

Pragmatic criteria

Three pragmatic criteria were used to help identify the number of classes that the selected model had. These criteria were: sample size, the distinctiveness of the trajectories and the comparability between the fuller sample and complete cases. The comparability of the trajectories for men and women also became a selection criterion during the development of the thesis.

Sample size

The sample size criterion was used to ensure that trajectories would have enough members to be of use in subsequent analyses. For only one of the resources, the BMI trajectory for men, did the final model include trajectories containing less than 200 individuals. Ironically, this was the only model for men to show a significant interaction with unemployment in the prediction of health, suggesting that different selection criteria should be used in future research. The reason for using sample size as a selection criterion was to try and improve statistical power. However, the results in this thesis would suggest that in future, classes with a lower number of cases could be allowed. Instead of a simple arbitrary cut-off based on sample size, it would be helpful if a more accurate fit index was developed. One possibility would be to balance improvements in explanatory power, gained by having a better fitting model, against losses in predictive power, due to the added classes having a smaller sample size.

Distinctiveness of the trajectories

The distinctiveness of the trajectories was selected as a criterion to identify the selected models, because it would be helpful if each additional trajectory indicated individuals who had distinctly different patterns of development. However, of all the criteria for selecting models, the distinctiveness of trajectories was the hardest to apply and was primarily applied in two contexts.

The first is exemplified by the models summarizing reading for women. For the majority of identified models all the trajectories were parallel. Increasing the number of classes to summarize the data simply added an extra trajectory that led to the population being more thinly sliced in one dimension. This suggested that the extra trajectories did not reflect people who were developing differently but simply identified people who varied on initial ability and adding further trajectories would not identify trajectories with different gradients.

The second context where the distinctiveness of the trajectories was applied is for the trajectories summarizing BMI for men. The majority of criteria for selecting trajectories indicated that a model containing two BMI trajectories should be used. However, the two trajectory BMI model merged groups of heavy individuals who would in theory have different origins and consequences. Thus a 4 class model was selected as appropriate. This decision was subsequently vindicated. When using a 4 class model the "constant increasing" trajectory was associated with parental social class and unemployment, but not with birthweight. In contrast, the other trajectories indicating a relatively high BMI, "consistently heavy" and "early developers", were associated with birthweight but not with parental social class or unemployment.

Comparability of samples

The fuller and the complete cases samples were compared in order to ensure that the trajectories generated by the fuller samples were not based on biases generated by missing data. For virtually all the identified models, the trajectories summarizing the complete cases and fuller samples were comparable. There was the odd minor exception, for example the women's 5 class model for reading was partly chosen because the 6^{th} class added in the fuller sample was not similar to the 6^{th} class added for the complete cases sample, but broadly the trajectories identified by the fuller sample and complete cases sample were the same.

An extra criterion was occasionally employed and that was to compare the trajectories identified for men with the trajectories identified for women. This was employed for the women's externalizing trajectory and the men's BMI trajectory when the other criteria did not give a clear answer.

Recommendations for the selection of future models

The results of this thesis, despite a wide variety of model selection criteria being used, indicate that new criteria for selecting models need to be developed. In one case, the BMI trajectories for men, the majority of criteria were ignored and the final model was selected on theoretical grounds. The decision was subsequently vindicated by associations with exogenous variables. The literature acknowledges that the current model selection criteria are not ideal and other methods, such as the bootstrap Likelihood Ratio Test(Muthén, 2006; Nylund et al., 2007), are being developed and included in the most recent versions of software. Ideally future measures of model fit, would measure absolute rather than relative fit (Connell & Frye, 2006). Many of these points may be somewhat moot as there will not be a single best model because different models will have advantages and disadvantages depending on the model's purpose.

9.6.3. Interpretation of the trajectories

Mixture models, which are used to identify the developmental trajectories, are generally used for one of two purposes (Bauer & Curran, 2003a). The first is to identify qualitatively distinct classes of individuals in the population being studied (Bauer & Curran, 2003a). The second is to approximate intractable or complex distributions with a small number of simpler component distributions (Bauer & Curran, 2003a; Nagin & Tremblay, 1999). The aim of using developmental trajectories in this thesis was to identify groups of individuals whose differing development patterns would imply different capabilities and resources to face the challenge of unemployment, thus ideally the developmental trajectories would have identified qualitatively distinct groups. In practice this is very unlikely.

Some of the questionnaires, in particular the Southgate reading test (Southgate, 1962) and the indicators of emotional well-being, were designed to identify individuals with higher risk of poor development but with no aim to differentiate between those of average and high functioning. As a result, any differences among those of poor ability are exaggerated. This exaggeration of differences is likely to lead to a variable with a non-normal distribution, and the statistical methods used cannot distinguish between non-normal distributions that are due to true population sub-groups, and non-normal distributions that are due to the measuring instrument. Transforming the data would not provide a solution.

Transformations cannot create information on which to better distinguish between those of high and average ability. To perform the correct transformation requires making assumptions about how the data should be distributed and this would require prior knowledge of what sub-groups should be in the population. However, in exploratory analysis, the sub-groups in the population are not known, making determination of the correct transformation impossible. It is safer to assume that the trajectories are a way of summarizing data on multiple dimensions. If this assumption is made, the worst that can happen is that some data are lost resulting in a reduction of statistical power to test hypotheses (Pickles & Angold, 2003). However, there are dangers if trajectory models are interpreted as being literarily true (Cudeck & Henly, 2003).

Treating trajectories as reality when they may not be is a process called reification (Nagin & Tremblay, 2005). In the context of this thesis reification may have two key consequences. Firstly, it may suggest that groups of individuals are distinctly separate, when in fact they are variations of a continuum. Secondly, it may lead to variation within developmental trajectories being ignored. A good example of the latter consequence is illustrated by the results for BMI. Thin men have different employment prospects from men of average weight. However, when modelling BMI using development trajectories, a separate group of thin men could not be distinguished. Reification has greater consequences if reified concepts are used in the policy arena.

Reification can lead to the separate groups being treated as "them" and "us". In reality individuals in two groups may simply be at the opposite ends of a continuum (Nagin & Tremblay, 2005). History is replete with tragedies in which fictional groups have been used to identify people as being "them" and then used to justify subsequent dehumanization (Nagin & Tremblay, 2005). Reification may also lead to the impression that these groups cannot be changed and may lead to the development of assessment instruments designed to assign individuals to their "true" trajectory group (Nagin & Tremblay, 2005). Unless the trajectories are linked with exogenous biological, genetic and social factors and replicated in multiple samples, developmental trajectories should be treated as only one of many ways of summarizing the data (Connell & Frye, 2006).

9.6.4. Alternative methodology

A number of alternative methods could have been used to identify developmental trajectories. Some methods would have used entirely different principles to identify developmental trajectories, while others would have used a variation of the latent class clustering methodology that was used.

Alternate ways of summarizing data

One alternative method to summarize the data is to allocate individuals into trajectories based on pre-determined criteria. The life course measure of internalizing symptoms is one way of allocating individuals to trajectories. Another method would be to classify individuals based on how relative levels of resources, indicated by population percentiles, change across time, as exemplified by the studies of Feinstein and Bynner (2004) and Fogelman et al. (1978).

Another alternative method that could be used to summarize the data would have been to use latent growth curves, or variants of that methodology such as growth mixture modelling (Muthén, 2001) and hierarchical linear modelling (Raudenbush 2001). These methods were not used due to their limitations. Growth curves require each indicator to be measured using the same unit. It is possible to transform variables so that they have the same unit as has been done by Power et al. (2006) for mathematics. However, ensuring that each indicator has the same unit is not sufficient to ensure a well fitting model. Latent class clustering was used to model BMI in preference to latent growth curves, because latent growth curves and growth mixture models provide a poor fit to the data. Had latent growth curves been possible to construct, they would have helped model some issues raised in this thesis, such as the possibility that people with a relatively stable BMI may have a different response to unemployment when compared to people whose BMI is rapidly increasing.

Alternate ways of using latent class clustering

There are also other ways of handling the data using the latent class clustering methodology. The models used in this thesis were modelled on the assumption that the mixture components were normally distributed. However, mixture models can be produced making different assumptions, for example, it could be assumed that the data was distributed using a censored normal distribution, as was used in preliminary analyses which generated poorly fitting models of emotional well-being. Another approach to modelling the data would have been to free some of the model parameters.

Theoretically it is possible to estimate models which allow the variances of each indicator to be different for each trajectory. However, stable models estimating different indicator variances for each trajectory could not be produced and so the models presented in this thesis have the variances of each indicator constrained to be the same across all trajectories.

Other changes to the modelling procedure would have been to use different methods to assess the validity of the trajectories. Two such approaches, which can be termed cross validation and exploratory analysis, are described here.

Cross validation is appropriate when there is a finite number of substantively interesting models. The research sample is randomly split into two samples. A best model is then identified for each sub-sample. Then two sets of fit indices are calculated by applying the models estimated for each random sub-sample to its partner sub-sample. If one model emerges as clearly having the best cross validation fit index in both samples, that model is considered the best approximation to the true model (Collins, Graham, Long & Hansen, 1994). However, cross validation only makes sense when the researcher has considerable background in the area (Collins et al., 1994) and there are only a limited range of models to be selected from. Cross validation also does not necessarily identify a true model as it is always possible that there are other alternative models that perform similarly (Cudeck & Henly, 2003).

