Fear and fearlessness in infants: A developmental approach

Erika Baker

Cardiff University

PhD 2012

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Acknowledgements

First and foremost I would like to thank my supervisor, Professor Stephanie van Goozen, for her support and the insight she has given me throughout the duration of this thesis. I am sincerely grateful for the time and care with which she has read, commented and critiqued my proposals and writing, and for supporting my development as a researcher.

I would like to thank Professor Dale Hay for giving me the opportunity to work on the Cardiff Child Development Study. I thoroughly enjoyed being part of the team. I am extremely grateful for the insight provided by Dr. Katherine Shelton, whose time and comments were invaluable to this thesis, and for offering support and guidance. I would also like to thank Dr Justin Savage for his ongoing support and humour. It was both a pleasure and a privilege to have worked with them all.

I am thankful to Cardiff University for the funding they provided me with for my study, without which I would not have been able to conduct or complete this thesis. I am also very grateful to all of the families who took part in this study that comprise this thesis.

I would like to thank the following people who have always been willing to provide support that has been essential to the completion of this thesis - Jane Baibazarova, Sasha Walters and Lisa Mundy for being a constant source of support and friendship.

A special thanks is extended to Simon White for the emotional support throughout these years. I am incredibly grateful.

Last, but definitely not least, I would like to thank my family; my parents, brothers and my nan, as well as Clare and David White for their constant support. My mum has given me nothing but full support and drive throughout, and I can’t begin to express how much I appreciate this.

Thesis Summary

The main aim of this thesis was to improve our understanding of the development of early inhibitory emotions and emotion regulation from infancy, and the role of these emotions in early risk pathways. More specifically, this thesis investigated (1) the development of fearful temperament, its stability over the first 3 years of life, and its associations with later developing effortful control (EC) and guilt; (2) risk factors in infancy that predict later externalising psychopathology; and (3) the development of EC, and its associations with fear and guilt. Psychophysiological and observational measures were used, when available, to examine these emotional systems as well as their role in predicting later psychopathology. The thesis consists of 3 empirical chapters, investigating a sample of 70 typically developing children in a longitudinal, prospective manner. Behavioural fear was stable over time, but physiological fear peaked in year 2. Fearful infants continued to be fearful toddlers, and fear in infancy predicted fearfulness 2 years later. Fear and guilt were associated, and we showed for the first time that infant fear is a predictor of later developing guilt. EC increased from year 2 to year 3, showed inter-individual stability across time, and girls' ability for EC surpassed the ability in boys. EC and guilt were not associated; however, EC and fear were associated in year 3, suggesting that early fear does not regulate later EC. This thesis identified two biomarkers in infancy for later psychopathology. A subgroup of toddlers with internalising problems displayed higher heart rate in infancy, whereas skin conductance arousal in infancy predicted aggressive behaviour in toddlers.

Collectively, the findings from this thesis support the notion that fearful temperament is stable over the first years of life, and that fear plays an important role in the development of later developing emotions and emotion-linked systems. The findings show that a multi-

method approach to studying temperament and risk factors for later psychopathology is necessary to identify biomarkers and obtain a fuller understanding of temperament development. In addition, the findings highlight the value of investigating emotion development from infancy onwards and that developmental investigations into risk pathways for later psychopathology should not wait until middle childhood.

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Chapter 1: Introduction

Child temperament is one of the most widely researched and important aspect of child development (e.g. Rothbart, 2007). Temperament is defined as a biologically based and relatively stable trait that accounts for individual differences in reactivity and regulation in early life (Rothbart & Bates, 1998). In this definition reactivity refers to excitability, arousal and responsivity, and self regulation is the modulation of reactivity (Rothbart & Derryberry, 1981). There is a consensus in the literature that the investigation of early temperament is important for our understanding of social development during childhood. Furthermore, some temperament dimensions have been found to play a role in the development of psychopathology. In order to identify risk pathways for later psychopathology it is crucial to examine early risk factors as early as possible. Extreme levels of emotional reactivity and regulation in particular have been postulated to lead to maladaptive behaviour (e.g. Blandon, Calkins, Keane, & O'Brien, 2010; Hirshfield, Biederman, Brody, Faraone, & Rosenbaum, 1997; Hirshfield-Becker, et al., 2003; Murray & Kochanska, 2002; Olsen, Schilling & Bates, 1999; Stuewig, Tangney, Heigel, Harty, & McCloskey, 2010). The focus of this thesis is on the development of fear, guilt and effortful control, as inner guiding mechanisms that promote adaptive socialisation and promote conscience development, and inhibit disruptive and aggressive behaviour.

Fearful temperament

Individual differences in fearfulness have been the focus of considerable developmental research in the last few decades. Temperamental fearfulness is defined as a child's initial withdrawal to unfamiliar or challenging events (Kagan, 1997). Conversely, children who are temperamentally fearless are behaviourally disinhibited; they display high approach and lack of restraint to novel and unfamiliar people and situations (Hirshfield-Becker et al., 2003). Extremes in fearful and fearless temperament have long been associated with later psychopathology and risk pathways. Fearfulness in early childhood has been found to predict behavioural inhibition in later childhood, which is in turn associated with anxiety and depression in later life (Biederman et al., 1993; Schwartz, Snidman, & Kagan, 1999). Conversely, fearlessness has been repeatedly associated with externalising behaviours including aggression and antisocial behaviour (Colder, Mott, & Berman, 2002; Raine, 1993). Despite this knowledge, little is known about the development of fear from infancy onwards.

It is as yet unknown to what extent temperamental fear in young children is stable (Kochanska, 2001; Lemery, Goldsmith, Klinnert, & Mrazek, 1999). Investigating stability in fearfulness and fearlessness has significant implications for later psychopathology. Many internalising disorders are identified in childhood and are found to persist into adulthood (Copeland, Shanahan, Costello, & Angold, 2009; Maughan & Kim-Cohen, 2005; Rao & Chen, 2009). Similarly, many externalising problems have an early onset, and many clinical diagnoses often require behaviours to be apparent before middle childhood. Moreover, aggression seems to show strong continuity throughout childhood and adulthood (Farrington, 1989), predicting disruptive school behaviours (Tremblay et al., 1991) and adult criminality (Huesmann, Eron, Lefkowitz, & Walder, 1984; Loeber & Le Blanc, 1990; Pulkkinen & Pitkanen, 1993). However, the vast majority of developmental research into risk pathways for psychopathology studies children from middle childhood onwards. Although individual differences in fear can be seen in infancy there is a lack of prospective, longitudinal research from infancy onwards examining the stability of fearful temperament and its role in risk pathways. Chapter 2 examines the stability of fear over the first 3 years of life in typically developing infants.

The role of physiology

Although most definitions of temperament suggest that there is a biological basis, developmental research has largely focused on observations of temperament in the laboratory and on parental reports. Physiological profiles of early temperament have been identified in infants and toddlers (Kagan, 1997); however, much less is known about physiological reactivity during stress in very young children. Physiological dysregulation is common in children with internalising and externalising disorders (Bauer, Quas, & Boyce, 2002). High resting heart rate (HR) and low HR variability predict more extreme fear and inhibition (Kagan, 1997). By contrast, low resting HR and low skin conductance activity (SCA) have been linked to externalising behaviour (Herpertz et al., 2005; van Goozen, Matthys, Cohen-Kettenis, Buitelaar, & van Engeland, 2000; Zahn & Kruesi, 1993) and have been found to predict persistence of antisocial behaviour from childhood into adolescence (van Bokhoven, Matthys, van Goozen, & van Engeland, 2005). Furthermore, low SCA has been identified as a biomarker for later aggression, with low SCA levels in 3 years olds predicting aggression at age 8, and criminal behaviour 20 years later (Gao, Raine, Venables, Dawson, & Mednick, 2010a, 2010b).

There is clear evidence to suggest that physiological measures are important to increase our understanding of temperament and in identifying, explaining and predicting risk pathways (e.g. Gao et al., 2010a, 2010b; Kagan, 1997; van Bokhoven et al., 2005). However, currently it is not known whether infant psychophysiological measures can predict later temperament outcome or psychopathology. Chapter 2 examines the development of fear across the first 3 years of life, using a multi-method approach including the measurement of autonomic nervous system (ANS) arousal, in order to investigate the stability of the different indices of fear, and to find out whether we can identify infant risk factors for later internalising psychopathology. Using a similar approach, we investigated in Chapter 3 the role of early ANS arousal in predicting the later development of aggression in toddlers.

As a consequence of our limited understanding of the development of fear from infancy, we also know very little about the associations between fear and later emerging emotions, for example moral emotions such as guilt, and inhibitory temperament dimensions such as effortful control, which also play an important role in the development of internalising and externalising psychopathology (e.g. Biederman et al., 1993; Kochanska, Barry, Jimenez, Hollatz, & Woodard, 2009; Schwartz, et al., 1999; Stuewig, et al., 2010). These issues are addressed in Chapter 2, which examines the relation between fear and guilt, and Chapter 4, which explores the relation between fear and effortful control, respectively.

Fear and guilt

The accumulated instances of experiencing discomfort following a transgression and coming to anticipate such feelings in the future are considered to be among the most important factors inhibiting rule violations and antisocial conduct (Kochanska, Gross, Lin, & Nichols, 2002; Lykken, 1995; Quay, 1965). A deficiency in the experience of guilt has been found to be positively related to the development of externalising problems (Ferguson, Stegge, Miller, & Olsen, 1999) and aggression (Stuewig, et al., 2010), and is part of the core deficit in the development of antisocial behaviour (Blair, Peschardt, Budhani, Mitchell & Pine, 2006; Fowles & Dindo, 2006). Despite what is known about guilt in older children and adults, we know very little about how this moral emotion develops and what factors influence its development.

Fearful temperament has been proposed to be a critical component in the development of guilt and conscience. Fearful children are proposed to be more guilt prone as they are sensitive to punishment and learn more easily to inhibit transgressions of moral behaviour that are associated with punishment (Dienstbier, 1984). Fearless children are by definition less likely to inhibit behaviour because they experience less arousal following aversive events, and are therefore less likely to experience guilt. The inability to assimilate these feelings over time will fail to act as a deterrent to misbehave in future (Dienstbier, 1984; Fowles, 1994; Lykken, 1995). This association has been found in young children (Kochanska et al, 2002), however there is still very little understanding of the early development of these emotions from infancy. Chapter 2 examines guilt in 3 year olds and assesses whether early fear predicts the development of guilt.

Fear and effortful control

Effortful control develops later than fear and is the ability to voluntarily inhibit a favoured behaviour or emotional response (Rothbart & Bates, 1998). Effortful control plays a central role in emotion-related regulation of behaviour (Rothbart & Bates, 1998) and in predicting children's social competencies and adjustment problems (Gartstein & Fagot, 2003). Similarly to fear, extremes in levels of effortful control are associated with maladaptive behaviours. In particular, low levels of effortful control in toddlers have been associated with impulsivity, externalising behaviour (Kochanska & Knaack, 2003), and attention problems (Murray & Kochanska, 2002) in early childhood. Conversely, high levels of effortful control in toddlers have been found to predict internalising behaviour in early childhood (Murray & Kochanska, 2002). These associations are also found throughout childhood and into adulthood (Alderson, Rapport, & Kofler, 2007; Barkley, 1997; Marakovitz & Campbell, 1998; Moffitt, Caspi, Dickson, Silva, & Stanton, 1996; Quay, 1997). Despite this, we know very little about the early development of effortful control, what influences its development, and whether the development differs for boys and girls.

It has been suggested (Derryberry & Rothbart, 1997) that as a child develops, initially reactive forms of regulation, such as fear, are supplemented by an increasing capacity for voluntary or effortful forms of control. Associations have been found between fear and effortful control (Aksan & Kochanska, 2004; Kochanska & Knaack, 2003), and it has been postulated that early fear plays an important role in regulating later approach behaviour (Rothbart, Ahadi & Hershey, 1994). Chapter 4 examines the early development of effortful control, the relation between fear and effortful control, and whether any associations are the same for girls and boys.

Guilt and effortful control

Kochanska and colleagues (2009) found that guilt and effortful control functioned together in an interactive fashion and that a deficiency in these systems led to the development of disruptive behaviour. Despite these findings few studies have investigated the role of effortful control in guilt, with the majority of studies focusing on self reports of conscience development in later childhood (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996; Kochanska & Knaack, 2003; Valiente et al., 2004). Chapter 4 investigates the relationship between effortful control and guilt, whether effortful control predicts the development of guilt, and whether these systems develop in similar fashion in boys and girls.

Thesis outline

There is evidence to suggest that fear, effortful control and guilt provide the child with an inner guiding system that inhibits disruptive and antisocial conduct. The overarching aim of this thesis is to examine the early development of these emotional systems and their associations across the first three years of life. The research to date has largely focused on older children, when these systems have already begun to develop. Furthermore, not only are there severe gaps in our knowledge of psychophysiological functioning in young children, we know even less about the role of these early biological factors in predicting later emotional or behavioural functioning. The aim of this thesis is to examine these issues and possibly identify risk factors for later psychopathology.

Chapter 2 reports on the early development of fearful temperament. The first aim of this chapter was to examine behavioural, maternal reported and physiological indices of fearful temperament in infancy, together with their relations and stability over time; and to establish whether early indices of fear predict fear later in toddlerhood. The next aim was to investigate behavioural and physiological indices of guilt, and whether fear and guilt are associated, and to establish whether fear in infancy predicts guilt in toddlers. Finally, infant risk factors for later internalising psychopathology were investigated.

Chapter 3 investigates whether SCA measured in infancy can predict the development of aggression. SCA was investigated at baseline, during an orienting habituation paradigm and during a fear challenge to establish the best way to measure SCA as a biomarker for aggression.

Chapter 4 examines the development of observed effortful control over the second and third years of life, together with the stability of effortful control and whether boys and girls differed in their ability. The next aim was to investigate associations between fear and effortful control, and to establish whether early fear predicts effortful control ability. Finally, we examined whether effortful control and guilt were associated in toddlerhood. Associations between effortful control and fear and guilt were examined separately in boys and girls to examine developmental patterns.

The thesis consists of three empirical chapters. All chapters are part of the same ongoing longitudinal, prospective study investigating the development of emotions and coping in young children. The sample consisted of 70 typically developing children, who took part in all three waves of assessment, around their 1st, 2nd and 3rd birthday. Where possible, a multi-method approach was adopted, measuring emotional systems behaviourally, maternally rated, and physiologically (HR and SCA). Due to the nature of the chapters as papers, there may be some repetition in the introduction and methods; however, the hypotheses and results are unique to the chapters.

Chapter 2: Development of fear and guilt in young children: Stability over time and relations with psychopathology

Published paper

Development and Psychopathology **24** (2012), 833-845

Abstract

Extremes in fearful temperament have long been associated with later psychopathology and risk pathways. Whereas fearful children are inhibited, anxious and avoid novel events, fearless individuals are disinhibited and more likely to engage in aggressive behaviour. However, very few studies have examined fear in infants from a multi-method and prospective longitudinal perspective. This study had the following objectives: to examine behavioural, maternal reported and physiological indices of fearful temperament in infancy, together with their relations and stability over time; and to establish whether early indices of fear predict fear later in toddlerhood. We also examined the association between behavioural and physiological measures of fear and guilt, and whether fear in infancy predicts guilt in toddlers. Finally, we investigated infant risk factors for later psychopathology. We recorded skin conductance level (SCL) and heart rate (HR) and observed children's responses during a Lab-TAB fear paradigm across the first 3 years of life, and during a guilt induction procedure at age 3 (N = 70). The results indicate that different measures of infant fear were associated across time. Observed fearlessness in infancy predicted observed fearlessness and low levels of SCL arousal to fear and guilt in toddlers. Low levels of HR and SCL to fear in infancy predicted low levels of physiological arousal to the same situation and to guilt 2 years later. Fear and guilt were significantly associated across measures. Finally, toddlers with clinically significant internalising problems at age 3 were already notably more fearful in Year 1 as reflected by their significantly higher HR levels. The results indicate that assessments of children in infancy are predictive of how these children react 2 years later and therefore lend support to the idea that the emotional thermostat is set in the first 3 years of life. They also showed, for the first time, that infant fear is a predictor of guilt, which is an emotion that

develops later. The implications of these findings for our understanding of developmental psychopathology are discussed.

Introduction

Individual differences in fearfulness have been the focus of considerable developmental research in the last few decades. Fearful individuals are characterised by behavioural inhibition, they tend to avoid risky acts and punishment, and become physiologically aroused with unfamiliar people, situations and events (Hirshfield- Becker et al., 2003; Hirshfield, Biederman, Brody, Faraone, & Rosenbaum, 1997). Fearfulness in early childhood has been found to predict behavioural inhibition in later childhood, which is in turn associated with anxiety and depression in later life (Biederman et al., 1993; Schwartz, Snidman, & Kagan, 1999).

Conversely, children who are temperamentally fearless are found to be behaviourally disinhibited; they display high approach and lack of restraint to novel and unfamiliar people and situations (Hirshfield-Becker, et al., 2003). Fearlessness is associated with higher levels of externalising symptoms (Colder, Mott, & Berman, 2002) and fearless individuals are more likely to engage in aggressive and antisocial behaviour because they do not fear the negative consequences of their behaviour (Raine, 1993).

Extremes in fearful temperament have long been associated with later psychopathology and risk pathways. However, there are three limitations in this line of work. First, there is a lack of prospective, longitudinal research from infancy onwards examining the stability of fearful temperament. Second, few studies have used a multi-method approach in which physiological parameters are assessed, as well as behavioural and maternally reported emotion. Third, we know very little about the associations between fear and later emerging emotions, for example moral emotions such as guilt, which also play an important role in the development of internalising and externalising psychopathology (Stuewig, Tangney, Heigel, Harty, & McCloskey, 2010). As a result our understanding of the early development of fearful temperament is limited. We address these limitations in this study by measuring fearful temperament longitudinally from infancy through to early childhood. In addition, we investigate the association between early fearfulness and the development of guilt later in childhood.

The development of fear

Past research in child psychopathology has focused almost exclusively on school-aged children (Calkins & Dedmon, 2000). It is important to improve our understanding of the development of children's temperament across early childhood, because we know that temperament is an underlying factor that can facilitate or inhibit children's socioemotional functioning (Blandon, Calkins, Keane, & O'Brien, 2010). Individual differences in fearful and fearless temperament are posited by some to be relatively stable over time (Buss & Plomin, 1984), while others argue that temperamental changes occur as a result of neurobiological changes (Blandon, et al., 2010; Derryberry & Rothbart, 2001). Further research is needed to understand the stability of fear, in order to make predictions about how it develops over time.

Although fear has been studied in infants (Kagan, 1982; Kochanska, Coy, Tjebkes, & Husarek, 1998; Schwartz, et al., 1999), much less research has focused on the development of fear from infancy onwards. Studies that have investigated the stability of fear from infancy failed to find consistency with respect to the age at which fear becomes a stable temperament characteristic. Kochanska (2001) investigated fear from 9 months, finding stability from 14 months onwards, whereas Lemery and colleagues began their investigation at 3 months, finding some stability from 24 months, but only intermediate forms of fearfulness were stable (Lemery, Goldsmith, Klinnert, & Mrazek, 1999). These studies used only one method of assessment (observational or mother reported fear, respectively).

Finding stability in fearfulness and fearlessness has significant implications for later psychopathology. Fearfulness in early childhood has been associated with shyness and internalising psychopathology, including agoraphobia, panic disorders and multiple anxiety disorders (Biederman, et al., 1993; Biederman, Rosenbaum, Hirshfield, & Faraone, 1990; Schwartz, et al., 1999). Many externalising behavioural problems also have an early onset. The Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2000) requires many behaviours to be apparent before middle childhood. However, the vast majority of developmental research into risk pathways for externalising disorders studies children from middle childhood onwards. Mothers of children with externalising behavioural problems have reported that their children were difficult and irritable as infants (Weiss & Hechtman, 1993). Frick (2004) has suggested that certain temperamental characteristics observed in infants could in fact be symptoms of externalising behaviours. Regardless of temperamental risk factors for aggression that are seen in infancy, such as a difficult temperament, there is a lack of longitudinal data to identify risk pathways.

Kagan and his colleagues examined early temperament, identifying profile patterns in children at 21 months of age. Children were either classified as inhibited or uninhibited. Inhibited children were identified as being fearful, avoiding novelty and displaying a higher heart rate (HR) during unfamiliar situations (Kagan, Reznick, Clarke, Snidman, & Garcia-Coll, 1984; Kagan, Reznick, & Snidman, 1987). Uninhibited children were identified as being fearless, approached novelty and had a lower HR during unfamiliarity. Behavioural differences between the two groups were maintained across childhood, as was a higher HR in inhibited children. However, Pfeifer, Goldsmith, Davidson and Rickman (2002) found that children changed in their levels of inhibition over the course of childhood. More research is needed to clarify the organization of children's behaviours over early development, whether there are changes in levels of fear, or whether behaviours remain stable over early childhood. In order to gain a fuller picture, a multi-method approach, investigating behaviour and biological components of fear is needed.

Fear physiology

Although most definitions of temperament suggest that there is a biological basis, developmental research has largely focused on observations of temperament in the laboratory and on parental reports. These measures are not without limitations (Kagan, 1994). Both behavioural and physiological measures of fear are needed in order to capture a reliable picture of individual differences in fear response (Lewis & Ramsay, 1999).

Psychophysiological measures are useful in the study of infant temperament for a number of reasons. They are sensitive to changes in psychological state; and because they are non-verbal they are particularly useful when studying infants (Campos, 1976). Measures of HR and skin conductance level (SCL) have been carried out in infants and children (for example, Burgess, Marshall, Rubin, & Fox, 2003; Buss, Goldsmith, & Davidson, 2005; Calkins & Dedmon, 2005; Fracasso, Porges, Lamb, & Rosenberg, 1994; Hernes, et al., 2002; Provost & Gouin-Decarie, 1979) and appear to be reliable, sensitive, and well validated physiological measures of temperament (Campos, 1976; Nigg, 2006; Strelau, 1998). However, psychophysiological assessments in infancy, specifically those involving the autonomic nervous system (ANS), are rarely carried out following emotion-provocation (i.e. Lab-TAB; Goldsmith & Rothbart, 1999); nor are they done across childhood (Fox, 1989; Scarpa, Raine, Venables, & Mednick, 1997). The few studies in which psychophysiology was measured during emotional challenge did not involve infants (Calkins & Dedmon, 2000; Kagan, et al., 1987).

Research in developmental psychopathology has integrated the role of physiology in order to understand the development of risk pathways (Cicchetti & Gunnar, 2008). It is important to investigate potential biological risk pathways to aggression, because antisocial and criminal adults often have their onset of deviant behaviour in childhood (Loeber & Stouthamer-Loeber, 1997). There is increasing evidence that aggressive children with persistent antisocial behaviour are characterized by neurobiological problems (van Goozen, Fairchild, Snoek, & Harold, 2007). Physiological dysregulation is common in children with internalising and externalising disorders (Bauer, Quas, & Boyce, 2002). High resting HR and low HR variability predict more extreme fear and inhibition (Kagan, 1997), and more behavioural inhibition longitudinally (Kagan, et al., 1984). By contrast, low resting HR has been proposed to be the best marker of antisocial behaviour (Scarpa, et al., 1997). Low baseline SCL has also been linked to externalising behaviour (Snoek, van Goozen, Matthys, Buitelaar, & van Engeland, 2004; van Goozen, Matthys, Cohen-Kettenis, Buitelaar, & van Engeland, 2000), and to predict persistence of conduct disorder from childhood onwards (Van Bokhoven, Matthys, van Goozen, & van Engeland, 2005).

