An Investigation of Future-Oriented Thinking in Middle Childhood

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Declaration

This thesis contains no material that has been extracted in whole or in part from a thesis that I have submitted towards the award of any other degree or diploma in any other tertiary institution. No other person's work has been used without due acknowledgment in the main text of the thesis. All research procedures reported in the thesis received the approval of the relevant Ethics Committees (where required).

Signed [redacted] ....

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Abstract

The overall aim of the current thesis was to explore three key components of future-oriented thinking, namely episodic future thinking (EFT), episodic foresight, and prospective memory (PM), in middle childhood. The developmental literature examining each of these future-oriented abilities has generally focused on their emergence in the preschool years, with less known about how these abilities present in middle childhood. In addition, research investigating what cognitive mechanisms may drive these abilities in this age band is limited and findings of those studies that have been conducted are inconsistent. Lastly, the literature has predominantly examined EFT, episodic foresight, and PM in isolation, and research has only just begun to explore interrelations between these future-oriented constructs. The first empirical study therefore aimed to investigate whether EFT ability was associated with age and to examine what cognitive mechanisms may contribute to this skill. The second empirical study aimed to examine, for the first time, whether episodic foresight was associated with age across middle childhood. A second aim of this study was to provide the first investigation of the cognitive mechanisms that may contribute to episodic foresight in this age group, with the particular interest in whether EFT contributed to episodic foresight. The final empirical study aimed to explore whether age was associated with children's PM performance across event-based and time-based PM tasks. An additional aim of this study was to explore the cognitive abilities that contribute to children's performance on both event-based and time-based PM tasks, with a particular interest in the contribution of EFT.

A single sample of 80 children aged 8 to 12 years were recruited for this research project. Study 1 indicated greater EFT ability was associated with age, consistent with some of the limited studies previously conducted with this age group. Study 1 also demonstrated strong

evidence regarding the contribution from episodic memory to children's EFT and a lack of contribution from executive functions. Study 2 was the first study to examine episodic foresight beyond the preschool years. Results of this study provided the first evidence of an association between age and better episodic foresight performance across the ages of 8 to 12 years. In addition, Study 2 identified age and IQ as significant contributors to successful episodic foresight performance, while retrospective memory, executive functions, and EFT were not found to contribute. The lack of contribution from EFT may have been due to the specific form of episodic foresight task used in this study, which did not require a specific scenario to be envisaged. Further research is now required to investigate whether EFT contributes to other types of episodic foresight task that involve clear scenarios that can be envisaged. The results of Study 3 indicated age was significantly correlated with performance on both event-based and time-based PM tasks. The findings also clearly revealed age, retrospective memory, and EFT were significant contributors to event-based PM performance, while retrospective memory was the only significant contributor to time-based PM performance. Furthermore, the results clearly demonstrated a lack of contribution from executive functions to performance on both task types. Importantly, Study 3 demonstrated that EFT selectively contributed to children's event-based PM performance. This finding is consistent with the only other study in this age band and used a more comprehensive set of predictors than this previous study.

The current research provided novel insights into the profile of children's future-oriented thinking across the middle childhood period. The findings regarding age-related improvements in EFT, episodic foresight, and PM help to bridge the gap in understanding of the development of these abilities between their emergence in the preschool years and their presentation later in development. Longitudinal research that extends from early childhood to adulthood is now needed to provide a thorough understanding of the developmental trajectory of these abilities across the lifespan. In addition, the current research revealed a clear pattern of results regarding the cognitive mechanisms that contribute to each of these abilities, providing some clarity to the previously mixed findings in the children's future oriented-thinking literature. Results regarding the inter-relationships between the future-oriented constructs also provided an important extension to current understanding of future-oriented thinking as a broader taxonomy. Furthermore, the current findings bring attention to the need for further theoretical distinction between different forms of episodic foresight and the cognitive processes that contribute to this skill. Overall, the findings from the current thesis have important implications for children's daily living. In particular, greater understanding of future-oriented thinking in the middle childhood period gained from this thesis may assist in fostering the development of these abilities early in life. This in turn will enable parents and teachers to create reasonable expectations regarding children's capacity to use these skills in their everyday functioning, thereby maximising success and minimising failure.

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List of Abbreviations

AI	Adapted Autobiographical Interview
D-KEFS	Delis-Kaplan Executive Functioning System
EFT	Episodic Future Thinking
FSIQ	Full Scale IQ
PRI	Perceptual Reasoning Index
PM	Prospective Memory
VCI	Verbal Comprehension Index
VW-Foresight	Virtual Week-Foresight
VW-PM	Virtual Week-Prospective Memory
WASI-II	Wechsler Abbreviated Scale of Intelligence, Second Edition
WISC-V	Wechsler Intelligence Scale for Children, Fifth Edition

Chapter 1: Introduction and Thesis Outline

1.1 Background to Future-Oriented Thinking in Children

Over the past decade, the general capacity to mentally envisage future events has gained much attention in the literature (Szpunar et al., 2014, 2016). Encompassing a range of abilities, future-oriented thinking has been argued to be an important part of daily living, serving various functions vital for adaptive behaviour and functional independence (Baumeister et al., 2016; Henry et al., 2014; Hering et al., 2018; Kvavilashvili & Rummel, 2020; Schacter, 2012; Suddendorf, 2006, 2017). Recently, it has been posited that future-oriented thinking may be organised into several interrelated modes that draw attention to both the conceptual similarities and distinctions between these constructs (Szpunar et al., 2014, 2016). The research presented in this thesis investigates three key components of future-oriented thinking, namely episodic future thinking (EFT), episodic foresight, and prospective memory (PM), and how each of these constructs present in the middle childhood period.

EFT refers to the capacity to imagine oneself pre-experiencing future events in imagination (Addis et al., 2008; Atance & O'Neill, 2001). For example, imagining yourself experiencing your holiday next month. Research examining children's EFT has predominately focused on the development of this skill in the preschool years (Atance, 2008; Atance & Jackson, 2009; Atance & Meltzoff, 2005, 2006; Atance & Metcalf, 2013; Atance & O'Neill, 2005a; Busby Grant & Suddendorf, 2010; Busby & Suddendorf, 2005; Quon & Atance, 2010), with fewer studies exploring its development later in childhood. In recent years, researchers have emphasised the adaptive role of future-oriented thinking, as it enables behavioural flexibility and allows us to take steps in the present in order to achieve desired future outcomes (Suddendorf, 2006; Suddendorf & Corballis, 2007; Suddendorf & Moore, 2011). This skill is referred to as episodic foresight, and has been defined as the ability to imagine future events and use those experiences to guide behaviour in the present (Suddendorf & Moore, 2011). For example, imagining yourself getting sunburnt on a hiking trip prompts you to pack sunscreen before you leave in the morning. Developmental research investigating episodic foresight is limited to identifying the emergence of this skill in young children (Atance et al., 2015; Atance & Sommerville, 2014; Boden et al., 2017; Moffett et al., 2018; Prabhakar & Hudson, 2014; Redshaw & Suddendorf, 2013; Suddendorf et al., 2011; Suddendorf & Redshaw, 2013). It therefore remains unclear how episodic foresight presents in older children. The final component of future-oriented thinking that this thesis will focus on is PM, which refers to the capacity to remember to complete a planned action at a particular moment in the future, such as remembering to call the dentist at 2 o'clock or to pick up dry cleaning after work (Einstein & McDaniel, 1990; Ellis & Kvavilashvili, 2000). PM is an area that has been the focus of research for longer than EFT and episodic foresight, particularly in the context of aging (for a meta-analysis see Henry et al., 2004). While research investigating children's PM performance has rapidly gained attention, the picture detailing development of this skill from early childhood until adolescence is still relatively unclear (Kvavilashvili et al., 2008; Mahy, Kliegel, et al., 2014; Mahy et al., 2018). Overall, there is a clear gap in the literature examining each of these future-oriented abilities in the middle childhood period that warrants further investigation.

In addition to identifying how these abilities develop in children, it has been highlighted that these future-oriented constructs are complex and therefore likely to be underpinned by other cognitive processes (Szpunar et al., 2014). While a number of potential contributors have been suggested in the literature, such as memory (Einstein & McDaniel, 1990; Schacter et al., 2007; Suddendorf & Corballis, 1997, 2007) and executive functions (D'Argembeau et al., 2010; Mahy, Moses, et al., 2014a; Schacter & Addis, 2007a; Suddendorf & Corballis, 2007; Suddendorf & Redshaw, 2013), research investigating the contribution of these cognitive abilities to children's future-oriented thinking is very limited and findings are inconsistent. Furthermore, while it has been suggested that the different future-oriented abilities may be interrelated, this has only recently begun to be empirically examined (e.g. Terrett et al., 2019; Terrett, Rose, et al., 2016). Exploration of the relationships between these constructs is potentially crucial for understanding the basic mechanisms of future-oriented thinking, and therefore remains an important gap in the literature that requires further investigation.

Middle childhood has been noted as a particularly valuable period to examine future-oriented thinking (Cottini et al., 2018; Coughlin et al., 2019) and will be the focus of this thesis. This important developmental period is characterised by increasing independence (Sanders, 1985), increasing use of more complex learning and problem solving strategies (Bjorklund & Rosenblum, 2000), and improvements in cognitive processes such as episodic memory (Picard et al., 2009; Piolino et al., 2007) and executive functions (Best & Miller, 2010). It is therefore surprising that little attention has been given to future-oriented thinking in this age group, as these abilities are thought to be associated with the development of independence, behavioural flexibility, and goal attainment (Causey

& Bjorklund, 2014; Henry et al., 2014; Kvavilashvili et al., 2008; Suddendorf, 2006, 2017). Development of these skills in the middle childhood years also becomes an important factor for later successful daily living, as the end of this period marks the transition to secondary school and increasing demands for functional independence in adolescence. Identifying how EFT, episodic foresight, and PM present in middle childhood, in addition to what may underpin these constructs, is therefore necessary for understanding what factors contribute to successful daily functioning, such that children's development of these abilities may be fostered early in life.

1.2 Objectives of the Research Project

The main objective of this research project was to examine future-oriented thinking in middle childhood, with a specific focus on EFT, episodic foresight, and PM. Three empirical studies were conducted to address research questions related to each of these constructs in children aged 8 to 12 years. These studies have been written as three separate chapters in the current thesis (Chapters 4, 5, and 6).

1.2.1 Study 1

Research investigating EFT in the middle childhood period is limited and findings regarding age-related improvements are inconsistent (Coughlin et al., 2014; Coughlin et al., 2019; Gott & Lah, 2014; Terrett et al., 2019; Wang et al., 2014). Furthermore, few studies have investigated the cognitive processes that may be associated with EFT in this age band. The aims of Study 1 therefore were:

- To examine whether EFT was associated with age across the ages of 8 to 12 years.

- To examine the cognitive abilities that may underpin EFT in this age band, with a specific focus on examining the contribution of episodic memory and executive functions.

1.2.2 Study 2

As previously noted, research investigating episodic foresight has only just begun to emerge and research in children has been limited to the preschool period. It therefore remains unclear how this ability continues to develop and what cognitive abilities may drive episodic foresight performance in middle childhood. As such, Study 2 aimed:

- To examine whether episodic foresight was associated with age in the middle childhood period, using a novel behavioural measure, Virtual Week-Foresight.
- To investigate what cognitive abilities contribute to successful episodic foresight performance in this age band, including retrospective memory and executive functions. A key aspect of this second aim was also to examine, for the first time, whether EFT contributed to children's episodic foresight performance.

1.2.3 Study 3

The final empirical study, Study 3, focused on investigating PM in 8 to 12 year old children. A key aspect of this study was to investigate children's performance on two types of PM task, event-based and time-based, which is a longstanding primary task distinction in the broader PM literature. To date, findings regarding age-related improvements in children's performance across the two types of PM task are inconsistent in the middle childhood period. Furthermore, understanding of what cognitive abilities contribute to children's successful performance on the different types of PM task remains unclear as previous investigations have produced inconsistent findings. The aims of Study 3 therefore were:

- To examine whether children's performance on event-based and time-based PM tasks was associated with age across middle childhood, using a reliable measure, Virtual Week-Prospective Memory.
- To examine what cognitive abilities may be implicated in children's PM performance across the two types of PM task, including retrospective memory and executive functions. Study 3 also aimed to examine the contribution of EFT to children's PM performance on both event-based and time-based PM tasks.

1.3 Thesis Structure

This thesis comprises seven chapters. This chapter (Chapter 1) provides an introduction to future-oriented thinking and the aims and objectives of the overall research project. Chapter 2 provides a review of the literature investigating EFT, episodic foresight, and PM, including their definitions, assessment, and cognitive abilities proposed to underpin each of these constructs. This review will include identifying the current gaps in the literature investigating these abilities in middle childhood. A detailed description of the methodology used in the current research project will then be provided in Chapter 3. This includes participant recruitment, sample characteristics, and measures used in the three empirical studies. Following this, Chapters 4, 5, and 6 present the three empirical studies of the research project. These chapters are written as three standalone studies that have been prepared for journal submission, which necessarily requires some repetition of information presented in earlier chapters. These chapters address research questions related to each of the future-oriented constructs. Chapter 4 reports the first empirical study, investigating EFT and the cognitive abilities that contribute to this skill in children. Chapter 5 then presents an investigation of episodic foresight and the possible cognitive processes that underpin this construct. The final empirical study is reported in Chapter 6, and presents an investigation of PM and proposed contributors to children's PM performance. Lastly, Chapter 7 concludes with a general discussion of the findings of the research project as a whole, including the implications of these findings, limitations and strengths of the project, and suggested future directions.

Chapter 2: A Review of Episodic Future Thinking, Episodic Foresight, and Prospective Memory in Middle Childhood

Preamble

This chapter reviews the existing literature exploring EFT, episodic foresight, and PM in children. This chapter will critically analyse the research investigating the development of each of these abilities and the methods of assessment used to measure each of these constructs in children. In addition, this chapter will review the potential cognitive abilities suggested to underpin EFT, episodic foresight, and PM. Lastly, this chapter will identify the current gaps in the literature which will provide a foundation for the subsequent investigation of a comprehensive profile of future-oriented thinking in middle childhood reported in this thesis.

2.1 Mental Time Travel and Episodic Future Thinking

Humans have the unique capacity to mentally experience personal events across different temporal periods (Suddendorf et al., 2009; Tulving, 2005). For many years research on such mental time travel has focused on episodic memory, the ability to re-experience past personal events, however, researchers have begun to investigate the ability to pre-experience personal future events (Suddendorf & Corballis, 2007; Tulving, 2005). This ability is referred to as episodic future thinking (EFT) and involves engaging in complex mental construction in order to pre-experience future events in imagination (Addis et al., 2008; Atance & O'Neill, 2001), for example, imagining yourself experiencing your birthday party next month or giving a presentation at work next week.

EFT has been suggested to require autonoetic consciousness, which refers to the awareness of one's existence through subjective time (Szpunar, 2010; Tulving, 1985; Wheeler et al., 1997). The involvement of autonoetic consciousness distinguishes EFT from semantic future thinking, which refers to general knowledge of future events (e.g. imagining where the next Olympic Games will be held; Atance & O'Neill, 2001; Atance & O'Neill, 2005a; Tulving, 1985). In contrast to EFT, semantic future thinking requires noetic consciousness, which is a sense of knowing general information without pre-experiencing personal events (Szpunar, 2010; Tulving, 1985; Wheeler et al., 1997). Autonoetic consciousness is therefore considered to be the hallmark of EFT, as it allows an individual to engage in mental time travel that leads to a sense of pre-experiencing personal future events (Suddendorf & Corballis, 2007; Tulving, 2002).

Another key element of EFT is that it involves imagining a future scenario that is both plausible and relevant to an individual's own personal future (Szpunar, 2010). Indeed, Szpunar (2010) notes that the relevance or plausibility of these imagined scenarios is what distinguishes EFT from broader conceptualisations of imagination such as daydreaming. Furthermore, thoughts about plausible future scenarios in everyday life are quite diverse and serve a variety of functions, ranging from everyday plans for the future, such as imagining what you will have for dinner tonight, to more complex scenarios, such as imagining yourself in your next job interview (Atance, 2008; D'Argembeau et al., 2011). EFT may therefore be considered a highly valuable ability in daily life that enables behavioural flexibility (Suddendorf, 2006, 2017; Suddendorf & Corballis, 1997, 2007). Lastly, research has found EFT to be implicated in other forms of future-oriented thinking, such as prospective memory (Mioni, Bertucci, et al., 2017; Nigro et al., 2014; Terrett et al., 2019; Terrett, Rose, et al., 2016). EFT may therefore be argued to be an important foundational ability for future-oriented thinking generally.

2.1.1 Development of Episodic Future Thinking

Most research examining EFT in children has focused on the preschool years and has typically examined children's mental time travel into both the past and the future. These studies suggest that children begin to develop EFT ability at approximately 4 years of age (Atance, 2008; Atance & Jackson, 2009; Atance & Meltzoff, 2005, 2006; Atance & Metcalf, 2013; Atance & O'Neill, 2005a; Busby Grant & Suddendorf, 2010; Busby & Suddendorf, 2005; Quon & Atance, 2010). For example, Busby and Suddendorf (2005) and Atance and Jackson (2009) asked 3 and 4 year olds to describe their activities from the previous day (episodic memory) and what they would be doing tomorrow (EFT), and then asked parents to confirm the accuracy of their child's response. 4 year old children could correctly remember events they had experienced yesterday and describe events they would be experiencing tomorrow, however while 3 year old children could provide event descriptions, these were often found to be incorrect. In another study, Quon and Atance (2010) asked children to report their past and future experiences on eight specific events (e.g. 'what did you do at bedtime last night?'; 'what are you going to do at play time tomorrow?'). In this study, 5 year olds were found to produce more accurate responses (as verified by their parents) regarding their specific future experiences than 3 and 4 year olds. However, it should be noted that some studies have found no difference between 3 and 5 year olds' EFT abilities (Hayne et al., 2011; Richmond & Pan, 2013). Nevertheless, the majority of studies have found EFT ability to be continuing to improve across the preschool years.

Relatively little research has investigated EFT in older children, especially in the middle childhood period (Coughlin et al., 2014; Coughlin et al., 2019; Mahy & Atance, 2016). This is surprising given that as previously noted, EFT has been suggested to be important for numerous tasks critical to daily life. Studies that have examined EFT in middle childhood have found mixed evidence regarding developmental changes in this age band (Coughlin et al., 2014; Coughlin et al., 2019; Gott & Lah, 2014; Terrett et al., 2019; Wang et al., 2014). For instance, using an interview format measure that asked participants to identify and describe personal future events, Coughlin et al. (2014) found significant improvements in children's EFT abilities from 5 to 9 years of age, however the performances between 5 and 7 year olds, and between 7 and 9 year olds, were not significantly different. Gott and Lah (2014) also examined this ability in 8 to 10 and 14 to 16 year olds, finding the adolescent group was able to describe future events in significantly more detail than the younger group. More recently, Coughlin et al. (2019)

found significant improvements with age when comparing 5, 7, 9, and 11 year olds' ability to generate episode details when describing future events. Furthermore, 5, 7, and 9 year olds required significantly more prompts when generating future events compared to 11 year olds (Coughlin et al., 2019). In contrast, however, Wang et al. (2014) found no evidence of age-related differences in the amount of episodic details produced by 7 to 10 year old children when describing future events, and Terrett et al. (2019) found EFT ability was not correlated with age in a group of 8 to 12 year olds. Overall, while together these limited findings suggest that the developmental trajectory of EFT in middle childhood may remain relatively stable, with improvements possibly not occurring until adolescence, the paucity and mixed outcomes of research indicates that further investigation of this ability in this age group is warranted.

2.1.2 Assessment of Episodic Future Thinking

Accurate assessment of EFT is challenging, especially when examining the development of this skill in children. In particular, it is difficult to distinguish whether children's descriptions of future events may be attributed to EFT or whether they are simply drawing upon their general knowledge of what an upcoming event will be like, which as previously noted, refers to semantic future thinking (Atance & O'Neill, 2001). Indeed, it has been suggested that it is possible to have conceptual knowledge about the future without generating a specific personal representation of that future scenario (D'Argembeau et al., 2011). For example, imagining going to the beach and describing bringing a towel and sunscreen is different to imagining yourself being at the beach on a hot and sunny day and, imagining feeling how hot it is, you envisage yourself putting up an umbrella for shade. The former draws on general facts about what one usually takes to the beach and represents semantic future thinking, while the latter describes a specific and personal scenario that one could imagine experiencing, reflecting EFT. An important component of measures developed to assess EFT has therefore been to distinguish EFT from semantic knowledge based scripts.

In order to examine EFT abilities in children, researchers have primarily employed tasks that require children to verbally describe future events, for example, asking children to report their activities from the previous day and those they would do the following day (Busby & Suddendorf, 2005). However, it has been argued that in order to measure EFT, participants should be required to describe experiencing an event they have not experienced before, as this involves generating a personal representation of that scenario, and cannot be achieved by relying solely on semantic details and general knowledge about what a future event would be like (Atance & O'Neill, 2005a). Tasks that measure EFT through verbal description of novel future experiences have therefore been said to produce a more accurate representation of children's EFT ability, as this arguably prevents participants from relying on semantic script based information (Hayne et al., 2011). It should be noted, however, that using verbal tasks with young children is problematic, as language and conceptual understanding of temporal terms (e.g. past and future) develops considerably between 3 to 7 years of age (Atance, 2008; Busby Grant & Suddendorf, 2010; Suddendorf, 2010a). Verbal measures may therefore be more appropriate for children over 7 years, as these abilities are considered to reasonably established by this age (Busby & Suddendorf, 2005).