Another approach to modelling could be termed exploratory analysis; as opposed to the hypothesis testing approach that was used in this thesis. In a hypothesis testing approach it is theorised that certain types of trajectories will have specific relationships with exogenous variables. The theory is tested by identifying the trajectories and then testing to see if these trajectories are associated with exogenous variables.

In exploratory analysis, the theories relating the shape of trajectories to specific exogenous variables are assumed to be true. Thus, when choosing the number of classes the best fitting model has, including exogenous variables can help improve model fit by increasing the Mahalanobis distance between classes (Lubke & Muthén, 2007) and the relationships between exogenous variables and the trajectories can be used as an extra criterion for selecting models. The final model can then be determined by selecting the models for which the developmental trajectories' relationship with the exogenous variables is most consistent with theory (Muthén, 2004a). However, this methodology does have its drawbacks.

The first drawback is a practical one. Cases which have data for the trajectory indicators but have missing data for the exogenous covariates are excluded from the analysis. This can lead to reduction in the size of the sample used to model the trajectory and the final sample is less likely to be representative of the population from which it was drawn. These problems may be reduced by using techniques to estimate missing data, but none of these techniques can cope with systematic biases due to unreported causes.

The second drawback is theoretical. By determining the final model on the basis of the trajectories' associations with covariates, those covariates are a priori associated with the developmental trajectories. In these circumstances, it becomes impossible to test hypotheses about the relationships between trajectories and exogenous variables, and testing such hypotheses was an important part of this thesis.

9.7. Implications of the thesis

This thesis has utilized new methods and concepts and in the process it has generated original substantive results describing development, protection and resilience. In addition, it has provided the opportunity to evaluate the methodology used. The context of these results also needs to be considered. The childhood and labour market experience of the NCDS cohort will be unique and future cohorts are likely to differ.

9.7.1. Developmental trajectories across the life course

For emotional well-being, this thesis expanded the literature by demonstrating that developmental trajectories, which had previously been concentrated on narrow bands of behavioural development, can also be identified for much broader clusters of eternalizing symptoms. For internalizing symptoms the results suggested that developmental trajectories could not be found, but there are concerns that the different measures of internalizing symptoms across the life course are not measuring the same underlying conceptual problems. How applicable these data are to other cohorts and periods is open to question. Younger cohorts have been shown to have more emotional problems (Collishaw et al., 2004) and this may be reflected in more trajectories indicating elevated symptoms of poor emotional well-being, or more individuals in disadvantaged trajectories equivalent to the ones identified in this thesis.

For cognitive ability, the developmental trajectories for reading provided further evidence that these skills progresses along pathways fixed early in childhood. However, mathematical skills do not necessarily develop at a consistent rate and there was some potential for decline or improvement for those of above average ability. School characteristics are an important area to investigate for declines and improvements of relative ability. There have been secular trends of increasing cognitive ability (Flynn, 1987). Thus there will be a need to investigate if this is reflected simply in higher means or whether in other cohorts this has lead to changing patterns of development.

The key implications for BMI from this thesis is that those who are heavy at age 7 or have a surge in BMI following puberty, do not necessarily go on to be obese, and that early adult obesity was the product of steady growth through childhood and adolescence. However, there have been dramatic rises in obesity especially during childhood (Stamatakis et al., 2005), and as a consequence conclusions based on children born in 1958 may not be applicable to children born more recently. There may be an additional trajectories indicating high BMI's during early childhood that continue to rise, and it is also possible that a larger proportion of children are on trajectories with a constantly high weight or weights that increase rapidly.

9.7.2. The social origins of development

Social disadvantage has been associated with increased risk of membership of all the disadvantaged trajectories. There a number of particular notable associations. Firstly, there was a very strong association between being from disadvantaged backgrounds and membership of the "high increasers" externalizing symptoms trajectory. Secondly, parental social class was able to differentiate between two groups of above average ability for mathematics, with those from disadvantaged background being more likely to have a decrease in mathematical ability. Thirdly, those from socially disadvantaged backgrounds were also at increased risk of membership of the only developmental trajectory that indicated obesity at age 23.

Since 1958 there have been many broad social changes. The changes in the labour market will mean that the effects of parental social class will have changed, and technological and economic changes will mean than conditions in the home will be different. Some amenities such as central heating have become the norm and today's children will be better provided for in many ways when compared to children born in 1958 (Power & Elliott, 2006). However, there have been increases in relative inequality and the proportion of children living in poverty based on relative wealth within the UK, has risen from 8 per cent to about 20 per cent (Schoon, 2006). The rises in relative inequality may have important implications as inequality leads to poorer outcomes in many areas (Wilkinson, 2005).The increased inequality is also likely to have lead to increasing levels of deprivation for many of the most important aspects of life including housing and job opportunities enabling social mobility.

In addition to material and economic circumstances, there will have been broader social changes that will have an impact on development. Changes in family structure and attitudes to parenting will alter how children are cared for. Changes in government policy will have an effect on numerous areas. In particular, a focus in education of achieving specific targets may enhance the development of reading and mathematics to the detriment of other aspects of child development such as emotional well-being. Changes in transport, entertainment and provision of amenities such as parks have lead to a reduction in physical activity. Thus despite calorie intakes falling at a population level rates of obesity have risen (Prentice & Jebb, 1995).

Social changes in the last 50 years have been diverse. The changes will have been both beneficial and detrimental and the widening inequality is likely to lead to greater variation in developmental differences, with the problems for those from disadvantaged backgrounds likely to increase.

9.7.3. Biological origins

Birthweight was associated with all the development trajectories, whilst preterm birth was associated with emotional and cognitive development. The associations were primarily due to developmental differences in childhood and the differences at older ages were more driven by social factors. The numbers of low birthweight infants have increased dramatically since the NCDS cohort were born. Following advances in obstetrics and neo-natal care which occurred in the 1970's (Goldstein & Peckham, 1976), the characteristics of surviving births are different. The perinatal mortality rate, 35 per 1000 births (Fogelman, 1983) when the NCDS children were born, had fallen to 8.6 per 1000 in 2003 (Confidential Enquiry into Maternal and Child Health, 2005). Thus today there will be smaller younger children who will not be represented in the NCDS cohort. Furthermore, the numbers of heavy infants have also risen (Power, 1994; Wen et al., 2003). Heavy infants are represented in the NCDS sample, but the proportions of such infants born today are likely to be higher. The increased survival of low birthweight infants may result in a higher proportions of children being on poor cognitive and emotional development trajectories. The increased numbers of heavy infants is likely to lead to more children being on trajectories that start with a high BMI and have faster growth rates.

9.7.4. Unemployment and health

The results in relation to unemployment were mixed and have to be summarized separately by gender. For women, for whom much less work has been published, the results suggested that unemployment only weakly challenges health. In addition, unemployment was only associated with one of the indicators of resources; internalizing symptoms. Thus there was little evidence that unemployment was a challenge for women.

For men, unemployment was associated with poorer health and should be considered a challenge to health. Emotional well-being, cognitive ability and BMI, all indicate resources that can protect people from experiencing unemployment. Furthermore, there is some evidence to suggest that people with good reading ability or low internalizing symptoms are more resilient to the health consequences of unemployment.

The results for unemployment have to be held in the context that they relate to experiencing at least one period of unemployment of at least 3 months in the period between March 1982 and the participants interviews in 1999/2000. The effects will have been specific to that period and the effects of those events will be determined by when they occur in people's lives.

The labour market experience of the NCDS

The experience of unemployment in NCDS is unique to its period. This has been shaped in many ways including the changing nature of the economy, and increased participation of women in the labour force.

Changing nature of the economy

The NCDS entered the labour market at the end of what has been termed a "Golden Age" with high welfare support and low unemployment (Stewart, 1999). Since then there have been dramatic changes. The period covered by the data included two recessions. The first, from 1979 to 1986, resulted in a dramatic loss in manufacturing, mining and textile industries (Sacker & Wiggins, 2002) and the contribution of the manufacturing sector to the total economy fell from 64% in 1951 to 38% in 1991 (Schoon 2006). The second recession from 1991 to 1994 affected all sectors (Sacker & Wiggins, 2002). Since which the economy has grown in terms of GDP, but this has primarily been due to the service sector with the importance of agriculture and manufacturing declining further.

Over the course of the NCDS participants' careers there have been a number of legislative changes that have increased the power of management and restricted unions. This has provided wider economic benefits, but will have also generated jobs with lower levels of autonomy, rewards, and greater insecurity, all of which are associated with associated with poorer health (Ferrie et al. 2001; Menéndez et al. 2007; Sacker et al. 2005). These changes have meant that the importance of employment versus unemployment is likely to have decreased and unemployment may now be relatively less stressful. In 1967 unemployment was considered the eighth most stressful life event (Holmes & Rahe 1967), in 1997 unemployment was only the thirteenth most stressful life event (Hobson et al. 1998), and changes in the last decade may have meant that unemployment's importance has fallen further. However, the introduction of the minimum wage may have countered some of the effects of the flexible labour market. The increased cost of employing individuals may have reduced opportunities for some jobs, but this is likely to have been off set by a reduction in worker turnover for the most unpleasant poorly paid jobs (Nickell 2004).