Much less is known about physiological reactivity during stress in very young children. The few available findings suggest that physiological reactivity is an important factor that not only reflects variation in temperament but also identifies those at risk for externalising or internalising behavioural problems in later life (Kagan, 1994).

There is evidence that physiological indices of fearlessness in early childhood predict later externalising psychopathology. In a prospective study Raine, Venables and Mednick (1997) found that children who had low HR at 3 years of age were rated as more aggressive at 11 years. Similarly, Gao, Raine, Venables, Dawson and Mednick (2010b) found that poor fear conditioning at age 3 predicted crime at age 23. According to the authors, these findings suggest that low levels of physiological arousal early in life impact on later behaviour through a lack of fear associated with the low arousal. The consequence is that the individual fails to avoid situations, events and contexts associated with punishment now and in the future, and this affects the development of their conscience. The question arises as to whether it is possible to identify predictors before the age of 3. The work by Raine and colleagues highlights the importance of a multi-method approach, including the identification of early physiological profiles. At present we do not know whether behavioural and physiological responses to fear challenge are stable in children, or whether there is differential stability in physiological and behavioural reactivity.

In the present research we were interested in (a) whether we would be able to identify fearless and fearful infants based on behavioural, physiological, and maternal report measures; (b) whether children would still be characterised as fearful or fearless 2 years later; and (c) which type of measure would be helpful in identifying these subgroups.

Fear and the development of guilt

As well as understanding the role of early fear as a precursor to later psychopathology, it is important to investigate other emotions with which fear may be associated, especially moral emotions such as guilt. Guilt in children is defined as the feeling of distress following a mishap or transgression (Cole, Barrett, & Zahn-Waxler, 1992; Kochanska, Gross, Lin, & Nichols, 2002). Extremes in guilt-proneness have been associated with later psychopathology. A lack of guilt proneness has been found to be positively related to externalising behaviour (Ferguson, Stegge, Miller, & Olsen, 1999), aggression (Stuewig, et al., 2010), and anger, hostility and externalisation of blame (Stuewig, et al., 2010; Tangney &

Dearing, 2002). Moreover, children who experienced guilt were less likely to be arrested, convicted, and incarcerated as adolescents, and more likely to practice safe sex and not abuse drugs (Tangney & Dearing, 2002). Explanations for these adaptive effects focus on the fact that guilt requires the individual to self-reflect and think about what they did and why (Stuewig, et al., 2010). Individuals high in psychopathic traits fail to experience guilt (Raine, 1993).

Guilt is likely to be influenced by temperament (Kochanska, Barry, Jimenez, Hollatz, & Woodard, 2009). Fearful temperament, in particular, has been proposed to be a critical component in the development of guilt and conscience. Guilt is said to develop once the child feels empathy for others and responsibility for themselves, with fearful children more likely to feel guilty following a transgression due to their increased sensitivity to punishment (Dienstbier, 1984; Gray, 1982; Kagan, 1998; Kochanska, 1993), and because they learn more easily to inhibit transgressions of moral behaviour that are associated with punishment (Dienstbier, 1984). Children who are temperamentally fearless, on the other hand, are less likely to learn from the distress associated with transgressing, not only because they are less responsive to the fear of punishment following a wrongdoing (Dienstbier, 1984), but also because they do not anticipate these feelings in future situations (Fowles, 1994; Lykken, 1995).

There are many inconsistencies in the developmental literature on guilt, including when guilt develops, how it differs from other moral emotions such as shame, and how it can be measured. Although there are large discrepancies in views about the age at which guilt develops, ranging from 8 years to 18 months (Ferguson, Stegge, & Damhuis, 1991; Kagan, 1984; Kochanska, 1991). Kochanska (2002) argues that most developmental psychologists believe that in the second year of life young children begin to be clearly aware of their transgressions, misbehaviours, or substandard performances. Defined in this way, guilt has been identified as early as 22 months (Kochanska, et al., 2002) or 24 months (Barrett, Zahn-Waxler, & Cole, 1993).

A number of researchers believe that it is important to distinguish between guilt and shame early in development (Barrett, et al., 1993; Ferguson, et al., 1999), whereas others question whether this is possible (Kochanska, et al., 2002). Kochanska (2002) believes that distinguishing guilt from shame at this point in development is premature, given the lack of understanding of very young children's responses to their transgressions. When children respond to transgressions by showing behavioural and affective signs of discomfort, this is regarded as an antecedent of future guilt (Kochanska, et al., 2002). Barrett (1995) also claimed that in order to safely claim that a child experiences guilt, the toddler must display guilt-relevant behaviour (e.g., facial/bodily distress, promoting reparation, acknowledgment/apology/confession for act) in a relevant context (i.e., just after a transgression happened). In the present research the term *guilt* will be used to describe a child's distress response to a mishap or transgression.

Most developmental research on guilt is with older children. It is difficult to relate empirical research on guilt in adolescents and adults to research on guilt in children. Guilt in adolescents and adults is often measured by self-report, with few studies using behavioural or physiological measures (Tilghman-Osborne, Cole, & Felton, 2010). Kochanska, DeVet, Goldman, Murray and Putnam (1994) used observational and maternal reported measures of guilt and found only a modest convergence between these two methods. Given our limited understanding of the development of guilt, a multi-method approach is needed to fully capture guilt expression in young children (Tilghman-Osborne, et al., 2010).

From the above it will be clear that little developmental research has investigated the physiological component of guilt. It seems reasonable to assume that individual differences in arousal will also play an important role in variations in guilt. Fowles and Kochanska (2000) investigated fear as a moderator of conscience in children at 32 months and 4 years using a multi-method approach. Fearful and SCL reactive children were more anxious later in childhood, and the behavioural and physiological measures of fear were almost equivalent in their role as moderators of socialisation.

Are fear and guilt linked?

It is widely accepted that the experience of guilt and the associated aversive arousal have an adaptive function. Diminished capacity to experience discomfort following a transgression may be a factor in poor avoidance learning and antisocial conduct (Lykken, 1995). If this is the case, children who experience guilt following a transgression would be less likely to transgress in the future (Dienstbier, 1984; Hoffman, 1983; Kochanska, et al., 2002). Fearless children are by definition less likely to inhibit behaviour because they experience less arousal following aversive events, and are therefore less likely to experience guilt. The inability to assimilate these feelings over time will fail to act as a deterrent to misbehave in future.

Kochanska and colleagues have investigated the association between fearful temperament and early conscience development using maternal report and behavioural data (Kochanska, et al., 1994). In an influential study, Kochanska et al. (2002) studied the association between observational guilt and fearfulness in 112 children at 22, 33, and 45 months; maternal ratings of guilt were collected at 22, 33, and 56 months. Fear and guilt were significantly correlated at every age of assessment, with fear at 33 months also being significantly associated with guilt at 45 months. Gender differences were also found, with girls displaying higher levels of guilt than boys at 33 and 45 months. These findings complement an earlier study finding a positive association between fearfulness in infancy and parent rated guilt at age 6 (Rothbart, Ahadi, & Hershey, 1994).

These findings show that there are associations between fear and guilt in early childhood. Fear has been found to be associated with guilt across early childhood, with higher levels of fear being associated with higher levels of guilt, and predicting later guilt. Kochanska and colleagues' research investigates children from the age of 2 years, using maternal report and observational data. At the moment, we do not know whether earlier assessments of fear would be associated with the later development of guilt, or how fear physiology is associated with guilt.

Guilt is a moral emotion which is believed to be an important emotion for adaptive behavior (Tangney, Stuewig, & Mashek, 2007), however, other moral, 'self-conscious' emotions, such as shame, pride, and embarrassment may also play an important role in the development of inner guiding mechanisms, but were not the focus of this thesis. As previously discussed, very little is known about the early development of guilt, its antecedents and predictors for later development. Similarly, other moral, self-conscious emotions, such as shame, pride, and embarrassment have also received little empirical investigation into their early development and associations with inhibitory emotions, such as fearfulness and fearlessness. Whilst early guilt, or the antecedent to guilt 'distress following mishap', can be and have been successfully investigated (Kochanska et al., 2002), less is known about the early antecedents to shame, pride, and embarrassment. There is a consensus in the literature that more self-conscious, self-evaluative emotions, such as shame, embarrassment, and pride begin to emerge from 3 years onwards, once the child become capable of evaluating their 'self' and standards relating to their identity (Lewis, Alessandri, & Sullivan, 1992), and only when the self-concept has become stable (e.g. Elison, 2005; Draghi-Lorenz, Reddy, & Costall, 2001; Luby, et al., 2009). One study (Heckhausen, Ertel, &

Kiekheben-Roelofsen, 1966) that attempted to measure shame and pride from 2 years of age, only found evidence of these in the majority of children from 42 months. Guilt however has been successfully observed in children before 3 years of age (e.g. Kochanska et al., 2002).

There is theoretical and empirical evidence to show that fear and guilt are related emotions. As discussed, the fear of punishment and learning to anticipate these feelings are core components of guilt. Like fear, extreme levels of guilt have been shown to lead to adaptive and maladaptive outcomes. However, there is no theoretical or empirical evidence to our knowledge, that other self conscious emotions, such as shame, pride, and embarrassment will be associated with the early development of fear. Most theorists agree that shame and embarrassment involves a sense that the entire self is bad and that others are evaluating one negatively, whereas guilt involves responsibility for one's behaviour (e.g. Barrett, 1995; Ferguson & Stegge, 1998). Shame-prone individuals are more likely to externalise blame, resulting in the expression of anger in physical, verbal, displaced and self-directed aggression (Stuewig et al., 2010; Tangney et al., 2007). One explanation for aggressive behaviour to shame is that the individual shifts responsibility to protect the self by reacting defensively (Stuewig et al., 2010). Unlike those experiencing shame, people who experience guilt do not need to defend their identity or self belief. They are left to consider their behaviour and its consequences, leading to tension, regret and, importantly, remorse (Tangney, et al., 2007). The majority of researchers agree that because of this, guilt is an adaptive emotion (Tilghman-Osborne, Cole, & Felton, 2010): those who experience guilt are likely to become motivated to repair various misdeeds. The focus of this study was to investigate inner guiding mechanisms that promote adaptive socialisation and conscience development, and inhibit disruptive and aggressive behaviour, and as such fear and guilt were assessed. It is recognised that the research investigating early moral emotions is limited and other moral emotions likely to play an important role in the early moral development should also be investigated, however this was beyond the scope of this study.

In the present research we studied the stability of fear over the first 3 years of life, using behavioural, maternal reported and physiological assessments, as well as its associations with guilt. Both fear and guilt may act to inhibit and prevent problem behaviours, such as aggression and antisocial behaviour, and as such are important emotions in our understanding of developmental psychopathology more generally.

Method

Participants

Participants were 100 infants who took first part in our research around their first birthday. All participants were re-invited around their second birthday. Of those, 20 were unable to attend, and a further 10 were unable to complete the final part of the study around the third birthday, although one mother-child dyad returned who had not taken part at age 2. The main reasons for participants not completing the study were that the mothers had returned to work, had moved away from South Wales or we were unable to contact them. Overall, 70 children (36 boys, 34 girls) took part in the three waves of the study and are included in the current sample. The sample did not differ from the participants who dropped out in demographic characteristics (e.g., maternal age, family composition) or any of the study's dependent measures. Participants and their families were recruited from local nurseries and play centers in Cardiff (Wales, UK) (Appendix 1). The study was approved by the School of Psychology Research Ethics board at Cardiff University. The study was conducted in accordance with British Psychological Society guidelines and ethical protocol.

Procedure of the experimental session

The procedure took place in a child-friendly laboratory playroom. Mothers were asked to accompany their child to the laboratory where the children were assessed individually using several procedures designed to present an increasingly novel and challenging situation for the infants. The infant was given time to adjust to being in the laboratory and allowed to play with some age-appropriate toys, whilst the procedure was explained to the mother. Once the mother thought the child had settled, ECG and SCL electrodes were placed on the child, and baseline HR and SCL measures were taken when the mother and child were quietly playing together in the room for 3.5 minutes. The fear procedure took approximately 3.5 minutes. The mishaps paradigm lasted for approximately 2 minutes, and was initiated after the child had recovered from the fear procedure. The mishaps/guilt paradigm was only used at the Year 3 assessment.

Lab-TAB fear paradigm

At each year of assessment, child fear and distress were assessed using the unpredictable mechanical toy component of the Lab-TAB (Goldsmith & Rothbart, 1999). It closely followed the protocol of the Lab-TAB, however, for the purposes of the present study the mechanical toy dog used in Lab-TAB was replaced by a remote-controlled robot and the mother was asked to leave the room. An unfamiliar experimenter entered the room and placed the robot approximately 1.5 meters away from the child, who was strapped into a children's car-seat. The experimenter made the robot approach the child, stopping approximately 15 cm from the child, while making movements with its arms and emitting noise. The robot then walked backwards and stopped at the back of the room for about 10 seconds before moving forward again. This trial was repeated three times, in line with the Lab-TAB protocol.

Coding

The Lab-TAB's guidelines were followed for the behavioural coding of the episode, which was carried out using video recording of the session (see Appendix 2). It was important to gain clear and full frontal shots of the infant's face. Each of the three trials of robot approach and movement in front of the child was separated into three epochs (robot walk towards child, robot moving in front of child part one, robot moving in front of child part two). This created a total of nine epochs that were scored separately. A subgroup of the six Lab-TAB dimensions was used for scoring in this study, in order to score the same distress parameters as the mishap procedure measuring guilt. Each epoch was scored on the following dimensions and scales: intensity of facial fear (0-3), intensity of distress vocalization (0-2), and intensity of bodily fear (0-3). A composite fear score was made from the sum of three scores. The fear score using three dimensions of Lab-TAB fear correlated highly with the full Lab-TAB composite score (year 1, r = .87, p<.01; year 2, r = .91, p<.01; year 3, r = .94, p<.01).

To reduce the number of data, the highest score from a single epoch was used in analyses to reflect the most intense behavioural score at a point in time. Scores ranged between 0 and 8 across all categories coded.

Four coders scored the episodes independently for 22 % of the sample. Intra-correlation coefficients between coders ranged between .70 and .99 across the behavioural variables.

Mishap guilt paradigm

The mishaps paradigm was adapted from Kochanska et al (2002). The task involved contrived transgressions or "mishaps". The experimenter presented the child with a tower, which she described as being her favourite toy and that she had made it herself. She told the child that she would share it with them, as long as they were very careful. Because the tower had been "rigged", the object fell apart as soon as the child began to handle it. The experimenter then said "Oh my…." with mild regret, and sat still in front of the child, with her face covered with her hands for 30 seconds. The experimenter then asked three standard questions, "What happened?", "Who did it?", and "Did you do it?" The child was then told that it wasn't their fault and there had been a problem with the tower. She then presented another partially built tower and asked the child to help her make it. The experimenter reassured the child the damage had not been the child's fault, and assumed responsibility for it.

Coding

The coding system used in the current study was adapted from Kochanska et al (2002). To avoid ambiguity over the distinction of guilt and shame, the coding system focused on the level of distress to a mishap (see Appendix 3). The child's behaviour was coded in five second epochs from when the tower fell, to when the experimenter first told the child it was not their fault. The scoring reflects the level, or intensity, of the behaviour. A subgroup of the five dimensions was used to measure the same parameters as distress during the fear procedure. Each epoch was scored on the following dimensions and scales: (a) bodily tension which was scored on four categories: facial, posture, discomfort, intense (if any behaviour within the category was observed, the category would get a single score) this behaviour was scored 0-3 depending on how many categories were present (intense would score the epoch a 3); (b) facial tension, scored the same as bodily tension with four categories: eyes, eyebrows, mouth intense (0-3); vocal distress (0-2). A composite guilt score was made from the sum of three scores. The intensity score using three dimensions of distress correlates highly with the full mishaps distress score (r = .94, p< .01).

Data reduction

In order to reflect the level of distress to guilt, an intensity score was given. The highest score from a single epoch was used. This score is regardless of when this peak response occurred, or the duration of the procedure. The score ranged between 0 and 8 across all categories coded, with 8 showing the highest level of distress. Kappa coefficients were calculated for two raters for each coded behaviour for 30% of the sample (bodily tension, κs = .69; facial tension, κs = .83; vocal distress, κs = .84).

Mother-reported fear (year 1)

Infant Behaviour Questionnaire Revised (IBQ-R; Gartstein & Rothbart, 2003). The IBQ-R assesses 14 domains of infant temperament and the current study focused on the domain of ‘fear’. The ‘fear’ subscale consisted of 16 items (Cronbach’s α = .88). Each item was rated by the frequency with which it had been observed over the last week (or in some cases 2 weeks) on a 7-point scale from (1) *never* to (7) *always*. There was also the option to respond “does not apply” to each item. The items were deliberately constructed so that parents rated observed behaviours and did not have to make comparisons or global judgments or recall past behaviours (Rothbart, 1981).

Mother-reported psychopathology (year 2 and 3)

The Child Behaviour Checklist for ages 1 ½ - 5 (CBCL; Achenbach & Rescorla, 2000) is a standardized form, rating diverse aspects of behavioural, emotional and social functioning within a normal or clinical range. The mother rates 99 problem items as 0 = *not true* of the child, 1 = *somewhat/sometimes true*, and 2 = *very true/often*. The scores are organized in syndromes and grouped into internalised or externalised groupings. Of interest in the current study is the internalising score (Cronbach’s α = .89), computed by summing the scores from the four internalising syndromes, emotionally reactive, anxious/depressed, somatic complaints, and withdrawn. Participants were identified as borderline or clinically internalised (*N = 10*), or within the normal range (*N = 60*) from their internalising syndrome scales and grouping scale in either Year 2 or Year 3.

Physiological reactivity

The HR and SCL recording and analysis software programme were custom made using the PSYLAB programme (PsyLab, 2007). Three ECG electrodes were attached to the child's back to measure HR in beats per minute. Two SCL electrodes were securely attached on the left foot (Edelberg, 1967).The electrodes placed on the participant were attached to a PSYLAB Stand Alone Monitor (SAM) which is powered by 12 volt universal power units which run on any voltage between 100 and 250V, 50/60Hz. Measures of HR and SCL were taken throughout, recording mean levels at 30 second intervals.

Missing data

All 70 participants in the sample took part in every procedure, at all three assessments (Year 1 [Y1]; Year 2 [Y2]; and Year 3 [Y3]). A number of participants had missing data during these episodes, but none had all the data missing during an entire episode. The missing data resulted from equipment malfunction or refusal to take part (missing data across variables: behavioural fear Y1 = 2, Y2 = 3, Y3 = 3; guilt = 3; SCL fear Y1 = 0, Y2 = 6, Y3 = 7; guilt = 7; HR fear Y1 = 0, Y2 = 6, Y3 = 9; guilt = 9). Data imputation was implemented using linear trend computation (Little & Rubin, 1987).

Coding strategy

All data were coded by 3 experienced researchers from the 'Emotions and Coping' study. Measures were taken to ensure bias was reduced and remained at a minimum: the main coder was not the researcher who was in the room with the child at the time of administering the task, in order to eliminate bias of expectation. Participant identification numbers were used instead of the child's name to reduce familiarity with the child. Finally, coding was completed in batches of around 10 children; some time after testing took place so that memory effects of the session were reduced to a minimum.

Data analysis

We first investigated the associations between variables by examining the inter-correlations between fear variables, and between fear and guilt variables. A step-wise (forward) regression was used to assess the unique contribution of Y1 and Y2 infant behavioural, physiological and maternal reported fear to the explanation of Y3 fear and guilt.

SCL and HR were measured continuously during baseline (3.5 minutes, seven 30-second periods), fear procedure (3.5 minutes, seven 30-second periods) and guilt (2 minutes, four 30-second periods). An overall mean baseline (SCL_{base}, HR_{base}), fear (SCL_{fear}, HR_{fear}) and guilt (SCL_{guilt}, HR_{guilt}) was calculated and used in subsequent analyses.

Results

Descriptive data are presented in Table 1 and the correlations between the variables in Table 2. Stepwise regressions examining predictors of later fear and guilt are presented in Table 3 and 4 respectively.

A repeated measures ANOVA revealed a significant main effect of year of assessment for HR (F (2, 138) = 80.35, p <.001) and SCL (F (2, 138) = 25.84, p<.001), and of condition for HR (F (1, 69) = 118.95, p<.001) and SCL (F (1, 69) = 8.30, p<.01). There was also a significant interaction between condition and year for HR (F (1.72, 118.48) = 53.83, p<.01) and SCL (F (2, 138) = 42.53, p<.001). The significant effect of year means that levels of HR and SCL arousal generally decreased over the three assessments, whereas the main effect of condition shows that physiological arousal significantly increased from baseline to stress, indicating that fear was successfully induced. However, the effect of our fear manipulation was much more pronounced in Y2 (percentage increase from baseline to fear: HR: 9.46%; SCL: 125.10%) compared to Y1 (HR: 3.74%; SCL: 87.48%) and Y3 (HR: 3.60%; SCL: 57.39), as reflected by the significant interaction effect for both HR and SCL (see Table 1 for means). There was no main effect of year on behavioural fear (F (2, 138) = 2.60, p = .08), suggesting that observed behavioural fear remained stable over time.

Table . *Descriptive Statistics for All Measures*

	Baseline		Fear (Means)	
	M	*SD*	*M*	*SD*
Maternal Report Fear				
Y1	-	-	2.48	.87
Behavioral Fear				
Y1	-	-	5.07	2.48
Y2	-	-	5.85	2.10
Y3	-	-	5.33	2.45
HR Fear				
Y1	136.43	12.15	141.34	15.78
Y2	121.86	9.74	133.11	13.97
Y3	113.72	9.84	117.72	14.77
SCL Fear				
Y1	10.87	8.04	16.80	11.71
Y2	6.75	4.31	11.66	6.64
Y3	7.35	3.83	9.11	3.64
Guilt				
Behavioral	-	-	4.30	2.01
HR	-	-	108.99	9.02
SCL	-	-	10.35	4.27

Note: - No measurement taken. Y1, Year 1; Y2, Year 2; Y3, Year 3; HR, heart rate; SCL, skin conductance level.

Table . *Correlations for each measure of fear and guilt, at each year of assessment.*

		1	2	3	4	5	6	7	8	9	10	11	12	13
	Y1													
1	Behavior $_{fear}$	--												
2	HR $_{fear}$	.54**	--											
3	SCL $_{fear}$	.06	.06	--										
4	Mother $_{fear}$	.25*	.09	.09	--									
	Y2													
5	Behavior $_{fear}$	.11	.09	.00	-.10	--								
6	HR $_{fear}$	-.03	.08	.21	-.09	.46**	--							
7	SCL $_{fear}$	.17	-.06	.27*	-.02	.06	.11	--						
	Y3													
8	Behavior $_{fear}$	.26*	.17	.09	.03	.36**	.32**	.10	--					
9	HR $_{fear}$	.10	.46**	.19	-.07	.26*	.44**	-.08	.45**	--				
10	SCL $_{fear}$	.25*	-.02	.25*	-.09	.16	.19	.30*	.19	.09	--			
11	Behavior $_{guilt}$	.18	-.10	-.12	.03	.05	.13	-.13	.25*	.03	.11	--		
12	HR $_{guilt}$	.18	.35**	-.00	.04	.19	.16	-.14	.20	.51**	.02	.21	--	
13	SCL $_{guilt}$	.33**	-.01	.27*	.03	.07	.05	.25*	.12	.04	.83**	.03	-.02	--

* $p < .05$, ** $p < .01$

Fear from Y1 to Y3: Associations across measures

Associations between all measures of fear at each age of assessment are presented in Table 2. Y1 behavioural fear was associated with Y1 HR_{fear} (r = .54, p< .01) and Y1 maternal reported fear (r = .25, p< .05). HR_{fear} and behavioural fear continued to have a positive association in Y2 (r = .46, p< .01), and Y3 (r = .45, p< .01). SCL_{fear} was not associated with any other fear measure at any of the assessments.