One verbal measure of EFT is the Autobiographical Interview (AI), first developed by Levine et al. (2002) and adapted by Addis et al. (2008) to examine EFT in older adults. Frequently used in the literature (for reviews see Miloyan, McFarlane, & Vasquez-

Echeverria, 2019; Miloyan & McFarlane, 2019), the AI requires participants to describe their experiences of past personal events and novel future events. The benefit of the AI is that the scoring allows separation of episodic knowledge of the future from other types of details (including semantic details). This is done by categorising content provided by participants into internal details (personal to the event) and external details (semantic details as well as other types of details unrelated to the event) so that EFT ability may be isolated. One study by Terrett et al. (2013) adapted the AI to investigate EFT abilities in 8 to 12 year old children with autism spectrum disorder and typically developing children. This measure was able to distinguish between the groups on EFT ability, as well as each group's ability to produce past versus future episodic details (Terrett et al., 2013). More recently, it has also been used to identify the role of EFT in other future-oriented abilities in typically developing children in this age band (Terrett et al., 2019). Given these findings, the AI may therefore be considered a valuable measure for further investigation of children's EFT ability.

2.2 Cognitive Abilities Underpinning Episodic Future Thinking

The literature examining EFT often focuses on the development of this ability. However, another key question relates to the cognitive mechanisms that might underpin EFT in children. Research has cited a number of potential contributors, such as episodic memory (Schacter et al., 2007; Suddendorf, 2010b), executive functions (D'Argembeau et al., 2010; Schacter & Addis, 2007a; Suddendorf & Corballis, 1997, 2007), semantic memory (Irish, 2016; Irish & Piguet, 2013), relational processing (Richmond & Pan, 2013; Wiebels et al., 2020), and theory of mind (Buckner & Carroll, 2007; Suddendorf & Corballis, 2007). The majority of recent empirical research has focused on investigating the role of episodic memory and executive functions in EFT. However, to date little is understood about the association between these underlying cognitive mechanisms and EFT in the middle childhood years.

2.2.1 Episodic Memory

Episodic memory refers to the ability to remember personal past experiences and mentally travel through time to re-experience those events (Tulving, 1972). Researchers have proposed that episodic memory has an important role in the anticipation of the future (Buckner & Carroll, 2007; Schacter et al., 2007; Suddendorf & Corballis, 1997, 2007; Tulving, 2005). The primary theory supporting the role of episodic memory in the construction of future events is the constructive episodic simulation hypothesis (Schacter & Addis, 2007a). According to this theory, the capacity to imagine and anticipate future events requires us to retrieve relevant information from our personal past memories which we then flexibly use to construct novel and plausible future events in imagination (Addis et al., 2008; Schacter & Addis, 2007a; Schacter et al., 2007; Schacter et al., 2017). Researchers have also suggested that episodic memory and EFT may rely on the same broader underlying processes, as postulated in the self-projection and scene construction theories (Buckner & Carroll, 2007; Hassabis & Maguire, 2007, 2009). However, to date, the constructive episodic simulation hypothesis remains the most prominent theory in the literature.

Support for an association between episodic memory and EFT has predominately been found in neuroimaging studies which have identified a core brain network that is activated when remembering events from the past and when imagining events in the future. This network includes prefrontal regions, the medial temporal lobe, posterior regions, and the hippocampal area (for reviews see Miloyan, McFarlane, & Suddendorf, 2019; Schacter et al., 2012; Weiler et al., 2010). Recent findings also indicate that activation of specific areas of this network involved in particular future simulation processes, such as the amount of simulated information required and time frame, are parallel to those activated when accessing episodic memory (Thakral et al., 2017). In children and adolescents, level of functional connectivity and local cortical expansion within this network has been found to be associated with the quality of past experiences recalled and future events imagined (Ostby et al., 2012). In adults, studies have found concurrent declines in both episodic memory and EFT with healthy aging (Addis et al., 2008; Gaesser et al., 2011; Madore et al., 2014; Schacter et al., 2013). Furthermore, clinical populations with episodic memory impairment have been found to also have difficulties constructing personal future events and making predictions about the future (Addis et al., 2009; Buckner & Carroll, 2007; D'Argembeau et al., 2008; El Haj et al., 2015; Gamboz et al., 2010; Hassabis et al., 2007; Klein et al., 2002; Levine et al., 1998; Rasmussen et al., 2017; Rasmussen & Berntsen, 2018; Schacter & Addis, 2007a; Tulving, 1985, 2002).

Developmental studies have noted that EFT and episodic memory both emerge at around 4 years of age (Addis et al., 2008; Atance & Meltzoff, 2005; Coughlin et al., 2014), further suggesting that children’s capacity for EFT may be associated with their episodic memory (Coughlin et al., 2014; Naito et al., 2020; Naito & Suzuki, 2011; Payne et al., 2015; Suddendorf, 2010a; Unal & Hohenberger, 2017). In addition, EFT ability in preschool children has been found to be limited by their episodic memory performance (Prabhakar & Ghetti, 2019; Prabhakar & Hudson, 2019). While the literature indicates that episodic memory continues to develop in middle childhood (Coughlin et al., 2014; Ghetti et al., 2011; Picard et al., 2009; Piolino et al., 2007), research investigating direct associations between EFT and episodic memory in this age group is still limited. In one of the few studies in this area, Coughlin et al. (2014) measured episodic memory and EFT abilities in children aged 5, 7, and 9 years by assessing their capacity to provide detailed descriptions of past and future events. They found that children's capacity to produce episodic details when describing past events continued to improve throughout middle childhood. Furthermore, individual differences in the amount of episodic details participants produced for past events (i.e. episodic memory ability) predicted the amount they produced for future events (i.e. their EFT ability). Coughlin et al. (2019) found similar results in 5 to 11 year olds, with episodic memory the most robust predictor of children's EFT, even after controlling for age-related improvements. Together these findings provide some indication that episodic memory continues to have a role in EFT ability in the middle childhood years. However, given the extremely limited number of studies conducted, further empirical investigation is required.

2.2.2 Executive Functions

As previously noted, EFT has been argued to rely not only on memory for the past, but also on executive functions. Executive functions have been suggested to help initiate, organise, and monitor the retrieval of appropriate information from long term memory, and assist in the flexible combination of disparate information in order to construct future events in imagination (D'Argembeau et al., 2010; Schacter & Addis, 2007a; Suddendorf & Corballis, 1997, 2007). Surprisingly however, few empirical studies have examined the relationship between executive functions and EFT in children.

While executive functions include a number of complex cognitive processes (Best & Miller, 2010), the literature has predominantly utilised the three function model proposed by Miyake et al. (2000) when investigating the role of executive functions in imagining future scenarios. Miyake and colleagues' model of executive functioning comprises working memory, cognitive flexibility, and inhibition. Working memory has been argued to play an important part in future-oriented thought by providing the space within which future scenarios are formed (Suddendorf, 2017; Suddendorf & Corballis, 2007; Suddendorf & Redshaw, 2013). An individual then must flexibly combine different elements of past experiences to simulate plausible future scenarios (Schacter & Addis, 2007a; Schacter et al., 2007). Inhibition has also been argued to contribute, as an individual must inhibit the retrieval of irrelevant past events from episodic memory to maximise the use of relevant past details in order to generate an accurate prediction of the future (Suddendorf, 2010b). In addition, D'Argembeau et al. (2010) propose that executive functions may be necessary not only for the retrieval of autobiographical information, but also for the search and selection of the most appropriate spatiotemporal context within which hypothetical future events are simulated. Support for these claims is provided by research with adults which found EFT placed the greatest demands on executive functioning (as indexed by verbal fluency) compared to other predictors, such as visual-spatial processing (D'Argembeau et al., 2010), as well as other studies which found an association between executive functions and EFT (Cole et al., 2013; de Vito et al., 2012; Mercuri et al., 2018). However, it should be noted that numerous studies have found no association between certain executive functions and EFT in a range of adult populations (Addis et al., 2008; Brown et al., 2014; Irish et al., 2013; Mercuri et al., 2015; Mercuri et al., 2018), thereby limiting the current conclusions that can be made regarding this relationship.

The literature investigating the relationship between executive functions and EFT in children is limited and current findings are inconsistent. For example, Atance and Jackson (2009) found 3 to 5 year olds' EFT was related to their planning abilities, while Hanson et al. (2014) and Unal and Hohenberger (2017) found no association between 3 to 5 year olds' EFT ability and a range of executive function measures. Gott and Lah (2014), however, found 8 to 10 and 14 to 16 year old children's EFT ability was associated with their working memory, possibly suggesting a relationship may not occur until later in childhood. In contrast however, two studies found no association between EFT ability, measured using the AI, and cognitive flexibility among 8 to 12 year old typically developing children (Terrett et al., 2019) and children with autism spectrum disorder (Terrett et al., 2013). Consequently, while executive functions have been proposed to be potential contributors to EFT, it is currently difficult to draw conclusions given the limited research and inconsistent findings of studies directly investigating a relationship between these abilities in children.

2.3 Episodic Foresight

Researchers have proposed that the evolutionary purpose of mental time travel to pre-experience future personal events is to increase behavioural flexibility, allowing one to act in the present in order to increase chances of future survival (Suddendorf & Busby, 2005; Suddendorf & Corballis, 2007). This has been labelled episodic foresight, and has been defined as the ability to imagine future events and use those experiences to guide behaviour in the present (Suddendorf & Moore, 2011). For example, in the morning you see the weather forecast which indicates that rain is expected later in the day. Upon imagining yourself walking home from work possibly getting caught in the rain, you decide to pack an umbrella before you leave for work to avoid getting wet later. When engaging in episodic foresight, it appears necessary to engage in EFT but then move a step beyond this and identify any future needs. Having established those future needs, episodic foresight then entails flexibly considering taking action in the present to ensure those future needs are met, without having to experience real life consequences (Suddendorf, 2006; Suddendorf & Moore, 2011; Szpunar, 2010). This highly valuable ability allows us to take advantage of opportunities to achieve desired outcomes while avoiding future problems (Atance, 2008; Suddendorf, 2017). In this regard, episodic foresight has been suggested to be an important adaptive cognitive ability necessary for successful daily living (Suddendorf, 2006, 2017).

2.3.1 Development of Episodic Foresight

Children have been shown to have an emerging capacity to engage in episodic foresight at 4 to 5 years of age (Atance et al., 2015; Atance & Sommerville, 2014; Moffett et al., 2018; Prabhakar & Hudson, 2014; Redshaw & Suddendorf, 2013; Suddendorf & Busby, 2005; Suddendorf et al., 2011; Suddendorf & Redshaw, 2013). Studies have shown that 4 year old children are capable of securing the solution to a future problem by connecting their past experience of that problem with their anticipated experience of future events (Boden et al., 2017; Redshaw & Suddendorf, 2013; Suddendorf et al., 2011). For example, Redshaw and Suddendorf (2013) presented children with a box containing a hidden toy that they could not open as they did not have the correct key to unlock it. Upon moving to another room, children were presented with a number of options of items (one being the correct key) that they could choose to bring to the first room. Findings indicated that 4 year olds could accurately pick the correct key above chance, suggesting that they were able to remember the problem previously encountered and obtain a solution in the present in expectation of returning to the problem later on (Redshaw & Suddendorf, 2013). Examining emerging episodic foresight abilities in young children, Redshaw, Leamy, et al. (2018) found 2.5 year old children were significantly worse at preparing for uncertain events compared to certain events. By 4 years of age however, children have been shown to be able to prepare for at least two potential outcomes in the immediate future (Redshaw & Suddendorf, 2016). In addition, it is only by 5 years of age that children accurately sequence a number of steps in order to solve a problem in the future (Martin-Ordas, 2018). It should be noted that while some studies have found 3 years olds to be capable of successfully completing episodic foresight tasks (Payne et al., 2015; Scarf et al., 2013), Atance (2018) notes that these studies varied in the nature of the tasks given to the children, such as the amount of information provided, which may have assisted them in correctly completing the task, thereby limiting definitive conclusions about the extent to which episodic foresight has developed by 3 years of age.

Researchers have proposed that children's ability to prepare for future needs continues to develop across childhood and adolescence (Suddendorf, 2017; Suddendorf & Redshaw, 2013). However, at present, no studies have explored the pattern of episodic foresight development beyond 5 years of age. This is surprising, given the practical implications of episodic foresight. For example, it has been argued that episodic foresight may increase children's motivation to perform academic behaviours that will benefit them in the future by increasing their connection with their sense of self in the future (Prabhakar et al., 2016). Investigating older children's episodic foresight ability is therefore required to clarify the developmental trajectory of this skill beyond the early childhood years.

2.3.1 Assessment of Episodic Foresight

Mahy and Atance (2016) note that one of the current issues in the research into episodic foresight is the lack of measures designed to directly tap the practical nature of this construct. One task that is frequently used with children is the Picture Book Trip Task (e.g. Atance & Meltzoff, 2005; Ferretti et al., 2018; Hanson et al., 2014; Marini et al., 2019; Mazachowsky et al., 2020; Mazachowsky & Mahy, 2020). In this task, children are presented with pictures of different locations (e.g. a waterfall or a desert) and are told to imagine going on a trip to that location. They are then presented with pictures of items to choose from that may or may not be useful for that location (e.g. raincoat; sunglasses). Participants are also asked to explain their choices to determine whether they were due to consideration of future needs (Atance & Meltzoff, 2005). While this task does appear to reflect children's ability to consider future needs, it has been suggested that it may not necessarily reflect the application of episodic foresight, as children's actions may have been due to learned associations or chance (Suddendorf & Busby, 2005; Suddendorf et al., 2011).

Mahy and Atance (2016) also note that most tasks designed to measure episodic foresight *cue* children to engage in thinking about future events, thus little is currently known about how children *spontaneously* generate solutions to future problems. Some recent attempts have been made to address this. For example, Moffett et al. (2018) asked 4 and 5 year old children to generate the means to complete a future game. Children were first required to name four items to pack for preschool (e.g. a book) and to draw them on cards if they were not in the set of object cards provided by the researcher. Children were then taken to a second room with the cards to play a game where the researcher asked them to put an object card in a basket if they had brought it. The last object needed, a banana, was not given to the children and they were told they would be continuing the game later. Taken back to the first room, children were told to draw what they wanted to take back to the second room, giving them the opportunity to draw the required item (i.e. the banana). Results indicated that 5 year old children drew the required item more often than 4 year old children (Moffett et al., 2018). In another study, Caza and Atance (2018) measured 3 to 5 year olds' spontaneous solving of a future problem by identifying any relevant future statements the children made *before* they were explicitly asked to think about the future (i.e. when they were explicitly asked to think about which room they would put extra toys or food in for their next visit to the laboratory). They found that children who correctly solved the future problem (i.e. chose to put extra toys and food in the room that did not have any) spontaneously uttered more future task-relevant statements before being told to think about the future than those who did not. However, while Caza and Atance's findings provide a foundation for future investigation of episodic foresight, relying on children's verbal skills may not provide a true reflection of their capacity to spontaneously engage in episodic foresight given that, as previously noted, children's language and understanding of temporal terms continues to develop up to 7 years of age (Atance, 2008; Busby Grant & Suddendorf, 2010; Suddendorf, 2010a). Taking children's verbal abilities into consideration is important in future studies in order to tease out the development of episodic foresight.

2.3.1.1 Behavioural Assessment of Episodic Foresight

Behavioural measures have been suggested to provide a more accurate representation of episodic foresight than those that rely on verbal responses (Miloyan &

McFarlane, 2019). Behavioural paradigms that have been developed often take inspiration from Tulving's (2005) 'spoon test' which is based on an Estonian children's story. The story describes a girl dreaming of attending a party where there is chocolate pudding, however having not brought a spoon, she is unable to eat any. The next night the girl takes a spoon to bed in anticipation of eating the pudding. By getting a spoon, Tulving suggests the girl shows the ability to mentally travel to both the past and future (i.e. the girl recalls her experience of being at the party and, by imagining a similar party in the future, is able to decide to get a spoon in anticipation of a similar situation). Studies have since developed experimental designs that conceptually follow the process Tulving described (for a review see Atance, 2018).

Suddendorf and Corballis (2010) proposed four criteria for valid behavioural measures of episodic foresight. These four criteria include: "(a) the use of single trials to avoid repeated exposure to the sample stimulus-reward relationships and to demonstrate memory of a specific event, (b) the use of novel problems to avoid relative learning histories and to demonstrate cognitive processes, (c) the use of different temporal and/or spatial contexts for the crucial future-directed action to avoid cuing and to demonstrate long term-memory, and (d) the use of problems from different domains to avoid specific behavioural dispositions and to demonstrate flexibility" (Suddendorf et al., 2011, p. 27).

One study employed this criteria to develop a measure, the two-room task, which was used to investigate episodic foresight in preschool children (Suddendorf & Busby, 2005). In this study, children were taken to a room and were presented with a puzzle board without its puzzle pieces. After two minutes they were taken to a second room filled with a number of unrelated items to play with for five minutes. Following this, participants were presented with several items to choose to take back to the first room, one being the puzzle pieces. Results showed that 4 and 5 year old children chose the puzzle pieces above chance, however 3 year old children did not. The two-room paradigm has since been used in several studies that have found similar results among preschool children (Atance & Sommerville, 2014; Redshaw & Suddendorf, 2013; Suddendorf et al., 2011). However, Atance (2018) does note that unlike the ‘spoon test’, where the girl had to actively seek out a spoon to solve the problem, tasks such as the two-room paradigm involve a forced choice response to obtain the correct item to solve the future problem. Consequently, tasks such as the two-room task may rely more on recognition and association than true episodic foresight ability (Atance, 2018). Despite this, such tasks are currently the most used type of measure to assess episodic foresight in children.

Recently, Atance et al. (2019) adapted the two-room paradigm to examine 3, 4, and 5 year old’s episodic foresight performance in the absence of specific cues by asking them to generate a response in three different conditions which varied in difficulty. The *forced choice* condition simply asked children to select the correct fruit to take back to the first room from three options of fruit. The *generate category* condition asked children to state what would be a good fruit to take back to the first room. The final condition, the *generate object* condition, asked children to state what would be a good thing to take back to the first room. In this way, Atance et al. (2019) varied the degree to which children had to self-generate the correct item with and without specific cues. Results indicated that as the generative requirements increased, children’s performance on the two-room task significantly decreased. Atance et al. (2019) suggest that children’s ability to self-generate the correct item may be more similar to the spontaneous response described in Tulving’s spoon test. The authors do note however, that this task still relied on children's verbal abilities, which is unlike Tulving's spoon test which involves a non-verbal response as the index of episodic foresight ability (Atance et al., 2019). Development of other measures for use with children that tap a more direct behavioural index of episodic foresight is therefore warranted.

Recently a measure based on the two-room paradigm, Virtual Week-Foresight (VW-Foresight), was created to assess episodic foresight in adults (Lyons et al., 2014). Unlike the two-room paradigm which only includes one problem-solving task, a key advantage of VW-Foresight is that it measures participants' performance across ten different tasks. Simulating real-life situations, participants must draw upon episodic foresight in order to successfully complete these tasks. For example, participants are first presented with a problem, such as forgetting to buy cheese from the supermarket that has now closed. Later in the game, participants are provided with the opportunity to acquire an item (i.e. cheese) when they pass a market stall selling local farm produce, which may be used to solve the earlier problem. Finally, participants are provided with the context in which they have the opportunity to resolve the problem, which in this example, involves them gathering the ingredients to make a pizza for dinner, including the cheese they previously acquired. Importantly, at each of these phases, participants receive no prompts or instructions and must self-initiate the actions, thereby paralleling the demands of daily living. VW-Foresight has been used to assess episodic foresight performance among older adults, opiate users, adults with schizophrenia, and stroke patients (Lyons et al., 2014; Lyons et al., 2016; Lyons et al., 2019; Terrett, Lyons, et al., 2016). However, to date, no studies have used a reliable behavioural measure of episodic foresight of this nature to assess this capacity in children.

2.4 Cognitive Abilities Underpinning Episodic Foresight

In addition to the emerging research examining our capacity to engage in episodic foresight, research has begun to examine what cognitive processes may contribute to this skill. Indeed, Suddendorf and Corballis (2007) argue that the ability to engage in episodic foresight likely involves integrating a complex system of cognitive components. Retrospective memory and executive functions (including inhibition, cognitive flexibility, and working memory) have been given particular attention in the theoretical literature (Suddendorf, 2017; Suddendorf & Corballis, 2007; Suddendorf & Redshaw, 2013). However, very little empirical investigation of the relationship between episodic foresight and these cognitive processes has been conducted.

2.4.1 Retrospective Memory

Retrospective memory is one contributor that has been argued as critical for episodic foresight (Suddendorf & Corballis, 2007). Indeed, part of the criteria for valid episodic foresight tasks requires memory to be demonstrated by using different spatial and/or temporal contexts (Suddendorf & Corballis, 2010). Tasks that follow these criteria, such as the two-room paradigm, argue that successful completion of the task requires participants to draw on their memory of the problem they encountered in order to seek its future solution (Miloyan, McFarlane, & Suddendorf, 2019). Studies that have utilised the two-room paradigm have shown that by 4 years of age, children are able to draw upon their memory of a problem in order to secure its future solution (Redshaw & Suddendorf, 2013; Suddendorf & Busby, 2005; Suddendorf et al., 2011), and the accuracy of children's memory has been shown to predict the likelihood of them selecting the correct solution (Atance & Sommerville, 2014). However, as research investigating episodic foresight is extremely limited, the role of retrospective memory requires further investigation. A clear gap in the literature is in investigating the relationship between these abilities in middle childhood, as no studies have examined children's episodic foresight beyond the preschool years.

2.4.2 Executive Functions

The literature has also identified executive functions as potential contributors to episodic foresight performance. Theoretically, working memory provides the space within which information regarding a future scenario is held, and inhibition and cognitive flexibility allow one to focus on information relevant to the future scenario and switch between different cognitive demands in order to achieve a desired future outcome (Suddendorf, 2017; Suddendorf & Corballis, 2007; Suddendorf & Redshaw, 2013). As such, executive functioning is likely, in VW-Foresight for example, to be required at the point where the preparatory action should be enacted (i.e. using the cheese when it is time to check if they have all the ingredients for their pizza) as this arguably requires inhibition of one's current activity and potential cognitive flexibility to shift from one activity to another. Research directly investigating a relationship between executive functions and episodic foresight is extremely limited and findings regarding a relationship have been mixed. For example, while one study found healthy adults and opiate users' performance on VW-Foresight to be moderately correlated with their executive functioning (Terrett, Lyons, et al., 2016), no association was found in other studies involving younger and older adults (Lyons et al., 2014), adults with schizophrenia (Lyons et al., 2016), and stroke patients (Lyons et al., 2019). Furthermore, no studies have investigated the relationship between children's episodic foresight and executive functions using a task that follows the criteria set out by Suddendorf and Corballis (2010). This represents a major gap in the episodic foresight literature that awaits empirical investigation.