Increased participation of women in the labour force

The importance of employment for women has increased dramatically in the lives of NCDS members. The proportion of women aged between 16 and 59 who were economically inactive has fallen from 41% in 1971 to 26% in 2003 (Lindsay & Doyle, 2003), and over that period more women have been able to have successful careers (Dex et al., 2006). This has had implications for a wide range of social factors. For example, partnerships are now formed later and women are delaying have children (Sacker & Wiggins, 2002). However, the beneficiaries of labour market changes are likely to have been more privileged women (Menéndez, Benach, Muntaner, Amable & O'Campo, 2007), who have the qualifications and ability to find work which has sufficient pay and benefits to meet the costs of using childcare. Between 1979 and 1999 inequality rose, for couples, the number of households in which both partners worked has risen from 55% to 64%. However, the number of households where neither partner is working has also risen from 4 to 8% (Nickell, 2004). The proportion of British men being classified as economically inactive has risen from 5% in 1971 to 15% in 2003 (Lindsay & Doyle, 2003) and the proportion of single mothers in work has fallen (Nickell, 2004). For any identified unemployed individual there is a 50% chance that the individual is a member of a household in which no-one works (Nickell, 2004). Thus the increased participation of women in the work force has increased financial inequality by concentrating earning power into fewer households.

The impact of unemployment for younger cohorts

Those who entered the labour market since the early 1990's have not experienced a recession. Thus for the last 10 years there has have been a relatively benign economic environment. The majority of individuals have been able to establish careers and for those unemployed there has been sufficient government funds available to provide some level of support. Thus unemployment is likely to have been a rarer and less adverse event for cohorts following the NCDS.

However, the economy has not been as benign as headline figures indicate. Unemployment figures have artificially been held low with real unemployment level likely to be close to 2.7 million (Beatty, Fothergil, Gore & Powell, 2007). Low inflation rates for consumer goods have enabled the government to ingnore very high inflation rates for other goods and services such as housing and energy. In addition, much of the growth has been based on increasing personal and government debt. These problems are now becoming more apparent, and many economic commentators predict a 50% chance of recession within the next year. This is likely to lead to job losses and reductions in government spending. Those on benefits are likely to be particularly vulnerable to the effects.

The wider global economy is also likely to influence the experience of unemployment and globalisation has widened both the availability of goods and provided additional sources of labour. In the experience of NCDS lives, cheaper imported goods have helped growth of the service sector at the expense of manufacturing and agriculture. Global development has now reached a critical period. Wages and education are rising in much of the developing world. This may make it easier for the UK manufacturing industry as demand will increase, although rising energy costs need to be factored in, conversely the UK's competitive advantage in the service sector may be reduced by the availability of cheaper highly educated workers elsewhere. Overall, we are entering an unstable and difficult to predict period.

The UK through expansion of the EU has effectively increased the size of its labour force. Some reports argue that the effect has actually reduced unemployment and increased wages (Blanchflower, Saleheen & Shadforth, 2007). Conversely others argue that the effects have increased unemployment and that there will be a negative impact particularly for the most vulnerable in society (Rowthorn, 2007). For those with the potential to have managerial or professional careers the changes will have undoubtedly improved opportunities, whilst low skilled workers are likely to face increased competition in the labour market.

For men, in the short to medium term, conditions are likely to deteriorate for those with less favourable work characteristics. This will affect both those in and out of work. Longer term, the future is harder to predict. A growing global economy may enable the UK to regain competitiveness in manufacturing sectors. Alternatively, limited resources and increased education in developing countries may reduce the competitiveness of many of the service industries in the UK. In all probability unemployment for men is likely to be more common and have more adverse consequences than it does now, but whether the effects of unemployment will be more adverse in the future than it was in the 1980's is difficult to predict.

The results of this thesis suggested that unemployment was only weakly an indicator of challenges for women, but this is likely to change. At the start of the NCDS women's careers, women were granted the same legal rights in the work place as men, but this did not mean those rights were enforced and cultural prejudices have declined slowly. Thus NCDS women will not have had the full benefit of legislation that was enacted at the start of their careers. Women entering the labour market today will have greater opportunities than NCDS women but there may also be disadvantages for these women. Women are now expected to work. This is driven by both financial mechanisms, for example at least two incomes may now be needed to afford a decent home, and by cultural prejudice that stigmatises women who stay at home looking after children. Thus women who are not in work are likely to experience increased stress and stigma and unemployment is likely to have greater implications for women.

9.7.5. Implications for protection from unemployment and resilience

The results of this thesis suggest that unemployment was not a particularly strong challenge for women and that other areas should be addressed. However, as illustrated by the changes in labour market experience for women, some of these challenges have been the target of government policies and are in the process of being addressed. Unemployment and labour market experience is likely to become more important for women and it is likely that the factors that protect and make women more resilient are likely to become more similar to those of men.

For men, all the indicators of resources were associated with unemployment and thus indicated some degree of protection. Emotional well-being and cognitive ability indicated that increasing levels of resources would provide increased protection. However, for BMI, it was only those at the extremes who were disadvantaged. Reading and internalizing symptoms were the only measures which suggested the presence or absence of resources to the health consequences of unemployment.

The factors that protect people from unemployment are likely to be altered because of changed circumstances. One example is labour market flexibility. The current labour market is less secure, to avoid unemployment people will need the academic ability to retrain and the emotional resources to adapt to a changing environment.

A second example focuses on the need for an increasingly skilled labour force and the increased numbers entering tertiary education. At one level having jobs requiring more educated people and more people being educated would suggest that measures such as reading and mathematics would become more important. However, this has to be taken in the context of declining social mobility (Bartley & Plewis, 2007). Prior to mass entry to university, many managerial positions would have been filled by non graduates who had risen through the ranks on merit. However, the increased supply of graduates means that non graduates are much less likely to move to more favourable employment conditions. Widened access to university has lowered the levels of academic ability required to enter university. However, individuals from disadvantaged backgrounds are still less likely to go university and may be losing out on job opportunities to people of lesser cognitive ability but better qualifications.

The final illustration of potential changes in protective factors is the rise in obesity. The effects of BMI may increase or decrease depending on two contrasting factors. The rise in numbers of obese and overweight people will lead to such individuals standing out less and potentially this could lead to less stigmatization. However, obesity is now considered a threat to society, and messages, that say that obesity is a problem potentially, inflame prejudice against obese people. It is unclear how BMI will in future be related to employment prospects but it needs considering.

Unemployment indicates many challenges and societal changes may have affected each of these challenges differently. Resources that make people resilient to challenges such as job seeking are likely to be similar to factors that protect people form experiencing unemployment. Resources that make people resilient to deprivation may be very different. Two of the key challenges likely to be indicated by deprivation are coping with the benefits system and gaining informal support. The benefit system now has a more rigorous evaluation of people's eligibility. This is likely to require more skill and persistence, thus both the importance of reading ability and emotional well-being are likely to increase. People are also increasingly separated from the communities and families in which they grew up. This is likely to place a greater demand on skills for building social support networks which are potentially indicated by an absence of internalizing symptoms.

The resources indicated in this thesis are likely to become more important in terms of resilience. However, it is less clear what effects societal changes have on protection from unemployment. The demands of an increasingly skilled labour force would suggest cognitive ability may become more important, but the reduction in social mobility would suggest that the importance of cognitive ability may have declined relative to that of factors not investigated in this thesis such as social position.

9.7.6. The methodological implications

This thesis demonstrates that the majority of resources are adequately measured by a single time point measure and that there is no need to summarize information throughout childhood. However, there are caveats to this. The single time point measure has to be recorded at an appropriate time. This thesis suggests that for some indicators, exemplified by BMI, that early childhood may not be appropriate. In addition, for internalizing symptoms the life course measure was in some circumstances a better indicator. This may be because the measures of internalizing symptoms in childhood were conceptually different to the single time point measure. Methodological issues may be less altered by cohort and period effects than substantive results, although it possible that different patterns of development could have emerged which would have implications not indicated by single time point measures.

9.8. Conclusions

In developing this thesis new statistical techniques have been allied with the controversial concept of resilience.

For emotional well-being, this thesis expands the literature by demonstrating that developmental trajectories, which had previously been concentrated on narrow bands of behavioural development, can also be identified for much broader clusters of externalizing symptoms.

For cognitive ability, the developmental trajectories for reading provided further evidence that these skills progresses along pathways fixed early in childhood. However, mathematical skills do not necessarily develop at a consistent rate: individuals from disadvantaged social backgrounds are more likely to have a relative decline in mathematical ability. In addition, this study demonstrated that mathematical ability at age 16 is more important for future employment prospects than ability in early childhood.

This is the first study using mixture models to generate group-based developmental trajectories for BMI. Patterns of development are identified which suggest that there are individuals who are born heavy and remain heavy throughout childhood, but are not obese by the age 23. Whilst there are other individuals, who have normal weight at birth and during early childhood, but gradually accumulate weight to become obese by age 23. Social factors are implicated as the cause of rapid weight growth that leads to obesity.

The results in relation to unemployment were mixed and have to be summarized separately by gender. For women, for whom much less work has been published, the results suggested that unemployment only weakly challenges health. In addition, unemployment was only associated with one of the indicators of resources; internalizing symptoms. Thus there was little evidence that unemployment was a challenge for women.