The measures of behavioural fear were associated between Y1 and Y3 (r = .26, p< .05), and between Y2 and Y3 (r = .36, p< .01) but not between Y1 and Y2 (r = .11, p = .37). Similarly, the measures of HR_{fear} were associated between Y1 and Y3 (r = .46, p< .01), and between Y2 and Y3 (r = .44, p< .01), but not between Y1 and Y2 (r = .08, p = .51). Positive associations were found for SCL_{fear} across all ages of assessment, from Y1 to Y2 (r = .27, p < .05), from Y1 to Y3 (r = .25, p < .05), and from Y2 to Y3 (r = .30, p < .05) (see Table 2).

Gender

Gender differences for all study variables were investigated using Fisher *r*-to-*z* transformations. There were no significant differences between the correlations coefficients for boys and for girls. Gender was not considered in further analysis.

Early fear as a predictor of fear in Y3

Table 3 summarizes the results of a series of regression analyses, highlighting the predictors of each measure of fear. In order to test whether early measures of fear predicted later fear, stepwise (forward) regressions were used for each measure of fear. At Step 1 the Y1 assessment of the dependent measure in question was included as a predictor variable. At Step 2 the other Y1 measures of fear were entered. At Step 3 the Y2 assessment of the dependent measure in question was included as a predictor variable.

Behavioural fear in Y3: Y1 behavioural fear positively predicted Y3 behavioural fear. This association was reduced to non-significance when the other Y1 variables were entered as predictors. Y2 behavioural fear positively predicted Y3 behavioural fear over and above all Y1 measures. None of the Y1 physiological measures of fear predicted Y3 behavioural fear.

Y3 HR_{fear}: Y1 HR_{fear} significantly predicted Y3 HR_{fear}, and this remained the case after the introduction of the other Y1 variables and the Y2 measure of HR_{fear}. This shows that infants who had a higher HR_{fear} in Y1 and Y2 continued to have a higher HR_{fear} in Y3. Y1 behavioural fear, SCL_{fear} or maternal report of fear did not predict Y3 HR_{fear}.

Y3 SCL_{fear}: Y1 SCL_{fear} predicted Y3 SCL_{fear} after controlling for the influence of the other Y1 measures. This association was reduced to non-significance with the introduction of Y2 SCL_{fear}. Infants with higher levels of behavioural fear in Y1 had higher levels of Y3 SCL arousal during fear. This association remained the largest after the introduction of other Y1 variables, and Y2 SCL.

Table . *Summary of all stepwise regression analysis for variables predicting behavioural, HR, and SCL fear in Y3 (N=70).*

Step and Predictors Entered	ΔR^2	β
Dependent variable: Y3 Behavior $_{fear}$		
Step 1:		
Y1 Behavior $_{fear}$		.26*
Step 2:		
Y1 Behavior $_{fear}$		.26
Y1 HR $_{fear}$		.03
Y1 SCL $_{fear}$		.07
Y1 Mother $_{fear}$		-.05
	.01	
Step 3:		
Y1 Behavior $_{fear}$		.21
Y1 HR $_{fear}$		.02
Y1 SCL $_{fear}$		.07
Y1 Mother $_{fear}$		.00
Y2 Behavior $_{fear}$		.34**
	.11**	
Total R^2 = .13		
Dependent variable: Y3 HR $_{fear}$		
Step 1:		
Y1 HR $_{fear}$		.46***
Step 2:		
Y1 HR $_{fear}$		.56***
Y1 Behavior $_{fear}$		-.20
Y1 SCL $_{fear}$		.18
Y1 Mother $_{fear}$		-.08
	.07	
Step 3:		
Y1 HR $_{fear}$		.52***
Y1 Behavior $_{fear}$		-.17
Y1 SCL $_{fear}$		.09
Y1 Mother $_{fear}$		-.04
Y2 HR $_{fear}$		.37***
Total R^2 = .36	.13***	
Dependent variable: Y3 SCL $_{fear}$		
Step 1: Y1 SCL $_{fear}$		.25*
Step 2:		
Y1 SCL $_{fear}$		.26*
Y1 Behavior $_{fear}$		.43**
Y1 HR $_{fear}$		-.25
Y1 Mother $_{fear}$		-.20
	.13*	
Step 3:		
Y1 SCL $_{fear}$		.21
Y1 Behavior $_{fear}$		.37*
Y1 HR $_{fear}$		-.21
Y1 Mother $_{fear}$		-.18
Y2 SCL $_{fear}$		.16
Total R^2 = .16	.02	

Note: HR, heart rate; SCL, skin conductance level; Y1, year 1; Y2, year 2; Y3, year3.

* $p < .05$, **$p < .01$, ***$p < .001$

Associations between fear and guilt

Y3 behavioural measures of fear were associated with Y3 guilt, and Y3 physiological measures of fear were also positively associated with Y3 guilt (see Table 2), suggesting that these are related constructs. However, these associations were only within type of measure: behaviour (r = .25, p< .05), HR (r = .51, p< .01) and SCL (r = .83, p< .01). There were no associations between different types of measure in Y3. There were no significant correlations between Y1 behavioural or physiological measures of fear, and Y3 behavioural guilt. Behavioural guilt was not included in further analyses.

Early fear as a predictor of guilt

Table 4 summarises the results of a series of regression analyses, highlighting the predictors of each type of measure of Y3 guilt. In order to test whether measures of fear in Y1 and/or Y2 predicted Y3 guilt, stepwise (forward) regressions were used.

Y3 HR_{guilt}*:* Y1 HR arousal during fear predicted HR arousal during guilt in Y3.

SCL_{guilt}*:* Y1 SCL_{fear} predicted SCL arousal during guilt in Y3. Regression diagnostics revealed that the relationship between behavioural fear and HR_{fear} at Y1 could be biasing the model (from inspection of the variance inflation factor). Stepwise regressions were conducted excluding Y1 HR_{fear}. The association between Y1 SCL_{fear} and SCL_{guilt} was reduced to non-significance with the introduction of Y2 SCL_{fear}. Infants with higher levels of behavioural fear in Y1 had higher levels of Y3 SCL arousal during guilt. This association remained significant after the introduction of other Y1 variables and Y2 SCL.

Taken together, the results show that measures of HR and SCL fear arousal in Y1 predicted guilt responses in toddlers. Year 2 measures of fear arousal did not predict Y3 guilt.

Table . *Summary of all stepwise regression analyses for variables predicting HR and SCL guilt in Y3 (N=70).*

Step and Predictors Entered	ΔR^2	β
Dependent variable: Y3 HR $_{guilt}$		
Step 1:		
Y1 HR $_{fear}$		.35**
Step 2:		
Y1 HR $_{fear}$		.36**
Y1 behavior $_{fear}$		-.02
Y1 SCL $_{fear}$		-.02
Y1 mother $_{fear}$		.02
	.01	
Step 3:		
Y1 HR $_{fear}$		.35*
Y1 behavior $_{fear}$		-.01
Y1 SCL $_{fear}$		-.06
Y1 mother $_{fear}$		.08
Y2 HR $_{fear}$		.15
Total R^2 = .08	.02	
Dependent variable: Y3 SCL $_{guilt}$		
Step 1:		
Y1 SCL $_{fear}$		.27*
Step 2:		
Y1 SCL $_{fear}$		.25*
Y1 behavior $_{fear}$		.33**
Y1 Mother $_{fear}$		-.07
	.10*	
Step 3:		
Y1 SCL $_{fear}$		.22
Y1 behavior $_{fear}$		.31*
Y1 mother $_{fear}$		-.06
Y2 SCL $_{fear}$		.13
Total R^2 = .19	.02	

* $p < .05$, ** $p < .01$, *** $p < .001$

HR and behavioural fear in infancy and later internalising psychopathology

Children who were rated by their mothers as clinically internalised at age 3 had significantly higher levels of HR during baseline and fear in Y1, $HR_{baseline}$ $U = 171$, $z = -2.17$, $p < .05$; HR_{fear} $U = 162.5$, $z = -2.31$, $p < .05$. Internalised children had significantly higher $HR_{baseline}$ (M = 143.16, *SD* = 7.69) and HR_{fear} (M = 152.74, *SD* = 14.81) in Y1 than those in the normal range ($HR_{baseline}$ M = 134.72, *SD* = 11.03; HR_{fear} M = 139.44, *SD* = 15.23). Clinically internalised children also had higher behavioural fear scores (M = 6.5, *SD* = 1.72) in Y1 than those in the normal range (M = 4.83, *SD* = 2.52); however, this difference was only marginally significant, $U = 193.5$, $z = -1.81$, $p = .07$).

Discussion

This study had four aims: 1) to investigate associations between behavioural, maternal reported, and physiological parameters of fear in infants; 2) to examine the stability of fear from infancy to early childhood; 3) to find out whether fear and guilt are associated, 4) to explore whether early fear predicts later guilt; and 5) to find out whether internalised toddlers differ from normal toddlers on measures taken in infancy.

We began by examining associations between different measures of fear. HR and SCL levels increased significantly from baseline during fear induction, confirming that the procedure used in the current study was successful in arousing the ANS. We predicted positive associations between behavioural and physiological fear, such that behaviourally fearless children would exhibit lower levels of ANS arousal during fear challenge. This prediction was partly supported: although at each year of assessment behavioural fear and

HR_{fear} were significantly positively associated, this was not the case for SCL. Fowles, Kochanska and Murray (2000) found associations between SCL and fear behaviour at 4 years, but not earlier. In the present study the association between SCL and fearfulness strengthened with each assessment (r = .06 - .19), suggesting that this association might develop across time.

HR and SCL are different components of the ANS; SCL is controlled solely by the sympathetic nervous system, whereas HR is the result of the combined action of the sympathetic nervous systems and parasympathetic nervous system. Particularly important in this respect is the vagal control of the heart (i.e., vagal tone) (Lovallo, 1997). HR and SCL were not associated in the present data, suggesting that although they both *independently* index arousal responses to fear, they reflect different components of fear. It is worth noting that the non-association of HR and SCL is a well-known phenomenon in research on antisocial behaviour (even though antisocial or conduct disordered individuals are characterized by both low HR and low SCL; e.g., Raine, 1993; van Goozen et al., 2000), and emotion research more generally. Fear is a complex construct and the findings from the present study underscore this once more. It is only through the continued use of multi-method approaches to testing that we can begin to understand it.

In Y1 mothers' reports of infant fear corresponded with independently observed fear, but not with physiological fear. This indicates that different observers may agree about what they see, but what they see is not necessarily what the child experiences. Thus mothers who rated their child as having a fearful temperament did not necessarily have a child who became highly aroused during fear. Kagan (1994) argues that maternal reports are too subjective, with mothers reporting their impressions of the child, which are likely influenced by their expectations of their child's temperament. Maternal report does not appear to be the best measure of a child's fear experience.

Our next aim was to assess the associations of fear from infancy up to age 3. Although HR and SCL baseline and stress levels decreased significantly over time, physiological fear reactivity was significantly higher in Y2, showing that physiological fear is not stable over time. This pattern of increased fearfulness in Y2 was not reflected in significantly greater behavioural fear, although observed fear distress was somewhat higher in Y2 (M = 5.85) than in Y1 (M = 5.07) and Y3 (M = 5.33). Individual differences in fearfulness were, however, found to be associated, as reflected in the positive and significant correlations between the measures over time. Fearless infants continue to be fearless toddlers.

In addition to the associations between different types of measures, we were interested in whether individual differences in early fear were predictive of later fear. Behavioural fearlessness in infancy predicted behavioural fearlessness and low SCL fear arousal in Y3, and low HR fear arousal in infancy predicted low HR fear arousal in Y3. All measures in infancy predicted their counterpart measures in Y3, with behavioural fear also predicting across measures in Y3. The inclusion of the equivalent measure of fear at Y2 enabled us to include this more temporally proximal measure in the analysis and to observe whether or not Y1 measures continued to have predictive utility. This was largely the case, especially for physiological fear. However, with the inclusion of other estimates of fear in Y1 and the Y2 behavioural measure of fear, behavioural fear in Y1 was no longer associated with behavioural fear in Y3. Overall, the inclusion of Y2 assessments shows that even after controlling for more proximal assessments, Y1 indices play a role in the explanation of variance in individual differences at Y3.

Kochanska and colleagues (2002) found that fearfulness and guilt were associated at each of their assessments. We therefore predicted that fearful individuals would experience and exhibit more guilt, and conversely, that fearless individuals would have lower levels of guilt. We assessed guilt in Y3, so we first were interested in the concurrent association with fear in Y3. Behavioural and physiological measures of fear and guilt were found to be positively associated within type of measure, confirming this prediction. Toddlers exhibiting less behavioural or physiological fear also showed less distress and experienced less arousal during the mishap guilt procedure.

We next predicted that fear in infancy would predict guilt proneness in toddlers. To our knowledge, there is no previous study investigating this relationship using behavioural and physiological measures, and few studies have examined this association from infancy. Our findings confirmed not only the existence of a concurrent association between fear and guilt, but also showed some evidence that fear in infancy was predictive of guilt 2 years later. Such an association was found for HR and SCL, but not for behavioural fear, although behavioural fear in infancy predicted SCL arousal during guilt.

Behavioural fear in infancy predicted Y3 behavioural fear, which was in turn strongly associated with behavioural guilt. However, contrary to our predictions, behavioural fear in infancy was not correlated with behavioural guilt in Y3. We can infer that although behavioural measures of fear and guilt are associated at the same stage of development, earlier behavioural fear is not predictive of later behavioural guilt. It is worth noting that Kochanska and colleagues (2002) also only found associations between concurrent measures of fear and guilt.

With increasing age, children are better able to engage in emotion regulation and therefore to inhibit or mask an overt expression of negative affect and to avoid intense emotional expressions (Kochanska, et al., 2002). It may therefore be that fear- and guilt-prone toddlers, the ones who become aroused when challenged, modulate their expression of their feelings during and following a transgression, resulting in a weaker association between infant fear and toddler guilt.

In contrast to fear, a basic emotion that is present from birth and does not necessarily entail a lot of cognitive processing, guilt is complex and requires a higher level of cognitive understanding. It is possible that guilt is still developing at the age of 3, and therefore that the stability of the relation between behavioural expressions of fear and guilt only emerges later. It is interesting, however, that physiological fear arousal in infancy predicted physiological arousal to guilt in Y3, suggesting that a child's arousal during these emotions draws on the same underlying mechanism.

Our findings indicate that the physiological response develops first and the cognitive processes follow. This concurs with current theories of emotion. According to Izard (1992) the brain mechanisms of the emotion systems mature earlier than some of the mechanisms (e.g., hippocampus) required for contextual learning and for autobiographical and declarative memory. He conceived emotion *experience* as a 'feeling state' that does not require cognitive mediation and suggested that emotion processes can operate independently of cognition. Emotions can be activated by a sub-cortical (thalamo-amygdala) pathway that can operate independently of the neo-cortex and therefore independently of any type of cognition requiring cortical processing or integration (LeDoux, 1987). Sympathetic arousal, an index of emotional behaviour released by the amygdala, can be seen as an indicator of an intervening feeling-motivational state generated by the sub-cortical pathway (Izard, 1992).

Our data show that the discomfort that fearful children experience during fear-arousing situations appears to bleed into other negative emotions such as guilt, and the proneness to experience these feelings seems to be relatively stable across early childhood. This is important because the subjective discomfort associated with fear and guilt encourages children to learn to avoid these situations in the future (Kochanska, et al., 2002), perhaps being influenced by somatic markers (Damasio, 1996). The present evidence suggests that the *feelings* associated with fear and guilt (insofar as these are captured by physiological measures) are relatively stable over time, but that the overt expression of these emotions is less stable, being consistent within but not across time. This highlights the importance of investigating multiple components of emotions.

The inclusion of the more temporally proximal counterpart measure of fear in Y2 did not play a role in the explanation of variance in levels of guilt proneness. Fear in infancy alone predicted guilt proneness in toddlers, within and across measures. The fact that Y1 measures were significant predictors even when controlling for Y2 highlights the importance of starting to assess these variables in the first year. Y2 measures may be less predictive than Y1 measures because the general tendency for children to score more highly on Y2 measures of fear arousal may have masked the relationship with guilt.

The present study investigated variations in fear in normally developing children to establish whether it is possible to identify risk pathways from an early age. Within a typically developing sample extremes can be identified and may even be classified in the clinical range. Although we predicted that extremes in early fearfulness would be associated with later internalising problems, little is known about the early risk factors for this association. We found that a subgroup of internalised toddlers showed significantly higher levels of HR during baseline and fear in infancy. These infants also showed more behavioural distress, which is consistent with previous findings (Kagan et al., 1984, 1987). These findings further underline the salience of investigating infant emotion and show that risk factors for later psychopathology can be identified at an early age.

Fearful temperament not only plays a role in children's expression of emotion but may also affect infants' developing sense of self-efficacy. Young children's expression of positive and negative emotions may play a significant role in their development of social relationships. Positive emotions appeal to social partners and seem to facilitate the formation of relationships, while problematic management or expression of negative emotions leads to difficulty in social relationships (Denham & Weissberg, 2004).

Between birth and the end of toddler age, children develop the foundation for all social interactions. They learn to feel and identify a wide variety of emotions, and they experience a wide range of social interactions. We already mentioned that infants experience and express emotions before they fully understand them. In learning to recognise, label, manage, and communicate their emotions children build skills that connect them with their family and later with their peers and others in their environment. These emerging capacities help young children to become competent in increasingly complex social interactions, and to reap the benefits of social support crucial to healthy human development and functioning.

Prior studies have found gender differences in fear and guilt, finding girls to be more fearful and guilt prone (Kochanska, et al., 1994, 2002), leading us to anticipate gender differences in fear and guilt. However, we found no differences between boys and girls on any of our study variables, at any age of assessment. It may be that gender differences in fear and/or guilt only become apparent after age 3. It is also possible that the power to detect gender differences in the current study was too low due to the relatively modest sample size. Future research should aim to investigate gender differences in fear and guilt in larger samples.

Developmental investigations into risk pathways for later psychopathology should not wait until middle childhood (Cicchetti & Toth, 2009). The current study highlights the value of investigating emotion development from infancy onwards and shows that fearfulness in infancy is stable and predicts fear and guilt in toddlerhood. Fearfulness and high levels of guilt have been linked to internalising problems (Biederman, et al., 1993; Biederman, et al., 1990; Harder, 1995; O'Connor, Berry, Weiss, & Gilbert, 2002; Schwartz, et al., 1999; Zahn-

Waxler, Kochanska, Krupnick, & McKnew, 1990). Conversely, fearlessness and deficient guilt experience have long been linked to externalising problems, including aggression and antisocial behaviour (Gao et al., 2010b; Raine et al., 1997). Although relationships between emotionality and later psychopathology have been confirmed in children, our results suggest that some patterns are already established in infancy, highlighting the early development of risk pathways.

The current study adopted a prospective, multi-method approach and by doing so showed that physiology is an important and stable measure of individual differences in children's temperament. Fearless infants not only had lower levels of ANS arousal across the years of assessment, but also showed less fear behaviour and physiological reactivity to fear and guilt 2 years later. Research in the area of developmental psychopathology should not wait until children have developed emotional and behavioural problems. If we seek to understand pathological development and to prevent problems from developing, we need to know when and how emotions develop and when temperament becomes stable. By showing that individual differences in fearful temperament are associated from the first year of life and predictive of later fear and guilt, the present study strongly suggests that the first 3 years of life represent a crucial period when important systems that are involved in the experience and expression of emotions are established and children become emotionally "hardwired". By investigating normal development from infancy onwards we can extend our understanding of developmental trajectories and begin to identify risk pathways that extend beyond early childhood.

The present study highlights the role of individual differences in physiology and fearful temperament at a time before important external factors also begin to affect emotion development (e.g. peers and school, or effects of smoking, exercise and puberty on ANS functioning; Raine, et al., 1997). Another important factor in early emotion development is the quality of the parent-child relationship. The period of our study coincides with the theorised development of attachment relationships with primary caregivers and the research paradigm shared some of its features with the Strange Situation Procedure (Ainsworth, Blehar, Waters, & Wall, 1978; e.g. a separation and reunion between parent and child, the presence of a stranger, exposure to a potential stressor and a laboratory setting). Future studies may wish to study features of the child's social world (including parenting behaviour and attachment security) as part of investigations into early temperament (Blandon, et al., 2010), emotion regulation (Bowlby, 1969; Kim & Cicchetti, 2010), risk pathways (Barker, Oliver, Viding, Salekin, & Maughan, 2011) and moral development (Kochanska, 1991; Kochanska, Barry, Aksan, & Boldt, 2008).

A possible limitation of our measure of guilt was the difficulty in distinguishing early guilt from shame. Kochanska and colleagues (2002), who investigated guilt using the same guilt paradigm as used in the current study, believe that distinguishing guilt from shame at this point in development is premature given the lack of understanding of very young children's responses to their transgressions. Furthermore, many researchers believe that shame develops after guilt, from 3 years onwards (e.g. Elison, 2005; Draghi-Lorenz, et al., 2001; Lewis, et al., 1992; Luby, et al., 2009). However, some authors argue that there are few situations that uniquely evoke guilt or shame (Tangney, 1996), with displays of guilt in very young children actually reflecting a combination of shame, guilt, and fear (Eisenberg, 2000), whereas others believe situations such as social blunders evoke shame but not guilt, whereas moral transgressions evoke guilt (i.e. Edelman, 1985; Moretti& Higgins, 1990). Barrett (1995) claimed that Kochanska and colleague's (2002) mishap paradigm coded shame as well as guilt (i.e. gaze aversion). As is the case with early research on guilt, there is little consistency. We attempted to rectify this issue by coding 'distress to a mishap' which focused on the definition of early guilt, where children respond to transgression by showing behavioural and affective signs of discomfort, as this is regarded as an antecedent of future guilt (Kochanska, et al., 2002). However, it is recognised that more research is needed to clarify the conceptual differences in the early expression of early guilt and shame, in order to have confidence that the mishap paradigm does not also measure shame.

A second limitation may be how generalisable our measure of guilt is. It is difficult to examine empirical research on guilt development and relate these findings to research on guilt in adolescents and adults. Guilt in adolescents and adults is often measured using (self-report) questionnaires, with very few studies using behavioural or physiological measures (Tilghman-Osborne, et al., 2010). It is not possible to examine young children's guilt using self-report. Although many toddlers have a vocabulary of emotions, the understanding of guilt is complex, and guilt is not part of a child's active lexicon until around 5.5-6 years of age (Ridgeway, Waters, & Kuczaj, 1985). Furthermore, clarifying fine distinctions between different emotional states is a complex skill for adults (Tilghman-Osborne, et al., 2010), let alone children (Barrett, 1995). One of the difficulties involved in measuring guilt is due to the large range of definitions and measurements used in adulthood, most of which cannot be applied to children (Tilghman-Osborne, et al., 2010). Although this may be a limitation as to how well this measure of guilt can be generalised into guilt later on in development, we hoped to have increased our understanding of early guilt by using a multi method approach, and consistency in the definition and measurement of early guilt.