2.4.3 Episodic Future Thinking

A final cognitive ability that has been suggested to contribute to episodic foresight is episodic future thinking (EFT), which as previously noted, refers to the ability to imagine experiencing future events in imagination (Addis et al., 2008; Atance & O'Neill, 2001). As described earlier, theoretically, episodic foresight has been argued to first involve imagining the self in the future (i.e. EFT) so that future needs may be identified, which allows one to take preparatory action in the present to ensure that those future needs are met (Suddendorf & Moore, 2011). This may suggest that EFT is a core component of episodic foresight. Surprisingly, no empirical research has been conducted to explore this theoretical claim. Investigation of a relationship between EFT and episodic foresight therefore remains a major gap in the overall future-oriented thinking literature.

2.5 Prospective Memory

Another key component of future-oriented thinking is prospective memory (PM), which refers to the capacity to remember to complete a planned action at a future time point (Einstein & McDaniel, 1990). PM is an important cognitive skill for both children and adults that is embedded in many aspects of daily functioning (Meacham & Colombo, 1980). For example, adults may need to remember to buy bread at the supermarket after work, or to phone the plumber at 2 o'clock, while children may need to utilise PM to remember to hand a school notice to their parents at the end of the day, or to submit their homework at a certain time. As such, PM ability is considered critical for the development of skills needed for independence (Henry et al., 2014; Kliegel, Jäger, et al., 2008), assisting children to learn to meet the demands of daily life as well as maintain social relationships (Kvavilashvili et al., 2001; Meacham & Colombo, 1980; Shum et al., 2008).

2.5.1 The Nature and Types of Prospective Memory Tasks and Theoretical Models

A number of phases are involved in successfully completing a PM task, including forming an initial intention, retaining the intention in memory, retrieving the intention, and executing and evaluating the action at the required time (Ellis, 1996; Ellis & Kvavilashvili, 2000; McDaniel & Einstein, 2000). As such, PM tasks have been described as having three fundamental characteristics: (1) a delay between forming the intention and completing the appropriate action; (2) no clear reminder to complete the PM task at the planned time; and (3) the interruption of current activities to complete the PM action (Ellis & Kvavilashvili, 2000; McDaniel & Einstein, 2007).

While all PM tasks display these features, PM tasks can be categorised into two main types, specifically event-based or time-based (Einstein & McDaniel, 1990). Event-based PM tasks involve remembering to respond to an external environmental cue, such as remembering to give your friend the money that you owe them next time you see them. The presence of your friend acts as an environmental reminder (i.e. cue) for you to give them the money. Time-based PM tasks by contrast involve remembering to complete the appropriate action at a particular point in time (e.g. remembering to take your medication at 11 o'clock), or after a certain period of time (e.g. remembering to take a pot off the stove after 30 minutes). Unlike event-based PM, successful completion of time-based PM tasks occurs without an explicit environmental cue (Einstein & McDaniel, 1990).

It has been proposed that successful performance on PM tasks can be achieved through two distinct processes. One process involves a spontaneous response to a cue, while the other involves strategic monitoring of one's environment for the cue (Ellis & Kvavilashvili, 2000; McDaniel & Einstein, 2000). McDaniel and Einstein's (2000) multiprocess framework suggests that which of these processes occurs varies depending on the features of the PM task, the nature of the ongoing task, and the type of cue to complete the PM action. Spontaneous processing is suggested to occur when a PM task is highly associated with the target cue, as well as being highly distinct from the ongoing task (Hicks et al., 2005). As such, according to McDaniel and Einstein, event-based PM involves spontaneous processing as the task is brought to mind by the presence of the environmental cue (Einstein & McDaniel, 1990; McDaniel & Einstein, 2000). For example, you decide that you must remember to call your mother after you have finished watching a movie. The credits at the end of the movie then act as an environmental cue to call your mother. By contrast, strategic monitoring requires an individual to pay attention in order to be prepared to respond to the appropriate cue when it occurs, and as such places greater demands on cognitive resources, thereby increasing the difficulty associated with successful PM performance (McDaniel & Einstein, 2000, 2007). Time-based PM is thought to require more strategic monitoring, as these tasks require an individual to monitor the time. For example, remembering to call your mother at 8 o'clock requires you to regularly check the time prior to 8 o'clock so that you do not miss making the call. Time-based PM is therefore considered to be more challenging than event-based PM as it is more demanding of cognitive resources and relies on an individual to self-initiate the action (Einstein & McDaniel, 1990; Einstein & McDaniel, 2005).

Some debate exists in the literature however as to whether PM task performance involves the processes described by the multiprocess framework. One alternative model is the preparatory attentional and memory processes (PAM) theory proposed by Smith (2003), which suggests that rather than spontaneous processing in event-based PM tasks, one must always monitor the environment to some degree for the target event, although this will vary according to the nature of the task. Smith (2003) suggests this monitoring is similar to divided attention. For example, if you plan to return money to your friend at work the next time you see them, the PAM theory suggests that part of your attention on your daily activities will be diverted to monitoring your environment for the presence of your friend. Consequently, dividing attention in this manner causes a decrease in ongoing task performance, i.e. your daily activities (Smith, 2003). While there is some evidence for this reduction in ongoing task performance (Hicks et al., 2005; Kliegel et al., 2013; Smith & Bayen, 2004) as would be predicted by the PAM theory, the multiprocess framework nevertheless remains the most influential model of PM thus far.

In addition to event-based and time-based PM tasks, PM tasks may also be categorised as regular and irregular. Regular PM tasks are part of a normal routine, such as remembering to brush your teeth after breakfast every morning, whereas irregular PM tasks are one-off and non-recurring, such as remembering to call your doctor to make an appointment (Rendell & Craik, 2000). Both time-based and event-based PM can additionally manifest as regular or irregular PM tasks (Rendell & Craik, 2000). Due to the repetitive nature of regular PM tasks, they are suggested to receive more thorough encoding than irregular tasks. As such, they arguably place fewer demands on cognitive resources, such as retrospective memory, and allow responses to be initiated more spontaneously (Rendell et al., 2007; Rendell & Henry, 2009; Rose et al., 2010).

2.5.2 Development of Prospective Memory

The development of PM ability is suggested to be a major developmental challenge of childhood (Altgassen et al., 2014). Greater demands are placed on children's PM upon entering a school environment, as they are increasingly required to remember to complete their formed intentions without assistance from parents and teachers (Causey & Bjorklund, 2014). Furthermore, the negative consequences of failing to carry out those intentions have an increasing impact on children's autonomy, social relationships, and academic performance as they progress through school (Guajardo & Best, 2000; Henry et al., 2014; Kretschmer et al., 2014; Kvavilashvili et al., 2008; Mahy, Moses, et al., 2014b). It has generally been accepted that PM improves until adulthood before declining later in life (Kliegel, Mackinlay, et al., 2008; Mattli et al., 2014; Maylor et al., 2002; Zimmermann & Meier, 2006). However, past research has predominantly focused on PM in adults and aging populations (for a meta-analysis see Henry et al., 2004) and only relatively recently has research begun to focus on PM in childhood (Mahy, Kliegel, et al., 2014). Despite this growing interest, there is still a lack of a detailed understanding of the developmental trajectory of PM across childhood through to adolescence (Kvavilashvili et al., 2008; Mahy, Kliegel, et al., 2014).

Of the work that has been done, there appears to be some consensus that children have an emerging event-based PM ability at around 2 to 3 years (Guajardo & Best, 2000; Kliegel & Jäger, 2007; Slusarczyk et al., 2018; Somerville et al., 1983). Age-related increases reportedly continue until age 6 (Mahy et al., 2018; Mahy & Moses, 2011) with another increase evident in middle childhood before plateauing in late childhood to early adolescence (Rendell et al., 2009; Shum et al., 2008; Ward et al., 2005; Zimmermann & Meier, 2006). By contrast, time-based PM appears to emerge later at around 5 to 7 years of age, and follows a longer developmental trajectory than event-based PM, with children becoming increasingly proficient in time-based PM up to 13 years of age before plateauing in late adolescence to early adulthood (Kerns, 2000; Kretschmer et al., 2014; Mackinlay et al., 2009; Rendell et al., 2009; Talbot & Kerns, 2014). Development of time-based PM is argued to occur later because, as previously noted, these tasks are more difficult, lacking the environmental cues of event-based PM tasks. Consequently, time-based tasks place greater demands on cognitive resources, such as planning and time-monitoring (Einstein & McDaniel, 1990; Einstein & McDaniel, 2005), such that successful performance relies on the additional development of these capacities (Mackinlay et al., 2009; Nigro et al., 2002; Yang et al., 2011).

It should be acknowledged, however, that the majority of studies with children have only examined children's PM performance on one type of task, with only a few studies examining children's performance on both event-based and time-based PM tasks. One study by Talbot and Kerns (2014) examined both event-based and time-based PM performance among 8 to 13 year old typically developing children and children with attention-deficit/hyperactivity disorder. Analysis of the whole sample (both groups combined) demonstrated a significant correlation between age and children's time-based PM performance, but not for event-based PM performance. Another study by Yang et al. (2011) calculated a composite PM score and found an improvement in children's overall PM performance from the ages of 7 to 12. Children's performance significantly improved between 7 and 8 years, however there appeared to be a plateau in improvement between 9 and 10 years of age. Performance significantly improved again between the ages of 10 and 11. However, Yang et al. (2011) did not discuss the individual trajectories of event-based and time-based PM development with age, although, they did report that children performed better on event-based tasks than time-based tasks when ages were combined. Recently, Terrett et al. (2019) investigated PM performance in 8 to 12 year old children using the children's version of Virtual Week-Prospective Memory (Rendell & Craik, 2000). This is a widely used measure of PM which assesses all four types of PM task (event-based and time-based, regular and irregular) in a computerised game format. Results indicated significant improvements with age on irregular and regular time-based PM tasks, but not for irregular and regular event-based PM tasks (Terrett et al., 2019). The findings of these studies that included both event and time based tasks generally support the argument that by middle childhood, children are reasonably proficient at event-based PM tasks, however due to the more difficult nature of time-based tasks, children appear to continue to develop this ability into adolescence (Kerns, 2000; Kretschmer et al., 2014; Mackinlay et al., 2009; Rendell et al., 2009; Talbot & Kerns, 2014).

A detailed picture of the developmental trajectory of PM, particularly across middle childhood, however, remains relatively unclear due to a number of factors. First, the age ranges of children that studies have investigated have greatly varied. Second, the results of studies are inconsistent (Aberle & Kliegel, 2010; Altgassen et al., 2014). For example, some researchers have reported improvements in event-based PM from 5 to 13 years (Rendell et al., 2009; Shum et al., 2008) and better performance by young adults compared to adolescents (Altgassen et al., 2014; Wang et al., 2006). Furthermore, improvements in time-based PM from 7 to 12 years have been reported (Kerns, 2000; Mackinlay et al., 2009; Voigt et al., 2011) and 10 year olds have been shown to display worse time-based PM performance than 14 year olds (Ceci & Bronfenbrenner, 1985). In contrast, however, other studies have found no improvements in event-based or time-based PM performance between 7 and 12 years (Mäntylä et al., 2007; Nigro et al., 2002). Recently, Mills et al. (2020) examined a broad sample aged 4 to 15 years using a newly adapted children's version of the Memory for Intentions Test (MIsT; Raskin et al., 2010), a clinical measure of PM used with adults. Results demonstrated that the 4 to 6 year old group performed significantly worse than the other age groups and the largest increase in performance was seen between the 4 to 6 year old group and the 7 to 8 year old group. The 7 to 8 year old group did not perform significantly differently to the 9 to 10 year old group on either event-based or time-based PM, however significant differences were found between the 7 to 8 year old age group and 11 to 12 year old and 13 to 15 year old age groups. In addition, the 9 to 10 year old group did not perform significantly differently to the 11 to 12 year old group, but performed significantly worse than the 13 to 15 year old group. Lastly, PM performance was also found to level off between the 11 to 12 year old age group and the 13 to 15 year old group and both groups performed similarly on event-based and time-based PM (Mills et al., 2020). These findings may suggest that children's performance on both event-based and time-based tasks continue to improve from middle until late childhood, before becoming proficient in the early adolescent years. Overall, however, given the limited number of studies that have examined children's performance across different types of PM task and variability of findings, it is currently difficult to make conclusions about the development of PM, especially within the middle childhood years. Further investigation of performance across event-based and time-based PM tasks is therefore warranted.

2.5.3 Assessment of Prospective Memory

Early studies of PM in adults relied on semi-naturalistic tasks to measure performance (for example, asking participants to remember to call an experimenter the following day), often as an addition to other unrelated experimental tasks (McDaniel & Einstein, 2007). More recent laboratory PM paradigms however now typically involve participants completing an ongoing task while also being required to remember to complete an unrelated action at a particular moment (McDaniel & Einstein, 2007). Einstein and McDaniel (1990) for example asked participants to verbally recall words presented on a computer (the ongoing task) with the added instruction to press a certain key whenever a specific word was presented (the PM task).

However, Kvavilashvili et al. (2008) highlight that certain methodological issues need to be considered when studying PM in children. Specifically, using adult laboratory paradigms is problematic as these tasks may be too complex, and children may be too young to understand the importance of a PM task assigned simply for research purposes (Kvavilashvili et al., 2008). Consequently, while some adult laboratory paradigms have been adapted to be more appropriate for children (Garvie et al., 2018; Mills et al., 2020), studies of PM in children have also used naturalistic paradigms. For example, one study asked parents to report whether or not their child had performed the PM task they were given (remind their parents to buy milk) (Somerville et al., 1983), while another assessed whether children remembered to find a sticker hidden in the previous session (Walsh et al., 2014). However, such naturalistic paradigms have been criticised for their lack of experimental control (Einstein & McDaniel, 1990). By contrast, laboratory based studies with children have involved PM tasks such as remembering an instruction during a card naming task (Kvavilashvili et al., 2001), or remembering to press the space bar whenever a target picture appears on the computer (Guajardo & Best, 2000). In their review, Mahy, Kliegel, et al. (2014) note that while laboratory paradigms such as these allow for multiple trials of the same PM task thereby increasing the reliability of the measure, this approach may be less ecologically valid as experiences in everyday life often only allow one opportunity to remember a planned action. Furthermore, Walsh et al. (2014) note that several task-related factors interact with age and PM performance, including the characteristics of the PM task, the cognitive load of the ongoing task, and the characteristics of cues to complete the task. Variability in these factors may therefore contribute to mixed findings in studying PM in children. Indeed, Walsh and colleagues found that, as cues to complete a PM task became more explicit, the difference between 3 to 5 year olds' PM performance was reduced. Studies examining PM cue focality in children aged 6 to 11 years have also produced similar findings (Cejudo et al., 2018; Cejudo et al., 2019). In terms of the ongoing task, Kliegel et al. (2013) found that PM performance among 6 to 10 year olds improved when the ongoing task was less absorbing. As such, numerous factors need to be considered when attempting to accurately measure children's PM performance.

There have been some attempts in the research to overcome these issues by combining laboratory and naturalistic paradigms. In particular, short game-based formats have been suggested to be particularly useful for measuring children's PM performance (Kerns, 2000; Kvavilashvili et al., 2008; Kvavilashvili et al., 2001). Indeed, children have been found to be more likely to engage in tasks when game-type formats are used

(Kvavilashvili et al., 2001). Furthermore, children often begin playing video games early in life, therefore it is a format that many children are accustomed to (Kvavilashvili et al., 2008). One example of such a measure, as previously mentioned, is the computer game Virtual Week-Prospective Memory (VW-PM; Rendell & Craik, 2000). VW-PM attempts to retain the experimental control of a laboratory setting while mimicking each type of PM task experienced in everyday life (Rendell & Craik, 2000). It has been shown to be a reliable measure of PM in adults (Rose et al., 2010) and in children (Henry et al., 2014). Furthermore, VW-PM measures children's PM performance on both event-based and time-based PM task, while also keeping children engaged in a game (Henry et al., 2014). VW-PM may therefore be considered a promising tool for continued research into children's PM performance.

2.6 Cognitive Abilities Underpinning Prospective Memory

The literature on PM has indicated that a number of cognitive abilities may underpin PM performance. Research has primarily examined the role of retrospective memory, executive functions, and most recently other future-oriented abilities such as EFT, in children's PM performance (for example, Einstein & McDaniel, 1990; Mahy, Kliegel, et al., 2014; Terrett, Rose, et al., 2016). However, current knowledge of the role of these abilities in PM performance in the middle childhood years is limited. Furthermore, little research has assessed the relationship between PM and these cognitive abilities across different types of PM task. As such, a comprehensive profile of their contribution to each type of PM task is yet to be empirically investigated.

2.6.1 Retrospective Memory

Retrospective memory is one cognitive ability considered crucial for PM performance and is the most widely studied contributor to PM. A relationship between PM and retrospective memory is expected because models of PM highlight that PM tasks include a retrospective memory component and a prospective memory component (Einstein & McDaniel, 1990; Graf & Uttl, 2001). The retrospective memory component is remembering the content of task, i.e. what must be done and under what circumstances. The prospective memory component is remembering that a task has to be done at a particular point (Einstein & McDaniel, 1990; Kliegel et al., 2000). Both components are considered necessary for successful PM task completion and difficulties with either can prevent successful completion in daily life (Graf & Uttl, 2001; McDaniel & Einstein, 2007). Studies have noted the role of retrospective memory in both the development and decline of PM performance with age (Mattli et al., 2014; Zimmermann & Meier, 2006). In adults, retrospective memory ability has been found to be a significant contributor to PM performance (Cherry et al., 2001; Terrett, Rose, et al., 2016). In children, Terrett et al. (2019) found 8 to 12 year olds' retrospective memory for the PM task content (i.e. what needed to be done), was significantly correlated and contributed to their PM performance. Given this relationship, it is important to take the contribution of retrospective memory ability into consideration when examining cognitive mechanisms underpinning children's PM performance.

2.6.2 Executive Functions

Executive functions have also been proposed as potential contributors to PM. Research has primarily drawn upon the three function model proposed by Miyake et al.

(2000) to examine the relationship between these constructs (Zuber et al., 2019). In particular, inhibition, and cognitive flexibility have been identified as possible contributors to PM, as it is has been argued theoretically that to successfully complete a PM task, an individual must interrupt their current activity, switch to the PM task, and inhibit their response to any irrelevant stimuli (Altgassen et al., 2014; Kvavilashvili et al., 2001).

There have been a number of empirical studies that have attempted to investigate the role of executive functions in children's PM. For example, some studies of event-based PM have found an association between children's inhibitory control and their PM performance (Ford et al., 2012; Shum et al., 2008; Wang et al., 2008; Ward et al., 2005). However, recently, Mahy et al. (2018) found monitoring and inhibitory control to be associated with 5 and 6 year olds' event-based PM performance, but not 4 year olds', which may suggest that a relationship only occurs in older children. In comparison to event-based PM, time-based PM has been argued to be more reliant on executive functions, as these tasks are considered to be more cognitively demanding (Rendell & Henry, 2009). Some studies have found small to moderate associations between children's time-based PM performance and inhibition (Kerns, 2000), cognitive flexibility (Mackinlay et al., 2009; Mäntylä et al., 2007), and working memory (Voigt et al., 2014). Furthermore, children with reduced executive function abilities, such as those with attention-deficit/hyperactivity disorder (Talbot & Kerns, 2014) and autism spectrum disorder (Henry et al., 2014), have been found to have reduced performance on time-based (but not event-based) PM tasks compared to typically developing children.

While together these studies are suggestive of a link between executive functions and PM, a number of studies have also failed to find significant associations between these constructs. For example, some studies have found no association between inhibition and event-based PM (Cottini et al., 2018; Mahy & Moses, 2011) and time-based PM (Kretschmer et al., 2014). Other studies have found no association between working memory and event-based PM (Ford et al., 2012; Mahy, Moses, et al., 2014b) and time-based PM (Mackinlay et al., 2009). Lastly, some studies have found no association between cognitive flexibility and event-based PM (Mahy, Moses, et al., 2014b) nor time-based PM (Mäntylä et al., 2007). Given the inconsistency of these findings, the relationship between executive functions and PM remains somewhat unclear in the literature.

Recently, Zuber et al. (2019) noted that part of the challenge in determining the role of executive functions in PM is that past studies have typically examined performance on a single type of PM task and often vary in the executive functions selected. Zuber and colleagues sought to address this by conducting a broader investigation, examining the relationship between inhibition, cognitive flexibility, and working memory and both event-based and time-based PM performance among 6 to 11 year old children. Results indicated that working memory, but not inhibition or cognitive flexibility, significantly predicted time-based PM performance. In relation to event-based PM, the researchers further distinguished performance on two subtypes of task, *focal* (i.e. where there is an overlap between the features of the PM cue and the features of the ongoing task) and *non-focal* (i.e. where the PM cue is present in the environment and distinct from features of the ongoing task; McDaniel & Einstein, 2000). *Focal* event-based PM performance was shown to be predicted by working memory and inhibition, while *non-focal* event-based PM performance was shown to be predicted by working memory, inhibition, and cognitive flexibility. The authors postulated that because *non-focal* tasks require increased strategic monitoring for the PM cue (compared to the spontaneous processing involved in *focal* tasks), such tasks would also draw upon additional cognitive resources to allow an individual to switch between the ongoing task and monitoring the environment for the presence of the PM cue (Zuber et al., 2019). The results of this study therefore provide important evidence to tease out the contribution of specific executive functions to time-based and event-based PM performance and indicate that this contribution may vary as a function of PM task demands. Despite these findings however, studies that comprehensively investigate the relationship between executive functions and PM in children are still relatively limited and further work is required to better understand the role of executive functioning in children's PM performance.