For men, unemployment was associated with poorer health and should be considered a challenge to health. Emotional well-being, cognitive ability and BMI, all indicate resources that can protect people from experiencing unemployment. Furthermore, there is some evidence to suggest that people with good reading ability or low internalizing symptoms are more resilient to the health consequences of unemployment.

This thesis has demonstrated that single time point measures of externalizing, reading, mathematics and BMI recorded in adolescence and young adulthood are as effective as developmental trajectories at predicting associations with unemployment. In the case of BMI the results would suggest that it may be misleading to assume that childhood obesity will progress to adult obesity and the problems associated with adult obesity. However, internalizing symptoms throughout childhood indicate resources that alter the chances becoming unemployed. Thus this thesis has furthered the life course literature by providing increased insight into how resources develop and the methodology that should be used to investigate the consequences of that development.

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Appendices

Appendix 1: Estimation of BMI using alternate methodology

Introduction

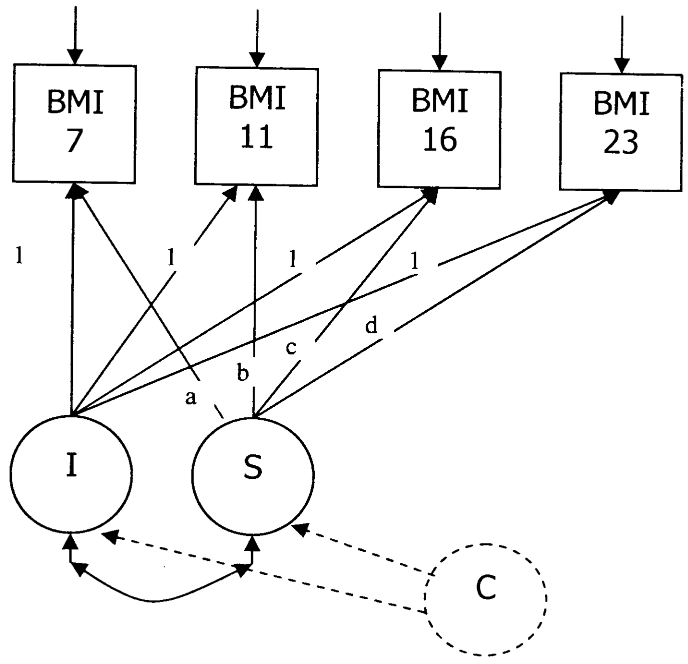
The same measure of body mass is used at each age. This enables a wider diversity of statistical techniques to model developmental trajectories and some preliminary analyses were carried out to determine which method should be used. The conclusion was that latent class clustering was the best method. Presented here is a brief summary of alternative methods that could be used to summarize the data: latent class growth analysis and growth mixture modelling.

Methods

Latent class growth analysis

Figure a1.1 can be used to represent both a growth mixture model and a latent growth model. If "C" representing the latent classes is ignored, the figure represents a latent growth curve model. In a latent growth curve model BMI at the ages of 7, 11, 16 and 23 is considered to be the product of a growth process produced by a growth curve with the intercept "I" and the slope "S" and independent variance specific to each BMI indicator represented by the small arrows. If the values for "a", "b", "c" and "d", are set as 0, 4, 9 and 16, to represent the passage of time, a linear model is produced. An alternative is the linear spline model in which "a" was set to 0 and "d" set to 1. A linear spline model allows for non linear growth as only the first and final factors loadings are fixed (Leve, Kim & Pears, 2005). Growth curves including quadratic terms were also attempted however they rarely converged and are not discussed further.

Figure a1.1: Structure of a growth mixture model.



Model fit for the latent growth curve analysis was assessed by the Root Mean Square Error of Approximation (RMSEA) and the Confirmatory Fit index (CFI) (Rigdon, 1996). The RMSEA gives a measure of the discrepancy in fit per degrees of freedom; it is 0 if the model fits exactly and a RMSEA <0.06 is considered a good fit (Hu & Bentler, 1999). The comparative fit index CFI has values between 0 and 1 with higher values indicating a better fit, with a good fit considered to be a score >0.95 (Hu & Bentler, 1999).

A growth mixture model combines aspects of a latent class growth curve and a latent class cluster analysis (see figure a1.1). A growth mixture model is similar to latent class clustering in that each case is allocated probabilistically to a latent class "C" and has similarities with latent class growth analysis in that each class is represented as latent growth curve with its own intercept and slope. It is not possible to estimate "a", "b", "c", "d", separately for each class, thus each class is constrained to having a linear trajectory with the values for a, b, c, and d, being set to 0, 4, 9, 16.

Model fit for the growth mixture model was assessed on the same criteria as the latent class cluster analysis (see chapter 3). Decision on whether latent class clustering or growth mixture models should be used was decided on theoretical and pragmatic grounds, and by the comparing the information criteria measures which can be used to compare model fit of non nested models (Lin & Dayton, 1997).

Results

The first models to be estimated were for linear latent growth curves. For women the CFI was 0.658 and the RMSEA was 0.310. For men the CFI was 0.815 and the RMSEA 0.219 in both cases indicating a poor model fit.

Next the linear spline models were conducted. For women the CFI was 0.979 indicating an acceptable fit, however, the RMSEA was 0.121 suggesting that the model did not fit the data well. The linear spline model for men had a CFI of 0.975 suggesting an acceptable fit but was rejected on the basis of the RMSEA 0.130

Next a series of growth mixture models were conducted. For both sexes models with up to 6 classes were estimated repeatedly until it could be ensured that the models did not reflect a local maxima. The model fit indices are present in table a1.1.

Discussion and conclusions

The model fit indices clearly indicated that a linear growth curve model was not a good fit for the data for either sex. The fit indices produced mixed conclusions for the linear spline models, however, a single class linear spline models were rejected on the basis of the RMSEA.

The information criteria measures for the growth mixture models were poorer than the information criteria for the latent class cluster models presented in chapter 6. Theoretically this makes sense as the linear growth mixture models are constrained to constant growth through out the period. To some extent the growth mixture models were overly constrained. Model fit would have been improved if “a” had been set to 0, “d” had been set to 1 and the values of “b” and “c” had been allowed to

Table a1.1: Model fit for growth mixture modelling

Number of Classes	AIC	BIC	ssaBIC	aLRT p value	Entropy
Men					
Two	94476.88	94559.38	94521.24	<0.001	0.962
Three	93734.57	93837.69	93790.02	<0.001	0.956
Four	93510.78	93634.53	93577.32	0.175	0.951
Five	93325.60	93469.97	93403.23	0.043	0.947
Six	93193.19	93358.19	93281.92	0.548	0.923
Women					
Two	97296.89	97378.75	97340.61	<0.001	0.937
Three	96417.73	96520.05	96472.38	<0.001	0.922
Four	96092.60	96215.39	96158.19	0.025	0.892
Five	95837.49	95980.73	95914.00	0.002	0.889
Six	95725.81	95889.52	95813.26	0.114	0.851

vary freely. However, in this slightly less constrained model "b" and "c" would still have been the same for all classes included in the model thus all the trajectories would still have had to have been linear. Thus it was concluded that latent class clustering was the best way to summarize the data.

Appendix 2: The association between trajectories of resources and health

Introduction

The main aim of thesis is to identify resources that protect against the effects that unemployment has on health and identifying how these resources develop. Whether resources have a direct relationship with health independently of unemployment is very much a side issue in this thesis, however, identifying these relationships helps in interpreting the interactions in chapter 8 and so the associations between resources and health are presented here.

Methods

Data

The analyses in this section are conducted using resources indicated by both single time point measures and life course measures. The samples sizes for the life course measures used in the analyses for both men and women are shown in table a2.1, whilst the sample sizes for the single time point measures used in the analyses are presented in table a2.2. It should be noted that these analyses are based on all cases that have health data rather than just those that have both economic activity and health data.

Variables

The variables used in these analyses are the health outcomes and resources. The health outcomes were measured at age 42 and are self rated health, limiting longstanding illness, Malaise inventory, GHQ and weight change. Resources are

Tables a2.1: Sample sizes for prediction of health: developmental trajectories

	Self rated health	Limiting Illness	Malaise	GHQ	Weight change
Men					
Externalizing	4873	4874	4811	4812	3999
Internalizing	2845	2846	2819	2819	2769
Reading/maths	4871	4872	4811	4812	4001
BMI	4926	4927	4864	4866	4151
Women					
Externalizing	5034	5033	5009	5007	4214
Internalizing	3064	3063	3052	3051	2945
Reading/maths	5036	5035	5011	5009	4223
BMI	5050	5049	5026	5022	4364

Tables a2.2: Sample sizes for prediction of health: single time point measures

	Self rated health	Limiting Illness	Malaise	GHQ	Weight change
Men					
Externalizing	3945	3946	3905	3904	3283
Internalizing	4418	4419	4367	4368	4288
Reading	3993	3994	3954	3953	3315
Mathematics	3979	3980	3941	3940	3307
BMI	4368	4369	4320	4321	4298
Women					
Externalizing	4155	4154	4133	4129	3519
Internalizing	4723	4722	4701	4698	4524
Reading	4175	4175	4155	4151	3532
Mathematics	4155	4155	4135	4131	3520
BMI	4676	4675	4653	4648	4535

indicated using both the single time point measures, as described in chapters 3 and 7, and life course measures, as indicated by the developmental trajectories of externalizing symptoms (chapter 4), reading (chapter 5), mathematics (chapter 5), and BMI (chapter 6) and the internalizing life course measure (chapter 4).