One potential limitation to our coding strategy was that the coder for the task was not always different across the 3 years. This was due to the coding strategy where the coder was not the experimenter that was in the room during testing, and so it may be that the same researcher coded the same child across years. Due to the time frame of the study this would be in very few cases, and 12 months would have passed between each coding session, however there may still be a potential experimenter bias that requires consideration when interpreting the results.

Similar developmental pathways to the ones identified in this study have been found in later life. Fearless individuals display low levels of ANS arousal to fear (Gao, et al., 2010b; Quay, 1965; Raine, 1993), and are seen to experience low levels of guilt (Kochanska, et al., 2002), whereas fearful individuals display higher levels of physiological fear (Kagan et al., 1987, 1998) and higher levels of guilt (Kochanska et al., 2002). These profiles in normal healthy samples can extend into psychopathological patterns, with extremely fearful and guilt-prone children showing anxious and depressive tendencies subsequently (Biederman, et al., 1990, 1993; Harder, 1995; Zahn-Waxler, et al., 1990), and fearless and low guilt-prone individuals being at risk for developing callous and unemotional (i.e., psychopathic) personalities and exhibiting antisocial and aggressive behaviour (Blair, 1997). This is not to say that these developmental patterns in infancy are fixed and will inevitably develop into these more extreme profiles. Children are resilient and continue to develop throughout their lives. However, we have shown that there is some degree of stability over time from infancy onwards. Early detection of more extreme variations in fear and guilt-proneness in very young children may ultimately have implications for the prevention of both internalising and externalising disorders.

Chapter 3: Low infant skin conductance activity predicts aggression in toddlers 2 years later

Accepted Paper in press

Psychological Science (In Press)

Abstract

Low autonomic nervous system activity is claimed to be a biomarker for aggressive and antisocial behaviour. Although there is evidence that low skin conductance activity (SCA) accounts for variation in severity of antisocial behaviour and predicts the onset of aggression in children and adults, it is not known whether SCA measured in infancy can predict the development of aggression. We measured SCA in 70 typically developing 12-month-old infants at baseline, and during an orienting habituation paradigm and a fear challenge. We also observed the infants' fear behaviour and mothers rated the infant's temperament and attachment to their children. When the children were 3 years old, mothers rated their children for aggressive and non-aggressive behavioural problems. Low infant SCA predicted aggressive behaviour, but there was no association with non-aggressive behavioural problems. Observed infant fear, mother-rated infant temperament and maternal attachment did not predict later aggression. These results suggest that SCA is a specific biomarker for aggression in low-risk samples.

Introduction

Early onset aggression poses challenges to families, educators and health professionals, and timely prevention efforts are therefore very important. Elevated aggression at age 2 has been identified as a risk factor for the persistence of these problems through childhood (Côté, Vaillancourt, LeBlanc, Nagin, & Tremblay, 2006; NICHD Early Child Care Research Network, 2004). Despite decades of research, very little is known about the early antecedents of aggression (Hay et al., 2012). There is evidence that children with persistent antisocial behaviour have neurobiological problems (Moffitt & Caspi, 2001; van Goozen, Fairchild, Snoek, & Harold, 2007). However, most studies investigating early aggression have focused on psychosocial influences (e.g., Murray-Close & Ostrov, 2009), with only a few studies examining neurobiological influences (Gao et al., 2010a & b; Raine, Venables, & Mednick 1997). The present research considers whether neurobiological factors measured in infancy predict aggression later in childhood.

Low autonomic nervous system (ANS) arousal is a well-replicated marker for aggressive behaviour (Raine, 2002). There are three theoretical explanations for the relation between reduced ANS arousal and the development of aggression. One theory focuses on the antecedents of aggression, specifically the stimulation-seeking aspects (Zuckerman, 1979), and argues that individuals with low physiological arousal are motivated to seek out stimulation to raise their arousal to a more optimal or normal level. Aggressive acts are undertaken to increase arousal.

According to the fearlessness theory (Raine, 2002), fearless children are more likely to engage in aggressive behaviour such as physical fights in order to obtain reward and social status because they are relatively insensitive to the negative consequences of their actions. Fear conditioning is the mechanism by which children learn to link antisocial acts with negative consequences, such as punishment. The fearlessness account, which focuses on the consequences of aggression, and the stimulation-seeking explanation, which focuses on the antecedents for getting into risky situations, are not incompatible.

A third explanation is that low ANS in young children may be a risk factor for externalising problems more generally because these individuals have difficulty attending and reacting to environmental stimulation (Wilson & Gottman, 1996). The prefrontal cortex is involved in the allocation of attentional resources, emotion regulation and stress reactivity

(Adolphs, 2010; Damasio, Tranel, & Damasio, 1990). Damage to this region leads to psychophysiological abnormalities (reduced skin conductance orienting and arousal) that predispose to characteristics (i.e., stimulation seeking, disinhibition, fearlessness) associated with antisocial behaviour.

A range of measures indexing low ANS have been linked to poor developmental outcomes. Raine, Venables and Mednick (1997) found that low resting heart rate (HR) in typically developing 3-year-olds predicted aggressive behaviour at age 11 years. A large literature has focused specifically on skin conductance activity (SCA) and aggression (Lykken, 1995). Low SCA has been found in children with Conduct Disorder (CD; Herpertz et al., 2005; van Goozen, Matthys, Cohen-Kettenis, Buitelaar, & van Engeland, 2000; Zahn & Kruesi, 1993) and it predicts persistence of CD from childhood into adolescence (van Bokhoven, Matthys, van Goozen, & van Engeland, 2005).

Although SCA can explain variations in aggression and antisocial behaviour, to conclude that SCA is a *biomarker* for aggression it needs to be shown that low SCA precedes the onset of aggression (Sterzer, 2010). Recently, Gao and colleagues (2010a, 2010b) used the Mauritian Child Health cohort to show an association between low SCA conditioning in typically developing 3-year-olds, on the one hand, and aggression at age 8, and criminal behaviour 20 years later, on the other. These findings show that low SCA at age 3 is a biological marker for aggression and criminality in later life. What is unclear is whether SCA measured at an even earlier age can predict which children will become aggressive. This is what the present study seeks to address.

There is conflicting evidence concerning the best way to assess low SCA as a marker for aggression. Most studies of children have focused on the sensation seeking theory and measured resting SCA (e.g., Raine, Venables & Williams, 1990); others aimed to test the fearlessness account and have measured SCA during emotionally challenging paradigms (e.g., van Goozen et al., 2000); and a few studies have measured SCA during fear conditioning (Gao et al., 2010a; 2010b). Very few studies have measured SCA in infants (Hernes et al., 2002; Storm, 2000) or toddlers (Posthumus, Böcker, Raaijmakers, van Engeland, & Matthys, 2009) and none have tested the relationship with aggressive behaviour before the age of 3, so we know surprisingly little about the biological risk factors for aggression in infancy. The aim of the present study was to assess SCA in a low-risk sample of infants using a multi-measure approach to establish whether SCA predicts aggressive behaviour at age 3.

Method

Participants

One hundred infants took part near their 1st birthday (mean age = 10.01 months, SD = 1.76, range = 7–14 months). For 70 of these infants (36 boys, 34 girls) the mothers filled out the CBCL questionnaire (Achenbach & Rescorla, 2000) when the children were 3 years old (mean age mothers = 35.66 years, SD = 3.95, range = 22–43 years). This retained sample (n = 70) did not differ from the participants who dropped out with respect to demographic characteristics or any dependent measures. Participants were recruited from local nurseries in Cardiff (UK) (see Appendix 1). Sixty-three participants reported themselves to be Caucasian, one as mixed race Caribbean, and six as South Asian; 97% described themselves as British. Ninety percent of mothers were educated to university level, two had post secondary education, and five had completed secondary education. Because our sample was relatively highly educated we qualified it as a low-risk sample. Ninety-four percent of mothers described themselves as married or living with a partner; the other 6% were single or separated. Finally, for 51% of the mothers the participating child was their first or only child.

The study protocol was approved by Cardiff University's School of Psychology Research Ethics Committee.

Procedure

Mothers accompanied their child to the child-friendly laboratory playroom. Once the child had settled, SCA electrodes were placed on the child's foot and baseline SCA measures were taken when mother and child were quietly playing together for 3.5 minutes. The Orienting Habituation Paradigm (OHP; Hernes et al., 2002) took approximately 3 minutes, followed by a fear challenge (Goldsmith & Rothbart, 1999), which took approximately 3.5 minutes.

Infant Measures

Skin conductance activity

The SCA recording and analysis software programme were custom made using PsyLab software. Two 8mm diameter Ag/AgCl electrodes with an applied voltage of 50mV rms were attached on the left foot, one on the medial side over the abductor hallucis muscle, the other midway between the phalanges and mid-point of the heel. Electrodes were secured using adhesive collars and tape. Abrasive electrolyte gel made of V14: Lectron II was used to improve conductivity. The electrodes were attached to a PsychLab Stand Alone Monitor, which is powered by 12-volt universal power units. SCA was sampled with a frequency of 50 Hz, with a 16-bit resolution.

Baseline SCA

To obtain a measure of baseline SCA, skin conductance level (SCL) was measured continuously when mother and child were quietly playing together for 3–4 minutes. Data were analysed in seven 30-second epochs, and an overall mean SCA baseline ($SC_{baseline}$) in μS was calculated by taking an average of the seven epochs.

Orienting habituation paradigm (OHP)

Ten auditory stimuli (1 sec bursts of broad spectrum white noise at 75 dB) were presented to the child (approximately 100cm away from the infant's ears; see Hernes et al., 2002); the noises were presented with a mean randomised inter-trial interval of 18 seconds (range = 13–28 seconds). Skin conductance responses (SCRs) were measured as an increase in conductivity occurring within a latency window of 1–3 sec post-stimulus. Amplitudes exceeding 0.01 μS were considered to indicate an elicited SCR. The dependent variable was the number of times ($SC_{frequency}$) the child showed an SCR to the noise (with scores varying between 0 and 10).

Lab-TAB fear paradigm

Infant fear was assessed using the unpredictable mechanical toy component of the Lab-TAB (Goldsmith & Rothbart, 1999). For the purposes of the present study the toy-dog used in Lab-TAB was replaced by a remote-controlled robot, and the mother was asked to monitor the child from an observation booth; she could go to the child if she felt the need to do so.

SCA during fear challenge

SCA was measured continuously throughout the fear challenge. Recording began when the experimenter entered the room with the robot, and lasted approximately 3.5

minutes. Data were analysed in seven 30-second epochs. An overall mean in μS was calculated by taking an average of the seven epochs (SC_{fear}). Because the SC_{fear} data were skewed, a square root transformation was applied.

The three SCA measures ($SC_{baseline}$, $SC_{frequency}$ and SC_{fear}) were standardised and combined by taking their averages to create a new variable, SC_{marker}. The reliability of this composite measure was high (α = .72).

Behavioural coding

The Lab-TAB's guidelines were followed for the behavioural coding of the episode using video recordings. A subgroup of the six Lab-TAB dimensions was used (Goldsmith & Rothbart, 1999). Each epoch was scored on the following dimensions: intensity of facial fear (0-3), intensity of distress vocalization (0-2), intensity of bodily fear (0-3). A composite fear score was derived from the sum of three scores (Lab-TAB_{fear}), and scores ranged between 0-8 across all categories coded. Four coders scored the episodes independently for 22% of the sample. Intra-class correlation coefficients for the coders ranged between .70 and .99.

Mother-reported behaviour

The Maternal Attachment Inventory (MAI; Muller, 1994)

The MAI measures maternal affectionate attachment to the infant. The MAI is a self-report, 26-item instrument representing maternal activities and feelings that indicate affection towards their child. Each item is scored from 1 (almost never) to 4 (almost always), and the possible range of scores is 26–104, with higher scores indicating higher maternal attachment to the infant (α = .84). The MAI has been shown to have good internal and test-retest reliability, as well as good validity compared to other indicators of maternal attachment (Muller, 1994).

Infant Behaviour Questionnaire Revised (IBQ-R; Gartstein & Rothbart, 2003).

The IBQ-R assesses 14 domains of infant temperament. We focused on the two domains that are relevant for the development of aggression (i.e., fear and anger). The ‘fear’ and ‘distress to limitations’ subscales of the IBQ-R each consist of 16 items (α =.87 and .82, respectively).

Outcome measures

Aggression and antisocial behaviour (Year 3): Child Behaviour Checklist for ages 1½ - 5 (CBCL; Achenbach & Rescorla, 2000).

The CBCL is a standardized questionnaire in which parents rate their children with respect to behavioural and emotional problems. The CBCL is widely used in population and clinical research. There is extensive evidence of its good psychometric properties. Of interest in the present context is the 19-item aggression scale. Following procedures detailed by Raine et al. (1997 & 1998) and suggestions by Burt (2012), we divided the CBCL aggression items into two subscales: aggressive antisociality (aggressive AS) and non-aggressive antisociality (non-aggressive AS). The aggressive AS scale consisted of 8 items measuring physical and verbal aggression (e.g., gets into many fights, hits others, screams a lot; α = .73). The non-aggressive AS scale consists of 11 items measuring difficult, oppositional and hard-to-manage behaviour (e.g., demands must be met immediately, is disobedient, punishment doesn’t change his/her behaviour; α = .74).

Results

The means and standard deviations for each variable are shown in Table 1. Correlations between the variables are presented in Table 2. Aggressive AS and non-aggressive AS were moderately correlated (r = .59, p < .001). Of the 70 children, 9% had CBCL externalising problem scores in the clinical range; this figure is slightly higher than the 6% of the population who represent the so-called 'early starters', a group of children who show a persistent course of conduct problems beginning in early childhood (Shaw, Gilliom, & Giovannelli, 2000).

All measures of SCA were positively associated (ranging from r = .24 to r = .78); however, infant behavioural fear and temperament were not significantly associated with SCA. There were no significant sex differences in the magnitude of these associations. Forty-four infants cried during the fear challenge and 12 mothers entered the room while the challenge was carried out. There were no differences in SC (baseline, fear, OHP frequency, or SC marker) between children who cried and those who did not cry, or between mothers who entered and those who did not enter.

Table 1. *Descriptive Statistics*

	Mean	*SD*
Year 1		
$SC_{baseline}$	10.87	8.04
SC_{fear}	16.80	11.71
$SC_{frequency}$	4.51	2.49
MAI	97.46	5.40
IBQ_{fear}	2.48	.87
$IBQ_{distress}$	3.62	.75
Lab-TAB_{fear}	5.07	2.48
Year 3		
Non-aggressive AS	6.61	4.09
Aggressive AS	2.36	2.43

Table 2. *Inter-correlations between study variables*

	1	2	3	4	5	6	7	8	9
Year 1									
1 $SC_{baseline}$	-								
2 SC_{fear}	.78**	-							
3 $SC_{frequency}$	.24*	.37**	-						
4 $Lab\text{-}TAB_{fear}$	-.07	.06	.10	-					
5 IBQ_{fear}	-.02	.10	-.06	.25*	-				
6 $IBQ_{distress}$	-.14	-.19	-.15	.33**	.46**	-			
7 MAI	-.06	-.03	-.10	-.02	.10	.06			
Year 3									
8 Non-aggressive AS	-.10	-.18	-.00	-.01	-.05	-.01	-.35**	-	
9 Aggressive AS	-.34**	-.36**	-.21	.10	.07	.11	-.18	.59**	-

* *p*<.05, ** *p*<0.01

Individual measures of SCA and aggressive/non-aggressive AS

Negative associations were found between each measure of SCA and aggressive AS, $SC_{baseline}$ (r = -.34, p = .005) and SC_{fear} (r = -.36, p = .002), and $SC_{frequency}$ (r = -.21, p = .083). Non-aggressive AS was not associated with any measures of SCA.

SC marker and AS behaviour

The variable SC_{marker} was used to examine whether SCA, as a general biological marker, predicted later aggression. SCA in infants was inversely correlated with aggressive AS (r = -.38, p < .001), with low SC arousal in infancy predicting higher levels of aggression in toddlers. Non-significant associations were found between SC_{marker} and non-aggressive AS (r = -.12, p = .324).

Discussion

Although normative trends show that aggression and related conduct problems peak during toddlerhood and that more children will desist from early aggression than will persist to disorder (Tremblay, 2006), evidence also shows that aggressive behaviour is moderately to highly stable in the most aggressive children (Shaw, Gilliom & Giovannelli, 2000), and that clinically significant Disruptive Behaviour Disorder can be diagnosed in pre-schoolers (Keenan et al., 2010). Although research on contextual factors has made progress toward identifying children who are at risk for later disorder, we know much less about the role of organic factors, including psychophysiological ones, during the time of considerable developmental transition.

Our study examined whether low infant SCA is a biomarker for later aggression. By showing that individual differences in psychophysiology are predictive of later aggression, the findings show that the first 3 years of life are a period when important systems involved in the experience and expression of emotions are being established.

Not only did low infant SCA predict aggressive behaviour at age 3, but it specifically predicted physical and verbal aggression, as opposed to a broader spectrum of difficult behaviour. These findings enhance our understanding of the early precursors of aggression and inform prevention efforts by highlighting the role of infant psychophysiology. It is noteworthy that other measures taken at 12 months did not predict later aggression. Mothers' reports of infant temperament, which correlated with independently observed fear (including observed fearlessness), were not correlated with SCA; nor did these reports predict aggression 2 years later.

The present study used a range of measures of SCA. SCA during baseline and fear were significantly correlated (r = .78, p < .01), and equally strongly associated with later aggression (rs = -.34, and -.36, respectively), supporting both the fearlessness and sensation-seeking accounts of aggression. As noted above, these accounts are compatible with each other. The prefrontal cortex is important in emotion and personality development. Damage to this region can lead to psychophysiological abnormalities (reduced SC orienting and arousal; Williams et al., 2000) that predispose to characteristics (i.e., stimulation seeking, fearlessness) that influence antisocial behaviour (Raine, 2002). Deficits in psychophysiological responding in very young children could adversely affect emotion regulation and prosocial development, and thereby cause aggression in later life.

Our sample of families was relatively middle-class. The findings, therefore, highlight a link between individual differences in physiology and emotion development early in the life course in a low-risk sample. By presenting the novel toy in the context of a brief separation, we provided a challenge that infants had to meet on their own. Low autonomic arousal under these conditions appears to be a biomarker for aggression.

Psychophysiological factors show stronger relationships to aggressive behaviour in those from benign social backgrounds (Raine, 2002). It is therefore possible that the link between SCA and later aggression identified in this low-risk sample would not be replicated in higher risk groups. Nevertheless, psychosocial factors have been found to interact with psychophysiological risk factors and antisocial behaviour exponentially increases when social and biological risk factors combine (Raine, 2002). In addition, shared environmental influences appear more pronounced in the association with child psychopathology among disadvantaged groups or in high risk contexts (Burt, 2009). Further research should examine whether the observed effects replicate in vulnerable populations. Future research should also incorporate features of the child's social environment (including parenting behaviour and maternal stress) into the study of early emotion regulation and risk pathways. Future research in the same early developmental time frame should also incorporate features of the child's environment (including parenting behaviour and maternal stress) into the study of SCA, early emotion regulation and risk pathways.

The present study identifies a biological marker that may help to identify subgroups with a distinct neurobiological profile early in life. Clearly, the scope for changing behaviour will be greatest in the early years because of the greater plasticity of the brain in childhood (Sterzer, 2010). Identifying the precursors of disorder in the context of typical development can inform the implementation of effective prevention programmes and ultimately reduce the psychological and economic costs of aggressive and antisocial behaviour to society. Although caution is needed in conducting this type of research given concerns about the possible consequences of early labeling of young children (Brotman et al., 2009), investigations into risk factors for later psychopathology should not be delayed until middle childhood.

Chapter 4: The development of effortful control, and associations with fear and guilt

Abstract

Extremes in fearful temperament and effortful control, as well as diminished levels of guilt, have long been associated with later psychopathology. Associations between effortful control and fear, and guilt have been found, however few studies explore associations from infancy, examining relationships for boys and girls. This study had the following main objectives: first, to examine the development of effortful control and the role of gender; secondly, to explore the early associations between fear and effortful control development from infancy to toddlerhood; third, to investigate the associations between guilt and effortful control. We observed fear during a Lab-TAB fear paradigm across the first three years of life, effortful control at age 2 and 3 with a battery of delay tasks, and guilt during a mishaps procedure at age 3 (N = 70). The results indicate that effortful control increased from age 2 to 3, showed individual stability across time, and that girls surpassed boys at both ages. Fear was stable across the first 3 years of life, and there were no gender differences in fear or guilt. In the sample of 70 children fear in Y1 and Y2 did not predict effortful control, however fear in Y2 predicted effortful control in Y3 for boys, but not for girls. This suggests that fear regulates emotion differently in boys and girls. In the full sample of children, fear and effortful control were associated in Y3, however there was no association between effortful control and guilt. The results indicate that viewing these temperament dimensions together, from infancy onwards and as they continue to develop, gives a more coherent understanding of these emotion systems across early childhood. The implications of these findings for our understanding of risk pathways to pathology are discussed.

Introduction

The ability to self-regulate is crucial in the development of children's adjustment (Posner & Rothbart, 2000). Of particular importance are the interactions between the child's motivational impulses and their efforts to control them (Rothbart & Rueda, 2005). The temperament construct of 'effortful control' is a core aspect of self regulation and refers to the attentional and inhibitory mechanisms that facilitate "the ability to inhibit a dominant response to perform a subdominant response" (Rothbart & Bates, 1998, pp.137). Effortful control plays a central role in emotion-related regulation of behaviour (Rothbart & Bates, 1998), and in predicting children's social competencies and adjustment problems (Gartstein & Fagot, 2003).

Effortful control and related temperaments have been implicated in the development of psychopathology. Impulsive behaviour in young children predicts later impulsivity and delinquency in adolescence (Olsen, Schilling & Bates, 1999), and is involved in the development of Attention Deficit Hyperactivity Disorder (ADHD; e.g. Alderson, Rapport, & Kofler, 2007; Barkley, 1997; Marakovitz & Campbell, 1998; Quay, 1997), and early onset Conduct Disorder (CD; Moffit, Caspi, Dickson, Silva, & Stanton, 1996). In particular, low levels of effortful control in toddlers have been associated with externalising behaviour (Kochanska & Knaack, 2003), and attention problems (Murray & Kochanska, 2002) in early childhood. Conversely, high levels of effortful control in toddlers have been found to predict internalising behaviour in early childhood (Murray & Kochanska, 2002), suggesting that 'more is better' is not the case with this temperament dimension. Over-controlled behaviour or too much effortful control has been found to lead to an unnecessary loss of available pleasures or rewards, a slower ability to show emotions, and the experience of less intense emotions (Funder & Block, 1989), suggesting that these individuals excessively suppress their emotions (Kochanska, Murray & Harlan, 2000). Murray and Kochanska (2002) proposed that there is an 'optimal level of effortful control', with children showing substantially higher or lower levels of effortful control experiencing internalising or externalising behaviour problems, similarly found with fearful temperament (Raine, 1993; Schwartz, Snidman, & Kagan, 1999). In toddlers and preschool children, they found that children with lower or higher levels of effortful control scored higher on the total problem behaviour scale compared to children with moderate levels.