2.6.3 Episodic Future Thinking

A more recently proposed contributor to PM performance is EFT (Schacter et al., 2008; Schacter et al., 2017; Szpunar, 2010). There are two sources of evidence supporting a link between EFT and PM. Firstly, evidence of brain activity in certain regions, particularly Brodmann area 10, has been found when engaging in both EFT and PM (Burgess et al., 2003; Schacter et al., 2007; Weiler et al., 2010). Secondly, future event simulation has been found to be a useful strategy to improve PM performance (Altgassen et al., 2015; Brewer & Marsh, 2010; Neroni et al., 2014; Spreng et al., 2018). For example, it has been found that adult participants who were instructed to imagine themselves completing a PM task subsequently performed better on the PM task than those who did not use imagery (Brewer et al., 2011; Neroni et al., 2014). This finding has also been supported in clinical populations (Mioni, Bertucci, et al., 2017) and in younger populations, including 7 year olds (Kretschmer-Trendowicz et al., 2016), 10 to 12 year olds (Kretschmer-Trendowicz et al., 2019), and adolescents (Altgassen et al., 2017). However, 5 year old children's PM performance was not found to improve with EFT, possibly because younger children's EFT ability has yet to develop enough to facilitate PM performance (Kretschmer-Trendowicz et al., 2016).

Despite this evidence, relatively few studies have directly explored the relationship between EFT and PM. In one of these studies, Terrett, Rose, et al. (2016) found younger and older adult's EFT and PM to have a significant positive association. Furthermore, they found EFT ability significantly contributed to PM performance in young adults, over and above executive functions and retrospective memory. In children, two studies have investigated this relationship in children under 5 years of age, although no association was found (Atance & Jackson, 2009; Nigro et al., 2014). However, EFT and PM were found to be significantly correlated among 7 year olds (Nigro et al., 2014), which may suggest that a relationship between these abilities does not occur until middle childhood.

It should be acknowledged that these previous studies only investigated the relationship between EFT and children's event-based PM performance. Recently, Terrett et al. (2019) examined the relationship between 8 to 12 year olds' EFT and performance across four PM task types (event-based and time-based, regular and irregular) using the children's version of VW-PM. Significant correlations were found between EFT and children's performance on regular and irregular event-based PM tasks and regular time-based PM tasks, and regression analyses indicated that children's EFT explained a significant portion of variance in performance on irregular event-based PM tasks over and above other cognitive abilities. Furthermore, the relationship between children's EFT and PM performance on regular and irregular event-based and regular time-based PM tasks was found to be mediated by their retrospective memory ability (i.e. memory for PM task content). Terrett et al. (2019) argued that this evidence supports the theoretical claim that EFT facilitates PM by reinforcing the encoding of the PM task content, allowing for more efficient retrieval from memory (Altgassen et al., 2017; Altgassen et al., 2015; Brewer & Marsh, 2010; Schnitzspahn & Kliegel, 2009). Notably, Terrett et al. (2019) also found EFT made a significant contribution to children's irregular event-based PM performance beyond its effect via retrospective memory. In explaining their pattern of results, Terrett and colleagues suggest that EFT abilities may have a greater impact on event-based PM performance as these tasks involve specific environmental cues that are easier to visualise in imagination. Consequently the act of pre-experiencing the PM task may reinforce the connection between the cue and the corresponding action, which in turn supports PM task initiation (Terrett et al., 2019). This claim is consistent with previous research that found better PM performance among adolescents when they used either a repeated encoding or a future simulation strategy (Altgassen et al., 2017). While this initial evidence may support the hypothesis that EFT facilitates PM by reinforcing the connection between the ongoing task context and the specific cue to complete the intended action (Altgassen et al., 2017; Terrett et al., 2019), further investigation is still required. Furthermore, it should be acknowledged that most studies investigating how EFT may impact PM have instructed participants to engage in future simulation. As such the nature of this relationship when individuals are not prompted is unclear, and further research is required to tease out how EFT and PM are linked across the middle childhood years.

2.7 Chapter Summary

In summary, the research to date has highlighted the uniquely human and adaptive function of future-oriented thinking in children's daily lives. While the literature presented in this chapter identifies their emergence in the preschool years, less is known about how EFT, episodic foresight, and PM present in the middle childhood years. In addition, researchers have noted that each of these abilities is quite complex and is therefore likely to rely on other cognitive processes. While there is evidence to support the role of memory for the past in future-oriented thinking, the evidence investigating the role of other processes, namely executive functions, is limited and somewhat inconsistent. It remains unclear whether executive functions are associated with EFT, episodic foresight, and PM and if they are, the extent to which they contribute to children's future-oriented thinking over and above other cognitive abilities. Furthermore, it remains unclear the extent to which these future-oriented abilities may be related to one another. While there is evidence to suggest the role of EFT in PM performance, no research to date has assessed the role of EFT in episodic foresight. These outstanding issues will be addressed in the current thesis through three empirical studies that focus on each of the future-oriented constructs respectively. Study 1 investigates 8 to 12 year old children's EFT ability and its associated cognitive mechanisms. Study 2 then examines, for the first time, children's episodic foresight performance across this age band and the cognitive abilities that contribute to it. Lastly, Study 3 explores PM performance across middle childhood and the cognitive abilities that underpin successful PM performance.

Chapter 3: Methodology for the Empirical Studies

Preamble

Chapter 2 identified that the current understanding of future-oriented thinking in the middle childhood years is relatively limited, particularly in regard to how these abilities present in this age group and other cognitive mechanisms that may contribute to children's performance. This next section of the thesis focuses on the empirical studies which sought to address those gaps identified in the literature. This chapter will provide a comprehensive overview of the data collection process, including description of participant recruitment and a detailed description of all measures used in the three empirical studies followed by an overview of testing procedures.

3.1 Research and Study Design

The empirical studies of the thesis address three distinct empirical questions, which have been labelled as Studies 1, 2, and 3. The same sample of 80 participants was used in all studies such that data for all three studies was collected concurrently. This allowed for a larger sample to be recruited and used across all three studies. Data was collected across two testing sessions to reduce fatigue and minimise potential learning effects on measures used. The three empirical studies conducted utilised correlational designs.

3.2 Participants

80 typically developing children participated in the current research; 42 girls and 39 boys, aged 8 years 0 months to 12 years 6 months (*M* = 122.4 months, *SD* = 16.1). 81 children were recruited to take part in the testing sessions, but one participant was excluded due to reading difficulties. Descriptive statistics for the participants included in the final sample are presented in Table 3.1.

Table 3.1

Descriptive Statistics for Participants

	Min	Max	*M*	*SD*
Age in months	96.0	150.0	122.4	16.1
Age in years	8.0	12.5	9.7	1.4
FSIQ	80.0	128.0	108.2	10.6
VCI	78.0	130.0	106.5	9.6
PRI	72.0	136.0	108.7	13.6

Note. FSIQ = Full Scale IQ. VCI = Verbal Comprehension Index. PRI = Perceptual Reasoning Index.

3.2.1 Participant Recruitment

Participants were recruited through personal networks, social media, and community-based sources (e.g. sporting clubs) via flyers, and were predominantly from the southern and eastern metropolitan regions of Melbourne, Australia (see Appendix A). Flyers instructed interested parents to call the dedicated research phone used by the researcher, or to email the researcher's university email account. Parents of potential participants were then contacted over the phone and screened for eligibility. The following criteria had to be met for participants to be included in the study:

(a) be 8 to 12 years of age and currently attending primary school; and

(b) have English as a first language.

Potential participants were excluded if they had:

(c) severe speech or language problems;

(d) medical conditions or health concerns (e.g. epilepsy, uncorrected visual or hearing impairments);

(e) a diagnosed developmental disorder (e.g. autism spectrum disorder, attention-deficit/hyperactivity disorder, intellectual disability);

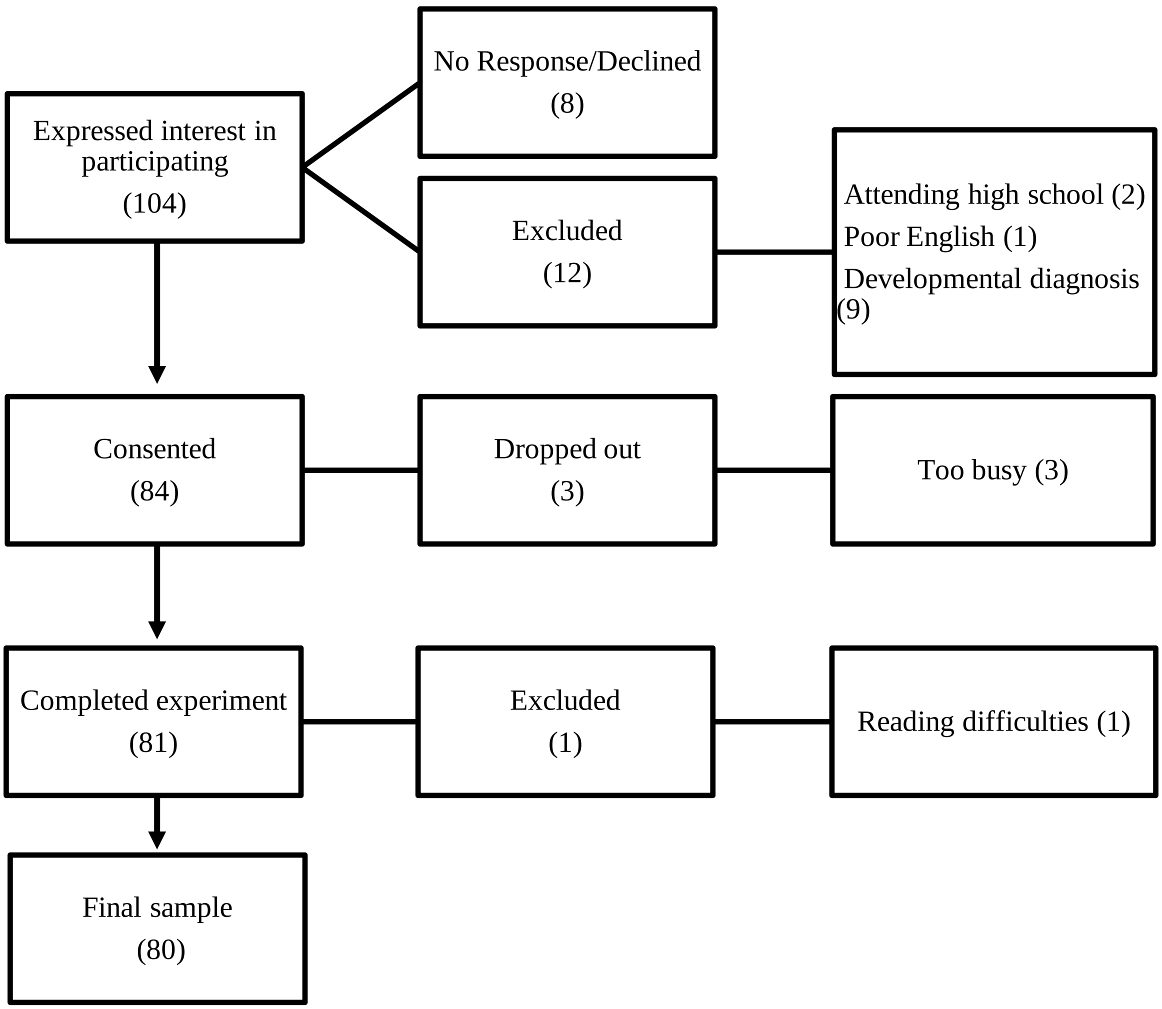
(f) current mental health concerns (i.e. anxiety or depression); and

(g) current use of prescription medication for mental health or sleep concerns (i.e. antipsychotics, antidepressants, antianxiety, or sleep medications).

Participants meeting the eligibility criteria were then booked in for two testing sessions. See Figure 3.1 for a flow chart of participant involvement throughout the stages of recruitment and testing.

Figure 3.1

Flow Chart of Participant Recruitment and Testing



3.3 Background Characterisation Measures

3.3.1 Demographics and Background Questionnaire

Parents or guardians of participants completed a questionnaire designed to provide background and demographic information for all three studies. This questionnaire contained 23 questions divided into four sections: parent or guardian demographics, second parent or guardian demographics (if applicable), child demographics, and child's health and wellbeing. Example questions included participants' age, sex, and cultural background, as well as parents' years of education and current occupation, in addition to current developmental diagnoses, speech or language problems, and quality of health and sleep. Appendix B provides the questionnaire completed by participants' parent or guardian.

3.3.2 General Cognitive Ability

The Wechsler Abbreviated Scale of Intelligence-Second Edition (WASI-II; Wechsler, 2011) is a reliable measure of general cognitive ability consisting of four subtests: Vocabulary, Similarities, Block Design and Matrix Reasoning. When variously combined, these subtests provide scores for the Verbal Comprehension Index (VCI), Perceptual Reasoning Index (PRI) and Full Scale IQ (FSIQ). FSIQ was used as an index of participants' general cognitive ability in all three studies.

The Verbal Comprehension Index (VCI) is designed to measure crystallised intelligence and comprises the Vocabulary and Similarities subtests. The Vocabulary subtest required participants to define a variety of words presented to them verbally, while the Similarities subtest required them to verbally describe how two objects or concepts are alike. The Perceptual Reasoning Index (PRI) is designed to measure fluid reasoning and is made up of Block Design and Matrix Reasoning. The Block Design subtest required participants to recreate pictured designs using blocks as quickly as possible, and the Matrix Reasoning subtest required them to correctly identify the missing part of a visual matrix from five options. The Full Scale IQ (FSIQ) measured participants' overall cognitive abilities and comprises the total of the VCI plus the PRI. Higher FSIQ indicated higher general cognitive ability. The FSIQ composite has strong internal consistency ranging from

.92 to .96 and test-retest reliability ranging from .79 to .92 for children aged 6 to 16 years. Inter-rater reliability for Vocabulary is .95 and for Similarities is .94 (Wechsler, 2011).

3.4 Key Measures

3.4.1 Episodic Future Thinking

The adapted version of the Autobiographical Interview (AI; Addis et al., 2008) was used to measure EFT for the three studies. The AI measured the amount of episodic details participants produced when describing personal events they had experienced in the past and events they could imagine experiencing in the future in response to a cue word. Following the procedure of Terrett et al. (2013), four cue words were used, two positive (*friend* and *easy*) and two negative (*naughty* and *tired*), taken from the autobiographical memory test developed by Vrielynck et al. (2007) for 9 to 13 year old children.

The interviewer first explained the task verbally and demonstrated a response to a sample cue word (e.g. *happy*). Participants then completed two trials (one using a positive and one using a negative word) in either the past or future condition, before repeating this procedure with two different positive and negative words for the other condition. The order of trials (i.e. temporal condition and positive and negative word selection) was counterbalanced across participants. For each word, children were given three minutes to produce as many details as possible about a past event they had experienced or a future event they could imagine themselves experiencing in response to the cue word presented to them on a card. Children were instructed that they had to describe only one event that occurred for no longer than one day and did not have to refer specifically to the cue word in their response. They were also informed that they needed to describe the event from their own point of view. Participants were additionally instructed that for the future condition they needed to describe a realistic event that they had not previously experienced. This was to avoid the possibility that the participant merely provided details of an event already stored in episodic memory. During responses, the researcher gave general probes to participants if necessary, as outlined in the training manuals provided by Donna Rose Addis. These included, for example, questions clarifying their responses and questions to encourage a more a detailed description of the event. Participant responses for each of the four trials were audiotaped and transcribed for scoring. Before recruitment, the interviewer was initially trained in administering the AI using material supplied by Donna Rose Addis.

3.4.1.1 AI Scoring

Transcripts of participants' responses were scored according to the procedure used by Addis et al. (2008). This procedure involved identifying a main event or theme in participants' responses for each trial. This was then divided into key details, categorised as either *internal* (episodic information specific to the main event described) or *external* (repetitions, non-episodic and semantic details, and details unrelated to the event described). The number of internal details participants produced for the two future events combined was used as an index of EFT in all three studies. The number of internal details participants produced for the two past events combined was used as an index of episodic memory in Study 1.

All transcripts were scored by a trained independent scorer. Training manuals were provided by Donna Rose Addis, which included an annotated example and 20 scoring events. Inter-rater reliability between three scorers across the 20 training events was estimated on the basis of a two-way mixed-design ANOVA intra-class correlation analysis.

The Cronbach alphas obtained for the three scorers were .98 for internal details and .87 for external details.

3.4.2 Episodic Foresight

The newly adapted children's version of Virtual Week-Foresight (VW-Foresight; Lyons et al., 2014) was used in Study 2 to measure episodic foresight. VW-Foresight is a computerised board game designed to measure the ability to engage in episodic foresight in a simulated everyday life context. Specifically, the game requires participants to show episodic foresight by registering that a problem exists, taking the opportunity to acquire an item that may help them avoid a future difficulty associated with the problem, and using the item when a later scenario arises that would benefit from use of the item. A key element of VW-Foresight is that participants are required to independently generate and initiate the intention to perform a future-directed behaviour (Lyons et al., 2014). The game presents participants with problems, items, and opportunities to solve problems without explicit instructions about what is required, such that participants have to resolve foresight problems independently. The VW-Foresight game has been used in past studies with older adults, opiate users, adults with schizophrenia, and stroke patients (Lyons et al., 2014; Lyons et al., 2016; Lyons et al., 2019; Terrett, Lyons, et al., 2016). The measure has recently been adapted to be more appropriate for school-aged children (i.e. changes in wordings, scenarios, and pictures).

To play the game, the children moved a token around the VW-Foresight board by rolling a die. One full circuit around the board was equivalent to one virtual day (see Figure 3.2). The board contained ten green 'S' squares that participants passed during each virtual day. Each time they landed on or passed an 'S' square, the children were prompted to select a *Situation Card*. Each *Situation Card* presented a realistic situation in daily life, such as eating breakfast. Participants were then asked to choose one of the options on the card in response to the situation (e.g. they could choose to have yoghurt, honey, or chocolate milk with their breakfast), which prompted them to roll a specific number on the die to continue (e.g. 'roll a six' or 'roll an odd number'). The act of choosing an option in response to the situation presented on each card did not contribute to the episodic foresight component of the game but provided ongoing distractor stimuli that continued the narrative of the game.

Figure 3.2

Virtual Week-Foresight Children's Version Game Interface

Some of the *Situation Cards* described a problem that participants were required to independently identify. For example, one situation card read “As you are rushing around to get ready for school you drop your glasses and one of the lenses breaks! You tell yourself that you will figure it out later because you can’t be late” (see Appendix C-1). During the Trial Day which provided instructions about how to play the game, the experimenter then asked participants whether the *Situation Card* contained a problem that could not be solved immediately (in this case, the problem is they have broken their glasses which may lead to poor eyesight for the rest of the day). Once they correctly identified the problem, participants were instructed to keep the problem in mind, as they may be able to acquire an item that would help them solve it later on in the game. These instructions were only provided during the Trial Day of the game. At a later point, the panel in the centre of the board instructed participants to pick up a *Daily Activity Card* and choose one of the five options to be stored in a repository called *Your Stored Items,* which was accessible on the board game interface for later use. *Daily Activity Cards* provided an opportunity for participants to acquire an item to solve the problem previously encountered, for example, that you broke your glasses earlier in the day (in this case, the appropriate choice of item to acquire and store would be your old pair of glasses; see Appendix C-2).

Participants then continued moving around the board until a different *Situation Card* was presented where a problem related to the original problem occurred (in this case, the relevant *Situation Card* says, “After a long day, you look for a comfy spot to sit to watch your movie. You turn on your movie and realise it looks blurry!”). At this point, participants were required to retrieve and use the appropriate item (i.e. your old pair of glasses) from their stored items to solve the problem (see Appendix C – 3). This was done by pressing the *Your Stored Items* button and then selecting to use 'your old glasses'. The *Situation Card* presenting the problem, the *Daily Activity Card* where an item is acquired, and the *Situation Card* presenting the opportunity to solve the previous problem by using the appropriate item, together form a single episodic foresight task.

The children's version of VW-Foresight consists of seven episodic foresight tasks presented across two virtual days (Monday to Tuesday). The two virtual days presented a total of 20 *Situation Cards*, seven of which presented an initial problem and seven presented the opportunity to resolve each problem. The remaining six *Situation Cards* presented everyday scenarios that continued the narrative of the game. There were 13 total *Daily Activity Cards*, seven of these contained items that could be acquired to solve each episodic foresight task and six continued the narrative of the game. All three components of each task were spatially and temporally separated on the game board with distractors presented in between. These elements of the VW-Foresight game were the key differences from the original adult version (Lyons et al., 2014), which contained ten episodic foresight tasks presented across three virtual days (Monday to Wednesday), 30 *Situation Cards* (ten presenting the problem, ten presenting the opportunity to resolve the problem, and ten distractors) and 20 *Daily Activity Cards* (ten presenting a required item and ten presenting distractor items). The adapted children's version of VW-Foresight was developed at the Cognition and Emotion Research Centre at the Australian Catholic University and underwent pilot testing that deemed this version appropriate for children in the sample age range.

3.4.2.1 Procedure for Administering VW-Foresight

Participants first completed a Trial Day of the game, which was structured similarly to the subsequent test days (i.e. *Situation Cards* and *Daily Activity Cards*). As previously noted, the Trial Day provided participants with instructions and demonstrated how to play the game. When the Trial Day was completed, participants were asked to complete two test days (Monday and Tuesday). It was ensured that all participants understood the instructions of the game before proceeding to the test conditions, as no further prompts were given after the Trial Day.