Statistical methodology

The association between resources and health is tested for both resources as indicated by developmental trajectories and indicators based on a single time point measures.

To test the association between the trajectories and health, the trajectory indicators (represented by Y in figure 3.4) are fixed to the means found for each trajectory in chapters, 4 5 and 6, for externalizing symptoms, cognitive ability and BMI. The health status variables are added as an extra endogenous variable (U in figure 3.4.) Thus the odds of scoring on U for each latent class can be identified and odds ratios calculated. Analyses were conducted using Mplus 3.12 (Muthén & Muthén, 2004).

The association between each single time point measure of resources (and the internalizing life course measure) and health will be tested for using univariate logistic regression for self rated health, limiting longstanding illness, Malaise and GHQ, whilst multinomial logistic regression will be used for weight change.

Table a2.3: Odds ratios for self rated (men)

Class name	OR	95CI%		Category	OR	95CI%	
				Externalizing			
High increasers	2.80	1.87	4.18	High sympt.	2.21	1.79	2.73
Late childhood	2.37	1.75	3.21	Low sympt.	1.58	1.30	1.93
Decreasers	1.44	1.05	1.98	No sympt.	1	-	-
Mod. increasers	2.38	1.81	3.14				
Consist. low	1	-	-				
				Internalizing			
3 or 4 times	3.91	2.85	5.36	High sympt.	7.03	4.95	9.98
2 times	2.01	1.47	2.73	Low sympt.	2.38	1.96	2.89
Once	1.35	0.98	1.84	No sympt.	1	-	-
No times	1	-	-				
				Reading			
Very poor	2.96	2.19	4.00	Poor	3.00	2.33	3.86
Weak	1.85	1.47	2.33	Moderate	1.64	1.31	2.06
Moderate	1.63	1.32	2.01	Good	1	-	-
Competent	1	-	-				
				Mathematics			
High perform.	0.30	0.24	0.38	Good	0.31	0.23	0.41
Late developer	0.37	0.26	0.52	Moderate	0.64	0.52	0.77
Mod. decreas.	0.59	0.44	0.78	Poor	1	-	-
Gen. pop.	1	-	-				
				BMI			
Const. increas.	3.69	2.26	6.00	Obese	2.57	1.66	3.98
Consist. heavy	1.01	0.56	1.81	Overweight	1.55	1.28	1.89
Early devel.	0.93	0.56	1.54	Healthy	1	-	-
Typical dev.	1	-	-	Thin	1.06	0.62	1.83

Results

Self rated health

All the resources were associated with self rated health for both men (see table a2.3) and women (see table a2.4). However, it should be noted that the only BMI trajectory that was associated with poorer health was the "constant increasing"

Table a2.4: Odds ratios for self rated (women)

Class name	OR	95CI%		Category	OR	95CI%	
			Externalizing				
High increasers	2.61	1.77	3.83	High sympt.	2.19	1.72	2.78
Late childhood	2.43	1.77	3.35	Low sympt.	1.68	1.38	2.03
Decreasers	1.48	1.03	2.12	No sympt.	1	-	-
Mod. increasers	1.99	1.47	2.69				
Consist. low	1	-	-				
			Internalizing				
3 or 4 times	4.03	2.95	5.50	High sympt.	7.61	5.57	10.39
2 times	2.49	1.83	3.40	Low sympt.	2.52	1.93	3.28
Once	1.57	1.15	2.16	No sympt.	1	-	-
No times	1	-	-				
			Reading				
Very poor	2.95	2.12	4.09	Poor	3.51	2.72	4.52
Weak	2.20	1.67	2.90	Moderate	1.37	1.09	1.733
Mod. weak	1.66	1.28	2.16	Good	1	-	-
Moderate	1.47	1.17	1.83				
Competent	1	-	-				
			Mathematics				
High perform.	0.39	0.30	0.49	Good	0.33	0.25	0.43
Transient lapse	0.13	0.05	0.34	Moderate	0.67	0.55	0.81
Mod. decreas.	0.50	0.39	0.64	Poor	1	-	-
Gen. pop.	1	-	-				
			BMI				
Const. increas.	2.93	2.07	4.15	Obese	2.56	1.80	3.65
Consist. heavy	1.13	0.72	1.75	Overweight	1.60	1.29	1.99
Early devel.	0.96	0.64	1.44	Healthy	1	-	-
Typical dev.	1	-	-	Thin	0.99	0.72	1.37

trajectory. Whilst for the single time point measure, being obese or overweight was associated with poorer health but being thin was not.

Table a2.5: Odds ratios for limiting longstanding illness (men)

Class name	OR	95CI%		Category	OR	95CI%	
				Externalizing			
High increasers	3.19	2.14	4.75	High sympt.	2.16	1.73	2.69
Late childhood	1.90	1.35	2.66	Low sympt.	1.30	1.05	1.62
Decreasers	1.45	1.04	2.02	No sympt.	1	-	-
Mod. increasers	2.01	1.49	2.72				
Consist. low	1	-	-				
				Internalizing			
3 or 4 times	3.21	2.29	4.50	High sympt.	5.14	3.58	7.37
2 times	1.72	1.23	2.40	Low sympt.	1.90	1.56	2.32
Once	1.61	1.16	2.23	No sympt.	1	-	-
No times	1	-	-				
				Reading			
Very poor	2.31	1.67	3.21	Poor	2.23	1.72	2.91
Weak	1.71	1.34	2.19	Moderate	1.29	1.02	1.62
Moderate	1.36	1.08	1.71	Good	1	-	-
Competent	1	-	-				
				Mathematics			
High perform.	0.44	0.34	0.55	Good	0.50	0.38	0.65
Late developer	0.53	0.37	0.75	Moderate	0.63	0.51	0.78
Mod. decreas.	0.57	0.42	0.79	Poor	1	-	-
Gen. pop.	1	-	-				
				BMI			
Const. increas.	2.28	1.32	3.93	Obese	2.02	1.25	3.25
Consist. heavy	1.13	0.61	2.11	Overweight	1.43	1.16	1.77
Early devel.	1.33	0.81	2.16	Healthy	1	-	-
Typical dev.	1	-	-	Thin	1.26	0.73	2.18

Limiting longstanding illness

For men all the resources were associated with limiting longstanding illness (see table a2.5). Again it should be noted that the only BMI trajectory associated with poorer health was the "constant increasing" trajectory, whilst for the single time point measure, being obese and overweight were associated with poorer health but being thin was not.

Table a2.6: Odds ratios for limiting longstanding illness (women)

Class name	OR	95CI%		Category	OR	95CI%	
				Externalizing			
High increasers	1.96	1.31	2.96	High sympt.	1.52	1.17	1.97
Late childhood	2.01	1.44	2.81	Low sympt.	1.43	1.17	1.75
Decreasers	1.13	0.76	1.67	No sympt.	1	-	-
Mod. increasers	1.41	1.02	1.97				
Consist. low	1	-	-				
				Internalizing			
3 or 4 times	3.54	2.57	4.87	High sympt.	4.27	3.16	5.79
2 times	2.09	1.51	2.89	Low sympt.	1.93	1.50	2.47
Once	1.75	1.27	2.40	No sympt.	1	-	-
No times	1	-	-				
				Reading			
Very poor	2.21	1.56	3.14	Poor	1.28	1.02	1.61
Weak	1.71	1.27	2.30	Moderate	2.23	1.73	2.88
Mod. weak	1.82	1.40	2.37	Good	1	-	-
Moderate	1.47	1.17	1.85				
Competent	1	-	-				
				Mathematics			
High perform.	0.46	0.35	0.59	Good	0.42	0.33	0.57
Transient lapse	0.34	0.19	0.60	Moderate	0.80	0.65	0.98
Mod. decreas.	0.73	0.58	0.92	Poor	1	-	-
Gen. pop.	1	-	-				
				BMI			
Const. increas.	2.61	1.83	3.72	Obese	1.90	1.30	2.78
Consist. heavy	1.12	0.71	1.77	Overweight	1.53	1.22	1.92
Early devel.	0.76	0.48	1.20	Healthy	1	-	-
Typical dev.	1	-	-	Thin	1.41	1.04	1.90

The results for women were similar to the results for men. All the resources were associated with limiting longstanding illness (see table a2.6). Again the only BMI trajectory that had increased risk of poor health was the "constant increasing" trajectory but unlike for men, thin women were also at increased risk of having a limiting longstanding illness.