Although we know that effortful control is a complex inner guiding system with extreme levels associated with psychopathology and risk pathways, much of the previous research has been done with older children (e.g. Eisenberg et al., 2004, 2005a, 2005b; Valiente et al., 2003; Wilson, Lengua, Tininenko, Taylor & Trancik, 2009), focusing on maladaptive outcomes. Therefore, we know very little about this temperament dimension in young children, how it emerges and develops over early childhood. Other inhibitory systems that are developing alongside effortful control may play a role in how effortful control develops. Therefore, in the current study effortful control and its associations with fear and guilt were examined within a developmental framework.

Development of effortful control

Effortful control ability is thought to be supported by advanced cortical areas of the brain such as the anterior cingulate cortex, which is a relatively late-developing system and shows continuing maturation across early childhood (Posner & Rothbart, 2000). Aspects of effortful control begin to emerge at the end of the 1st year of life, along with the maturation of the attentional mechanisms that are linked to the anterior attention network (Rothbart, Derryberry & Posner, 1994). The ability to inhibit behaviour on demand begins to develop from around 18 months, improving considerably from 22 to 36 months of age (Kochanska, et al., 2000; Kochanska & Knaack, 2003; Kochanska, Barry, Jimenez, Hollatz, & Woodard, 2009) and begins to function to regulate the more reactive aspects of temperament (Rothbart, 1989). Kochanska and colleagues (2000) found that effortful control abilities from 22 months predicted later effortful control abilities, and by 33 months it provides the foundation for the developing personality (Derryberry & Rothbart, 1997), showing stability from early childhood to adolescence and adulthood (Ayduk et al., 2000; Shoda, Mischel, & Peake, 1990).

As well as clear age effects on the ability to suppress a dominant response in favour of a non- dominant one, gender effects have also been found. Girls perform better on effortful control tasks from 22 months (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996; Kochanska et al., 2000; Kochanska & Knaack, 2003). These findings are supported by a meta-analysis investigating the magnitude of gender differences in children's temperaments (Else-Quest, Hyde, Goldsmith, & van Hulle, 2006). Small effect sizes were found for the majority of temperament systems, including fearful temperament (Else-Quest et al., 2006), concluding that boys and girls do not differ in their levels of fear in early childhood. However, effortful control consistently showed that girls are more able to regulate or allocate their attention and inhibit their impulses (Else-Quest et al., 2006). We too did not find gender differences in fear reactivity across early childhood in an earlier study (Baker, Baibazarova, Ktistaki, Shelton, & van Goozen, 2012; Baker, Baibazarova, Shelton, Hay & van Goozen, In Press). We would, therefore, expect to find gender differences in effortful control in this study, but not fear.

The ability of effortful control has been found to improve over time, with girls and boys differing in their ability. However, although we know that temperament develops, we know little about potential developmental patterns of temperament for boys and girls. That is, gender differences may be present in the associations between different temperaments, and they may emerge or diminish over the course of temperament development (Else-Quest et al., 2006). Therefore, in the current study the investigation of gender differences were extended to the associations between temperament dimensions.

Effortful control and the development of fear

Fearfulness in children is defined as a child's initial withdrawal to unfamiliar or challenging events (Kagan, 1997). Fearfulness in early childhood has been found to predict behavioural inhibition in later childhood, which is in turn associated with anxiety and depression in later life (Biederman et al., 1993; Schwartz et al.1999). Conversely, children who are temperamentally fearless are behaviourally disinhibited; they display high approach and lack of restraint to novel and unfamiliar people and situations (Hirshfield-Becker et al., 2003). Fearlessness is associated with higher levels of externalising symptoms (Colder, Mott, & Berman, 2002), and fearless individuals are more likely to engage in aggressive and antisocial behaviour because they do not fear the negative consequences of their behaviour (Raine, 1993). Both fear and effortful control are inhibitory temperament systems, where too much, or too little inhibition or control has been found to be a factor in later psychopathology.

Fear in infancy has been found to be relatively stable across time, predicting fear across childhood, as well as activity, impulsivity and approach (Rothbart, Ahadi & Hershey, 1994). These findings suggest that fear plays an important role in regulating later approach behaviour. Individual differences in fearful temperament can be seen as early as 4 months of age (Kagan, 1994). Kagan found that infants characterised as highly reactive and highly distressed at 4 months of age, were found to be more fearful at 14 and 21 months of age.

Findings from our laboratory also show that individual differences in observed fear are stable from infancy to toddlerhood (Baker et al., 2012).

Are effortful control and fear linked?

According to Rothbart's model of self regulation (Derryberry & Rothbart, 1997; Posner & Rothbart, 2000; Rothbart & Bates, 1998), fear and effortful control work in distinct but important ways in the development of self regulation. Rothbart proposed that fearful reactivity helps to set the stage for the motivation to avoid wrongdoing. Similarly, effortful control, representing a more active, voluntary capacity, provides the executive capacity to abide by standards of conduct, by inner guiding systems. It has been postulated that behaviour is regulated through a reactive emotional system, fear, or through self-regulative attention systems, such as effortful control, both of which are important for the development of social behaviour (Rothbart, Ahadi & Evans, 2000).

Fear is an earlier developing temperament and it has been proposed that fearfulness may underpin children's ability for self regulation (Derryberry & Rothbart, 1997; Rothbart & Ahadi, 1994; Rothbart & Bates, 1998; Rothbart et al., 2000). Derryberry and Rothbart (1997) suggest that as a child develops, initially reactive forms of regulation are supplemented by an increasing capacity for voluntary or effortful forms of control. Fear may regulate approach by altering the speed of approach (Aksan & Kochanska, 2006). Over time the negative association between inhibition to novelty and the speed of approach may become stronger for fearful children. Consequently, children who were fearful as infants are more likely to inhibit, or slow down, approach on instruction when they become toddlers (Kochanska & Aksan, 2006).

Reciprocal relationships between these temperament dimensions have been identified over development, where infants high in effortful control tend to be low in negative affectivity (Ahadi, Rothbart & Ye, 1993), and adults high in attentional control are low in negative affect (Derryberry & Rothbart, 1988). Rothbart and colleagues state that later in childhood self regulatory systems, particularly the executive attention system, develop to modulate reactivity (Derryberry & Rothbart, 1997; Rothbart & Derryberry, 1981; Rothbart & Rueda, 2005). This is consistent with neurobiological theories, where there is evidence to suggest that the amygdala and the anterior cingulated activation work together. Distress and fear, related to amygdala activation, can be modulated by frontal activity (Davidson & Sutton, 1995). This is also found in pain studies, where an effort was made to control the distress produced by a stimulus, and the amount of anterior cingulated activation reflected the felt distress (Rainville, Duncan, Price, Carrier, & Bushness, 1997).

Dienstbier (1984) proposed that fearful children are more easily conditioned to inhibit transgressions. Individuals high in temperamental fear will be more sensitive to cues of punishment (Gray, 1982), with the fear of punishment driving young children to comply with caregiver requests (Rothbart et al., 2000). This is supported in findings from Kochanska, Coy and Murray (2001), where fearful children more easily suppressed prohibited behaviour, displaying committed compliance, from 22 months old. Kochanska and Knaack (2003) measured fear using a composite measure from 14 and 22 months from the ‘masks’ episode from the Lab-TAB (Goldsmith & Rothbart, 1999), and effortful control using a battery of tasks, including delay of gratification. Infants who expressed more novelty fear demonstrated better effortful control performance at 22, 33 and 45 months old. Parental reports of fear at 22 months correlated positively with effortful control, and girls demonstrated higher levels of effortful control at all ages.

Another study by Aksan and Kochanska (2004) assessed fearfulness at 9, 14, 22 and 33 months again using the masks and risk room paradigms, delay of gratification at 22, 33 and 45 months, and Go-No-Go task at 45 months. They found fearfulness was associated with consecutive measures of delay from 14 months, but associations were not found concurrently at 22 or 33 months, suggesting early developmental links between these temperament dimensions. The authors concluded that these results support the hypothesis that fearful inhibition can have regulatory influences on later behaviour.

However, there have been contrary findings. For example, Hill-Soderlund and Braungart-Rieker (2008) found a negative correlation between behavioural fear reactivity, measured as an increase between 8 and 16 months of age and observed effortful control at 4.5 or 5.5-years. It was proposed that fearful infants find their environments more threatening and therefore concentrate their efforts on avoiding such situations; consequently, these children have fewer opportunities to learn effective coping techniques to deal with fear and ultimately suffer in their development of self-regulation and effortful control. The authors do not discuss the findings regarding children with low increases in fear and their effortful control development. Therefore, these findings tell us little about the role of temperamental fear on effortful control. It is likely that too little reactivity would affect the expression and perhaps the development of regulation (Rothbart & Bates, 2006).

Theoretically, fear and effortful control play important roles in the motivation to suppress an act, and to avoid punishment and perform a desired behaviour. Little research has been conducted to explore these early temperament systems together in young children, with some early findings being inconsistent. Further research is needed to investigate fear reactivity, from infancy and its role in the development of early effortful control. It is theorised that fear underpins the ability to self regulate, therefore one would predict that early fear is associated with the development of effortful control.

Effortful control and the development of guilt

In addition to understanding early temperament, it is also important to investigate related inner guiding systems that may also play a role in early socialisation or psychopathology, especially moral emotions, such as guilt. Guilt in children is defined as the feeling of distress following a mishap or transgression (Cole, Barrett, & Zahn-Waxler, 1992; Kochanska, Gross, Lin, & Nichols, 2002). Extremes in guilt proneness have been associated with later psychopathology. A lack of guilt proneness has been found to be positively related to externalising behaviour (Ferguson, Stegge, Miller, & Olsen, 1999); aggression (Stuewig, Tangney, Heigel, Harty, & McCloskey, 2010), and to anger, hostility, and externalisation of blame (Stuewig et al., 2010; Tangney & Dearing, 2002). Moreover, children who experience guilt are less likely to be arrested, convicted, and incarcerated as adolescents and more likely to practice safe sex and not abuse drugs (Tangney & Dearing, 2002). Explanations for these adaptive effects focus on guilt requiring the individual to self-reflect and think about what they did and why (Stuewig et al., 2010). Individuals high in psychopathic traits fail to experience guilt (Raine, 1993).

Kochanska (2001) argues that most developmental psychologists believe that in the second year of life young children begin to be clearly aware of their transgressions, misbehaviours, or substandard performances. Defined in this way, guilt has been identified as early as 22 months (Kochanska et al., 2002) or 24 months (Barrett, Zahn-Waxler, & Cole, 1993).

There are large discrepancies in the guilt literature around the early development of guilt. The majority of research focuses on older children, largely using self report, making it difficult to understand the early development of this emotion. Guilt in early childhood has been associated with the inhibitory temperament, fear. Kochanska et al., (2002) found that children with higher levels of fear at 22, 33, and 56 months, had higher levels of guilt. These findings complement an earlier study finding a positive association between fearfulness in infancy and parent rated guilt at age 6 (Rothbart et al, 1994). Findings from our laboratory, with the same sample of children as the current study, found across measures that fear and guilt were associated, with more fearful toddlers having higher levels of guilt (Baker et al., 2012). Of interest in the current study is the role of another inhibitory temperament, effortful control, on guilt.

Are effortful control and guilt linked?

Both guilt and effortful control have been identified as crucial inner guiding mechanisms, that inhibit aggressive and antisocial behaviour and promote conscience (Kochanska, et al., 2009). Together these inhibition systems have been reviewed as the dual-deficit approach to psychopathy, emphasising compromised guilt and deficient voluntary inhibition (Fowles & Dindo, 2006). Both low fear and impulsivity/executive function deficits (poor effortful control ability) have been identified as contributing to antisocial disorder, externalising behaviour problems and psychopathy (Fowles & Dindo, 2006).

Effortful control has been investigated in young children in relation to later moral internalisation at 22-45 months (Kochanska & Knaack, 2003) and 43-56 months (Kochanska, et al., 1996), with higher effortful control predicting better moral internalisation in later childhood. In school age children (6-7 years old) high levels of effortful control were associated with high levels of empathy and guilt, and low levels of aggression (Rothbart, et al., 1994). Negative affectivity, a component of effortful control and fearfulness, was discussed as contributing to guilt by providing strong internal cues of discomfort, increasing the likelihood that the cause of these feelings would contribute to an internal conscience (Kochanska, 1993; Rothbart et al., 1994).

Few studies have investigated the role of effortful control in guilt, with the majority focusing on self reports on conscience development in later childhood (Kochanska et al., 1996; Kochanska & Knaack, 2003; Valiente et al., 2004). However, Kochanska and colleagues investigated guilt and effortful control as two mechanisms that prevent disruptive developmental trajectories (Kochanska et al., 2009). Effortful control was tested using a battery of tasks, including delay, whilst guilt was tested using the mishaps paradigm, both at 22, 33, and 45 months of age, and later disruptive outcomes at 73 months. The findings showed that guilt and effortful control functioned together in an interactive fashion. For children who were highly guilt prone, differences in effortful control were not associated with future disruptive behaviour. However, children who were low guilt prone, differences in effortful control were significantly associated with disruptive behaviour. In this latter group, children with low guilt and low effortful control had the highest disruptive conduct scores, whereas low guilt and high effortful control children had scores comparable to guilt-prone children. In children with moderate levels of guilt, differences in effortful control were also associated with disruptive behaviour. This finding suggests that as children's tendency to respond with guilt weakens, the role of effortful control in preventing disruptive behaviour gets stronger (Kochanska et al., 2009). This study highlights the role of effortful control as an alternative inhibitory mechanism to control behaviour.

The current study

In this study effortful control was assessed by observing delay of gratification. Delay of gratification is a central component of effortful control, as it requires executive attention and future-oriented self control (Metcalfe & Mischel, 1999; Mischel, Shoda, & Rodriguez, 1989). Delay of gratification has been found to most strongly predict conduct problems and hyperactivity in early childhood (Campbell & Von Stauffenberg, 2009; Gusdorf, Karreman, van Aken, Deković, van Tuijl, 2011), and externalising problems, high levels of delinquency and aggression in adolescents (Krueger, Caspi, Moffitt, White & Stouthamer-Loeber, 1996). Conversely, children who were better able to delay gratification had better coping strategies (Shoda, et al., 1990), and are described as prosocial, moral and empathic (Krueger, et al., 1996). Furthermore, delay of gratification has been found to be stable across childhood and adulthood (Casey et al., 2012). Based on these findings, we expected delay of gratification to be a successful measure of effortful control in early childhood (Metcalfe & Mischel, 1999; Mischel et al., 1989; Shoda et al., 1990; Wilson et al., 2009).

Effortful control is understood to play an important role in regulating emotions and preventing disruptive developmental trajectories. However, what is currently known about the early development of this temperament construct comes from the work of relatively few groups of researchers (e.g. Kochanska, et al., 2000; Kochanska & Knaack, 2003; Kochanska et al., 2009; Murray & Kochanska, 2002). The majority of research in this area assesses an older sample of children, when much of development has already taken place. Our first aim was to look at the early development of effortful control, using a prospective, longitudinal design. We expected effortful control ability to increase over early childhood.

Early developing temperament, fear, has consistently been found to play a role in the development of later psychopathology (e.g. Biederman et al., 1993; Colder et al., 2002; Raine, 1993; Schwartz et al., 1999). Findings suggest that early fear and later developing effortful control are associated, and are both seen as having regulatory influences on behaviour (Aksan & Kochanska, 2004; Rothbart & Bates, 1998). Rothbart referred to fear as a passive system of control, and effortful control as an active system of control (Rothbart & Bates, 1998). Although both inhibitory temperaments are implicated in the development of self regulation, little is known about their early development, with inconsistencies in the findings. Our second aim was to investigate the association between fear, from infancy, with effortful control across early childhood. We expected to find associations between these temperament dimensions, across development.

The third aim of the study was to investigate whether effortful control and guilt are associated. One study indicated that they function together in an interactive fashion (Kochanska et al., 2009). However, although both are seen as inner guiding systems that prevent disruptive outcomes, little is known about their early associations. We predicted that effortful control and guilt would be associated and this study will provide evidence for when these associations may emerge.

Little is known about the early development of effortful control, and even less is known about whether girls and boys developmental patterns are the same. We predicted that girls would be better able to suppress their behaviour on demand. The study will provide some of the first evidence for whether associations between effortful control and fear and guilt would be the same for boys and girls.

In the present research study we investigated the stability of observed effortful control over the second and third years of life, as well as its associations with observed fear and guilt. Effortful control, fear and guilt may act to inhibit and prevent problem behaviours, such as aggression and antisocial behaviour, and internalising problems, and as such are important emotions in our understanding of developmental psychopathology more generally.

Method

Participants

Participants and their families were recruited from local nurseries and play centers in Cardiff (Wales) (see Appendix 1). The participants were 100 infants who first took part in our research around their first birthday. All participants were invited again around their second birthday. Of those, 20 were unable to attend and a further 10 were unable to complete the final part of the study around their third birthday, although one mother – child dyad returned who had not taken part at age 2. The main reasons for participants not completing the study were that the mothers had returned to work or had moved away from South Wales or we were unable to contact them. Overall, 70 children (36 boys, 34 girls) took part in the three waves of the study and are included in the current sample. The sample did not differ from the participants who dropped out in demographic characteristics (e.g., maternal age, family composition) or any of the study's dependent measures. The study was approved by the School of Psychology Research Ethics board at Cardiff University. The study was conducted in accordance with British Psychological Society guidelines and ethical protocol.

Lab-TAB fear paradigm

At each year of assessment, child fear and distress were assessed using the unpredictable mechanical toy component of the Lab-TAB (Goldsmith & Rothbart, 1999). It closely followed the protocol of the Lab-TAB, however, for the purposes of the present study the mechanical toy dog used in Lab-TAB was replaced by a remote-controlled robot and the mother was asked to leave the room. An unfamiliar experimenter entered the room and placed the robot approximately 1.5 meters away from the child, who was strapped into a children's car-seat. The experimenter made the robot approach the child, stopping approximately 15 cm from the child, while making movements with its arms and emitting noise. The robot then walked backwards and stopped at the back of the room for about 10 seconds before moving forward again. This trial was repeated three times, in line with the Lab-TAB protocol.

Coding

The Lab-TAB's guidelines were followed for the behavioural coding of the episode, which was carried out using video recordings of the session (see Appendix 2). It was important to gain clear and full frontal shots of the infant's face. Each of the three trials of robot approach and movement in front of the child were separated into three epochs (robot walk towards child, robot moving in front of child part one, robot moving in front of child part two). This created a total of nine epochs that were scored separately. A subgroup of the six Lab-TAB dimensions was used for scoring in this study, in order to score the same distress parameters as the mishap procedure measuring guilt. Each epoch was scored on the following dimensions and scales: intensity of facial fear (0-3), intensity of distress vocalization (0-2), and intensity of bodily fear (0-3). A composite fear score was made from the sum of these three scores. The fear score using three dimensions of Lab-TAB fear correlated highly with the full Lab-TAB composite score (year 1, r = .87, $p<.01$; year 2, r = .91, $p<.01$; year 3, r = .94, $p<.01$).

To reduce the number of data, the highest score from a single epoch was used in analyses to reflect the most intense behavioural score at a point in time. Scores ranged between 0-8 across all categories coded.

Four coders scored the episodes independently for 22 % of the sample. Intra-correlation coefficients between coders ranged between .70 and .99 across the behavioural variables.

Effortful control: delay of gratification

Snack Delay: Year 2

This procedure was adapted from Kochanska, Murray and Harlan (2000). The child was fastened into a chair and a table was placed directly in front of him/her. The mother was seated in a chair next to the child, outside his/her visual field, at a distance of approximately .5 metres. The experimenter knelt beside the child and produced a transparent plastic cup filled with raisins (or another favourite snack as chosen by the mother). The experimenter then said the following:

Hello (infants name), I have some snacks here for you. (Experimenter eats a snack). Mmm, that tastes delicious! Would you like one (Infant's name)? Sorry, but you are not allowed one until I ring the bell. I will put the snack under the cup (Experimenter puts one raisin under a transparent cup), and when I ring this bell you can take it. Do you understand? You can only eat the raisin when I ring the bell.

According to Garon, Bryson and Smith (2008) it is important to select a simple task that would not put high demand on the child's working memory given their young age. The task also needs to be accessible, but not too easy. For those reasons, delay of gratification was chosen for this sample. The instructions were repeated if the child did not understand what they had to do. If English was not their first language, the mother was asked to repeat the instructions once more in the infant's first language. The hidden snack was placed in front of the child and the dish filled with snacks was left next to the transparent cup. Time was recorded by the experimenter, starting after the instructions were given and the experimenter had moved facing away from the child, behind their seat.

Snack Delay: Year 3

In Year 3 the Snack delay procedure was adapted slightly to increase the level of challenge, due to the increasing capabilities of the child, as recommended by Murray and Kochanska (2002). The child was required to keep the snack (a raisin, or another favourite snack) on their tongue, instead of under the plastic cup. The procedures detailed above, including instructions, were kept the same.

Coding and data reduction

Coding reflected the number of times the child was able to delay from eating the snack before the experimenter rang the bell (adapted from Kochanska et al., 2000; and Carlson, 2005). The number of trials on which the child delayed eating the snack until the experimenter had rung the bell was scored on a range of 0 to 3. Coding was done via video recordings. Inter-rater reliability for 19% of the sample was .99 in Year 2 and Year 3. Kochanska and colleagues (2000) also coded the ability to delay, based on the behaviour on a 1-7 scale, averaging scores across trials. However, as the task in this study was adapted in year 3 to avoid ceiling effects whilst keeping the task consistent, coding the number of trials that the child could delay best reflected the ability across the 2 years (Carlson, 2005).

Gift Task (Kochanska, Murray & Harlan, 2000)

The procedure was the same in Year 2 and 3. The child was again fastened into a chair and a table was placed directly in front of the child. The mother was seated on a chair next to the child, outside the child's visual field, at a distance of approximately 0.5 metres. The experimenter brought in a colourful box at the end of the study, containing a gift for the child. The experimenter said that she had to leave the room and asked the child to wait and not to touch the box until she came back into the room (i.e., after 180 seconds).

Gift Task Coding

Scores for the behaviour involving the gift box ranged from 1 to 5 (1= opens the box and takes the gift, 2 = opens the box, takes the gift, and then puts it back in the box as if nothing happened, 3 = opens to peek, 4 = touches the box, but does not open it, 5 = does not touch the box at all).

Data Reduction

Coding for Snack Delay and Gift task were similar to Kochanska's battery in that a higher score reflected a better capacity for effortful control. Kochanska included multiple measures of coding for the gift task (including latency for any behaviour performed in the gift task), however in order to allow both delay tasks to have equal number of measurements, we chose to code the tasks in a way that reflected the child's behaviour during the tasks. Performance on both tasks was correlated, so in accordance with Kochanska and colleagues (Kochanska, et al., 2000; Kochanska et al., 2001; Kochanska & Knaack, 2003), scores were combined to create a composite score after normalising the individual scales from 0 to 1. This was done by dividing each score on the task by the total number of points on the scale (raisin: scale 0-3, score/3; gift: scale 1-5, score/5). An average of the sum of these scales created the effortful control composite score.