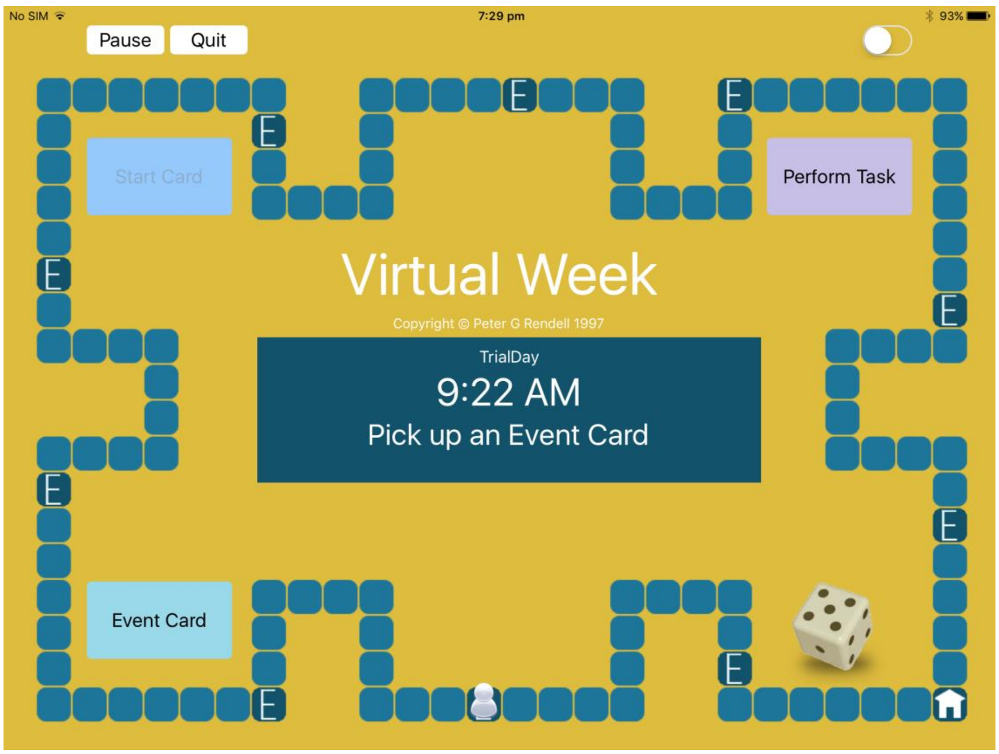
At the end of the game, participants received two scores, namely the *number of correct items acquired* and the *number of correct items used*. The *number of correct items acquired* variable reflected children's ability to act in the present (i.e. to obtain a correct item) with the anticipated future in mind, whereas the *number of correct items used* variable reflected children's ability to perform an independently generated intention to resolve a problem at the appropriate time (Lyons et al., 2014). Together, these two variables were used to index participants' level of episodic foresight. Reliability estimates calculated using Cronbach's alpha for Study 2 were .53 for item acquisition and .62 for item use.

3.4.3 Prospective Memory

In Study 3, PM was measured using Virtual Week-Prospective Memory (VW-PM; Rendell & Craik, 2000), a computerised board game designed to represent PM in everyday life. It has been shown to be a reliable measure of PM (Rose et al., 2010) and the adapted version for children has been shown to have a split-half reliability between .78 and .84 for typically developing children aged 8 to 12 years (Henry et al., 2014). VW-PM has a similar interface to VW-Foresight but involves different activities and places different cognitive demands on participants (see Figure 3.3). Unlike VW-Foresight which was presented on a laptop, VW-PM was adapted to be administered on an iPad for the current study and was visually quite distinct from VW-Foresight, which helped reduce any possible carry over effects for participants having previously completed VW-Foresight.

Figure 3.3

Children's Virtual Week-Prospective Memory iPad Version Game Interface



When playing the VW-PM game, children moved a token around the board by rolling a die. One full circuit of the board represented one virtual day and the centre of the board displayed the day and time. For every two squares the token moved, 15 minutes of virtual time elapsed. Participants were prompted to pick up *Event Cards* each time they landed on or passed a square marked with an ‘E’. Each virtual day contained ten of these *Event Cards* that presented a different activity appropriate for the time of the day, such as eating breakfast (see Appendix D-1). In response to each *Event Card*, participants were required to choose from three options related to the activity presented on the card. For example, for the *Event Card* that involved eating breakfast, three options were presented regarding the type of toast (crunchy peanut butter, smooth peanut butter, or plain buttered toast). Each option was associated with a different consequence in terms of the number on the die participants then needed to roll (e.g. ‘roll any number’, or ‘roll a four’) before they could continue on in the game. The act of moving the token, rolling the die, and reading and choosing options on *Event Cards* constituted the ongoing task, which is a vital component of PM paradigms (Einstein & McDaniel, 1990).

Children were also asked to perform PM tasks that were embedded in the game. Each virtual day included eight PM tasks (four event-based and four time-based). Event-based tasks were completed when the relevant *Event Card* was selected, while time-based tasks were performed when the clock on the board indicated a specific time. Four of the PM tasks (two event-based and two time-based) were the same each virtual day and were designed to replicate regular daily activities. The two event-based tasks of this nature involved taking antibiotics at breakfast and dinner, and the two time-based tasks involved using an asthma inhaler at 11am and 9pm (see Appendix D-2). Instructions to carry out these tasks were given once a Trial Day was completed. More specifically, following Trial Day, and before starting the two virtual days, participants were required to read the task instructions aloud twice and then recite them once from memory without looking at the iPad. This was to confirm that they understood what was required for these PM tasks.

Two other PM tasks (one event-based and one time-based) were presented on *Start Cards* which participants were instructed to pick up at the start of each virtual day. Two additional PM tasks (one event-based and one time-based) were presented later in the game as participants moved around the board. These tasks differed each day and represent tasks that occasionally need to be carried out in everyday life, for example "Collect your trophy for running when you are at physical education class" (see Appendix D-3). Participants completed PM tasks by clicking on the *Perform Task* button located on the board (either in response to an event presented on an *Event Card* or at a particular time on the virtual clock). Clicking the *Perform Task* button presented participants with a list of tasks, from which they selected the task that needed to be completed (see Appendix D-4).

3.4.3.1 Retrospective Memory for the Content of PM tasks

At the completion of each virtual day in VW-PM, participants were presented with *Task Review Cards* to assess retrospective memory for the content of PM tasks (see Appendix D-5). This required participants to match each PM task completed on the day (e.g. buy some pencils) with the relevant PM cue (e.g. when shopping). Four distractor tasks were also included on the *Task Review Cards* and participants were expected to indicate that these actions were 'not required'. This task was used to measure children's retrospective memory for the content of PM tasks.

3.4.3.2 Procedure for Administering VW-PM

Similar to VW-Foresight, participants were first taken through a Trial Day during which instructions to play the game were explained before the beginning of the test conditions. Once the Trial Day was completed, two virtual days were administered (Monday and Tuesday). During the game, participants performed eight event-based and eight time-based PM tasks in total. Responses were considered correct if completed at the specified time or when the specific *Event Card* was encountered. This required participants to perform the task directly after the die roll that moved their token on or past the square on the board that corresponded with the specified time, or directly after picking up the specific *Event Card*. Tasks were only considered correctly performed if completed before they rolled the die again. The proportion of correct responses for the different PM task types (event-based and time-based) was used to measure PM performance.

It should be noted that Study 3 used the 2-day version of VW-PM. This version differs from longer versions (e.g. 3-day and 7-day) used in some previous PM studies that have used VW-PM, in that the longer versions allowed for further distinction of PM tasks into regular event-based and time-based tasks and irregular event-based and time-based tasks. *Irregular* tasks are different each day and reflect tasks that occasionally need to be performed in everyday life (e.g. buy pencils when shopping). By contrast, *regular* tasks are the same each day and are carried out daily in the game (e.g. take antibiotics every day at breakfast). This repetition is argued to lead to better encoding of task content and therefore reduces the demands on retrospective memory, making the regular tasks less cognitively demanding than the irregular tasks (Rendell et al., 2007; Rendell & Henry, 2009; Rose et al., 2010). However, given the 2-day version of the game restricts the opportunity for the regular tasks to be overlearned due to the limited exposure in this shorter version of the game, the regular versus irregular task distinction was not addressed in Study 3.

3.4.4 Executive Functions

3.4.4.1 Inhibition

The Delis-Kaplan Executive Functioning System (D-KEFS; Delis et al., 2001) is a standardised test battery consisting of nine subtests measuring different executive functions in children and adults. All three studies used the D-KEFS Colour-Word Interference Test (Delis et al., 2001) to measure inhibition. The Colour-Word Interference Test consists of four conditions: colour naming, word reading, inhibition, and inhibition/switching. Children completed the first three conditions, with the first two conditions presented as preliminary conditions to familiarise participants with the task. The variable of interest (i.e. inhibition) was measured in the inhibition condition. In this condition, colour names were printed in different coloured ink. Participants were asked to say the ink colour and not the colour name as quickly and accurately as possible. Participants' raw completion time was used to measure inhibition, with slower times indicating a poorer ability to inhibit automatic responses. The D-KEFS Colour-Word Interference Test has internal consistency ranging from .72 to .79 for children aged 8 to 12 years and test-retest reliability ranging from .77 to .90 for 8 to 19 year olds (Delis et al., 2001).

3.4.4.2 Cognitive Flexibility

In all three studies, cognitive flexibility was assessed using the D-KEFS Trail Making Test (Delis et al., 2001), which consists of five conditions: visual scanning, number sequencing, letter sequencing, number-letter switching, and motor speed. Participants completed the first four conditions, with the visual scanning, number sequencing, and letter sequencing conditions administered as preliminary conditions to familiarise participants with the task. The variable of interest (i.e. cognitive flexibility), was then measured in the number-letter switching condition. In this condition, participants switched between drawing a line to connect numbers and letters in order as quickly and accurately as possible. Participants' raw completion time was used to measure cognitive flexibility, with higher scores indicating poorer cognitive flexibility. The D-KEFS Trail Making Test has internal consistency ranging from .57 to .79 for children aged 8 to 12 years and test-retest reliability ranging from .20 to .82 for 8 to 19 year olds (Delis et al., 2001).

3.4.4.3 Working Memory

The Letter-Number Sequencing subtest from the Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V; Wechsler, 2014) was used to measure working memory in all three studies. The WISC-V is a standardised measure of children's intellectual abilities consisting of ten primary subtests and six secondary subtests. The Letter-Number Sequencing subtest of the WISC-V involved verbally presenting participants with a series of letters and numbers that they were then asked to recall in numerical and alphabetical order. In sets of three sequences per item, participants were presented with demonstration and sample items followed by ten test item sets. Item sets increased in length from two (one number and one letter) to eight (four numbers and four letters). Children received a score for the number of sequences recalled correctly. The raw Letter-Number Sequencing score was used to measure working memory, where a higher score indicated greater working memory capacity (maximum = 30). The overall reliability for Letter-Number Sequencing is .86 (Wechsler, 2014).

3.4.5 Retrospective Memory

The List Memory Delayed condition from the NEPSY-II (Korkman et al., 2007) was used to index retrospective memory in Study 2. The List Memory Delayed is part of the List Memory and List Memory Delayed subtest. Participants were first read a list of 15 words which they were then asked to immediately recall in any order over five separate trials. This was followed by an interference trial, where a different list of 15 words were presented and children were asked to recall the new list. Immediately following the interference trial, participants were asked to recall the first list, without the experimenter repeating the list of words they had to recall. The List Memory Delayed condition was administered following a 25-30 minute interval. Children were asked to recall as many words from the first list as possible and were provided with the first word from the list, *store*, as a cue. Children received one point for each word correctly recalled. The raw List Memory Delayed score was used as an index of retrospective memory, where higher scores indicated better retrospective memory ability (maximum = 15). The List Memory and List Memory Delayed subtest has an internal consistency of .91 and test-retest reliability of .75 for children aged 7 to 10 years (Korkman et al., 2007).

3.5 Procedure

Ethical approval of this project including approval for the testing materials, information letter, and consent forms, was granted by the Australian Catholic University Human Research Ethics Committee prior to recruitment (see Appendix E). Before testing, parents of participants were sent an information letter informing them about the study (see Appendix F) and a consent form for both themselves and their child to sign (see Appendix G) which confirmed their agreement to participate. Participants were tested in their homes across two sessions. Both sessions required approximately two hours to complete, with regular breaks included between tasks to minimise fatigue. At least one parent or guardian was required to be present throughout both testing sessions. The order of task administration for participants is outlined in Figure 3.4.

In the first session, once informed consent had been provided, participants first completed a measure of episodic foresight (VW-Foresight; Lyons et al., 2014), administered on a laptop. Following this, participants completed the first condition of a measure of retrospective memory (NEPSY-II List Memory Test immediate condition; Korkman et al., 2007). Participants then completed a measure of general cognitive ability (WASI-II; Wechsler, 2011). The NEPSY-II List Memory Test delayed condition was administered 25-30 minutes following the immediate condition, which was at the conclusion of the WASI-II. In this session, parents were also asked to complete a background questionnaire to gather demographic information and to confirm participants met eligibility criteria.

The second session occurred approximately four weeks later. In the second session, participants first completed a measure of PM (VW-PM; Rendell & Craik, 2000), administered on an iPad. Following this, participants completed a measure of EFT (AI; Addis et al., 2008), administered in an interview format and audiotaped for scoring. Participants then completed measures of cognitive flexibility (D-KEFS Trail Making Test; Delis et al., 2001) and inhibition (D-KEFS Colour-Word Interference Test; Delis et al., 2001). Lastly, participants completed a measure of working memory (WISC-V Letter-Number Sequencing subtest; Wechsler, 2014). Following completion of both sessions, all participants received one adult and one child movie voucher as reimbursement for their time. All data collected and used for the current research was de-identified.

Figure 3.4

Task Administration Procedure for Testing Sessions

Session 1	**Session 2**
VW-Foresight	VW-PM
NEPSY-II List Memory	Autobiographical Interview
WASI-II	D-KEFS Trail Making Test
NEPSY-II List Memory Delayed	D-KEFS Colour-Word Interference Test
Background Questionnaire (Parent Completed)	WISC-V Letter-Number Sequencing

3.6 General Statistical Analyses

Power analyses were calculated using G*Power 3.1.9.2 to determine an appropriate sample size for the current research with an alpha level of .05, power of .80, and effect sizes obtained from previous studies. More specifically, in relation to correlational analyses, previous research has found evidence of moderate effect sizes for the relationship between age and EFT ability, age and PM performance, and between children's EFT ability and PM performance (Nigro et al., 2014; Terrett et al., 2019). Power analyses using these effect sizes produced estimated sample sizes ranging from 44 to 133 participants. Estimation for the multiple regression analyses was difficult due to the lack of previous research investigating predictors of EFT, episodic foresight, and PM in children aged 8 to 12 years. Of the limited research, one study investigating EFT among children with Autism Spectrum Disorder observed a large effect (Cohen, 1992) for a multiple regression analysis examining predictors of EFT among the control group of 30 typically developing children (Terrett et al., 2013). Terrett et al. (2019) similarly observed large effects for multiple regression analyses examining predictors of regular event-based, irregular event-based, and regular time-based PM performance and among 62 typically developing children. Following this, the current sample of 80 participants was deemed appropriate for correlational and regression analyses.

Data collected for the three studies were screened and cleaned prior to completing analyses. Two cases were identified as univariate outliers on the D-KEFS Colour-Word Interference Test with *z*-scores greater than 3.29 (Tabachnick & Fidell, 2014). All variables were assessed for normality and two variables, D-KEFS Colour-Word Interference Test and D-KEFS Trail Making Test were identified as positively skewed and one variable, VW-Foresight items acquired, was identified as negatively skewed. Square root and log transformations were applied to these three variables where appropriate in order to address outliers and reduce skewness (Tabachnick & Fidell, 2014). Correlation and multiple regression analyses were conducted using transformed data. Analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 26.0 for Windows (IBM Corp). Intercorrelations between all variables are shown in Table H.1 in Appendix H. Further details regarding analyses are provided in the empirical studies in chapters 4, 5, and 6 of this thesis.

Chapter 4: Study 1 – Episodic Future Thinking in Middle Childhood

Preamble

This chapter presents the first empirical study of the thesis. Study 1 aimed to explore future-oriented thinking in middle childhood by investigating a foundational form of this general ability, namely episodic future thinking (EFT). This study investigated EFT in 8 to 12 year old children and the cognitive mechanisms that may underpin this ability. As noted in the review of the literature in Chapter 2, the research to date on EFT in children has primarily focused on the preschool period, with fewer studies as yet examining children's EFT abilities in middle childhood. This study aimed to clarify the picture of EFT across this age band, particularly whether EFT is associated with age, using a frequently used measure of EFT, the adapted Autobiographical Interview (AI). A second key focus of Study 1 was to examine the cognitive abilities that might underpin EFT in middle childhood, specifically episodic memory and executive functions. While the role of episodic memory in EFT has often been explored in the wider EFT literature, research involving children is more limited. In addition, data concerning the relationship between executive functions and EFT, particularly in children, is scarce and findings are inconsistent. The current study therefore sought to clarify whether these cognitive abilities contributed to EFT in children aged 8 to 12 years.

4.1 Introduction

The capacity to engage in mental time travel in order to mentally experience future events, referred to as episodic further thinking (EFT), is a uniquely human ability (Addis et al., 2008; Atance & O'Neill, 2001; Suddendorf et al., 2009; Tulving, 2005). EFT is considered an important cognitive capacity as much of our behaviour is driven by our ability to imagine future events to achieve distant goals (Martin-Ordas et al., 2012; Suddendorf, 2006). Research investigating the development of EFT in children has predominantly examined the emergence of this ability in the preschool years at approximately 4 years of age (Atance, 2008; Atance & Jackson, 2009; Atance & Meltzoff, 2005, 2006; Atance & Metcalf, 2013; Atance & O'Neill, 2005a; Busby Grant & Suddendorf, 2010; Busby & Suddendorf, 2005; Quon & Atance, 2010).

In contrast, relatively little research has investigated EFT in older children, particularly in the primary school years (Coughlin et al., 2014; Coughlin et al., 2019; Mahy & Atance, 2016). Furthermore, studies that have examined EFT in middle childhood have found mixed evidence regarding age-related changes in this developmental period (Coughlin et al., 2014; Coughlin et al., 2019; Gott & Lah, 2014; Terrett et al., 2019; Wang et al., 2014). For example, Coughlin et al. (2014) found significant improvements in children's capacity to provide detailed descriptions of personal future events between 5 to 9 years of age, however differences in performance between a group of 5 to 7 year olds and a group of 7 to 9 year olds were not significant. Gott and Lah (2014) also examined this ability in 8 to 10 and 14 to 16 year olds, finding the adolescent group was able to describe future events in significantly greater detail than the younger group. More recently, Coughlin et al. (2019) found significant improvements with age when comparing EFT ability in 5, 7, 9, and 11 year old children. Furthermore, 5 to 9 year olds required a greater number of prompts when generating future events than the older children (Coughlin et al., 2019). However, some studies have found no evidence of age-related improvements. For example, Wang et al. (2014) did not find any age-related improvements in the amount of episodic details produced by 7 to 10 year olds, and Terrett et al. (2019) found 8 to 12 year olds' EFT ability was not correlated with age. Given the limited number of studies and the mixed findings to date regarding age-related improvements, it appears that additional research is required to clarify the picture of EFT ability in the middle childhood period.

One factor potentially contributing to the mixed findings is the challenge of measuring EFT in children. Researchers have primarily relied on verbal tasks that require children to verbally describe future events, for example, asking them to report their activities from the previous day and those they would do the following day (Busby & Suddendorf, 2005), or asking them to describe going on a trip in the future (Atance & O'Neill, 2005b). One difficulty with the scoring of these types of verbal tasks however lies in distinguishing between children's capacity to generate a personal representation of a future scenario, versus their use of semantic details and general knowledge of what a future event would be like (Atance & O'Neill, 2001). Consequently, researchers have suggested that asking children to describe an event they have not previously experienced may provide a more accurate reflection of EFT (Atance & O'Neill, 2005a).

One measure of EFT that uses this approach is the Autobiographical Interview (AI), originally developed by Levine et al. (2002) and adapted by Addis et al. (2008) to assess EFT in older adults. Frequently used in the literature (for reviews see Miloyan, McFarlane, & Vasquez-Echeverria, 2019; Miloyan & McFarlane, 2019), the AI requires participants to describe their experiences of past personal events and novel future events. In the AI, episodic knowledge of the future is reflected in the amount of internal details (personal to the event) that participants produce when describing future events, and is distinguished from the number of external details (details unrelated to personal experience of the event) provided by participants. Among studies with children, an adapted children's version of the AI has been used to compare EFT abilities in typically developing children and children with autism spectrum disorder (Terrett et al., 2013) and has also been used to identify the role of EFT in other future-oriented abilities in typically developing children (Terrett et al., 2019). The AI may therefore be considered a valuable measure for further investigation of EFT ability in children.

In addition to disentangling the picture of children's EFT ability across middle childhood, a key question yet to be fully addressed concerns the identification of cognitive mechanisms that may underpin EFT. The literature has paid particular attention to episodic memory and executive functions as potential contributors to EFT (D'Argembeau et al., 2010; Schacter et al., 2007; Schacter et al., 2012; Suddendorf & Corballis, 1997, 2007; Tulving, 2005). However, the research examining the relationship between these abilities, especially in the middle childhood period, is limited.

The relationship between episodic memory and EFT has been given considerable focus in the future-oriented thinking literature. Indeed, researchers have suggested that episodic memory plays a critical role in the mental simulation of future events (Buckner & Carroll, 2007; Schacter & Addis, 2007a; Schacter et al., 2007; Suddendorf & Corballis, 1997, 2007; Tulving, 2005). The primary theory supporting this proposal is the constructive episodic simulation hypothesis, which postulates that our capacity to mentally envisage ourselves experiencing future events requires us to retrieve relevant information from our personal past memories, which we then flexibly use to construct novel and plausible future events in our imagination (Addis et al., 2008; Schacter & Addis, 2007a; Schacter et al., 2007; Schacter et al., 2017).

Numerous studies have provided evidence to support a relationship between episodic memory and EFT. For example, studies examining individuals with episodic memory impairment have found they also have difficulty constructing personal future events and making predictions about the future (Buckner & Carroll, 2007; Hassabis et al., 2007; Klein et al., 2002; Levine et al., 1998; Schacter & Addis, 2007a; Tulving, 1985, 2002). Further supporting this link, studies have found a core brain network is activated when remembering events from the past and when imagining events in the future (for a review see Miloyan, McFarlane, & Suddendorf, 2019; Schacter et al., 2012; Weiler et al., 2010). For instance, Ostby et al. (2012) found functional connectivity and local cortical expansion within this core network was associated with the quality of past experiences recalled and future events imagined by children and adolescents. In addition, research examining EFT in preschool children found their EFT ability to be constrained by their episodic memory performance (Prabhakar & Ghetti, 2019; Prabhakar & Hudson, 2019), while among older children (5, 7, and 9 year olds), individual differences in episodic memory have been found to predict EFT ability (Coughlin et al., 2014). Episodic memory has also been shown to be the most robust predictor of EFT among 5 to 11 year olds, even after controlling for age (Coughlin et al., 2019). As episodic memory has been found to continue to develop across middle childhood (Ghetti et al., 2011; Picard et al., 2009;

Piolino et al., 2007), it is likely an important factor to consider when examining contributors to EFT in this age band.