Table a2.7: Odds ratios for Malaise (men)

Class name	OR	95CI%		Category	OR	95CI%	
			Externalizing				
High increasers	2.91	1.90	4.48	High sympt.	1.95	1.54	2.47
Late childhood	2.66	1.93	3.67	Low sympt.	1.48	1.19	1.84
Decreasers	1.71	1.23	2.38	No sympt.	1	-	-
Mod. increasers	1.62	1.17	2.26				
Consist. low	1	-	-				
			Internalizing				
3 or 4 times	4.98	3.39	7.32	High sympt.	23.3	15.8	34.3
2 times	2.79	1.91	4.09	Low sympt.	3.95	3.07	5.10
Once	1.86	1.27	2.75	No sympt.	1	-	-
No times	1	-	-				
			Reading				
Very poor	2.23	1.58	3.12	Poor	1.61	1.23	2.11
Weak	1.36	1.05	1.77	Moderate	1.15	0.91	1.45
Moderate	1.17	0.92	1.48	Good	1	-	-
Competent	1	-	-				
			Mathematics				
High perform.	0.48	0.37	0.61	Good	0.41	0.31	0.55
Late developer	0.40	0.26	0.62	Moderate	0.54	0.44	0.67
Mod. decreas.	0.73	0.54	0.99	Poor	1	-	-
Gen. pop.	1	-	-				
			BMI				
Const. increas.	1.24	0.63	2.42	Obese	1.07	0.59	1.94
Consist. heavy	0.96	0.48	1.92	Overweight	1.29	1.04	1.61
Early devel.	1.23	0.74	2.04	Healthy	1	-	-
Typical dev.	1	-	-	Thin	1.48	0.86	2.52

Malaise

For men all resources were associated with Malaise except BMI. For BMI there was only a weak association between Malaise and being overweight (see table a2.7).

Table a2.8: Odds ratios for Malaise (women)

Class name	OR	95CI%		Category	OR	95CI%	
				Externalizing			
High increasers	2.64	1.81	3.83	High sympt.	1.91	1.51	2.42
Late childhood	2.37	1.73	3.23	Low sympt.	1.56	1.29	1.88
Decreasers	1.38	0.98	1.95	No sympt.	1	-	-
Mod. increasers	1.69	1.25	2.28				
Consist. low	1	-	-				
				Internalizing			
3 or 4 times	7.11	5.06	10.0	High sympt.	34.0	23.2	49.8
2 times	4.30	3.07	6.04	Low sympt.	5.46	3.87	7.71
Once	2.43	1.72	3.42	No sympt.	1	-	-
No times	1	-	-				
				Reading			
Very poor	2.24	1.61	3.11	Poor	2.73	2.15	3.48
Weak	1.88	1.43	2.46	Moderate	1.43	1.15	1.77
Mod. weak	1.39	1.07	1.80	Good	1	-	-
Moderate	1.60	1.30	1.97				
Competent	1	-	-				
				Mathematics			
High perform.	0.34	0.26	0.43	Good	0.34	0.26	0.43
Transient lapse	0.28	0.16	0.52	Moderate	0.68	0.57	0.82
Mod. decreas.	0.62	0.50	0.77	Poor	1	-	-
Gen. pop.	1	-	-				
				BMI			
Const. increas.	1.59	1.09	2.31	Obese	1.37	0.93	2.01
Consist. heavy	1.37	0.92	2.02	Overweight	1.35	1.09	167
Early devel.	1.13	0.80	1.61	Healthy	1	-	-
Typical dev.	1	-	-	Thin	1.51	1.15	1.99

For women all the resources including BMI were significantly associated with Malaise (a2.8). For BMI the only trajectory that was significantly associated with Malaise was the "constant increasing". For the single time point measure, overweight and being thin were associated with increased risk of Malaise, however obesity was not.

Table a2.9: Odds ratios for GHQ (men)

Class name	OR	95CI%		Category	OR	95CI%	
			Externalizing				
High increasers	1.24	0.74	2.06	High sympt.	1.24	0.99	1.56
Late childhood	1.72	1.23	2.40	Low sympt.	0.96	0.78	1.19
Decreasers	0.85	0.58	1.23	No sympt.	1	-	-
Mod. increasers	1.33	0.97	1.82				
Consist. low	1	-	-				
			Internalizing				
3 or 4 times	2.17	1.56	3.01	High sympt.	6.21	4.36	8.84
2 times	1.66	1.22	2.26	Low sympt.	1.85	1.52	2.25
Once	1.47	1.08	1.99	No sympt.	1	-	-
No times	1	-	-				
			Reading				
Very poor	1.27	0.88	1.82	Poor	0.92	0.75	1.12
Weak	0.90	0.69	1.18	Moderate	0.90	0.79	1.16
Moderate	1.08	0.86	1.34	Good	1	-	-
Competent	1	-	-				
			Mathematics				
High perform.	1.04	0.85	1.28	Good	1.11	0.86	1.44
Late developer	0.91	0.66	1.26	Moderate	1.02	0.81	1.28
Mod. decreas.	0.86	0.63	1.16	Poor	1	-	-
Gen. pop.	1	-	-				
			BMI				
Const. increas.	1.08	0.56	2.09	Obese	1.05	0.60	1.83
Consist. heavy	0.98	0.51	1.86	Overweight	1.00	0.80	1.24
Early devel.	1.10	0.67	1.81	Healthy	1	-	-
Typical dev.	1	-	-	Thin	1.29	0.76	2.17

GHQ

For men the only indicators of resources that were associated with GHQ were those for emotional well-being (a2.9). This was primarily limited to the indicators of internalizing symptoms, but “high symptoms” as measured by the single time point measure of externalizing was also associated with GHQ.

Table a2.10: Odds ratios for GHQ (women)

Class name	OR	95CI%		Category	OR	95CI%	
			Externalizing				
High increasers	1.64	1.10	2.44	High sympt.	1.56	1.23	1.98
Late childhood	1.48	1.06	2.06	Low sympt.	1.36	1.13	1.64
Decreasers	0.95	0.66	1.38	No sympt.	1	-	-
Mod. increasers	1.60	1.19	2.15				
Consist. low	1	-	-				
			Internalizing				
3 or 4 times	2.53	1.91	3.34	High sympt.	5.69	4.30	7.53
2 times	2.04	1.56	2.67	Low sympt.	2.09	1.66	2.62
Once	1.32	1.00	1.73	No sympt.	1	-	-
No times	1	-	-				
			Reading				
Very poor	1.42	1.01	1.99	Poor	1.00	0.83	1.21
Weak	0.94	0.70	1.27	Moderate	1.25	0.99	1.57
Mod. weak	1.21	0.94	1.55	Good	1	-	-
Moderate	0.95	0.77	1.18				
Competent	1	-	-				
			Mathematics				
High perform.	0.73	0.59	0.90	Good	0.64	0.51	0.81
Transient lapse	0.64	0.41	1.01	Moderate	0.79	0.66	0.96
Mod. decreas.	0.97	0.78	1.19	Poor	1	-	-
Gen. pop.	1	-	-				
			BMI				
Const. increas.	1.38	0.95	2.01	Obese	1.18	0.80	1.74
Consist. heavy	1.13	0.76	1.68	Overweight	1.09	0.87	1.35
Early devel.	0.99	0.69	1.42	Healthy	1	-	-
Typical dev.	1	-	-	Thin	0.96	0.71	1.30

For women, all of the resources were associated with GHQ with the exception of BMI (see table a2.10). For externalizing symptoms, relative to the "consistently low" trajectory, the "high increasers," "late childhood" and "moderate increasers" but not the "decreasers" trajectory had raised odds of being a GHQ case, whilst those in either of the more disadvantaged categories for the single time point measure had increased risk of being a GHQ case. All those with elevated internalizing symptoms as indicated by both the life course measure and the single time point measures had increased risk of being a GHQ. For reading the results were equivocal. Being a

Table a2.11: Odds ratios for weight loss (men)

Class name	OR	95CI%		Category	OR	95CI%	
				Externalizing			
High increasers	1.21	0.78	1.89	High sympt.	1.77	1.26	2.49
Late childhood	1.16	0.86	1.56	Low sympt.	1.28	0.95	1.74
Decreasers	1.16	0.87	1.55	No sympt.	1	-	-
Mod. increasers	1.29	0.99	1.70				
Consist. low	1	-	-				
				Internalizing			
3 or 4 times	2.12	1.39	3.24	High sympt.	2.68	1.66	4.33
2 times	1.28	0.84	1.93	Low sympt.	1.36	1.07	1.72
Once	1.05	0.69	1.58	No sympt.	1	-	-
No times	1	-	-				
				Reading			
Very poor	1.74	1.27	2.38	Poor	2.13	1.47	3.09
Weak	1.38	1.12	1.71	Moderate	1.13	0.81	1.56
Moderate	1.05	0.87	1.26	Good	1	-	-
Competent	1	-	-				
				Mathematics			
High perform.	0.81	0.68	0.96	Good	0.54	0.40	0.74
Late developer	0.93	0.72	1.20	Moderate	0.53	0.37	0.78
Mod. decreas.	0.61	0.47	0.78	Poor	1	-	-
Gen. pop.	1	-	-				
				BMI			
Const. increas.	2.08	1.21	3.55	Obese	4.99	2.91	8.56
Consist. heavy	2.16	1.28	3.66	Overweight	2.53	1.97	3.26
Early devel.	2.33	1.53	3.52	Healthy	1	-	-
Typical dev.	1	-	-	Thin	0.18	0.24	1.29

member of the "very weak" trajectory increases the odds of being a GHQ case. However, for the single time point measure of reading it is those of moderate ability that have raised odds of being a case as indicated by GHQ rather than the poorest readers. For mathematics the results were clearer with those good at mathematics, as indicated by the developmental trajectories and the single time point measures, being less likely to be a GHQ case.