Whereas Kochanska and colleagues (2000) found an increase in reliability in tasks from 22 to 33 months ($\alpha = .42 - .77$), our reliability increased only marginally ($\alpha = .62 - .64$). Kochanska, Murray and Harlan (2000) had an item-total correlation of .27 at 22 months, and of .42 at 33 months, and for delay tasks .59 and .52 respectively, at 22 and 33 months. The item-total correlation for the battery in the current study was .48 ($p < .001$) in Year 2 and Year 3.

Mishap guilt paradigm (year 3)

The mishaps paradigm was adapted from Kochanska and colleagues (2002). The task involved contrived transgressions or "mishaps". The experimenter presented the child with a tower, which she described as being her favourite toy and that she had made it herself. She told the child that she would share it with them, as long as they were very careful. Because the tower had been "rigged", the object fell apart as soon as the child began to handle it. The experimenter then said “Oh my….” with mild regret, and sat still in front of the child, with her face covered with her hands for 30 seconds. The experimenter then asked three standard questions, “What happened?”, “Who did it?”, and “Did you do it?” The child was then told that it wasn’t their fault and there had been a problem with the tower. She then presented another partially built tower and asked the child to help her make it. The experimenter reassured the child the damage had not been the child’s fault, and assumed responsibility for it.

Coding

The coding system used in the current study was adapted from Kochanska and colleagues (2002) (see Appendix 3). To avoid ambiguity over the distinction of guilt and shame, the coding system focused on the level of distress to a mishap. The child’s behaviour was coded in five second epochs from when the tower fell, to when the experimenter first told the child it was not their fault. The scoring reflects the level, or intensity, of the behaviour. A subgroup of the five dimensions was used to measure the same parameters as distress during the fear procedure. Each epoch was scored on the following dimensions and scales: bodily tension which was scored on four categories: facial, posture, discomfort, intense (if any behaviour within the category was observed, the category would get a single score) this behaviour was scored 0-3 depending on how many categories were present (intense would score the epoch a 3); facial tension, scored the same as bodily tension with four categories: eyes, eyebrows, mouth intense (0-3); vocal distress (0-2). A composite guilt score was made from the sum of three scores. The intensity score using three dimensions of distress correlates highly with the full mishaps distress score (r = .94, $p<.01$).

Missing data

All 70 participants in the sample took part in every procedure, at all three assessments (Year 1 [Y1], Year 2 [Y2], and Year 3 [Y3]). A number of participants had missing data during these episodes, but none had all of the data missing during an entire episode. The missing data resulted from equipment malfunction or refusal to take part. Data imputation was implemented using linear trend computation (Little & Rubin, 1987). The pattern of missingness of the data was tested and found to be Missing Completely at Random (MCAR; Acock, 2005).This shows that there was no systematic missing pattern in the dataset and that missing values were randomly distributed across all observations.

Results

The development of effortful control

Descriptive data indicated that 62.86% of the sample (N = 44) improved in effortful control from Y2 to Y3, 21.43% (N = 15) did not improve, whilst 15.71% (N = 11) decreased in ability.

Table 1. *Descriptive statistics for all measures*

	Full sample (N = 70)		Girls (N = 34)		Boys (N = 36)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Fear						
Y1	5.07	2.48	5.08	2.58	5.07	2.43
Y2	5.85	2.10	5.56	2.21	6.11	1.98
Y3	5.33	2.45	5.56	2.38	5.11	2.52
Effortful control						
Y2	.56	.30	.65	.26	.47	.32
Y3	.77	.23	.86	.11	.69	.28
Guilt	4.30	2.01	4.37	2.41	4.23	1.58

A repeated measures ANOVA showed a main effect of year on effortful control ability, F (1, 68) = 33.73, $p < .001$, with higher scores in Y3 than Y2. Figure 1 shows that the distribution of effortful control ability is more varied in Y2, whereas in Y3 the majority of children achieved higher scores.

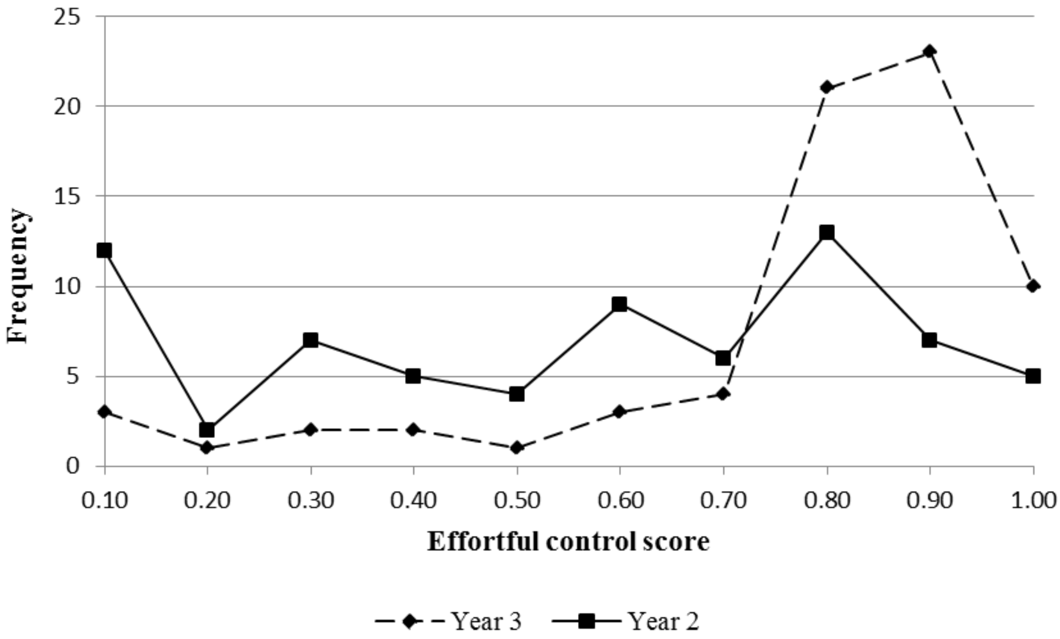

Figure 1. The distribution of effortful control scores in Y2 and Y3.

The stability in individual differences from Y2 to Y3 was moderate, r = .36 (p < .01). Murray and Kochanska (2002) found stability on delay tasks at .24 (p< .001) from toddler to preschool. This suggests that children higher in effortful control in Y2 continued to be higher in Y3. Age in months was not correlated with effortful control composite scores in Y2 (r = .11, p = .36), or Y3 (r = -.04, p = .77).

Gender

There was also a main effect of gender, F (1, 68) = 13.02, $p < .001$, with girls having generally higher scores than boys (see Figure 2), but no interaction between time and gender, F (1, 68) = .07, p = .79. Fisher r-to-z transformations showed no differences in the relationship between effortful control scores from Y2 to Y3, in boys or girls (z = -.47, *p* = .64). These results indicate that effortful control developed similarly over time in boys and girls, but with girls outperforming boys in both years.

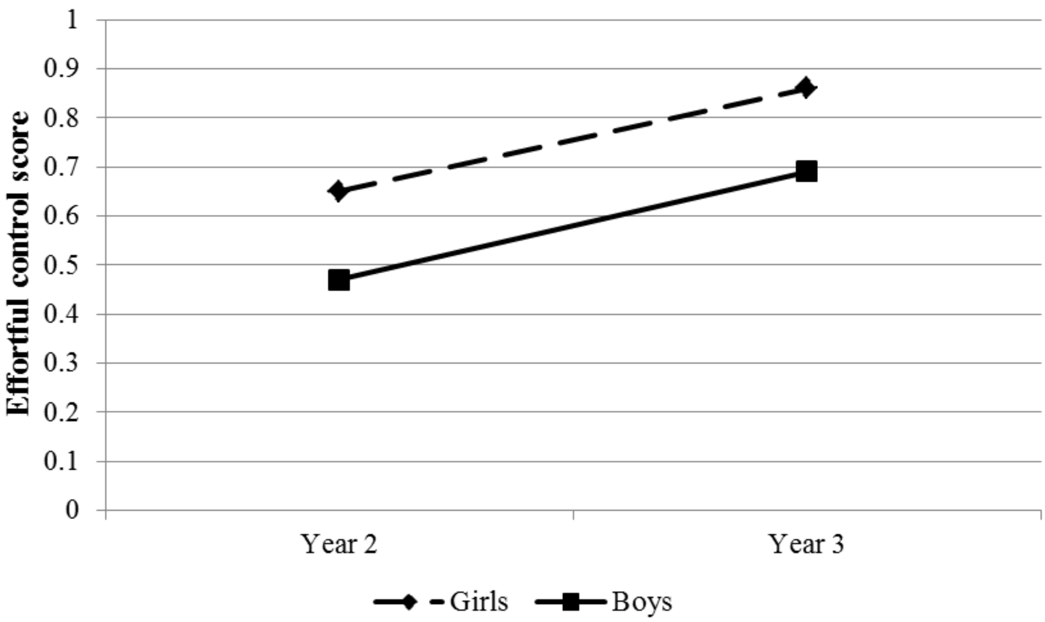

Figure 2. The development of effortful control ability across Y2 and Y3 for boys and girls.

The development of fear, and guilt

There was no main effect of year on fear, F (2, 138) = 2.60, p = .08, suggesting that observed fear remained stable over time. There was also no main effect of gender on fear, F (1, 68) = .00, p = .95, and no interaction between time and gender, F (2, 136) = 1.07, p = .35.

Individual differences in fear were stable across time, with significant positive correlations between Y1 and Y3 (r = .26, p = .03), and Y2 and Y3 (r = .36, p = .01), but not between Y1 and Y2 (r = .11, p = .37).

An ANOVA showed no gender differences in behavioural guilt F (1, 68) = .08, p = .78.

Associations between effortful control and fear

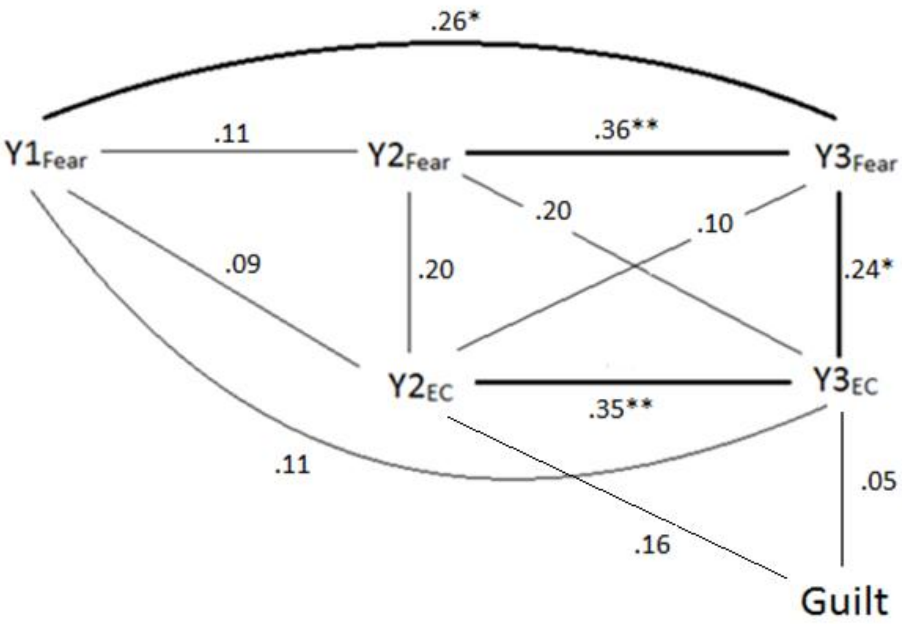

Figure 3. Associations between effortful control, fear and guilt across time (N=70).

Fear in Y1 and Y2 did not correlate significantly with effortful control in Y2 or Y3. In Y3 fear and effortful control were, however, significantly positively associated, suggesting that fearful toddlers have better effortful control.

Effortful control and fear: Gender

Girls:

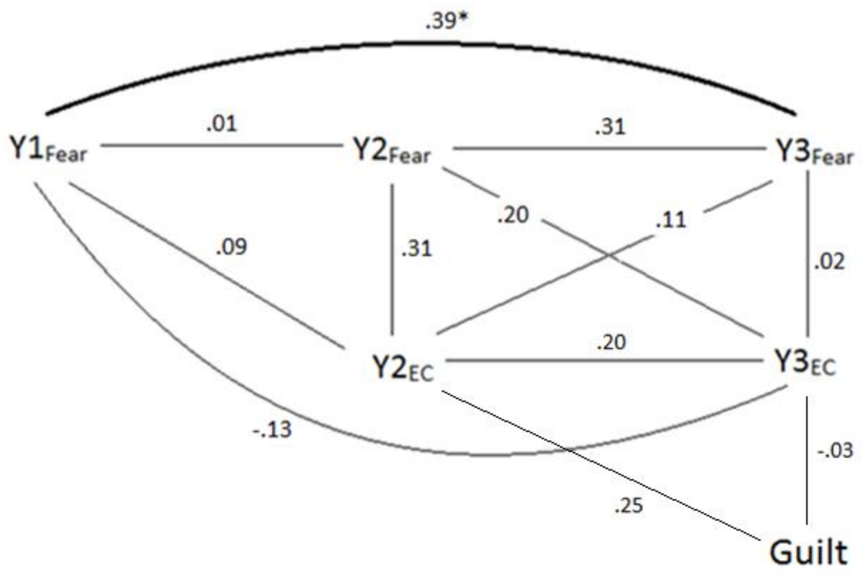

Figure 4. Associations between effortful control, fear and guilt across time, for girls (N=34).

Boys:

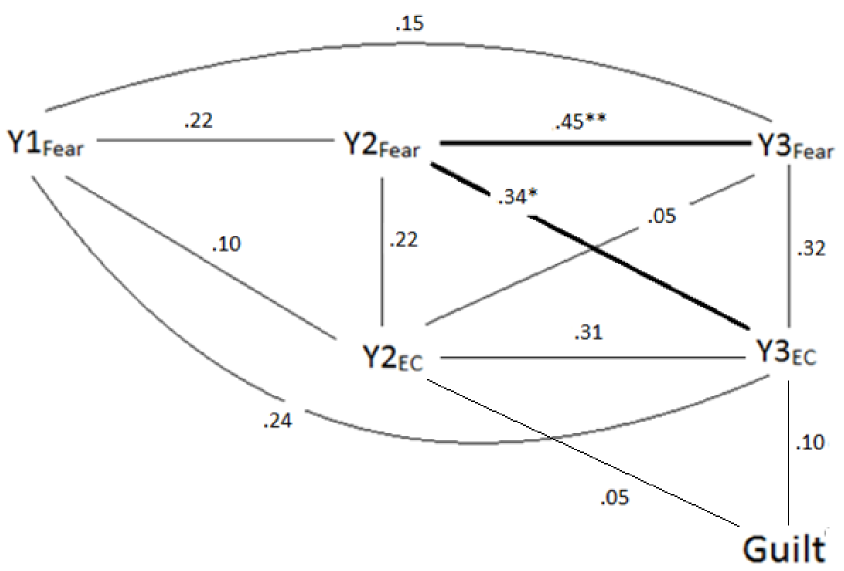

Figure 5. Associations between effortful control, fear and guilt across time, for boys (N=36).

The associations between fear and effortful control for the whole sample (Figure 3) is different from the story we see in girls (figure 4) and boys (figure 5). In the whole sample, and for girls, earlier fear does not predict later effortful control. However, for boys only, fear in Y2 predicts effortful control in Y3. Fearful boys in Y2 have higher levels of effortful control in Y3.

Effortful control and guilt

Guilt was not associated with effortful control in Y2 or Y3 (see Figure 3) in the whole sample, and no differences were found between associations for boys or girl (Figures 4 & 5).

Analysis Strategy

The overall sample size for the study is moderate, however when investigating gender differences, the sample size is effectively halved (N= 36 for boys, N= 34 for girls). A small sample size has potential implications for statistical analysis. The first of which is statistical power, which gives confidence in testing the hypothesis. Following Cohen's (1992) guidelines, the power for our sample of boys and girls is small, which is a problem for interpreting the results. An inadequate power could increase the chance of making a type II error, where we believe there is no association found, when in fact there is. Due to the problems with power, caution is needed in drawing conclusions from these results. These results require replication in a larger sample in order to be confident in the conclusions we make.

Another issue to take in to consideration is the use of multiple correlations in this analysis to investigate relationships between variables across time. Calculating numerous correlations increases the risk of a type I error, which is to erroneously conclude the presence of a significant correlation. However, in order to avoid this it is recommended that the level of significance of correlation coefficients should be adjusted to consider the family-wise error, that is where significance levels are adjusted to the number of variables being measured to reduce the risk of obtaining significant results by chance only. However, when there are a large number of variables, a correction can be too conservative, leading to the rejection of true correlations (type II error) (Curtin & Schulz, 1998). One way to overcome this problem is to focus the investigation to a small number of variables (Curtin & Schulz, 1998), however this was not appropriate for this study as it was exploratory and required multiple correlations. Another recommendation to overcome this problem is to use multivariate statistical methods, which make adjustments for the multiple comparisons (Curtin & Schulz, 1998). This was not appropriate in this study, as few correlations were found to be significant, therefore little theoretical reason to move on to multivariate tests.

Table 2. *Effect sizes for gender differences in level of effortful control, fear, and guilt, at each year of assessment.*

	effect-size *r*	Cohen's *d*
Effortful control		
Y2	.29	.62
Y3	.37	.80
Fear		
Y1	.00	.00
Y2	.13	.26
Y3	.09	.18
Guilt	.03	.07

One way to assess the size of the difference rather than confounding this with sample size is by examining the effect size. An effect size is a standardised way of quantifying the size of the difference between two groups. Table 2 indicates that there is a medium to large effect size for gender differences in effortful control in Y2, and a large effect size between boys and girls in Y3. There is no effect size for the gender differences in fear in Y1, nor for guilt, however a small effect size was found in fear in Y2 and Y3, suggesting gender differences in fear may emerge over time. However, a small effect size only has a 53% probability that one could guess which group a person was in from knowledge of their score, so little can be derived from this effect size (Cohen, Kulik, & Kulik, 1982).

The conclusions drawn from these results should be considered with caution due to the limitations of the analysis strategy. Taken together, these factors suggest that the confidence in these results may be compromised, and as such, should be taken into account when interpreting the findings. The aim of this study was to highlight the need and importance of researching this area, and to provide insights into the investigation of early inhibitory emotions. However, this research requires replication in a larger study.

Discussion

The aims of the present study were to investigate the development of effortful control across early childhood, and the associations between effortful control, fear and guilt. These associations were examined separately in boys and girls to investigate early developmental patterns.

Our first goal was to test the development of effortful control from age 2 to 3. Effortful control has been found to develop from 18 months, improving considerably from 22 to 36 months of age (Kochanska, et al., 2000; Kochanska & Knaack, 2003; Kochanska et al., 2009). As predicted, we also found an improvement in ability from age 2 to 3. The longitudinal stability of effortful control for toddlers and children of early school age appears to become increasingly coherent over the second year and into early childhood (Kochanska et al., 1996; Kochanska & Knaack, 2003), and later becomes a salient personality variable (Ahadi & Rothbart, 1994; Rothbart & Ahadi, 1994; Rothbart & Bates, 1998). We found moderate stability in individual differences (r = .36, p <.01), similar to previous studies (ranging from r = .24 - .44) (Kochanska et al., 2009; Kochanska & Knaack, 2003; Kochanska et al., 2000; Kochanska et al., 2001; Murray & Kochanska, 2002). This suggests that 2 year old children with good effortful control continued to have good effortful control as toddlers, and similarly, those children who had relatively poor effortful control continued to have problems in toddlerhood. Figure 2 indicates that children's ability is varied in Y2, however in Y3 the majority of children are able to effortfully control their behaviour during the tasks. Furthermore, the majority of children show improvements in their ability to delay. The relatively modest test-retest correlation was due to the large increase in ability for most of the children from Y2 to Y3. These findings show that the development of effortful control occurs between the ages of 2 and 3, with typically developing children achieving effortful control by 3 years of age.

As hypothesised we found that girls had higher levels of effortful control in Y2 and Y3. Studies consistently find this gender difference from an early age, favouring girls (Else-Quest et al., 2006; Kochanska et al., 1996; Kochanska et al., 2000; Kochanska & Knaack, 2003). These findings strongly suggest that girls are better able to regulate or allocate their attention, to control inappropriate behaviours and have an overall stronger ability to manage and regulate their attention and inhibit their impulses than boys. There was no interaction between time and gender, where girls and boys increased in ability similarly over time, suggesting that there may be an overall developmental lag in boys. The meta analysis on gender suggest that this pattern appears to continue across childhood, as gender differences were consistently found up until their cut off age at 13 years old (Else-Quest et al., 2006). Related adult personality constructs however, do not indicate later gender differences, such as conscientiousness (Costa, Terracciano, & McCrae, 2001; Feingold, 1994) and impulsiveness (Feingold, 1994), and it is not yet known when (and if) these differences fade. These findings have implications for boys' early development, in particular the maladaptive behaviours associated with lower levels of effortful control.

The next goal was to examine the associations between fear and effortful control. Fear develops earlier than effortful control, so our aim was to examine whether fear predicted effortful control ability. Kochanska and Knaack (2003) found that more fearful infants, measured using a composite behavioural fear score from 14 - 22 months, had higher levels of effortful control at 22, 33 and 45 months, and concluded that passive and active inhibition share some underlying qualities. Similarly, Aksan and Kochanska (2004) found fearfulness from 14 months was positively associated with consecutive assessments of effortful control. Contrary to our predictions, we did not find an association between fear in Y1 or Y2 and effortful control in Y2 or Y3 for the full sample of 70 children. However, we did find this association for boys, where boys who were more fearful at age 2, were more fearful and had better effortful control ability at age 3. These findings show that different developmental processes are taking place in early childhood for boys and girls. This seems to suggest that during this stage of development fear plays an important role in regulating later approach behaviour. This is not the same for girls, where fear does not appear to regulate the speed of approach in Y2. However, girls' ability to inhibit behaviour on demand is better than boys in Y2 and Y3. It may be that as effortful control develops, boys rely on fear to regulate their behaviour, whereas girls do not.

However, these findings should be approached with some caution as the findings may also suggest that there may be a ceiling effect in girls' ability to delay in these tasks, as they were consistently better than boys in their effortful control ability in Y2 and Y3. Therefore, there may not be enough variation in ability to find a relation with fear. Although these findings are interesting, further investigation is required, with larger groups of girls and boys.

The second point of discussion from these findings is that in the overall sample of 70 children, fear at age 3 was associated with concurrent effortful control ability. This association was found for the overall sample, not more so in boys or girls. These findings suggest that as effortful control ability increases, the association with fear develops. It may be that as effortful control abilities become competent they start to regulate other reactive emotions. Effortful control is perhaps a more complex temperament than fear, which is a basic emotion present from birth and does not necessarily entail a lot of cognitive processing (Rothbart & Bates, 1998). As effortful control is still developing at 3 years of age, perhaps the stability of the relation between fear and effortful control only emerges later.