In regard to the role of executive functions in EFT, it has been suggested that, in order to simulate future events, we need to hold relevant details retrieved from long term memory in mind, flexibly recombine and manipulate those disparate details to construct a novel future scenario, and inhibit the retrieval of irrelevant information from long term memory (D'Argembeau et al., 2010; Schacter & Addis, 2007a; Suddendorf & Corballis, 1997, 2007). Given this process, it is not surprising that the literature exploring the role of executive functions in EFT has primarily drawn on Miyake’s three function model of executive functions which comprises working memory, cognitive flexibility, and inhibition (Miyake et al., 2000). Even so, findings from studies investigating the relationship between executive functions and EFT are limited and findings are inconsistent. For, example, studies have shown executive functions contributed to EFT in healthy younger adults (D'Argembeau et al., 2010) and older adults (Cole et al., 2013) and deficits in EFT have been found to be related to poor executive functioning among adults with Parkinson’s Disease (de Vito et al., 2012). However, several studies have found no association between EFT and executive functions in a range of adult populations (Addis et al., 2008; Brown et al., 2014; Irish et al., 2013; Mercuri et al., 2015; Mercuri et al., 2018).

Few studies have examined the association between executive functions and EFT in children, and current findings are similarly inconsistent. For example, no association was found between executive functioning and EFT among 3 to 5 year old children (Hanson et al., 2014; Unal & Hohenberger, 2017). In a study of older children, however, Gott and Lah (2014) found 8 to 10 and 14 to 16 year old children’s EFT was associated with their working memory, which may suggest a relationship between these constructs does not occur until later in childhood. In contrast, two studies found no association between EFT ability and cognitive flexibility among 8 to 12 year old typically developing children (Terrett et al., 2019) and children with autism spectrum disorder (Terrett et al., 2013). Thus, while it may be suggested that executive functions play a role in EFT, it is currently difficult to draw firm conclusions given the limited research and inconsistent findings of studies directly investigating a relationship between these abilities in children.

The current study therefore had two aims. The first was to investigate whether children's EFT ability was associated with age across middle childhood. This study extends previous work addressing this issue by including a larger sample size, and using a broader age range (i.e. 8 to 12 years) than earlier studies that generally examined the abilities of children of specific ages (e.g. 5, 7, and 9 year olds) or included more limited age bands (e.g. 7 to 10 years). Furthermore, the current study uses a valuable methodological approach, namely the AI (Addis et al., 2008), that distinguishes EFT from general semantic knowledge. It was predicted that EFT would be associated with age, given previous evidence of age-related improvements in this age band. The second aim was to examine the cognitive abilities that are related to EFT ability in this age group, in light of the limited number of studies that have addressed this question in middle childhood. Specifically, this study aimed to further understanding of the contribution of episodic memory and executive functions to EFT in this age band.

In line with previous findings and theoretical claims, it was hypothesised children's episodic memory would significantly contribute to their EFT ability. While executive functions have been noted in the literature as potential contributors to EFT, the limited research and mixed findings of previous studies makes it difficult to propose specific hypotheses regarding their contribution to children's EFT ability. Furthermore, studies have typically investigated the association between EFT and children's performance on one or two executive function tasks. An additional aspect of this second aim therefore was to examine the contribution of executive functions using separate measures to index inhibition, cognitive flexibility, and working memory.

4.2 Method

A detailed methodology is provided in Chapter 3 of this thesis. A summary is provided here to facilitate comprehension.

4.2.1 Participants

80 participants were included in this study, 42 girls and 39 boys aged 8 years 0 months to 12 years 6 months (*M* = 122.4 months, *SD* = 16.1). Of the 81 children recruited to take part in the testing sessions (see Chapter 3 for a description of the recruitment process), one participant was excluded due to reading difficulties. Participants' IQs, assessed by the Wechsler Abbreviated Scale of Intelligence-2nd Edition (WASI-II; Wechsler, 2011), were all within the normal range (Full Scale IQ range 80-128, *M* = 108.2, *SD* = 10.6).

4.2.2 Measures

4.2.2.1 General Cognitive Ability

The Wechsler Abbreviated Scale of Intelligence-Second Edition (WASI-II; Wechsler, 2011) is a measure of general cognitive ability consisting of four subtests: Vocabulary, Similarities, Block Design, and Matrix Reasoning. When combined, these subtests form the Verbal Comprehension Index (VCI), Perceptual Reasoning Index (PRI), and Full Scale IQ (FSIQ). The FSIQ was used as a measure of participants' general cognitive ability. A higher FSIQ score indicated greater general cognitive ability. The FSIQ composite has internal consistency ranging from .92 to .96 and test-retest reliability ranging from .79 to .92 for 6 to 16 year olds (Wechsler, 2011).

4.2.2.2 Executive Functions

The inhibition condition of the Colour-Word Interference Test from the Delis-Kaplan Executive Functioning System (D-KEFS; Delis et al., 2001) was used to measure inhibition. Participants were presented with colour words printed in a different coloured ink. Participants were asked to say the ink colour and not the colour word as quickly and accurately as possible. Participants' completion time was used as an index of inhibition, with slower completion times indicating a poorer ability to inhibit automatic responses. The D-KEFS Colour-Word Interference Test has internal consistency ranging from .72 to .79 for 8 to 12 year olds and test-retest reliability ranging from .77 to .90 for 8 to 19 year olds (Delis et al., 2001).

The number-letter switching condition of the Trail Making Test from D-KEFS was used to measure cognitive flexibility. Participants switched between drawing a line to connect numbers and letters in order as quickly and accurately as possible. Participants' completion time was used to index cognitive flexibility, with slower completion times indicating poorer cognitive flexibility. The D-KEFS Trail Making Test has internal consistency ranging from .57 to .79 for children aged 8 to 12 years and test-retest reliability ranging from .20 to .82 for 8 to 19 year olds (Delis et al., 2001).

The Letter-Number Sequencing subtest from the Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V; Wechsler, 2014) was used as a measure of working memory. Participants were verbally presented with a series of letters and numbers they were then asked to recall in numerical and alphabetical order. Sequences increased in length from two (one number and one letter) to eight (four numbers and four letters). Children received a score for the number of sequences recalled correctly (maximum = 30). A higher score indicated greater working memory capacity. The Letter-Number Sequencing subtest has an overall reliability of .86 (Wechsler, 2014).

4.2.2.3 Episodic Future Thinking and Episodic Memory

The adapted version of the Autobiographical Interview (AI; Addis et al., 2008) was used to measure EFT. The AI measured the amount of episodic details participants produced when describing events they had experienced in the past and events they could imagine experiencing in the future in response to a cue word. Following the procedure of Terrett et al. (2013), four cue words, two positive (*friend* and *easy*) and two negative (*naughty* and *tired*), were taken from the autobiographical memory test developed by Vrielynck et al. (2007) for 9 to 13 year old children. Participants completed two trials (one positive and one negative word) in either the past or future condition, before the completing the other condition. The order of temporal conditions, as well as positive and negative word selection, was counterbalanced across participants. For each three-minute trial, children were required to produce as many details as possible about a past event they had experienced or a future event they could imagine themselves experiencing in response to the cue word presented to them on a card. Participant responses for each of the four trials were audiotaped and transcribed for scoring by an independent scorer, trained in the standardised scoring procedure provided to the researcher by Donna Rose Addis. This procedure involved identifying a main event or theme in participants' responses for each trial. This was then divided into key details, categorised as either *internal* (episodic information specific to the main event described) or *external* (repetitions, non-episodic and semantic details, and details unrelated to the event described). The number of internal details participants produced for both future events combined was used as an index of EFT. The number of internal details produced for both past events combined was used as an index of episodic memory. In the current study, inter-rater reliability calculated using Cronbach's alpha was .98 for internal details and .87 for external details.

4.2.3 Procedure

Informed consent was obtained from participants' parents before testing commenced. Participants completed the measures included in Study 1 as part of a larger test battery administered across two, 2-hour sessions with regular breaks between tasks (see Chapter 3 for an overview of procedures). The WASI-II was completed in the first session and the AI, D-KEFS subtests (Colour-Word Interference Test and Trail Making Test), and WISC-V Letter-Number Sequencing subtest, were completed in the second session. The research was conducted with the approval of the Human Research Ethics Committee of Australian Catholic University (HREC 2018-145H; "Future-oriented thinking in middle childhood").

4.2.4 Data Analysis

All statistical tests were conducted using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp). All statistical tests were two-tailed and an alpha level of $p < .05$ was considered significant in all analyses. Raw scores on all measures were used in all analyses, except for the WASI-II where composite scores were used. Outliers with *z*-scores greater than 3.29 were brought in as per procedures outlined by Tabachnick and Fidell (2014). All variables were assessed for normality, and square root and log transformations were applied where appropriate to reduce skewness (Tabachnick & Fidell, 2014). Descriptive statistics are presented in Table 4.1.

Table 4.1

Descriptive Statistics for Scores on the Autobiographical Interview and Executive Functioning

	Min	Max	*M*	*SD*
Autobiographical Interview[a]				
Past internal	14.0	125.0	58.8	24.7
Future internal	17.0	93.0	45.4	16.6
Past external	1.0	66.0	17.6	11.8
Future external	1.0	71.0	19.6	13.7
Executive Functioning				
Inhibition	49.0	180.0	83.5	25.2
Cognitive flexibility	43.0	240.0	114.2	50.6
Working memory	9.0	23.0	17.4	2.7

Note. Descriptive statistics were calculated for untransformed data for ease of interpretation.

[a]Total number of details produced per temporal direction and detail type on the AI.

4.3 Results

4.3.1 Correlational Analyses

In order to examine the relationship between EFT and age, Pearson bivariate correlations were first conducted between age and EFT, indexed by the total number of internal details generated for future events on the AI. A significant positive correlation was found between age and children's EFT ability ($r(80) = .26$, $p = .02$), indicating a small improvement in EFT ability as the age of children increased.

The next step was to explore relationships between EFT (number of future internal details generated on the AI) and episodic memory (number of past internal details generated on the AI) and executive functions using partial correlations controlling for age (Table 4.2). A significant strong positive correlation was found between children's EFT ability and episodic memory. In relation to executive functions, correlations between EFT and inhibition, cognitive flexibility, and working memory were not significant.

Table 4.2

Partial Correlations between Episodic Future Thinking and Episodic Memory and Executive Functioning Controlling for Age

	Episodic Future Thinking[a]
Episodic memory[b]	.54***
Executive functioning	
Inhibition	-.08
Cognitive flexibility	.09
Working memory	.06

[a]Autobiographical Interview total future internal details.

[b]Autobiographical Interview total past internal details.

* $p \le .05$. ** $p \le .01$. *** $p \le .001$.

4.3.2 Hierarchical Multiple Regression Analysis

A hierarchical multiple regression analysis was then conducted to examine the contributors to children's EFT ability. Age and IQ[1] were first entered into the regression analysis. Episodic memory and executive functioning indexed by inhibition, cognitive flexibility, and working memory were entered at step two in order to explore whether they accounted for unique variance in EFT ability after accounting for the contribution of age and IQ.

Results of the hierarchical multiple regression analysis are shown in Table 4.3. Age and IQ did not significantly contribute to EFT, $R^2 = .07$, adjusted $R^2 = .05$, $F(2,77) = 2.85$, $p = .06$. The addition of episodic memory, inhibition, cognitive flexibility, and working memory significantly improved the model, explaining an additional 32% of the variance in children's EFT, $\Delta R^2 = .32$, $\Delta F(4,73) = 9.31$, $p < .001$. The combination of all six variables explained 38% of the variance in children's EFT, $R^2 = .38$, adjusted $R^2 = .33$, $F(6,73) = 7.57$, $p < .001$. In the final model, episodic memory was identified as the only significant contributor to EFT.

[1] To account for the verbal demands of the AI, a hierarchical multiple regression analysis was also conducted using the WASI-II Verbal Comprehension Index (VCI). This produced a similar pattern of results to FSIQ. FSIQ was included in the final analysis due to the greater reliability of this index score.

Table 4.3

Hierarchical Multiple Regression Analysis Predicting Episodic Future Thinking from Age, IQ, Episodic Memory, and Executive Functioning

	β	sr^2	R^2	ΔR^2
Step 1			.07	
Age	.26*	.07		
FSIQ	-.01	.00		
Step 2			.38	.32
Age	.05	.00		
FSIQ	-.19	.03		
Episodic memory	.58***	.27		
Inhibition	.05	.00		
Cognitive flexibility	-.10	.00		
Working memory	.18	.02		

Note. FSIQ = Full Scale IQ.

* $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

4.4 Discussion

The current study had two key aims, (1) to investigate whether EFT was associated with age across middle childhood, and (2) to examine the cognitive abilities that may drive EFT, over and above any potential contribution of age and general cognitive ability. In relation to the first aim, a significant, albeit relatively small, positive correlation was found between age and EFT, indicating a degree of age-related improvement in children’s ability to mentally envisage a future scenario across the ages of 8 to 12 years. While EFT has previously been shown in some studies to be relatively stable across middle childhood (Terrett et al., 2019; Wang et al., 2014), the current findings provide support for other studies that have found improvements in EFT ability across this age group (Coughlin et al., 2014; Coughlin et al., 2019). An important next step will be to investigate children's EFT ability using longitudinal designs, in order to build a more comprehensive picture of the development of EFT across middle childhood and into adolescence.

In relation to the second aim, children's episodic memory, specifically the amount of details participants could describe about a past experience, was found to be strongly associated with their EFT ability. In addition, results of the multiple regression analysis demonstrated that episodic memory was not only a strong contributor, but was the only contributor to EFT, after controlling for age and IQ. This finding aligns with previous research that found episodic memory to contribute to EFT in younger children (Prabhakar & Ghetti, 2019; Prabhakar & Hudson, 2019) and other studies of children in this age group (Coughlin et al., 2014; Coughlin et al., 2019; Gott & Lah, 2014; Terrett et al., 2013). This finding also provides further support for the theoretical proposal that episodic memory plays an important role in EFT by providing the basic building blocks of information used to construct future scenarios in imagination (Buckner & Carroll, 2007; Schacter & Addis, 2007a; Schacter et al., 2007; Suddendorf & Corballis, 1997, 2007; Tulving, 2005).

Interestingly, findings regarding the contribution of executive functions were in stark contrast to those relating to episodic memory, as results indicated almost no association nor contribution from inhibition, cognitive flexibility, or working memory to children's EFT ability. While not consistent with some theoretical arguments

(D'Argembeau et al., 2010; Schacter & Addis, 2007a; Suddendorf & Corballis, 1997, 2007), these findings are consistent with other empirical studies that have failed to identify any association between executive functions and EFT in preschool children (Hanson et al., 2014; Unal & Hohenberger, 2017), primary school aged children (Terrett et al., 2019; Terrett et al., 2013), and adults (Addis et al., 2008; Brown et al., 2014; Irish et al., 2013; Mercuri et al., 2015; Mercuri et al., 2018). While executive functions have been implicated in a number of applied cognitive tasks, the current findings suggest that greater executive functioning does not contribute to a better ability to imagine future scenarios. Taken together with similar previous findings, this suggests that EFT is a unique cognitive task, for which executive functions are not critical. As such, EFT may be regarded as an important fundamental process that should be independently assessed and considered, rather than viewed as being simply a proxy for core executive functions. Nevertheless, given the limited number of studies exploring the relationship between these constructs and the wide range of executive function measures that have been used in studies of children and adults, it appears that further research is still required to tease out the relationship between executive functions and EFT across the lifespan.

One limitation of the present study relates to the use of the AI, which required participants to verbally describe recalled and imagined events in detail. It is possible that differences in children's AI responses may have, to some extent, reflected individual differences in narrative ability rather than the capacity to envisage a future scenario in imagination (see Coughlin et al., 2019; Gaesser et al., 2011). It will therefore be beneficial for future studies to include a measure of narrative ability when investigating EFT in children. Despite this limitation, the current study has important implications regarding the capacity of children to engage in EFT. Firstly, identifying that increases in EFT ability were associated with age across middle childhood adds to the limited emerging literature exploring the development of EFT after the preschool years. Understanding that children are still developing EFT across the ages of 8 to 12 is particularly important, given that EFT has been noted to play an important role in everyday living (Coughlin et al., 2019; Prabhakar et al., 2016; Terrett et al., 2013). For example, EFT has been found to be associated with prosocial behaviour (Gaesser et al., 2015), decision making (Bromberg et al., 2015), and prospective memory (Nigro et al., 2014; Terrett et al., 2019; Terrett, Rose, et al., 2016). Supporting children's engagement in EFT may be beneficial for scaffolding the development of these skills in daily life.

In conclusion, this study is one of the few to explore EFT ability in children aged 8 to 12 years. Furthermore, it is one of the first to examine a comprehensive number of contributors to EFT in children, finding episodic memory to be the strongest contributor to this ability in this age band. Further research utilising longitudinal research designs is now needed to clarify the developmental trajectory of EFT across childhood into adolescence and to examine the relative contribution of abilities, such as executive functions, across development.

Chapter 5: Study 2 – Episodic Foresight in Middle Childhood

Preamble

This chapter presents the second empirical study of the thesis. Study 2 aimed to extend exploration of future-oriented thinking in middle childhood by investigating another form of this general ability, namely episodic foresight. This study investigated episodic foresight in 8 to 12 year old children and the cognitive abilities that may underpin this construct. As noted in the review in Chapter 2, the limited research to date on episodic foresight in children has focused on the preschool period, with no studies as yet examining this ability in middle childhood. This study aimed to clarify children's capacity for episodic foresight across this age band, including whether episodic foresight is associated with age, using a recently adapted children's version of a reliable behavioural measure, Virtual Week-Foresight. A second key focus of Study 2 was to examine the cognitive abilities that might underpin successful episodic foresight performance. Of particular interest was the contribution of EFT to episodic foresight, which has not yet been explored in the literature.

5.1 Introduction

Episodic foresight, the ability to imagine future events and to use that experience to guide behaviour in the present (Suddendorf & Moore, 2011), is an important adaptive cognitive ability suggested to be critical for daily living (Baumeister et al., 2016; Suddendorf, 2006, 2017). This is because imagining future experiences arguably allows us to identify future needs and then flexibly consider our actions in the present to ensure those needs are met without having to experience real life consequences (Suddendorf, 2006; Suddendorf & Moore, 2011; Szpunar, 2010). This highly valuable ability thus allows us to take advantage of opportunities to achieve desired outcomes while avoiding future problems (Atance, 2008; Suddendorf, 2017). While research investigating episodic foresight has recently begun to emerge, it has mostly focused on identifying decline with aging and deficits in this ability in clinical groups (Lyons et al., 2014; Lyons et al., 2016; Suddendorf et al., 2011; Terrett, Lyons, et al., 2016). Understanding of how episodic foresight ability normally develops across childhood however is limited and represents a clear gap in current literature.

The few studies conducted that have investigated the development of episodic foresight in children have predominantly examined the preschool years (Mahy & Atance, 2016), with findings indicating some capacity apparent at 4 to 5 years of age (Atance et al., 2015; Atance & Sommerville, 2014; Boden et al., 2017; Moffett et al., 2018; Prabhakar & Hudson, 2014; Redshaw & Suddendorf, 2013; Suddendorf et al., 2011; Suddendorf & Redshaw, 2013). It has however, been suggested that episodic foresight ability in children continues to develop across childhood and adolescence (Suddendorf, 2017; Suddendorf & Redshaw, 2013), but this is yet to be empirically addressed as, at present, no studies have investigated how this ability develops beyond 5 years of age. One factor contributing to the limited research is the paucity of measures designed to encapsulate the practical nature of episodic foresight (Mahy & Atance, 2016; Mazachowsky & Mahy, 2020; Miloyan & McFarlane, 2019; Miloyan, McFarlane, & Suddendorf, 2019). In other words, few currently available measures tap the capacity to take action in the present in order to maximise future success. The need for measures to capture this core characteristic of episodic foresight is highlighted by Suddendorf and colleagues who note that not all future-oriented actions reflect the application of episodic foresight, as some future-oriented actions may be due to learned associations from previous experiences, or may be due to chance (Suddendorf & Busby, 2005; Suddendorf & Corballis, 2010; Suddendorf et al., 2011). To address this, Suddendorf and Corballis (2010) proposed four criteria for valid measures of episodic foresight. These four criteria are: "(a) the use of single trials to avoid repeated exposure to the sample stimulus-reward relationships and to demonstrate memory of a specific event, (b) the use of novel problems to avoid relative learning histories and to demonstrate cognitive processes, (c) the use of different temporal and/or spatial contexts for the crucial future-directed action to avoid cuing and to demonstrate long term-memory, and (d) the use of problems from different domains to avoid specific behavioural dispositions and to demonstrate flexibility" (Suddendorf et al., 2011, p. 27).

One measure that includes these criteria is the two-room task, which was designed to assess episodic foresight in preschool children (Suddendorf & Busby, 2005). In this task, Suddendorf and Busby presented children in the first room with a puzzle board without its puzzle pieces. After two minutes they were taken to a second room filled with a number of unrelated items to play with for five minutes. Following this, participants were presented with several items, any of which they could take back to the first room. One of these options was puzzle pieces. According to the authors, correct selection of the required puzzle pieces demonstrates children's capacity to remember a past problem and use episodic foresight to take steps to solve it in the future (Suddendorf & Busby, 2005). Results from Suddendorf and Busby's study indicated that 4 and 5 year olds were capable of successfully choosing the puzzle pieces above chance level, suggesting children as young as 4 years of age were able to engage in episodic foresight. The two-room paradigm has since been used in a number of studies, all of which have found similar results to those of Suddendorf and Busby among preschool children (Atance et al., 2019; Atance & Sommerville, 2014; Redshaw & Suddendorf, 2013; Suddendorf et al., 2011).