Table a2.12: Odds ratios for high weight gain (men)

Class name	OR	95CI%		Category	OR	95CI%	
				Externalizing			
High increasers	1.14	0.73	1.81	High sympt.	1.17	0.95	1.44
Late childhood	1.22	0.90	1.66	Low sympt.	0.95	0.80	1.14
Decreasers	1.36	1.02	1.81	No sympt.	1	-	-
Mod. increasers	1.08	0.81	1.43				
Consist. low	1	-	-				
				Internalizing			
3 or 4 times	1.07	0.83	1.37	High sympt.	1.17	0.82	1.67
2 times	0.97	0.78	1.21	Low sympt.	1.13	1.00	1.31
Once	0.89	0.72	1.10	No sympt.	1	-	-
No times	1	-	-				
				Reading			
Very poor	1.46	1.07	2.00	Poor	1.07	0.86	1.33
Weak	1.21	0.97	1.50	Moderate	0.91	0.77	1.08
Moderate	0.98	0.81	1.18	Good	1	-	-
Competent	1	-	-				
				Mathematics			
High perform.	0.92	0.77	1.10	Good	0.90	0.74	1.09
Late developer	1.20	0.93	1.55	Moderate	0.97	0.77	1.21
Mod. decreas.	0.66	0.50	0.96	Poor	1	-	-
Gen. pop.	1	-	-				
				BMI			
Const. increas.	0.69	0.38	1.26	Obese	1.45	0.90	2.33
Consist. heavy	1.83	1.10	3.05	Overweight	1.30	1.10	1.55
Early devel.	2.03	1.36	3.03	Healthy	1	-	-
Typical dev.	1	-	-	Thin	1.67	1.11	2.54

Weight change

There were mixed results for the association between the indicators of resources and those of weight change. For men weight loss was associated with all the resource indicators with the associations being in the expected direction (see table a2.11). The association between weight loss and externalizing symptoms was limited to just the

Table a2.13: Odds ratios for weight loss (women)

Class name	OR	95CI%		Category	OR	95CI%	
Externalizing							
High increasers	1.37	0.89	2.10	High sympt.	1.34	0.96	1.88
Late childhood	1.43	1.01	2.01	Low sympt.	1.23	0.95	1.59
Decreasers	0.98	0.70	1.35	No sympt.	1	-	-
Mod. increasers	1.15	0.87	1.52				
Consist. low	1	-	-				
Internalizing							
3 or 4 times	0.96	0.69	1.34	High sympt.	1.69	1.20	2.37
2 times	0.87	0.63	1.18	Low sympt.	1.18	0.93	1.49
Once	0.94	0.70	1.25	No sympt.	1	-	-
No times	1	-	-				
Reading							
Very poor	1.45	1.00	2.09	Poor	1.29	0.94	1.76
Weak	1.32	1.01	1.71	Moderate	0.97	0.75	1.25
Mod. weak	0.92	0.72	1.16	Good	1	-	-
Moderate	1.32	1.09	1.60				
Competent	1	-	-				
Mathematics							
High perform.	0.78	0.65	0.93	Good	0.77	0.57	1.05
Transient lapse	0.75	0.53	1.06	Moderate	0.92	0.71	1.20
Mod. decreas.	0.91	0.74	1.11	Poor	1	-	-
Gen. pop.	1	-	-				
BMI							
Const. increas.	3.36	2.28	4.50	Obese	3.09	1.88	5.08
Consist. heavy	2.07	1.38	3.10	Overweight	2.58	1.98	3.36
Early devel.	1.93	1.39	2.68	Healthy	1	-	-
Typical dev.	1	-	-	Thin	0.37	0.22	0.63

single time point measures. Also to be noted was that thin men were less likely to lose weight.

For men associations with high weight gain were less consistent (see table a2.12). None of the developmental trajectories and single time point measures of externalizing symptoms were associated with high weight gain with the exception of the "decreasers" trajectory. The only indicator of internalizing symptoms associated with high weight gain was a very weak association for the low symptoms category.

Table a2.14: Odds ratios for weight loss (women)

Class name	OR	95CI%		Category	OR	95CI%	
				Externalizing			
High increasers	1.25	0.80	1.93	High sympt.	1.27	0.98	1.63
Late childhood	1.47	1.04	2.08	Low sympt.	1.23	1.02	1.49
Decreasers	1.10	0.78	1.55	No sympt.	1	-	-
Mod. increasers	1.13	0.84	1.53				
Consist. low	1	-	-				
				Internalizing			
3 or 4 times	1.35	1.05	1.73	High sympt.	1.70	1.32	2.19
2 times	1.31	1.04	1.66	Low sympt.	1.24	1.04	1.46
Once	1.10	0.88	1.38	No sympt.	1	-	-
No times	1	-	-				
				Reading			
Very poor	1.58	1.09	2.28	Poor	1.19	0.94	1.50
Weak	1.26	0.96	1.65	Moderate	0.88	0.73	1.06
Mod. weak	1.08	0.84	1.39	Good	1	-	-
Moderate	1.46	1.19	1.78				
Competent	1	-	-				
				Mathematics			
High perform.	0.74	0.61	0.89	Good	0.72	0.57	0.91
Transient lapse	0.72	0.42	1.05	Moderate	0.92	0.75	1.12
Mod. decreas.	0.83	0.68	1.03	Poor	1	-	-
Gen. pop.	1	-	-				
				BMI			
Const. increas.	2.01	1.42	2.84	Obese	3.38	2.27	5.04
Consist. heavy	2.12	1.44	3.13	Overweight	2.52	2.04	3.11
Early devel.	2.22	1.61	3.07	Healthy	1	-	-
Typical dev.	1	-	-	Thin	0.91	0.70	1.18

There was a moderate association between the "very poor" readers developmental trajectory but none of the other indicators of reading was associated with high weight gain. In addition, none of the indicators of mathematics were associated with high weight gain. The most consistent associations between weight gain and resources for men were for BMI. Those heaviest at age 23 as indicated by "constant increasing" developmental trajectory and obese category were not at increased risk of weight gain, however, those who were thin, overweight or members of the "consistently heavy" or "early developers" trajectories were at increased risk of high weight gain.

There were mixed associations with weight change for women. For many of the resource indicators only one of the developmental trajectories or one of the single time point measures was associated with weight loss (see table a2.13). The only group with elevated externalizing symptoms who were at increased risk of weight loss were members of the "decreasers" trajectory. Women who had high internalizing symptoms were more likely to lose weight. For reading only the "very poor" and "weak" readers were increased risk of weight loss, whilst for mathematics only the "high performers" were less likely to lose weight. The one resource for which there was a consistent relationship was BMI. All the heavier developmental trajectories were more likely to lose weight, whilst obese and overweight women were at increased risk of weight loss, whilst thin women were at lower risk of weight loss.

The associations with high weight gain were again inconsistent (see table a2.14). For externalizing symptoms only the "late childhood" and low symptoms categories were associated with increased risk of high weight gain. For reading only the "very poor" and "moderate" trajectories were associated with increased risk of high weight gain. However for internalizing, mathematics and BMI the associations with high weight gain were more consistent.

For mathematics, membership of the "high performers" trajectory and the good single time point measure category was associated with reduced chance of high weight gain. Having more frequently raised internalizing symptoms as indicated by the life course measure or having high symptoms as indicated by the single time point measure was associated with high weight gain. Individuals with an elevated BMI, as indicated by the "constant increaser" "constantly heavy" and "early developer" developmental trajectories and the overweight or obese categories, were more likely to have a large increase in weight. It should also be noted that being thin at age 23 was not associated with subsequent high weight gain.

Conclusions

Overall externalizing symptoms were associated with all the health outcomes, although associations with GHQ for men and weight change for both sexes were limited. Internalizing symptoms were associated with all health outcomes, although the associations with high weight gain for men and weight loss for women were limited. For reading there were consistent associations with self rated health, limiting longstanding illness and Malaise for both men and women and mixed results for GHQ and weight change. Being better at mathematics was consistently associated with better health with the exception of GHQ and high weight gain for men. Whilst BMI was associated with the physical health outcomes, self rated health, limiting longstanding illness, and weight change but not consistently with the mental health outcomes Malaise and GHQ. For all health outcomes with the exception of weight change the only BMI developmental trajectory that was associated with poorer health was the constant increasing trajectory. Some of the associations between weight change and BMI may have been due to floor and ceiling affects. However, floor and ceiling effects would not explain the association between high weight gain and being overweight for men, and high weight gain and being both overweight and obese for women. Nor would it explain why thin women were no more likely than women of healthy weight to gain weight.

Appendix 3: Examples of Mplus syntax

Introduction

Presented in this appendix are examples of the syntax used to generate the trajectories in Mplus. All the examples are for externalizing symptoms developmental trajectories for men.

The first example, A, is an example of the syntax used to generate developmental trajectories. B is an example of the syntax used to test for associations between the exogenous variables and developmental trajectories. C is the syntax used to test for associations between developmental trajectories and the health outcomes. D and E are examples of the syntax used to generate the likelihood values and the scaling correction factors required to test for interactions.