Finally, we did not find an association between fear and effortful control from infancy, as was found in previous studies (Aksan & Kochanska, 2004; Kochanska & Knaack, 2003). Our findings show that fear and effortful control are largely separate inhibitory temperaments, except later in childhood, and only in boys. It is possible that the different paradigms used in studies may play a role in these findings. We assessed effortful control by observing delay of gratification, which is a central component of effortful control. However, studies investigating effortful control commonly measure effortful control with a battery of tasks, including delaying, motor inhibition, suppressing-initiating response to signal (Go-No Go), and effortful attention (e.g. Stroop-like tasks) (Kochanska, et al., 2000). Effortful control encompasses two types of processing, ‘hot’, which are tasks that include a salient emotional component (a positive or negative consequence), and ‘cool’, which are tasks that involve various demands, void of the affective component (Kim, Nordling, Yoon, Boldt, & Kochanska, 2012; Metcalfe & Mischel, 1999; Shoda, et al.,1990). Delay of gratification is the most typical ‘hot’ task, which has been found to engage children’s emotion regulation to a much greater degree than ‘cool’ effortful control tasks (Kim et al., 2012, Metcalfe & Mischel, 1999), especially during stressful, highly arousing situations (Metcalfe & Mischel, 1999). Therefore, delay of gratification would theoretically be associated with affective, reactive emotions, such as fear. However, our findings suggest that this association develops in toddler years (and slightly earlier for boys). It may be that a more ‘cool’ task in the battery used in previous studies (Aksan & Kochanska, 2004; Kochanska & Knaack, 2003) shares the early components of behavioural inhibition in infancy. Gusdorf and colleagues investigated the structure of effortful control, identifying two key components of observed effortful control, self control, and attention/motor control (Gusdorf et al., 2011). It is possible that early in life, the association lies with a different aspect of effortful control, such as attention/motor control, and it is not until later on in early infancy that the association with self control emerges. In order to understand these relationships better, a number of effortful control tasks including ‘hot’ and ‘cool’ tasks should be used in future research.

An earlier study by Aksan and Kochanska (2004) found association with delay tasks and fear, so it is also possible the differences may be due to the measurements of fear. Although this study and previous studies (Aksan & Kochanska, 2004; Kochanska & Knaack, 2003) used a standardised Lab-TAB task focusing on inhibition, unfamiliarity and novelty, different paradigms were used. Previous studies measured fear with the masks and risk room paradigms, which are described as ‘mildly stressful’, whereas the current study measured fear with the unpredictable toy paradigm, which incorporates novelty, with the additional element of separation from the mother and being left alone with the novel toy and a stranger. By presenting the novel toy in the context of a brief separation, we provided a challenge that infants had to meet on their own. It may be that the additional stressors, the stranger and separation may mask the associations with effortful control. In future research a combination of measures would be useful to better understand the relationships.

Next, we investigated the relationship between effortful control and guilt, two constructs developing from around the second year of life. We did not find any associations between effortful control in Y2 or Y3 and guilt. These associations have been found in older children (Kochanska, et al., 1996; Rothbart, et al., 1994), and effortful control has been found to moderate the relationship between guilt and disruptive behaviour (Kochanska et al., 2009), but little is known about earlier direct associations. It is possible that as effortful control and guilt are still developing at 3 years old, the associations are yet to emerge. Further studies, following the current sample, will help investigate this further.

Another possible reason for the absence of an association between effortful control and guilt is our measurement of effortful control. Fear and guilt are associated across early childhood, with early fear predicting later guilt (Baker et al., 2012), however effortful control is not associated with guilt at this age. Both fear and guilt are inhibitory emotions, therefore it may be that inhibitory components are associated. Again, similar to the lack of early association with fear, it may be that the attention/motor control component of effortful control may be associated with guilt in the early years of life. Rothbart (2007) suggests that effortful control provides the attentional flexibility needed to link distress cues, action, and moral principles, and so it is also possible that a task focusing more on attention and inhibition may be more associated with guilt. These suggestions are speculative, and more research is needed to fully understand these associations.

The current study had some limitations. Effortful control is a multidimensional construct composed of different, yet related constructs (Murray & Kochanska, 2002). Whilst there is an argument for measuring a battery of tasks to investigate effortful control, inter-correlations among tasks are often modest at best, suggesting that effortful control is a complex, broad trait with key components including self control and attention/motor control (Gusdorf et al., 2011). Recently researchers have sought a more refined understanding of the individual processes involved under the broad term of effortful control (e.g. Duckworth & Kern 2011; Gusdorf et al., 2011; Kim et al., 2012). Some studies indicated that different forms of effortful control may differentially predict developmental outcomes (Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009; Gusdorf et al., 2011). Components of executive functioning contribute differently to performance on complex frontal lobe tasks (Miyake et al., 2000), and different components of effortful control have been linked with categories of externalising problems, including ADHD and CD (e.g., Barkley 1997; Krueger, Caspi, Moffitt, White, & Stouthamer-Loeber, 1996; Sonuga-Barke, Dalen, Daley, Remington, 2002). Gusdorf and colleagues argue that there is a multidimensional structure of effortful control, as it appears to be composed of a number of different, but related competencies. Future research should include a range of tasks to measure the different aspects of effortful control.

Another limitation is that this study was a behavioural study, whereas we know that fear, guilt and effortful control also have clear physiological components (e.g. Baker et al., 2012; Wilson et al., 2009). Future research should incorporate measures of physiological activity to better capture the experiences of the children. Our earlier study found that infant physiological fear predicted later physiological fear and guilt, but not behavioural guilt (Baker et al., 2012). It was suggested that with increasing age, children are better able to inhibit or mask overt expressions of negative affect and to avoid intense emotional expression (Kochanska et al, 2002), and so behavioural measures may not best reflect the underlying arousal.

Third, this study focused on the normal development of these systems, and as such our sample was a typically developing, low risk sample of children. The children in our sample came mostly from two-parent, educated families (see Baker, et al., in press), reflecting a low risk sample. Previous studies have found associations between early effortful control and problem behaviours (e.g. Kochanska & Knaack, 2003; Murray & Kochanska, 2002). It would be of interest to compare this model with that of children at high risk for problem behaviours, to identify if differences are occurring in early developmental stages.

Finally, this study focused on the child's development, with a focus on developmental patterns and associations. That is not to say that the role of external factors is not considered an important factor. Future studies should incorporate parenting factors into the investigation of these temperaments as parent discipline begins around the second year continuing into the childhood and preschool years, overlapping with the development of these systems (Kochanska & Knaack, 2003). Studies have found maternal responsiveness, interactions, power-assertion and discipline, to name a few, to play a role in the development of early temperament, including effortful control (Kochanska et al.,2000; Kochanska & Knaack, 2003; Shaw 2003; Thompson, 2006; Wilson et al., 2009).

It is difficult to interpret many of the results found in the current study in relation to findings from other studies. This has been due to differences in the measurements taken, with many studies employing composite scores of effortful control or fear over the longitudinal assessments. This makes it difficult to know where in the stages of development the associations took place (Hill-Soderlund, & Braungart-Rieker, 2008; Kochanska & Knaack, 2003). The differences in paradigms used have provided an insight into the complexity of these systems, highlighting associated components. However, this makes comparing the results a challenge, as combinations of paradigms differ across studies. Although identifying these differences has been useful, it is important to take this into account when interpreting results and designing future studies.

In summary, early childhood is a crucial period for the development of effortful control, with young children at first being almost totally dependent on external regulation, gradually becoming increasingly guided by inner mechanisms. There is stability in the ability to delay on demand across early childhood, with girls having a higher ability. However, associations between fear and effortful control differed in boys and girls in Y2, with fear playing an important role in regulating boys' later approach behaviour. As effortful control ability increases in toddlerhood, the association between fear develops. Effortful control and guilt were not associated at this age; however, both showed associations with fear. These systems are all widely accepted to be important in the development of later problem behaviour, including antisocial behaviour in later childhood. Early investigations, such as this, may provide the basis for future interventions for the development of risk pathways.

Chapter 5: General Discussion

The main aim of this thesis was to improve our understanding of the development of early inhibitory emotions and emotion regulation from infancy, and the role of these emotions in early risk pathways. More specifically, this thesis investigated (1) the development of fearful temperament, its stability over the first three years of life, and its associations with later developing effortful control and guilt; (2) risk factors in infancy that predict later externalising psychopathology; and (3) the development of effortful control, and its associations with fear and guilt. Psychophysiological and observational measures were used to examine these emotional systems as well as their role in predicting later psychopathology. The thesis consisted of 3 empirical chapters, investigating a sample of 70 typically developing children in a longitudinal, prospective manner, using a multi-method approach when available. This chapter describes and discusses the main findings of this research and puts forward suggestions for future research.

The overall findings

The development of fear

Chapter 2 aimed to gain a better understanding of the early development of fearful temperament. More specifically, the stability of fear across the first three years of life was examined, and whether fearfulness in infancy predicts fearfulness in toddlers. Little is known about the stability of fear across the first few years of life, despite our knowledge that temperament is an underlying factor that can inhibit or facilitate children's socioemotional functioning (Blandon, Calkins, Keane, & O'Brien, 2010). Furthermore, what we do know about fear development is based solely on behavioural assessments and maternal reports. One of the strengths of the current study was the multi-method approach to investigate the development of behavioural, physiological and maternally reported fear.

Results of this study indicate that physiological fear was not stable over the first 3 years of life. Heart rate (HR) and skin conductance level (SCL) during baseline and stress decreased significantly over time (see pp. 28, Ch. 2), although physiological fear reactivity was highest in year 2. A reduction in HR is commonly reported in early childhood (Massin & von Bernuth, 1997), but less is known about the early development of skin conductance activity (SCA), as it is less commonly assessed in infants. This pattern of increased fearfulness in year 2 was not found in observed fear, which was stable over time (see pp. 29, Ch. 2). Year 2 is recognised as a salient time in a child's early development. During this time, developmental effects may be related to more extensive experience, greater memory capacity, more competent communication strategies and the formation of attachment by the end of the first year, all of which may have contributed to the more intense fear at age 2. The different patterns of observed and physiological fear in year 2 suggest that although the child may be highly aroused during a stressful situation, they may already have learnt to disguise or regulate the presentation of their distress.

There is little agreement over the stability of individual differences in fearful and fearless temperament. For example, Kochanska (2001) found stability from 14 months, whereas Lemery and colleagues found stability from 24 months (Lemery, Goldsmith, Klinnert, & Mrazek, 1999). Individual differences in fearlessness and fearfulness were found to be significantly associated in all measures (i.e., observed behaviour, HR and SCL; see Table 2, pp. 31, Ch. 2), meaning that fearless infants continued to be fearless toddlers. There were also interesting cross-method associations, with behaviourally fearless children having lower levels of HR across early childhood. Fearlessness and low ANS fear arousal in infancy also predicted fearlessness and low ANS fear arousal in toddlers (see Table 3, pp. 34, Ch. 2). Together, these findings indicate that the developmental trajectory of fearfulness and fearlessness begins in infancy. Future research is needed to extend this trajectory from toddlerhood into adulthood, as fear has been linked to psychopathology in adults (Raine, 2002).

Another aim was to examine multiple indices of fear in order to gain a more complete understanding of fear as an emotion, and to find out what is the best way to measure fear in young children. Many studies on fear in infancy focus largely on maternal reports. In this study, maternal reports corresponded with observed fear in the laboratory. However, maternal reports did not correspond with physiological fear, predict fear in year 2 or 3, or predict internalising problems at age 3 (see Table 2, pp. 31, Ch. 2). This indicates that although the mothers agreed at the time with independent observers about what they saw, maternal observation did not necessarily correspond with what the child experienced internally. Thus mothers who reported their child to be fearful did not necessarily have a child who became highly aroused during fear exposure. There are conflicting views over the use of maternal report to measure temperament. Kagan (1994) argues that maternal reports are too subjective, with mothers reporting their impression of the child, which are prone to bias. However, an advantage is mothers are able to report on their child's behaviour across contexts (Rothbart & Bates, 1998). All measures arguably have their limitations, including laboratory assessments, which have been criticised for being context specific (Epstein, 1986). However, our laboratory measure of fear and our observation of the child's fearful temperament corresponded with the child's observed temperament across contexts, and predicted clinically internalised toddlers. The lack of association of maternal report with other measures of fear suggests that maternal report does not appear to be the best measure of a child's fear experience. Furthermore in Chapter 2, maternally reported fear in infancy did not predict later maternally reported internalising problems. The association between maternally reported and observed fear suggests that mothers are able to report current child behaviour but are unable to predict future behaviour.

Physiological arousal is an important component of emotions and a marker for psychopathology (Damasio, Tranel, & Damasio, 1990). However, it is very rarely used to measure fear in infants, therefore we know very little about ANS arousal to fear early in life, especially associations between multiple measures. Our findings show that HR and SCL were not associated at any age of assessment, and only predicted its counterpart measure (see Table 2, pp. 31, Ch. 2). HR and SCL are different components of the ANS; SCL is controlled solely by the sympathetic nervous system, whereas HR is the result of the combined action of the sympathetic and parasympathetic nervous system (SNS and PNS). Both the SNS and PNS play an important role in the response to stress in general and in emotions in particular. However, it is a widely accepted phenomenon that HR and SCL, or measures of SNS and PNS more generally, are weakly, if at all, correlated (e.g. Bradley, Codispoti, Cuthbert, Lang, 2001; Buss, Goldsmith, & Davidson., 2005; Scarpa, Raine, Venables, & Mednick, 1997). It is only through the continued use of multi-method approaches to testing that we can begin to understand the role of HR and SCL in emotional arousal. One advantage of this study was the use of multiple measures, allowing us to conclude that HR and SCL are both physiological indices of fear and independently index arousal responses to fear, suggesting they reflect different components of fear.

Physiological risk factors for later psychopathology

The study presented in this thesis was carried out in a low-risk, community sample of 70 typically developing infants and their mothers. The rationale for using this sample was to gain a better understanding of the normal development of temperament and emotions. By understanding normal development we can extend our understanding of developmental trajectories and begin to formulate an in-depth portrayal of how deviations in normal developmental processes can eventuate in maladaptation and psychopathology (Cicchetti & Gunnar, 2008). Two psychophysiological risk factors for psychopathology were investigated in this thesis. In Chapter 2, we identified HR in infancy as a precursor for later internalising problems. The aim of Chapter 3 was to examine whether low skin conductance activity in infancy was a biomarker for later aggression.

The study as reported in Chapter 2 aimed to investigate whether it was possible to identify risk pathways to internalising problems from an early age. Although it was predicted that extremes in fearfulness would be associated with internalising problems, as found in older samples (Biederman et al., 1993; Schwartz, Snidman, & Kagan, 1999), very little is known about the early risk factors for this association. It was found that a subgroup of toddlers with internalising problems at age 3 had significantly higher levels of HR during baseline and fear in infancy (see pp. 37, Ch. 2). Furthermore, these children showed more behavioural distress in infancy. These findings further underline the salience of investigating infant emotion and show that assessments of children in infancy are predictive of how these children react 2 years later. These findings lend *some* support to the idea that the emotional thermostat is set in the first 3 years of life; however caution must be taken due to the limitations discussed in this chapter.

Whilst Chapter 2 focused, in part, on the role of HR in predicting later internalising psychopathology, the study as reported in Chapter 3 examined whether low SC arousal is a biomarker for aggression in young children. Little is known about the role of SCA in infants and toddlers, and no studies to date have tested the relationship with aggressive behaviour before the age of 3. Our findings show that low infant SCA *specifically* predicted aggressive behaviour, as there was no association with non-aggressive behavioural problems (see Table 2, pp. 58, Ch. 3). We were therefore able to conclude that low SCA is a biomarker for aggression, as it preceded the onset of aggression (Sterzer, 2010). These results extend on previous findings predicting aggression and criminality in adulthood from 3 years of age (Gao, Raine, Venables, Dawson, & Mednick, 2010a, 2010b). By showing that individual differences in psychophysiology are predictive of later aggression, these findings show that the first 3 years of life are a salient period when important systems involved in the experience and expression of emotions are being established.

Furthermore, it was interesting that we found that low infant SCA specifically predicted physical and verbal aggression, as opposed to a broader spectrum of difficult behaviour. The majority of studies investigating aggression in children continue to conceptualise it as a unitary construct (Calkins & Dedmon, 2000; Gill & Calkins, 2003; Posthumous, Bockers, Raajmakers, van Engeland & Matthys, 2009; Van Beijsterveldt, Bartels, Hudziak & Boomsma, 2003). Burt (2012) argues that this approach is potentially problematic as studies that fail to define the differences between aggressive and non-aggressive behaviours may obscure or distort important findings. Our findings underline this by showing that SCA as a biomarker only predicted later aggression rather than the broader construct of hard-to-manage or problem behaviour. Our findings enhance our understanding of the early precursors of aggression and inform prevention efforts by highlighting the role of infant psychophysiology.

Another advantage of the study as reported in Chapter 3 was that a multi measure approach was used to identify the role of physiology. Most studies of children have focused on the sensation seeking theory and measured resting SCA (e.g., Raine, Venables & Williams, 1990); others aimed to test the fearlessness account and have measured SCA during emotionally challenging paradigms (e.g., van Goozen, Matthys, Cohen-Kettenis, Buitelaar, & van Engeland, 2000); and a few studies have measured SCA during fear conditioning (Gao et al., 2010a; 2010b). SCA during baseline and fear were correlated (see Table 2, pp. 58, Ch. 3), and equally associated with later aggression, supporting both the fearlessness and sensation-seeking accounts of aggression. The prefrontal cortex is important in emotion and personality development. Damage to this region in young children can lead to deficits in psychophysiological responding, such as reduced SC orienting and arousal (Williams et al., 2000), which could adversely affect emotion regulation and prosocial development, and thereby cause aggression in later life.

One point for discussion is that we found that HR was associated with internalised problems (see Chapter 2), whereas SCA predicted externalising problems (see Chapter 3). Although this was not reported in the individual chapters, HR did not predict externalising problems, nor did SCL predict internalising problems. Although HR and SCL are both indicators of fear, in our findings they appear to play a different role in predicting psychopathology. This is an interesting issue for future systematic research. Although HR baseline has been found to be the best-replicated measure for antisocial behaviour (Raine, 2002), we did not find this to be the case in our sample of young children. Not many studies have combined assessments of HR and SCL into the same study. Only when both measures of ANS system arousal are taken together can one properly examine the role of each system as a measure for aggression.

Inconsistencies have been found in this study between the multiple measures of fear. Due to the dearth of studies using multiple measures, conclusions have been exploratory. We did not find associations between HR and SCL during fear, and SCL was not associated with behavioural fear. Furthermore, HR and SCL appear to play a different role in predicting psychopathology. These inconsistencies have been found in other studies investigating different stress systems, including the hypothalamic -pituitary -adrenal axis (HPA). Laurent and colleagues (2012) found that mothers and infants showed a higher, more sustained arousal in the HPA system during the attachment stress during Strange Situations (Ainsworth, et al., 1978) however there was higher, more sustained arousal in the SNS during the challenge tasks. These findings suggest that different stress systems, which serve overlapping but distinct functions in stress responding (Nigg, 2006), respond differently to particular types of stressors. In the current study, challenge was created from maternal separation, similar to the Strange Situation paradigm (Ainsworth, et al., 1978), but also from challenge designed to elicit affect. These two aspects were independently associated with HPA and SNS in Laurent’s study leading them to conclude that different stress systems respond to different aspects of stress. It is possible that HR and SCL respond to different aspects of the tasks, resulting in them both showing heightened arousal, yet lacking in associations between measures. Pathways regulating SNS and PNS are interconnected, yet the associations are complex, allowing for both suppressive and stimulatory effects during stress (Sapolsky, Romero, & Munck, 2000). Associations between the HPA and ANS has been more commonly investigated in adults, finding mixed results across the two stress systems (El-Sheikh, Buckhalt, Erath, Granger, & Mize, 2008; Gordis, Granger, Susman, & Tricket, 2008). Little is known about whether these inconsistencies are normal and/or adaptive, with further research needed.

Together, the findings from Chapters 2 and 3 highlight the importance of examining physiological measures, as they provide an insight into risk pathways that measures of observed behaviour are unable to do. There are not only serious gaps in our knowledge of psychophysiology in young children, but we also know very little about early biological risk factors for later emotional and behavioural problems. The findings from this thesis enhance our understanding of the role of the psychophysiological system in the development of emotion and temperament, and possibly the later development of psychopathology. The findings highlight the importance of studying these systems from infancy onwards.

Effortful control

In Chapter 2 the focus was on the early development of fear. In Chapter 4, we investigated a closely related, but later developing temperamental aspect; effortful control. Effortful control begins to develop from around 18 months old (Kochanska, Murray, & Harlan, 2000) and so was investigated in the second and third waves of our study. In Chapter 4, the aim was to gain a better understanding of how effortful control (EC) develops. Extreme levels of EC have been associated with internalising and externalising behaviour in childhood (Murray & Kochanska, 2002), and are seen as a key element of later psychopathology. Although studies have examined the development of EC over time, not much is known about the factors that predict EC from infancy. We examined whether infant fear was a predictor of the later development of EC.

As predicted, EC ability increased from age 2 to 3 years (see Figure 1, pp. 83, Ch. 4). We found moderate stability in individual differences, similar to previous studies (Kochanska, Barry, Jimenez, Hollatz, & Woodard, 2009; Murray & Kochanska, 2002; Kochanska & Knaack, 2003; Kochanska et al., 2000; Kochanska, Coy & Murray, 2001). This suggests that 2 year old children with good EC continued to have good EC as toddlers, and similarly, that children who had relatively poor EC continued to have problems in toddlerhood. The relatively modest test-retest correlation was due to the large increase in ability for most of the children from year 2 to year 3. These findings show that the development of EC occurs between the ages of 2 and 3, with typically developing children achieving EC that is as operationalised in the present research, at age 3.

A next and more important goal was to investigate the role of early fear in the development of effortful control. Temperament researchers view fear as a more reactive inhibition, distinct and separate from EC, which involves more voluntary inhibition (Rothbart & Bates, 1998). However it has been proposed that fearfulness may underpin children's ability for self regulation (Derryberry & Rothbart, 1997; Rothbart & Ahadi, 1994; Rothbart & Bates, 1998; Rothbart, Ahadi, & Evans, 2000), by altering the speed of approach (Aksan & Kochanska, 2004). Furthermore, studies have found that fear and EC are associated in early childhood (Aksan & Kochanska, 2004; Kochanska & Knaack, 2003). However, there are inconsistencies in the findings (Hill-Soderlund & Braungart-Rieker, 2008) and we still know very little about these early associations, so our aim was to investigate whether early fear predicts later developing EC. Contrary to our prediction, no positive associations were found between fear in Year 1 or Year 2, on the one hand, and EC in Year 2 or Year 3, on the other (see Figure 3, pp. 85, Ch. 4). Although this pattern applied to the total sample of 70 children, we did find a significant positive association between fear at age 2 and EC at age 3 in boys (see Figure 5, pp. 86, Ch. 4). This suggests that during this stage of development fear plays a role in regulating later approach behaviour in boys only. Girls were generally better than boys in EC at age 2 and 3 (see Figure 2, pp. 84, Ch. 4). It may be that as effortful control develops, boys are more reliant on fear to regulate their behaviour than girls. These findings show that different developmental processes are taking place in boys and girls in early childhood.

We found that fear and EC were associated at age 3 in the whole sample (see Figure 3, pp. 85, Ch. 4). This suggests that there is only an association once EC ability has reached a certain level. It may be that EC needs a certain level of competence before it can start to affect emotions. It will be interesting to examine how the relation between EC and emotions such as fear develops further over time, as EC continues to develop after age 3 years.