Recently a computerised measure based on the two-room paradigm, Virtual Week-Foresight (VW-Foresight), was created to assess episodic foresight in adults (Lyons et al., 2014), with a parallel children's version recently becoming available. Unlike the two-room paradigm, which only includes one episodic foresight task, an advantage of VW-Foresight is that it measures participants' performance across multiple different tasks. Simulating real-life situations, participants in the game must draw upon episodic foresight in order to successfully complete these tasks. For example, in one task in the children's version, participants are first presented with a problem, such as dropping their glasses and breaking one of the lenses. They are, however, unable to fix it immediately because they are late for school. Later in the game, participants are provided with the opportunity to acquire an item (i.e. their old glasses) when cleaning out their desk at school which may be used to solve the problem. Finally, participants are later provided with a scenario related to the problem (which in this example, involves watching a movie and finding the screen blurry) and have the opportunity to resolve the problem by accessing and using their old glasses. The VW-Foresight adult version has good psychometric properties and is sensitive to episodic foresight difficulties associated with normal adult ageing, opiate use, schizophrenia, and stroke (Lyons et al., 2014; Lyons et al., 2016; Lyons et al., 2019; Terrett, Lyons, et al., 2016). The current study however will be the first to use the VW-Foresight children's version that retains all the general structure and features of the adult version while substantially changing the content to represent plausible activities for children aged 8 to 12.

Another area lacking clarity relates to the cognitive processes that underpin episodic foresight in middle childhood. This is a key question, as an understanding what contributes to successful episodic foresight performance is important for supporting the development of this highly adaptive ability in children. It has been suggested that episodic foresight involves integrating a complex system of cognitive components (Suddendorf & Corballis, 2007). However, research examining relationships between episodic foresight and other cognitive abilities in children is limited.

Retrospective memory has been argued to be critical for episodic foresight (Suddendorf & Corballis, 2007). Indeed, part of Suddendorf and Corballis' criteria is that episodic foresight tasks involve different spatial and/or temporal contexts for the future-directed behaviour so that memory for the initial problem can be demonstrated (Suddendorf & Corballis, 2010). Using the previous example from the children's VW-Foresight game, retrospective memory is likely to be required to remember what the initial problem is (e.g. the broken glasses), in order to take the opportunity, when it is presented, to acquire an item that may be useful later (e.g. their old glasses). Retrospective memory is again likely to be used when the opportunity to solve the problem is presented, as it is necessary to remember that a useful item (i.e. their old glasses) has been acquired. There is currently a measure of empirical support for the role of retrospective memory in episodic foresight. For example, in studies with preschool children it has been noted that successful completion of the two-room task relied foremost on participants' ability to draw upon their memory of the problem (Redshaw & Suddendorf, 2013; Suddendorf & Busby, 2005; Suddendorf et al., 2011). Furthermore, the accuracy of preschool children's memory has been shown to predict the likelihood of their selection of the correct solution (Atance & Sommerville, 2014). While these findings provide some indication that retrospective memory may also be likely to contribute to episodic foresight performance in older children, this is yet to be explored empirically.

A second proposed contributor to episodic foresight is executive functioning (Suddendorf, 2017; Suddendorf & Corballis, 1997; Suddendorf & Redshaw, 2013). It has been theorised that working memory provides the space within which information relevant to the future is held and that inhibition and cognitive flexibility allow one to focus on relevant information and switch between different cognitive demands in order to achieve a desired future outcome (Suddendorf, 2017; Suddendorf & Corballis, 2007; Suddendorf & Redshaw, 2013). As such, executive functioning may be necessary at the point in an episodic foresight task where the preparatory steps in anticipation of future needs should be enacted. In the previously mentioned task example from VW-Foresight, this would be the point where participants would choose to use their old glasses when they find that the movie they are watching is blurry. This arguably requires inhibition of one's current activity (i.e. watching a movie) and cognitive flexibility to shift from one activity to another (i.e. shift from watching a movie to access and use their old glasses). However, limited research has directly investigated the relationship between executive functions and episodic foresight and findings from those studies conducted have been mixed. For example, while one study found healthy adults and opiate users' performances on VW-Foresight were moderately correlated with their executive functioning (Terrett, Lyons, et al., 2016), no association was found in other studies involving younger and older adults (Lyons et al., 2014), adults with schizophrenia (Lyons et al., 2016) and stroke patients (Lyons et al., 2019). In children, no studies have investigated the relationship between executive functions and episodic foresight using a task that adheres to Suddendorf and Corballis' criteria. Consequently, the role of executive functions in episodic foresight remains unclear.

A final ability suggested to contribute to episodic foresight is episodic future thinking (EFT), which refers to the ability to imagine one-self pre-experiencing future events in imagination (Addis et al., 2008; Atance & O'Neill, 2001). Theoretically, episodic foresight has been argued to first involve imagining the self in the future (i.e. EFT) so that future needs may be identified, leading to the taking of steps in the present to ensure that those future needs are met (Suddendorf & Moore, 2011). This, therefore, suggests that EFT may be a core component of episodic foresight. However, no studies have directly examined the relationship between these abilities in adults or children. This represents a major gap in the future-oriented thinking literature and awaits empirical investigation.

The current study therefore had two aims. The first was to investigate whether increasing age across the middle childhood years is associated with improvements in episodic foresight performance using the recently adapted children's version of VW-Foresight. Given it has been argued in the literature that episodic foresight continues to develop into adolescence (Suddendorf, 2017; Suddendorf & Redshaw, 2013), it was hypothesised that age and the capacity for episodic foresight would be significantly related. The second aim was to explore the cognitive abilities that might underlie episodic foresight in this age group. While empirical work is limited and findings somewhat mixed, theoretical arguments suggest retrospective memory, executive functions, and EFT may be anticipated to contribute to episodic foresight.

5.2 Method

A detailed methodology is provided in Chapter 3 of this thesis. A summary is provided here to facilitate comprehension.

5.2.1 Participants

80 participants participated, 42 girls and 39 boys aged 8 years 0 months to 12 years 6 months (*M* = 122.4 months, *SD* = 16.1). Of the 81 children recruited to take part in the testing sessions (see Chapter 3 for a description of the recruitment process), one participant was excluded due to reading difficulties. Participants' IQs, assessed by the Wechsler Abbreviated Scale of Intelligence-2nd Edition (WASI-II; Wechsler, 2011), were all within the normal range (Full Scale IQ range 80-128, *M* = 108.2, *SD* = 10.6).

5.2.2 Measures

5.2.2.1 General Cognitive Ability

The Wechsler Abbreviated Scale of Intelligence-Second Edition (WASI-II; Wechsler, 2011) is a measure of general cognitive ability consisting of four subtests: Vocabulary, Similarities, Block Design, and Matrix Reasoning. When combined, these subtests form the Verbal Comprehension Index (VCI), Perceptual Reasoning Index (PRI), and Full Scale IQ (FSIQ). The FSIQ was used as a measure of participants' general cognitive ability, where a higher FSIQ indicated greater general cognitive ability. The FSIQ composite has internal consistency ranging from .92 to .96 and test-retest reliability ranging from .79 to .92 for children aged 6 to 16 years (Wechsler, 2011).

5.2.2.2 Retrospective Memory

The List Memory Delayed condition from the List Memory and List Memory Delayed subtest of the NEPSY-II (Korkman et al., 2007) was used to measure retrospective memory. Children were read a list of 15 words which they were immediately asked to recall in any order over five separate trials. This was immediately followed by an interference trial, where another list of 15 words was presented, and participants were again asked to recall these words. Following this, participants were asked to recall the first list of words learnt, without the experimenter repeating the list. The List Memory Delayed condition was administered after a 25-30 minute interval. In this condition, children were asked to recall as many words from the first list of words as possible and were provided with the first word in the list, *store*, as a cue. One point was given for each word correctly recalled. The number of correct words on the List Memory Delayed (maximum = 15) was used as an index of participants' retrospective memory ability, where higher scores indicated better retrospective memory ability. The List Memory and List Memory Delayed subtest has an internal consistency of .91 and test-retest reliability of .75 for 7 to 10 year olds (Korkman et al., 2007).

5.2.2.3 Executive Functions

The inhibition condition of the Colour-Word Interference Test from the Delis-Kaplan Executive Functioning System (D-KEFS; Delis et al., 2001) was used to measure inhibition. Participants were presented with colour words printed in a different coloured ink. Participants were asked to say the ink colour and not the colour word as quickly and accurately as possible. Participants' completion time was used as an index of inhibition, with slower completion times indicating a poorer ability to inhibit automatic responses. The D-KEFS Colour-Word Interference Test has internal consistency ranging from .72 to .79 for children aged 8 to 12 years and test-retest reliability ranging from .77 to .90 for 8 to 19 year olds (Delis et al., 2001).

The number-letter switching condition of the Trail Making Test from D-KEFS was used to measure cognitive flexibility. Participants switched between drawing a line to connect numbers and letters in order as quickly and accurately as possible. Participants' completion time was used to index cognitive flexibility, with slower completion times indicating poorer cognitive flexibility. The D-KEFS Trail Making Test has internal consistency ranging from .57 to .79 for children aged 8 to 12 years and test-retest reliability ranging from .20 to .82 for 8 to 19 year olds (Delis et al., 2001).

The Letter-Number Sequencing subtest from the Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V; Wechsler, 2014) was used as a measure of working memory. Participants were verbally presented with a series of letters and numbers they were then asked to recall in numerical and alphabetical order. Sequences increased in length from two (one number and one letter) to eight (four numbers and four letters). Children received a score for the number of sequences recalled correctly (maximum = 30). A higher score indicated greater working memory capacity. The Letter-Number Sequencing subtest has an overall reliability of .86 (Wechsler, 2014).

5.2.2.4 Episodic Foresight

The newly adapted children's version of Virtual Week-Foresight (VW-Foresight; Lyons et al., 2014) was used to measure episodic foresight. VW-Foresight is a computerised board game designed to measure the ability to engage in episodic foresight in a simulated everyday life context. To play the game, children moved a token around the VW-Foresight board by rolling a die. One full circuit around the board was equivalent to one virtual day (see Figure 5.1 for the VW-Foresight interface). The board contained ten green 'S' squares that participants passed during each virtual day. Each time they landed on or passed an 'S' square, children were prompted to select a *Situation Card*, which presented a realistic situation in daily life, such as eating breakfast. Participants were then asked to choose one of the options on the card in response to the situation. Some of the *Situation Cards* described a problem that participants were required to independently identify. For example, "As you are rushing around to get ready for school you drop your glasses and one of the lenses breaks! You tell yourself that you will figure it out later because you can't be late". Participants were then asked whether the *Situation Card* contained a problem that could not be solved immediately (in this case, the problem is they have broken their glasses which may lead to poor eyesight for the rest of the day). Once they correctly identified the problem, participants were instructed to keep the problem in mind, as they may be able to acquire an item that will help them solve it later on in the game. At a later point, participants were instructed to pick up a *Daily Activity Card* and choose one of the five options to be stored in *Your Stored Items* for later use. *Daily Activity Cards* were presented to allow an opportunity for participants to acquire an item to solve the problem previously encountered, for example that you broke your glasses earlier in the day (therefore you select your old pair of glasses).

Participants then continued moving around the board until a different *Situation Card* was presented where a problem related to the original problem occurred (in this case, the card says, “After a long day, you look for a comfy spot to sit to watch your movie. You turn on your movie and realise it looks blurry!”). At this point, participants were required to retrieve and use the appropriate item (i.e. your old pair of glasses) to solve the problem. This was done by pressing the *Your Stored Items* button and selecting to use ‘your old glasses’. The *Situation Card* presenting the problem, the *Daily Activity Card* where an item is acquired, and the *Situation Card* presenting the opportunity to solve the previous problem by using the appropriate item, together formed a single episodic foresight task.

The children’s version of VW-Foresight consisted of seven episodic foresight tasks. The two virtual days presented a total of 20 *Situation Cards*, seven of which presented the initial problem and seven presented the opportunity to resolve each problem. The remaining six *Situation Cards* presented everyday scenarios that continued the narrative of the game. There were 13 total *Daily Activity Cards*, seven of which presented items that could be acquired to solve each episodic foresight task, and six that continued the narrative of the game.

Participants first completed a Trial Day of the game, which demonstrated how to play the game, before completing two virtual days (Monday and Tuesday). At the end of the game, participants received two scores, namely the *number of correct items acquired* and the *number of correct items used*. The *number of correct items acquired* variable reflected children’s ability to act in the present (i.e. to obtain a correct item) with the anticipated future in mind, whereas the *number of correct items used* variable reflected children's ability to perform an independently generated intention to resolve a problem at the appropriate time (Lyons et al., 2014). Together, these two variables were used to index participants' level of episodic foresight. Reliability estimates calculated using Cronbach's alpha for the current study were .53 for item acquisition and .62 for item use.

Figure 5.1

Virtual Week-Foresight Children's Version Game Interface

5.2.2.5 Episodic Future Thinking

The adapted version of the Autobiographical Interview (AI; Addis et al., 2008) was used to measure EFT. The AI measured the amount of episodic details participants produced when describing events they had experienced in the past and events they could imagine experiencing in the future in response to a cue word. Following the procedure of Terrett et al. (2013), four cue words, two positive (*friend* and *easy*) and two negative (*naughty* and *tired*), were taken from the autobiographical memory test developed by Vrielynck et al. (2007) for 9 to 13 year old children. Participants completed two trials (one positive and one negative word) in either the past or future condition, before completing the other condition. The order of temporal conditions, as well as positive and negative word selection, was counterbalanced across participants. For each three-minute trial, children were required to produce as many details as possible about a past event they had experienced or a future event they could imagine themselves experiencing in response to the cue word presented to them on a card. Participants' responses for each of the four trials were audiotaped and transcribed for scoring by an independent score trained in the procedure outlined in the training manuals provided by Donna Rose Addis. This procedure involved identifying a main event or theme in participants' responses for each trial. This was then divided into key details, categorised as either internal (episodic information specific to the main event described) or external (repetitions, non-episodic and semantic details, and details unrelated to the event described). The number of internal details participants produced for both the future events combined was used as an index of EFT. In the current study, inter-rater reliability calculated using Cronbach's alpha was .98 for internal details and .87 for external details.

5.2.3 Procedure

Informed consent was obtained from participants' parents before testing commenced. Participants completed the measures included in Study 2 as part of a larger test battery administered across two 2-hour sessions (see Chapter 3 for an overview of procedures). In the first session, participants completed VW-Foresight administered on a laptop, the NEPSY-II List Memory and List Memory Delay subtest, and the WASI-II. The AI, D-KEFS subtests (Colour-Word Interference Test and Trail Making Test), and WISC-V Letter-Number Sequencing subtest were completed in the second session. Participants received regular breaks between tasks. The research was conducted with the approval of the Human Research Ethics Committee of Australian Catholic University (HREC 2018-145H; "Future-oriented thinking in middle childhood").

5.2.4 Data Analysis

All statistical tests were conducted using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp). All statistical tests were two-tailed and an alpha level of $p < .05$ was considered significant in all analyses. Raw scores were used on all measures, except for the WASI-II where composite scores were used. Outliers with *z*-scores greater than 3.29 were brought in as per procedures outlined by Tabachnick and Fidell (2014). Square root and log transformations were applied to reduce skewness in variables that violated assumptions of normality (Tabachnick & Fidell, 2014). Descriptive statistics are presented in Table 5.1.

Table 5.1

Descriptive Statistics for Episodic Foresight, Retrospective Memory, Episodic Future Thinking, and Executive Functioning

	Min	Max	*M*	*SD*
Episodic foresight				
Item acquisition[a]	1.0	7.0	5.4	1.4
Item use[b]	0.0	7.0	3.4	1.9
Retrospective memory	3.0	14.0	10.4	2.6
Episodic future thinking	17.0	93.0	45.4	16.6
Executive functioning				
Inhibition	49.0	180.0	83.5	25.2
Cognitive flexibility	43.0	240.0	114.2	50.7
Working memory	9.0	23.0	17.4	2.7

Note. Descriptive statistics were calculated for untransformed data for ease of interpretation.

[a]Virtual Week-Foresight total number of items acquired out of seven possible items.

[b]Virtual Week-Foresight total number of items used out of seven possible items.

5.4 Results

5.4.1 Correlational Analyses

The first part of the analyses was to investigate age-related improvements in episodic foresight. Pearson bivariate correlations were first conducted between the two scores indexing episodic foresight and age. Significant positive correlations were found between age and item acquisition ($r(80) = .43$ $p < .001$) and item use ($r(80) = .29$, $p = .01$).

The next step was to examine relationships between episodic foresight, and executive functions, retrospective memory, and EFT, using partial correlations to control for age. Partial Pearson correlations were conducted between episodic foresight scores and executive functions, retrospective memory, and EFT (Table 5.2). In relation to executive functions, item acquisition was negatively correlated with inhibition (i.e. greater item acquisition was associated with faster inhibition task completion times) and positively correlated with working memory. Item use was negatively correlated with inhibition and cognitive flexibility (i.e. greater item use was associated with faster inhibition and cognitive flexibility task completion times) and positively correlated with working memory. Neither of the components of episodic foresight were correlated with children's retrospective memory or their EFT ability.

Table 5.2

Partial Correlations between each Component of Episodic Foresight and Executive Functioning, Retrospective Memory, and Episodic Future Thinking, Controlling for Age

	Executive functioning				
	Inhibition	Cognitive flexibility	Working memory	Retrospective memory	EFT
Episodic foresight					
Item acquisition[a]	-.26*	-.11	.29**	.04	.03
Item use[b]	-.25*	-.24*	.25*	.07	.02

Note. EFT = episodic future thinking.

[a]Virtual Week-Foresight total number of items acquired.

[b]Virtual Week-Foresight total number of items used.

* $p \leq .05$. ** $p \leq .01$.

5.4.2 Hierarchical Multiple Regression Analyses

Two hierarchical multiple regression analyses were conducted to examine the contributors to children's performance on the two indices of episodic foresight. The same predictor variables were used for each analysis. Age and IQ were first entered into each regression analysis. Retrospective memory and executive functioning indexed by inhibition, cognitive flexibility, and working memory, were entered at step two in order to explore whether they accounted for unique variance in episodic foresight performance after accounting for the contribution of age and general cognitive ability. EFT was entered in the final step, to examine the unique contribution of children's EFT abilities to their episodic foresight performance, over and above the other predictors.

5.4.2.1 Item Acquisition

Results of the hierarchical multiple regression analysis of item acquisition are shown in Table 5.3. Age and IQ contributed significantly to item acquisition, accounting for 29% of the variance, $R^2 = .29$, adjusted $R^2 = .27$, $F(2,77) = 15.51$, $p < .001$. The addition of retrospective memory, inhibition, cognitive flexibility, and working memory did not significantly improve the model, $\Delta R^2 = .05$, $\Delta F(4,73) = 1.44$, $p = .23$. EFT entered at step three also did not significantly improve the model, $\Delta R^2 = .00$, $\Delta F(1,72) = 0.00$, $p = .99$. The combination of all seven variables explained 34% of the variance in children's item acquisition, $R^2 = .34$, adjusted $R^2 = .28$, $F(7,72) = 5.29$, $p < .001$. In the final model, age and IQ were identified as significant contributors to item acquisition.

Table 5.3

Hierarchical Multiple Regression Analysis Predicting Item Acquisition from Age, IQ, Retrospective Memory, Executive Functioning, and Episodic Future Thinking

	β	sr^2	R^2	ΔR^2
Step 1			.29	
Age	.44***	.19		
FSIQ	.32	.10		
Step 2			.34	.05
Age	.41***	.11		
FSIQ	.26*	.05		
Retrospective memory	-.09	.01		
Inhibition	-.15	.01		
Cognitive flexibility	.22	.02		
Working memory	.25	.03		
Step 3			.34	.00
Age	.41***	.11		
FSIQ	.26*	.05		
Retrospective memory	-.09	.01		
Inhibition	-.15	.01		
Cognitive flexibility	.22	.02		
Working memory	.25	.03		
Episodic future thinking	.00	.00		

Note. FSIQ = Full Scale IQ.

* $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

5.4.2.2 Item Use

Results of the hierarchical multiple regression analysis of item use are shown in Table 5.4. Age and IQ significantly contributed to item use, accounting for 23% of the variance, $R^2 = .23$, adjusted $R^2 = .21$, $F(2,77) = 11.34$, $p < .001$. The addition of retrospective memory, inhibition, cognitive flexibility, and working memory did not significantly improve the model, $\Delta R^2 = .02$, $\Delta F(4,73) = 0.38$ $p = .82$. EFT entered at step three also did not significantly improve the variance explained by the model, $\Delta R^2 = .00$, $\Delta F(1,72) = 0.08$, $p = .78$. The combination of all seven variables explained 24% of the variance in children's item use, $R^2 = .24$, adjusted $R^2 = .17$, $F(7,72) = 3.32$, $p < .01$. In the final model, IQ was identified as the only significant contributor to item use.

Table 5.4

Hierarchical Multiple Regression Analysis Predicting Item Use from Age, IQ, Retrospective Memory, Executive Functioning, and Episodic Future Thinking

	β	sr^2	R^2	ΔR^2
Step 1			.23	
Age	.30**	.09		
FSIQ	.34***	.14		
Step 2			.24	.02
Age	.24	.04		
FSIQ	.32**	.07		
Retrospective memory	-.08	.01		
Inhibition	-.06	.001		
Cognitive flexibility	-.06	.001		
Working memory	.08	.003		
Step 3			.24	.00
Age	.23	.03		
FSIQ	.32**	.07		
Retrospective memory	-.08	.01		
Inhibition	-.05	.001		
Cognitive flexibility	-.07	.002		
Working memory	.08	.003		
Episodic future thinking	.03	.001		

Note. FSIQ = Full Scale IQ.

* $p \le .05$. ** $p \le .01$, *** $p \le .001$.