Key to variables in syntax

A number of variables are included in the syntax, however, not all were used in each analysis and listed here are those utilized in the presented examples

Sex is used to indicate the gender of the participants.

E7, e11 and e16 are the variables indicating externalizing symptoms at age 7, 11, and 16.

Dummy variables are used to indicating birthweight; llbw represents birthweights <2.51 kg, mlbw 2.51-3.00 kg, mbw 3.01-3.50 kg and hbw >4.01 kg.

Pt is a variable indicating whether an individual was born preterm.

Sc3nm, sc3man, sc4 and sc5 are dummy variables representing social class III non-manual, III manual, IV and V respectively.

Limitill is the variable for limiting longstanding illness.

Fullex indicates whether are study participant is a member of the fuller sample for externalizing symptoms.

Exunem indicates whether a study participant is a member of the fuller sample of externalizing symptoms and has valid unemployment data.

The syntax

A: Generating developmental trajectories.

```
Title: This is a 5 class latent class cluster model for
       men using the fuller sample;

Data: File is exfull.dat;

Variable: Names are Key sex E7 E11 E16;
Useobservation sex eq 1;
USEVARIABLES ARE E7 E11 E16;
Classes = c (5);
Missing are all (-1);

Analysis: type= mixture missing;
starts = 150 20;

Model:

%OVERAll%
e7 with e11 e16;
e11 with e16;

%c#1%
[e7*6.534     e11*18.185    e16*2.155];

%c#2%
[e7*5.953     e11*6.946     e16*6.896];

%c#3%
[e7*17.720    e11*6.572     e16*1.585];

%c#4%
[e7*7.534     e11*10.327    e16*12.949];

%c#5%
[e7*2.647     e11*2.432     e16*0.577];

output:

tech11;
```

B: Testing for associations between developmental trajectories and exogenous variables

```
Title: This is a 5 class latent class cluster model testing for
       associations between the developmental trajectories and the
       exogenous variables birthweigtht, prematurity and social
       class;

Data: File is ext.dat;

Variable: Names are key sex
llbw mlbw mbw hbw
pt
sc3nm sc3man sc4 sc5
e7 e11 e16;
Useobservation sex eq 1;
USEVARIABLES ARE E7 E11 E16 llbw mlbw mbw hbw pt sc3nm sc3man sc4
sc5;
Classes = c (5);
Missing are all (-1);

Analysis: type = mixture missing;

starts = 0;

Model:

%OVERAll%
e7 with e11 e16;
e11 with e16;

c#1 c#2 c#3 c#4 on llbw mlbw mbw hbw pt sc3nm sc3man sc4 sc5;

!High increasers
%c#1%
[e7@8.706      e11@12.306     e16@12.751];

!Late childhood
%c#2%
[e7@6.732      e11@18.900     e16@2.671];

!Decreasers
%c#3%
[e7@18.449     e11@7.386      e16@1.719];

!Moderate increasers
%c#4%
[e7@5.326      e11@5.682      e16@6.768];

!Consistently low
%c#5%
[e7@2.716      e11@2.496      e16@0.573];

output:

cint;
```

C: Testing for associations between developmental trajectories and health

```
Title: Testing for associations between the externalizing symptoms
       trajectories and limiting longstanding illness.

Data: File is full.dat;

Variable: Names are
key sex
e7 e11 e16
r7 r11 r16 m7 m11 m16 BMI7 BMI11 BMI16 BMI23
Genhel Limitill Mal GHQ BMIgain Unemp Missemp
Fullex Fullbmi Fullcog Exunem BMIunem cogunem;
Useobservation sex eq 1 and Fullex eq 1 and limitill ne -1;
USEVARIABLES ARE e7 e11 e16;
Limitill;
Categorical = Limitill;
Classes = c (5);
Missing are all (-1);

Analysis: type= mixture missing ;
starts = 50 10;

Model:

%OVERAll%
e7 with e11 e16;
e11 with e16;

!High increasers
%c#1%
[e7@8.706     e11@12.306    e16@12.751];
[Limitill$1];

!Late childhood
%c#2%
[e7@6.732     e11@18.900    e16@2.671];
[Limitill$1];

!Decreasers
%c#3%
[e7@18.449    e11@7.386     e16@1.719];
[Limitill$1];

!Moderate increasers
%c#4%
[e7@5.326     e11@5.682     e16@6.768];
[Limitill$1];

!Consistently low
%c#5%
[e7@2.716     e11@2.496     e16@0.573];
[Limitill$1];

Output:

cint;
```

D: Model allowing for an interaction between unemployment and the developmental trajectories in the prediction of health.

```
Title: Unconstrained model allowing the association between the
       externalizing developmental trajectories and health to vary
       depending on employment status;

Data: File is full.dat;

Variable: Names are
key sex
e7 e11 e16
r7 r11 r16 m7 m11 m16 BMI7 BMI11 BMI16 BMI23
Genhel Limitill Mal GHQ BMIgain
g Missemp
Fullex Fullbmi Fullcog Exunem BMIunem cogunem;
!g represents unemployment status;
Useobservation sex eq 1 and Exunem eq 1;
USEVARIABLES ARE e7 e11 e16 Limitill;
categorical = Limitill;
Classes = cg (2) c (5);
Knownclass = cg (g= 0 g=1);
Missing are all (-1);

Analysis: type= mixture missing ;
starts = 50 10;

Model:

%OVERAll%
e7 with e11 e16;
e11 with e16;

!The never unemployed.
!Late childhood
%cg#1.c#1%
[e7@6.732     e11@18.900     e16@2.671];
[Limitill$1] (p1);

!Moderate increasers
%cg#1.c#2%
[e7@5.326     e11@5.682      e16@6.768];
[Limitill$1] (p2);

!Decreasers
%cg#1.c#3%
[e7@18.449    e11@7.386      e16@1.719];
[Limitill$1] (p3);

!High increasers
%cg#1.c#4%
[e7@8.706     e11@12.306     e16@12.751];
[Limitill$1] (p4);

!Consistently low
%cg#1.c#5%
[e7@2.716     e11@2.496      e16@0.573];
[Limitill$1] (p5);
```

```
!Experienced unemployment

!Late childhood
%cg#2.c#1%
[e7@6.732     e11@18.900    e16@2.671];
[Limitill$1] (p6);

!Moderate increasers
%cg#2.c#2%
[e7@5.326     e11@5.682     e16@6.768];
[Limitill$1] (p7);

!Decreasers
%cg#2.c#3%
[e7@18.449    e11@7.386     e16@1.719];
[Limitill$1] (p8);

!High increasers
%cg#2.c#4%
[e7@8.706     e11@12.306    e16@12.751];
[Limitill$1] (p9);

!Consistently low
%cg#2.c#5%
[e7@2.716     e11@2.496     e16@0.573];
[Limitill$1] (p10);

output:
cint;
```

E: Model where the associations between the trajectories and health are constrained to be the same for both the employed and unemployed

```
Title: Constrained model with the association between the
       externalizing developmental trajectories and health to be the
       same for both the employed and unemployed;

Data: File is full.dat;

Variable: Names are
key sex
e7 e11 e16
r7 r11 r16 m7 m11 m16 BMI7 BMI11 BMI16 BMI23
Genhel Limitill Mal GHQ BMIgain
g Missemp
Fullex Fullbmi Fullcog Exunem BMIunem cogunem;
!g is unemployed;
Useobservation sex eq 1 and Exunem eq 1;
USEVARIABLES ARE e7 e11 e16 Limitill;
categorical = Limitill;
Classes = cg (2) c (5);
Knownclass = cg (g= 0 g=1);
Missing are all (-1);

Analysis: type= mixture missing ;
starts =  0 10;

Model:

%OVERAll%
e7 with e11 e16;
e11 with e16;

!Never unemployed
!Late childhood
%cg#1.c#1%
[e7@6.732     e11@18.900    e16@2.671];
[Limitill$1] (p1);

!Moderate increasers
%cg#1.c#2%
[e7@5.326     e11@5.682     e16@6.768];
[Limitill$1] (p2);

!Decreasers
%cg#1.c#3%
[e7@18.449    e11@7.386     e16@1.719];
[Limitill$1] (p3);

!High increasers
%cg#1.c#4%
[e7@8.706     e11@12.306    e16@12.751];
[Limitill$1] (p4);

!Consistently low
%cg#1.c#5%
[e7@2.716     e11@2.496     e16@0.573];
[Limitill$1] (p5);
```

```
!Experienced unemployment
!Late childhood
%cg#2.c#1%
[e7@6.732      e11@18.900    e16@2.671];
[Limitill$1] (p6);

!Moderate increasers
%cg#2.c#2%
[e7@5.326      e11@5.682     e16@6.768];
[Limitill$1] (p7);

!Decreasers
%cg#2.c#3%
[e7@18.449     e11@7.386     e16@1.719];
[Limitill$1] (p8);

!High increasers
%cg#2.c#4%
[e7@8.706      e11@12.306    e16@12.751];
[Limitill$1] (p9);

!Consistently low
%cg#2.c#5%
[e7@2.716      e11@2.496     e16@0.573];
[Limitill$1] (p10);

Model constraint:
p6 = p1 - p5 + p10;
p7 = p2 - p5 + p10;
p8 = p3 - p5 + p10;
p9 = p4 - p5 + p10;
```

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