The development of guilt

Chapter 2 also examined the role of guilt. Guilt is widely accepted to be a prosocial emotion, associated with adaptive socialisation. However, extremes in guilt proneness have been associated with later psychopathology (Ferguson, Stegge, Miller & Olsen, 1999; Stuewig, Tangney, Heigel, Harty, & McCloskey, 2010; Tangney & Dearing, 2002). Despite this, guilt has rarely been studied in early childhood and little is known about its early development. Due to our limited understanding of the development of guilt, a multi-method approach was adapted in an attempt to better capture guilt expression in toddlers. Guilt is a later developing emotion and so was examined in the last wave of our study, at 3 years of age. In Chapter 2 we examined the role of fear in the development of guilt. In Chapter 4 we studied the association between effortful control and guilt.

In Chapter 2, we aimed to extend the findings by Kochanska and colleagues (2002) by investigating physiological indices of fear and guilt from infancy. As we predicted, behavioural and physiological measures of fear and guilt were positively associated within measures (see Table 2, pp. 31, Ch. 2). Toddlers exhibiting less behavioural or physiological fear also showed less distress and experienced less arousal during the mishap guilt procedure. HR and SCL fear arousal in infancy predicted guilt proneness in toddlers, within measure (see Table 4, pp. 36, Ch. 2). Our findings not only confirmed the existence of a concurrent association between fear and guilt, but also showed evidence that fear in infancy was predictive of guilt 2 years later. To our knowledge, ours is the first study to examine the role of ANS arousal in early guilt. These findings show that the discomfort that fearful children experience during fear-arousing situations appears to influence or affect the development of other negative emotions, such as guilt, and the proneness to experiencing these emotions is relatively stable over early childhood.

Although infant physiological arousal during fear predicted later arousal during guilt, behavioural fear in infancy did not predict behavioural guilt (see Table 4, pp. 36, Ch. 2). However, behavioural fear did predict SCL arousal during guilt. These results suggest that better emotion regulation in toddlerhood may mask the level of distress expressed following a transgression, resulting in the weaker association between behavioural measures. Taken together, the findings provide further support for the important role of physiological measures in the study of early emotional development.

In Chapter 4 we investigated the relationship between EC and guilt. Theoretically, EC and guilt are considered crucial inner guiding mechanisms that inhibit aggressive and antisocial behaviour and promote conscience (Kochanska et al., 2009). Low levels of guilt and executive function deficits (including poor EC) contribute to antisocial, aggressive behaviour and psychopathy (Fowles & Dindo, 2006). Research has so far focused on older children (e.g. Kochanska, Murray & Coy, 1997; Rothbart & Bates, 2006). Contrary to predictions, we did not find that EC and guilt were associated in toddlerhood (see Figure 3, pp. 85, Ch. 4). Previous findings suggest that this relationship may develop after year 3 (Kochanska et al., 1996; Kochanska & Knaack, 2003; Valiente et al., 2004; Rothbart, et al., 1994). The lack of a significant association between effortful control and guilt, adds to our limited knowledge of these constructs. It would be informative to continue to examine the role of EC in the development of guilt. One possibility is to examine the role of EC as a moderator, as has been the case in previous findings (Kochanska et al., 2009), using a multi-method approach.

Another possible reason for the absence of an association between EC and guilt is our measurement of EC. We assessed EC by observing delay of gratification. Delay of gratification is a central component of self regulation, as it requires executive attention and future-oriented self control (Mischel, Shoda, & Rodriguez, 1989). However, studies investigating effortful control commonly use a wider range of tasks to measure EC. These include delaying or slowing down gross and fine motor activity, suppressing/initiating activity to signal, lowering voice, and effortful attention. We discussed the possibility that the ability to delay may not be associated with guilt. Guilt is an inhibitory emotion; a task focused more heavily on inhibition may be better associated with guilt. Future research may wish to include a different range of tasks to measure EC.

Gender differences

Gender was investigated throughout this thesis. From an early age, gender differences in emotions have been reported with little consistency in many of the findings (Else-Quest et al., 2006). It is important to investigate gender differences in emotions in early childhood so we can begin to understand when, and if, developmental trajectories differ. The measures in our study have been associated with maladaptive behaviour in later life, including internalising and externalising problems. Later in life, there appear to be gender differences in the prevalence of these problems, with females more susceptible to internalising problems, such as depression (e.g. Kessler, McGonagle, Swartz, Blazer, & Nelson, 1993; Weissman & Klerman, 1977; Weissman, Leaf, Holzer, Myers, & Tischler, 1984), and a higher prevalence of externalising disorders in males (e.g. Bongers, Koot, van der Ende, & Verhulst, 2003; Lemery, Essex, & Smider, 2002; Rosenfield, 2000). Understanding when these differences emerge, or identifying whether different processes may link temperament and adjustment for boys and girls (Rothbart & Bates, 1998) is important for the development of prevention and intervention models.

Our findings show that boys and girls do not differ in their behavioural distress or physiological arousal to fear and guilt in the first 3 years of life. There were no gender differences in aggressive behaviour and the subsample of children with internalising problems was too small to examine gender differences. The gender differences in EC (see Figure 2, pp. 84, Ch. 4) show that boys may differently regulate their attention to girls, and from the age of 2 year old boys are less able to effortfully control their behaviour. The inability to successfully regulate and inhibit behaviour is a key component of externalising behaviour (Lahey, Moffitt, & Caspi, 2003; Lemery et al., 2002), and so further research is needed on the different developmental patterns exhibited in boys and girls EC ability early in life. Extending this period of assessment would allow us to see whether this early regulation is beneficial to boys' regulation of other emotions, or whether fear plays a role earlier to compensate for their developmental lag.

Limitations of the thesis

The current study explored the relations between early biological risk factors and later psychopathology in a normally developing, low risk sample of children. Investigating risk factors in low risk samples is subject to limitations. A number of studies have found that psychophysiological factors show stronger relationships to antisocial behaviour in those from low risk backgrounds that lack the psychosocial risk for crime (Raine, 2002). For example, low resting HR in 3 year olds was related to aggression at 11 years of age, in high but not low social classes (Raine, Reynolds, Venables, Mednick & Farrington, 1997). Similarly, low SCA activity characterises antisocial adolescents from high, but not low social classes (Raine & Venables, 1981). This may be explained by the 'social push' hypothesis, which suggests that where an antisocial child lacks social factors that push them to antisocial behaviour, then biological factors are more salient (Raine & Venables, 1981). It is therefore possible that the link between SCA and later aggression identified in this low-risk sample would not be replicated in higher risk groups. Further research should examine whether the observed effects replicate in vulnerable populations. Nevertheless, psychosocial factors have been found to interact with psychophysiological risk factors and antisocial behaviour exponentially increases when social and biological risk factors combine (Raine, 2002). In addition, shared environmental influences appear more pronounced in the association with child psychopathology among disadvantaged groups or in high risk contexts (Burt, 2009). Although investigating low risk populations is limited, understanding normal development can inform the understanding of atypical development, and vice versa (Cicchetti & Hinshaw, 2002).

A second limitation to this study, specifically in relation to Chapter 4, was the absence of physiological measurement of EC. Chapters 2 and 3 showed that physiology is an important and stable measure of individual differences in children's temperament. Also, the absence of an association between behavioural fear in infancy and behavioural guilt at age 3 suggests that the emerging ability to self regulate may be masking behavioural expressions in older children. Physiological measures were not included in Chapter 4 due to time constraints. Future research will aim to extend these findings by incorporating physiological measures of EC.

Furthermore, EC was measured by observing delay of gratification. It was discussed that this measure of EC may not be the best measure to examine early associations with fear and guilt. Association with EC and fear have been found from infancy in previous studies (Aksan & Kochanska, 2004; Kochanska & Knaack, 2003), and with guilt in older children (Kochanska, et al., 1996; Rothbart, et al., 1994), however our study failed to replicate these findings. It was suggested that future research may wish to examine EC with a wider range of tasks.

There is a number of limitations to this study which are addressed in order to understand the constraints of the findings, but also to make suggestions for future studies investigating the early development of inhibitory emotions. Throughout the thesis, fearful temperament was examined by solely investigating the stability and instability of fearfulness and fearlessness over the first 3 years of life. Measuring stability allows us to investigate the maintenance over time of individual differences within a sample. Typically, this approach uses correlational analysis in order to investigate relationships, as opposed to differences between variables. This approach allows us to assess the individual differences across the sample as a whole; however this fails to highlight potential patterns of individual differences within the sample. Another approach to investigating individual differences in early temperament is to examine the continuity and discontinuity of individual differences across time. Kagan and colleagues (Kagan, Reznick, Clarke, Snidman, & Garcia, 1984; Kagan, Reznick, & Snidman, 1987) identified a group of children as either inhibited or uninhibited at 21 months of age, finding that at age 4 the inhibited children were more socially inhibited with unfamiliar peers, compared to the children identified as uninhibited. By age 6, 40% of the inhibited children became less inhibited, whilst 10% of the uninhibited children became more inhibited with age. Kagan’s studies show that there is some continuity across the early years of life, but also some discontinuity in the extreme forms of temperamental inhibition across the early years of life. Another large study by Fox and colleagues (Fox, Henderson, Rubin, Calkins, & Schmidt, 2001) identified continuity and discontinuity across early childhood. They identified 10% of infants as inhibited, and over the 4 years more than a quarter remained inhibited, another quarter were no longer inhibited at 4 years of age, with the remaining showing no pattern over time. Within the uninhibited group, 60% of the children showed no pattern of continuity in inhibition, with few remaining uninhibited across the years. Within these groups subgroups were created looking at EEG activity, finding that frontal EEG asymmetry differentiated in those infants who would remain inhibited over the 4 years from those who would change in behaviour. Continuity and discontinuity highlights patterns of individual differences within a sample, however a large sample is required in order to have power in the subgroups. The approach used in the current study was appropriate for the modest sample size, however these findings highlight the potential patterns which may exist within our group that may account for modest correlations across years, where the majority of children show stability across years, there may also be a small number of children exhibiting extreme levels of fear that do not show stability. This may also highlight the inconsistencies between differences in stability across the parameters measured, where observed fear was found to be stable, yet physiological fear was heightened in year 2. It may be that children exhibiting extreme levels of fear have heightened physiological arousal which our analysis did not pick up.

Fear was measured in this study by examining multiple parameters of the child's response to a challenging situation, that is, by investigating endogenous factors, within the child (Fox, 2010). However we did not consider exogenous factors in the development of fear, which views temperament trajectories across childhood as a response to factors in the environment to which a child is exposed (Fox, 2010). Parenting was not a focus of investigation in this study; however it is recognised to play a role in the development of emotions. Fox and colleague's study (2001) also examined factors associated with change in inhibition over time, indicating that early childcare environments might be important in understanding the patterns of continuity and discontinuity in the expression of behavioural inhibition. Infants who were classified as inhibited at 4 months of age, but were placed in childcare during the first 2 years of life were more likely to change their behaviour than were similarly reactive infants who remained in the exclusive care of their parents. It was suggested that the children in childcare had more experience interacting with people outside of the family, making them more likely to interact with other infants and children which may have led to an increase in independence and a decrease in fearfulness. A number of studies have supported this finding, showing that inhibited infants who experienced less childcare were more likely to exhibit decreased inhibition over time (Arcus, Gardner, & Anderson, 1992; Belsky, Fish, & Isabella, 1991; Park, Belsky, Putnam, & Crnic, 1997). An earlier study indicated that even though temperament was stable from 12-24 months, infants who became less negative, more attentive, and more socially oriented had mothers who were more expressive and involved with them and came from families that were more emotionally cohesive (Matheny, 1986).

Future studies also need to incorporate parenting factors, as there is a lot of evidence to show that they play an important role in the development of emotion and psychopathology. Patterns of social relatedness in infancy can be characterised, in part, by the security of the infant-caregiver attachment relationship (Ainsworth, Blehar, Waters, & Wall 1978) and physiological stress responses have been found to be mediated by attachment security (Gunnar, Brodersen, Nachmias, Buss, & Rigatuso, 1996; Spangler & Schieche, 1998). Studies have found that maternal responsiveness, interactions, power-assertion and discipline, to name a few, play a role in the development of early temperament, including fear and effortful control, and guilt proneness (Kochanska et al., 2000; Kochanska & Knaack, 2003; Shaw 2003; Thompson, 2006; Wilson, Lengua, Tininenko, Taylor, & Trancik., 2009).

The role of the mother has also been found to influence arousal levels in infants during stress. Maternal physiology translates into behaviours that, in turn, influence the infant's physiology through affective matching (Feldman, 2007). It has been suggested that mothers who are better able to regulate their own stress reactivity may be more sensitive to subtle affective signals in their infants behaviour and able to respond with coordinated behaviours, such as gaze, touch, and soothing, which results in calming the infant's stress systems (Laurent, Ablow, & Measelle, 2012). Conversely, where mothers have difficulty regulating their own stress during infant interactions, the result may be insensitive or intrusive behavioural responses to their infant's signals of stress, leading to heightened infant stress (Laurent et al., 2012). Heightened infant-mother physiological attunement has been found in families characterised by maternal depression (Laurent, Ablow, &Measelle, 2011). A recent study (Laurent et al., 2012) found mother-infant attunement in the HPA stress system during an emotion task, and also during a Strange Situation paradigm (Ainsworth, Blehar, Waters, & Wall, 1978) when the dyads were separated. Previous findings have shown that stress associations are found even when the dyads are not in close proximity (Sethre-Hofstad, Stansbury, & Rice, 2002).This physiological attunement appears to be an interesting factor to consider when measuring infant stress response, as it suggests that parent variables may influence, and be influenced by, infant responsiveness.

It is recognised that the conclusions drawn from this study should be taken with some caution, as it is likely a combination of both endogenous and exogenous factors, or interactions between these factors affect the stability in behaviour over time. The narrow focus on inhibitory emotions and underlying physiology, although providing us with insights into the early development of fear, guilt and effortful control over the first few years of life, the conclusions are restricted as the focus is solely on the child. Caution should be taken on the interpretation of the stability over time, as it is likely that external factors to the child may also play a role in the early development, therefore indicating that stability is context dependent. These findings aim to highlight the early development of inhibitory emotions, however further research is needed to extend these findings.

Implications of findings

Biological risk factors for later psychopathology may also play a central role in identifying children who are at risk for maladaptive behaviour in later life. Identifying the precursors of disorder in the context of typical development can inform the implementation of effective prevention programmes and ultimately reduce the psychological and economic costs of aggressive and antisocial behaviour to society. These findings are an important step to this goal, as they identify a biomarker that may help to identify subgroups with a distinct neurobiological profile in infancy. Early aggression poses challenges to families, educators and health professionals and timely prevention efforts are therefore important. Elevated aggression at age 2 is a risk factor for the persistence of these problems through childhood (Côté, Vaillancourt, LeBlanc, Nagin, & Tremblay, 2006; NICHD Early Child Care Research Network, 2004). To date, preventative interventions conducted with children have paid little attention to psychophysiological risk factors in their evaluations of treatments (Cicchetti & Gunnar, 2008), however the scope for changing behaviour will be greatest in the early years because of the greater plasticity of the brain in childhood (Sterzer, 2010). These findings aim to enable the identification of vulnerable subgroups for early intervention.

In order to further test the role of physiology in the early development of inhibitory emotions, further examination of stress arousal across stress systems should be examined. As previously discussed, due to the dearth of studies investigating early temperament by including physiological measures, a range of physiological measures is very rarely examined. Recent findings suggest that the HPA and SNS respond differently to temperament dimensions (Laurent et al., 2012). Surgency predicted higher cortisol, whereas inhibitory control predicted lower SNS arousal, with similar patterns found in previous studies (e.g.

Fortunato, Dribin, Granger, & Buss, 2008; Stroud et al., 2009). Effects of HPA or SNS measure were specific to the stress episode that most activated the system, suggesting that temperament dimensions may be more or less relevant for physiological stress response depending on the task demands. In order to learn more about early infant stress responding, investigating a larger range of measures across stress systems would be insightful. The inclusion of a range of physiological measures could highlight stability in systems over time, but discontinuity in the responding to stress type or context (Fortunato, et al., 2008; Laurent et al., 2012; Stroud et al., 2009).

Research in the area of developmental psychopathology should not wait until children have developed emotional and behavioural problems. Between birth and toddler age, children develop the foundation for all social interactions. We have shown that fearful temperament is relatively stable and that children improve considerably in their ability to self regulate their emotions and behaviour. Furthermore, young children's expression of their emotions may play a significant role in the development of their social relationships with their family and peers. Numerous studies have shown that a toddler's problem behaviours or difficult temperament may affect their parents' disciplinary strategies as well as subsequent interactions with peers and other adults (Chess & Thomas, 1987; Lytton, 1990; Moffitt, 1993). Research on aggressive children has examined how interactions between children and their families can create aversive patterns of behaviour (Patterson & Bank, 1990). This may be a salient time to target families with children exhibiting extreme levels of emotions, lack of regulation, or maladaptive behaviour. During this stage in development, albeit very early on, aiding children to recognise, label, manage and communicate their emotions may enable them to build skills that connect them with their family and later with their peers and environment. These findings, in particular the stability of these temperament systems and the role of physiology, could be used in communication aimed at educating families and childcare practitioners.

For obvious reasons, there is very little research on the development of children's ability to cope with distressing situations in the absence of their mother. Although informative, there are many occasions, especially in the life of 2 and 3 year olds, which they will have to face novel and potentially stressful situations while their mother is not around. Our results show that 3 year olds still get quite distressed while being separated from their mothers. Mothers' ratings of their child's temperament were not a reliable measure of the child's internal state, neither were they able to predict their child's reaction to the novel toy, suggesting that mothers may benefit from information about children's internal states. It seems that more research should be conducted in order to understand how and at what age a child learns to cope with stress in the absence of their mothers. This can have important implications for informing policies of better transition into day care and other scenarios involving mother-child separation.

Identifying the precursors of disorder in the context of typical development can inform the implementation of effective prevention programmes and ultimately reduce the psychological and economic costs of problem behaviour to society. One way to intervene to reduce or eliminate maladaptive pathways is to promote resilience. The resilience associated with having good self-regulatory skills may be useful in the development of possible interventions. For example, Rothbart developed a training programme for preschool children to develop their executive attention skills, finding some improvements in attention related tasks (Rothbart & Rueda, 2005). Our findings indicate that age 2 to 3 is a particularly important time for the development of self regulation. The differences between boys and girls at this age, as well as the role of fear in the development of effortful control in toddlers may be crucial in the design of preventative interventions to enhance self regulatory abilities.

Summary

Similar developmental pathways to those identified in this study have been found in later life. Fearless individuals display low levels of ANS arousal to fear (Gao, et al., 2010a, 2010b; Quay, 1965; Raine, 1993), are seen to experience low levels of guilt (Kochanska, et al., 2002), poor emotion regulation and failing to inhibit prohibited behaviour (Olsen, Schilling & Bates, 1999). Fearful individuals display higher levels of physiological fear (Kagan et al., 1987, 1998), higher levels of self control (Kochanska et al., 2000) and higher levels of guilt (Kochanska et al., 2002). These profiles in normal healthy samples can extend into psychopathological patterns, with extremely fearful, over-regulated and guilt-prone children subsequently showing anxious and depressive tendencies (Biederman, et al., 1993; Biederman, Rosenbaum, Hirshfield, & Faraone, 1995; Zahn-Waxler, Kochanska, Krupnick & McKnew, 1990), and fearless and low guilt-prone individuals being at risk for developing callous and unemotional (i.e., psychopathic) personalities and exhibiting antisocial and aggressive behaviour (Blair, 1997). Early detection of more extreme variations in fear, guilt-proneness and effortful control in very young children may ultimately have implications for the prevention of both internalising and externalising disorders.

This thesis does not claim that any of the developmental pathways in infancy are fixed and will inevitably develop into more extreme profiles, or maladaptive behavioural problems. Children are resilient and continue to develop throughout their lives. However, we have shown that there is some degree of stability over time from infancy onward, and patterns identified in infancy have resembled maladaptive profiles seen in later childhood and adulthood. At the moment we do not know how to identify the children who are most at risk for later disorder during a time of considerable developmental transition. Early detection of more extreme variations in emotion systems is needed, and comparison with high risk samples to identify consistent patterns to later psychopathology. However, caution is needed in conducting this type of research, given concerns about the possible consequences of early labeling of young children (Brotman et al., 2009).

The findings from this thesis highlight the value of investigating emotion development from infancy, supporting the contention that developmental investigations into risk pathways for later psychopathology should not wait until middle childhood (Cicchetti & Toth, 2009).

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Appendix 1

Recruitment

leaflet

Emotions and Coping in Children

We would like to invite you and your child to take part in a study of children's emotions and early coping behaviour. This would take up about 1 hour of your time, and would involve a visit to a specially designed playroom in the School of Psychology on Park Place, in central Cardiff. We can arrange parking or pay your bus or taxi fare.

We would like to find out why some children are born with a more easy going temperament than others. Temperamental differences in children are generally seen from birth onwards but especially also when children start to crawl and explore their environments. You will probably know that some children approach new people or new toys quite readily, whereas others prefer to stay closely to their parent and take time before cautiously approaching or responding. The reason is that children differ in fearlessness. Children who are less fearful react less strongly to novel events, and are more prepared to approach new objects and take risks.

We are particularly interested in the development of fear and risk taking in 6-12 months old children. If you decide that you want to participate, we will video your child's behaviour and record his/her bodily responses while we present him/her with different objects. We measure sweat reaction by attaching two metal stickers to the sole of your child's foot.

We also want to collect some saliva from your child. Some children are less likely than others to produce certain hormones that help them deal with new situations. We can measure that from their saliva.

In the session we will record your child's reaction to calming music, to novel sounds and to a robot toy, that slowly approaches your child.

To show our appreciation for your participation, we will give your child a present and give you a £10 gift voucher. In addition, we will pay for your travel to and from the School of Psychology.

For further details, you may ring the project coordinator at Cardiff University on 029 20 876191.
Thank you for taking the time to read this information sheet. We hope that you will be able to help us.

CARDIFF UNIVERSITY PRIFYSGOL CAERDYDD

Appendix 2

Coding sheet for child behavioural distress (Lab-TAB)

Unpredictable Toy Scoring

EC: 1, 2

Subject#_____________ Scorer___________
Subject Name_________ Date Scored______
Visit 1 or 2 Tape#_____ Episode Order_____
Counter#________ Experimenter Code____
DOB_____ DOV_________

Latency to fear Response
T1______s
T2______s
T3______s

Latency to sadness response
T1_____s
T2_____s
T3_____s

	Trial 1				Trial 2			
Time Begin/End				avg.				avg.
Intensity of facial fear (0-3)								
Intensity of facial sadness (0-3)								
Intensity of vocal distress (0-5)								
Intensity of bodily fear (0-3)								
Presence of startle response 0=yes 1=0								
Intensity of escape behavior (0-3)								

Continues to next page

	Trial 3			
Time Begin/End				Avg.
Intensity of facial fear (0-3)				
Intensity of facial sadness (0-3)				
Intensity of vocal distress (0-5)				
Presence of startle response 0=yes 1=0				
Intensity of escape behaviour (0-3)				

Appendix 3

Coding sheet for mishap paradigm

	5 sec	10 sec	15 sec	20sec	25sec	30sec	**Mean**
Avoiding gaze (0-3)							
Bodily tension (0-3) SCORE:							
facial							
posture							
discomfort							
intense							
Facial distress (0-3) SCORE:							
eyes							
eyebrows							
mouth							
intense							
Vocal distress (0-2)							
Attempt to fix Y =1, N =0							
Seeking support (EC/PC)							