5.5 Discussion

The current study had two aims, (1) to examine whether episodic foresight was associated with age across middle childhood; and (2) to investigate the contribution of other cognitive abilities to children's episodic foresight. In relation to the first aim, a significant moderate positive correlation was found between age and item acquisition and a significant, albeit relatively small, positive correlation was found between age and item use. Furthermore, age was found to be the strongest contributor to children's item acquisition in the regression model. These results suggest that older children were more capable of taking steps in the present in service of the future by identifying and acquiring items that would solve a future problem. These findings provide support for previous claims regarding the likelihood of continued improvement in episodic foresight across the 8 to 12 year old age band (Suddendorf, 2017; Suddendorf & Redshaw, 2013). As this is the first empirical study to identify continued improvement in episodic foresight performance beyond 5 years of age, the findings provide important evidence that addresses the current gap in knowledge regarding the trajectory of episodic foresight development following the preschool years.

In relation to the second aim, the lack of a significant contribution from retrospective memory to children's episodic foresight performance was not consistent with theoretical claims regarding the role of memory in episodic foresight (Schacter & Addis, 2007b; Schacter et al., 2007; Suddendorf, 2010b; Suddendorf & Corballis, 1997, 2007). This finding was also not consistent with previous studies that showed young children's successful completion of the two-room task reflected, at least in part, their capacity to remember the initial problem (Atance & Sommerville, 2014; Redshaw & Suddendorf, 2013; Suddendorf & Busby, 2005; Suddendorf et al., 2011). One possible explanation is that the retrospective memory demands in the VW-Foresight game (i.e. remembering the details of the problem and remembering to use the appropriate item) were not overly challenging for typically developing children in this age group. As such, greater retrospective memory capacity did not lead to greater episodic foresight performance. It should however be acknowledged that the List Memory Delayed task used to index retrospective memory in the current study primarily assesses the ability to recall a list of single unrelated words, which may not capture the contribution of memory to episodic foresight. Investigating other measures of memory will therefore be important for clarifying the role of memory in children's episodic foresight performance. One potential solution is to further develop the VW-Foresight game to include a retrospective memory feature similar to a different version of Virtual Week, Virtual-Week-Prospective Memory (VW-PM; Rendell & Craik, 2000). The children's version of VW-PM includes a series of recall questions at the conclusion of each virtual day to assess children's memory and has been used successfully to assess the role of retrospective memory ability in children's PM performance (Terrett et al., 2019). Developing a similar but distinct feature for the VW-Foresight game, i.e., one that specifically assesses children's memory for the details of episodic foresight tasks, may be a useful inclusion in future studies to better understand the role of memory in successful episodic foresight performance.

In relation to executive functioning, while significant correlations were found between children's executive functions and their episodic foresight performance, these were only small to moderate in magnitude and not significant predictors in the multiple regression analyses. While executive functions have been proposed theoretically to be potential contributors to episodic foresight (Suddendorf, 2017; Suddendorf & Corballis, 1997; Suddendorf & Redshaw, 2013), the current findings most strongly align with previous studies that have found no association between executive functions and the performance of adults on VW-Foresight (Lyons et al., 2014; Lyons et al., 2016; Lyons et al., 2019). These converging data may indicate the role of executive functioning has been over-estimated in the literature to date and that better executive functioning ability does not contribute to better episodic foresight performance. However, as this is the first study to examine the relationship between these constructs in children over the age of 5 years using a task that follows Suddendorf and Corballis' criteria, further research is required to replicate these findings.

The lack of contribution of EFT to episodic foresight performance in children was unexpected, given that it has been suggested conceptually that episodic foresight requires the ability to first pre-experience the self in the hypothetical future so that future needs can be identified and addressed in the present. The current findings suggest that a greater ability to envisage future scenarios in rich detail, as reflected in the AI, may not necessarily be related to better episodic foresight performance. One possible explanation for this finding could be that children's EFT is still improving across this age band and may not be sufficiently developed to contribute in a systematic way to successful episodic foresight performance. This suggestion is supported by the findings from Study 1 in Chapter 4 of this thesis that indicated a small but significant association between age and EFT, as well as previous studies that have found significant improvements in EFT ability with age in the middle childhood years (Coughlin et al., 2014; Coughlin et al., 2019; Gott & Lah, 2014). Alternatively, it should be acknowledged that while the problems encountered in the VW-Foresight game were plausible and representative of real life, they may only reflect one type of episodic foresight task. Specifically, the episodic foresight tasks in VW-Foresight involve the presentation of a problem (e.g. breaking glasses), but do not simultaneously indicate the specific scenario where that problem will resurface later in the game (i.e. watching a movie and the screen is blurry). Rather, details of the relevant future scenario unfold as the game progresses. Thus, it may be that individuals only give general consideration to a range of possible scenarios that could be adversely affected in the future as a result of the presented problem, rather than engaging in detailed imagination of a specific future scenario, thereby placing fewer demands on EFT. For example, breaking your glasses likely leads to acknowledgement that you will need your glasses in the future across a range of scenarios and that it would be beneficial to engage in preparatory action in the present, but it is not necessary (or efficient) to generate detailed pictures of numerous hypothetical scenarios linked to not having your glasses.

This contrasts with another form of episodic foresight task where the specific details of a future scenario in which a problem is to be resolved are able to be identified ahead of time. For example, in preparation for your job interview next week, greater imagination of the specific scenario may allow you to identify your limited knowledge regarding the role. This then leads you to take the time to research and prepare for the interview questions and increases your likelihood of getting the position. It is possible that successful performance on this type of episodic foresight task may benefit from greater EFT ability, such as imagining the specific types of questions you might be asked and the answers you would give. It is therefore possible that a different profile of contributors may be implicated in different forms of episodic foresight task. While additional research is required to address this claim, the current findings provide valuable direction for future research and suggest that further theoretical work is needed to break down episodic foresight as a construct.

An important novel finding from this study was the significant contribution of IQ to successful episodic foresight performance across both indices. While higher general cognitive ability has been found to be associated with other future-oriented abilities in children, such as EFT (Terrett et al., 2013) and prospective memory (Henry et al., 2014; Yang et al., 2011), as well as episodic foresight in healthy adults (Terrett, Lyons, et al., 2016) and adults with schizophrenia (Lyons et al., 2016), no previous studies have included a measure of general cognitive ability when examining correlates of children's episodic foresight. The current study used the Full Scale IQ from the WASI-II (Wechsler, 2011), which provides a measure of both crystallised and fluid intelligence, suggesting that both general knowledge and the ability to reason and think abstractly may be important factors for successful episodic foresight (Lyons et al., 2016). It may be, for example, that general knowledge of personal goals provides a frame for retrieving, integrating, and interpreting relevant information used to construct future-thoughts more generally (D'Argembeau & Mathy, 2011). Furthermore, general intellectual ability may contribute to the behavioural flexibility and adaptiveness required to successfully identify problems and generate appropriate solutions when engaging in episodic foresight (Lyons et al., 2016; Schacter et al., 2007; Suddendorf & Corballis, 1997). Indeed, this process is reflected in the VW-Foresight game, as children had to independently identify that a problem existed, take advantage of the opportunity to obtain an item that may be used to solve that problem, and also identify the appropriate moment to use that item. It will therefore be important for future studies to continue to include a measure of general intelligence when investigating contributors to episodic foresight.

A limitation of the current study that should be acknowledged relates to the use of the List Memory Delayed subtest to index retrospective memory. As previously noted, this task may not have captured the role of memory in children's episodic foresight performance. Future studies should therefore consider the use of other measures in order to clarify the contribution of memory to successful episodic foresight performance. Despite this, a key strength of the current study was the use of VW-Foresight. This is one of the few measures that has been developed according to the criteria set out by Suddendorf and Corballis (2010), and its adaptation for children provides the first measure to assess episodic foresight in children beyond the preschool years.

The findings from the current study have important implications. In particular, given that episodic foresight appears to continue to develop across the middle childhood years, both parents and teachers may aim to foster optimal episodic foresight development by supporting children in this age range to consider future needs. This will potentially be valuable given the adaptive significance of episodic foresight, particularly in maximising future success while also mitigating negative future outcomes (Atance, 2008; Baumeister et al., 2016; Bulley et al., 2020; Suddendorf, 2017). For example, the development of episodic foresight has been proposed to increase children's motivation to complete academic behaviours that will be of later benefit to them by increasing their connection with their sense of self in the future (Prabhakar et al., 2016). Therefore, supporting children to consider future needs will be important in fostering their episodic foresight abilities in daily life and will minimise the negative consequences of failing to consider future problems.

In conclusion, this is the first study to investigate episodic foresight in children over 5 years of age. The current evidence of continued improvements in episodic foresight with age across middle childhood provides an important extension to the growing literature on episodic foresight in children. Second, this study is the first to investigate a comprehensive set of contributors to children's episodic foresight performance in this age band. The pattern of results indicated that age and IQ were strong contributors to episodic foresight performance, while retrospective memory, executive functions and EFT did not contribute. However, findings regarding the role of EFT are limited to the particular practical application of episodic foresight reflected in the VW-Foresight game used in the current study. As such, further investigation is required to tease out the contribution of EFT to other types of episodic foresight task that may benefit from greater imagination of contextual details, given specific knowledge of the future scenario ahead of time. Overall, then, the current study provides a valuable foundation and direction for future investigations of episodic foresight in children.

Chapter 6: Study 3 – Prospective Memory in Middle Childhood

Preamble

This chapter reports the third empirical study of the thesis. It focuses on the investigation of prospective memory (PM) performance in 8 to 12 year old children, and the cognitive abilities that may be associated with this skill. As noted in the review in Chapter 2, only relatively recently has research begun to investigate children's PM abilities in middle childhood. This study builds on this recent research and aimed to examine children's performance across both event-based and time-based PM tasks. Additionally, this study aimed to provide a thorough investigation of contributors to children's PM performance across the two task types in order to clarify the picture of PM in this age group.

6.1 Introduction

The ability to successfully remember to complete a future plan, known as prospective memory (PM; Einstein & McDaniel, 1990), is an important cognitive skill embedded in many aspects of daily life (Meacham & Colombo, 1980). In the school context, for example, there are the demands of having to remember to hand in homework at a certain time, bring materials to class, and pass on messages to parents. Successful PM performance is therefore an important factor in goal directed behaviour and academic achievement (Causey & Bjorklund, 2014; Kerns, 2000) and is considered critical for the development of skills needed for independence (Kliegel, Jäger, et al., 2008). Consequently, the development of PM is considered a major developmental challenge of childhood (Altgassen et al., 2014). However, compared to the number of studies investigating PM in adults, particularly in the context of aging, studies of children are fewer in number (Mahy, Kliegel, et al., 2014). Greater understanding of PM in the middle childhood years, especially the identification of contributors to successful performance, is therefore required to support PM development in children.

PM tasks involve a number of phases including forming an intention, retaining the intention in memory, retrieving the intention, and executing and evaluating the action at the appropriate time (Ellis, 1996; Ellis & Kvavilashvili, 2000; McDaniel & Einstein, 2000). PM tasks are also typically distinguished on the basis of being either event-based, where a response is cued by an event (e.g. buying bread *when you go to the supermarket*) or time-based tasks, which are completed at a specific time (e.g. call your friend at *7 o'clock*) or after a period of time (e.g. take a pot off the stove after *20 minutes*) (Einstein & McDaniel, 1990). Time-based PM tasks are considered to be more challenging than event-based tasks, as they do not have the environmental cues inherent to event-based tasks and require demanding time-monitoring, thus relying more heavily on an individual's self-initiation (Einstein & McDaniel, 1990; Einstein & McDaniel, 2005).

Research investigating the development of PM in children has reported evidence of event-based PM abilities as early as 2 to 3 years of age (Guajardo & Best, 2000; Kliegel & Jäger, 2007; Slusarczyk et al., 2018; Somerville et al., 1983), while time-based PM has been found to emerge later, at approximately 5 to 7 years of age, arguably reflecting the greater cognitive demands of this PM task type (Kerns, 2000; Kretschmer et al., 2014; Mackinlay et al., 2009; Rendell et al., 2009; Talbot & Kerns, 2014). While a number of studies broadly suggest improvements in PM performance occur with age from early to late childhood, the results of studies specifically targeting the middle childhood period are inconsistent (Aberle & Kliegel, 2010; Altgassen et al., 2014). For example, some researchers report improvements in event-based PM from 5 to 13 years (Rendell et al., 2009; Shum et al., 2008) and time-based PM from 7 to 12 years (Kerns, 2000; Mackinlay et al., 2009; Voigt et al., 2011), whereas other studies found no improvement in event-based or time-based PM performance between 7 to 12 years (Mäntylä et al., 2007; Nigro et al., 2002). Furthermore, previous studies have tended to examine only one type of PM task performance, such that a profile across task types is still relatively unclear.

A few studies that have examined children's performance on both types of PM task found 8 to 12 year old children's performance was significantly better on event-based than time-based PM tasks and also found time-based PM significantly improved with age while event-based PM did not (Henry et al., 2014; Talbot & Kerns, 2014; Terrett et al., 2019). In contrast, however, one recent study by Mills et al. (2020) reported significant differences in performance among 4 to 15 year olds on both event-based and time-based PM tasks. This study also suggested a complex picture of developmental changes in PM between 4 and 15 years with results showing the 4 to 6 year old group performed significantly worse than the 7 to 8 year old group on both event-based and time-based tasks, but performance plateaued between the 7 to 8 year old group and the 9 to 10 year old group. However, significant differences were then found between the 9 to 10 year old group and 11 to 12 year old group and 13 to 15 year old group. Another plateau in performance was observed between the 11 to 12 year old age group and the 13 to 15 year old group, with comparable performance for these two older age groups on both event-based and time-based tasks (Mills et al., 2020). Overall, current literature provides some indication that children may be reasonably proficient at event-based PM tasks by middle childhood but due to their more difficult nature, performance on time-based tasks may continue to improve into adolescence (Kerns, 2000; Kretschmer et al., 2014; Mackinlay et al., 2009; Rendell et al., 2009; Talbot & Kerns, 2014). However, the limited number of studies that have examined children's performance across task types and the inconsistency of their findings suggests that further research is needed to clarify the picture of PM in middle childhood.

Another issue that is currently unclear relates to the abilities that underpin PM performance in middle childhood. This is an important question, as understanding what drives PM is vital for fostering children's development of this ability. The broader literature indicates that a number of cognitive processes may be involved in PM performance. Retrospective memory ability is one cognitive component considered crucial for PM performance. This is highlighted in models of PM that propose PM tasks include a retrospective memory component, i.e. remembering what has to be done and under what circumstances, as well as a prospective memory component, i.e. remembering to complete the action (Einstein & McDaniel, 1990; Graf & Uttl, 2001). Studies have noted the role of retrospective memory in both the development and decline of PM performance with age (Mattli et al., 2014; Zimmermann & Meier, 2006) and recently, Terrett et al. (2019) found 8 to 12 year olds' retrospective memory for PM task content (i.e. what needed to be done) strongly contributed to their PM performance.

Executive functions have also been argued to be important for PM performance (Mahy, Kliegel, et al., 2014; Mahy & Moses, 2011; Mahy, Moses, et al., 2014a). Most research examining the relationship between PM and executive functions has used Miyake's three function model (Miyake et al., 2000), suggesting that inhibition, cognitive flexibility, and working memory may be implicated in PM (Zuber et al., 2019). These abilities may assist PM by allowing an individual to retain the PM intention in memory, interrupt their current activity, switch to the PM task, and inhibit their response to any irrelevant stimuli (Altgassen et al., 2014; Kvavilashvili et al., 2001; Mahy, Moses, et al., 2014a). A number of studies have sought to examine the relationship between children's PM performance and executive functions. The results of some of these studies have shown significant associations between inhibition and children's event-based PM performance (Ford et al., 2012; Mahy et al., 2018; Shum et al., 2008; Wang et al., 2008; Ward et al., 2005), while for time-based PM, significant associations have been found with inhibition (Kerns, 2000), cognitive flexibility (Mackinlay et al., 2009; Mäntylä et al., 2007), and working memory (Voigt et al., 2014; Zuber et al., 2019). However, by contrast, a number of studies have failed to find evidence of a relationship between executive functions and PM in children. For example, some studies have found no association between inhibition and event-based PM (Cottini et al., 2018; Mahy & Moses, 2011) or time-based PM (Kretschmer et al., 2014; Zuber et al., 2019), nor between cognitive flexibility and event-based PM (Mahy, Moses, et al., 2014b) or time-based PM (Mäntylä et al., 2007; Zuber et al., 2019). Lastly, some studies have found no association between working memory and event-based PM (Ford et al., 2012; Mahy, Moses, et al., 2014b) or time-based PM (Mackinlay et al., 2009). Given the overall inconsistency of previous findings, it is not currently possible to make strong conclusions regarding the association between executive functions and PM performance in children.

A more recently proposed contributor to PM performance is episodic future thinking (EFT; Schacter et al., 2008; Schacter et al., 2017; Szpunar, 2010). EFT refers to the ability to engage in complex mental construction to pre-experience future events in imagination (Addis et al., 2008; Atance & O'Neill, 2001). EFT is an important ability as much of our behaviour is driven by our capacity to imagine future events in order to facilitate our achievement of distant goals (Martin-Ordas et al., 2012; Suddendorf, 2006). There are two distinct sources of evidence that support a link between EFT and PM. Firstly, activity in specific regions of the brain, particularly Brodmann area 10, has been found when engaging in both EFT and PM (Burgess et al., 2003; Schacter et al., 2007; Spreng et al., 2018; Weiler et al., 2010). Secondly, there is evidence that future simulation may be used as a strategy to improve PM performance (Altgassen et al., 2015; Brewer & Marsh, 2010; Neroni et al., 2014; Spreng et al., 2018). For example, adult participants directly instructed to imagine themselves completing a PM task had better subsequent PM performance relative to those not given these instructions (Brewer et al., 2011; Neroni et al., 2014). EFT has also been used as a strategy to successfully improve PM in younger populations, including 7 year old and 10 to 12 year old children (Kretschmer-Trendowicz et al., 2016; Kretschmer-Trendowicz et al., 2019) and adolescents (Altgassen et al., 2017). In contrast however, Kretschmer-Trendowicz et al. (2016) did not find EFT to improve PM performance in 5 year old children and proposed this may be due to EFT ability in younger children not being sufficiently developed to facilitate PM performance.

Only a few studies, however, have directly investigated whether EFT and PM are associated. In one study with adults, Terrett, Rose, et al. (2016) found a significant positive association between EFT and PM in both young and older adulthood. Furthermore, EFT ability significantly contributed to PM performance in young adults, even after partialling out the influence of executive functions and retrospective memory (Terrett, Rose, et al., 2016). With respect to studies focused on children, only a small number of studies to date have been completed. In two studies that focused on children aged 5 or younger, no association between EFT and PM emerged (Atance & Jackson, 2009; Nigro et al., 2014). However, in a slightly older age group (7 year olds), EFT and PM were found to be significantly correlated (Nigro et al., 2014). Taken together, these data therefore indicate that a relationship between these abilities may not become apparent until the middle childhood years.

In the most recent study (and the only study to date to include tests of time-based PM, in addition to event-based PM), this possibility was directly tested by including 8 to 12 year old children (Terrett et al., 2019). Significant correlations were found between EFT and children's performance on event-based PM tasks and time-based PM tasks that were performed regularly or routinely (but not for one-off time-based tasks). Furthermore, the association between children's EFT and performance on those PM task types was mediated by their retrospective memory ability (i.e. memory for PM task content). Terrett and colleagues argued that this pattern of findings supports the claim that EFT facilitates PM by reinforcing the encoding of the PM task content, allowing for more efficient retrieval from memory (Altgassen et al., 2017; Altgassen et al., 2015; Brewer & Marsh, 2010; Schnitzspahn & Kliegel, 2009). Furthermore, the authors suggest that their finding that EFT had a greater impact on event-based than time-based PM performance may have been because event-based tasks involve specific environmental cues that are easier to visualise. As such, the act of pre-experiencing the event-based PM task is easier and in turn reinforces the connection between the cue and the relevant action. This then supports PM task initiation (Terrett et al., 2019). This claim is consistent with Altgassen et al. (2017) who found adolescents' PM performance was better when they used a future simulation strategy. However, given that to date only a single study has been conducted with a focus on how EFT and PM are related across PM task types in the middle childhood period, further empirical research is needed.

The current study therefore sought to cross-validate, but also substantially build on, the earlier work by Terrett et al. (2019) by using a larger sample and conducting a more thorough investigation of potential contributors to children's PM performance. This study had two key aims. The first was to examine whether improvements in children's event-based and time-based PM performance were associated with age across middle childhood. As previously noted, current evidence regarding age-related improvements in PM on both task types is inconsistent, particularly in this age band. However, given some evidence of age-related improvements in time-based but not event-based PM performance in this age group, it was hypothesised that time-based PM would be positively correlated with age, while event-based PM would be stable.

The second aim was to examine the contribution of cognitive abilities that have been suggested to be implicated in PM performance. Most prior studies examining the role of retrospective memory, executive functions, and EFT in PM performance have investigated these abilities in isolation, with the current study only the second to investigate the association of all of these abilities concurrently with children's performance on both event-based and time-based PM tasks within the one study. Furthermore, given the limited investigation to date of the contribution of EFT to PM in children, a particular interest of this study was in testing whether children's EFT made a unique contribution to their PM performance beyond any broader contributions of age and other cognitive abilities (IQ, retrospective memory, and executive functions). With respect to hypotheses, it was predicted that retrospective memory would make a significant contribution to children's event-based and time-based PM. Less clear was whether executive functions would also contribute to children's event-based and time-based PM. While theoretical models assign a prominent role to executive functions in PM, empirical studies have proven more inconsistent. Finally, it was anticipated that EFT would significantly contribute to children's event-based PM performance, but not time-based PM performance, given previous evidence of a significant contribution of EFT to event-based PM over and above retrospective memory and executive functions.

6.2 Method

A detailed methodology is provided in Chapter 3 of this thesis. A summary is provided here to facilitate comprehension.

6.2.1 Participants

80 participants were included in this study, 42 girls and 39 boys aged 8 years 0 months to 12 years 5 months (*M* = 122.4 months, *SD* = 16.1). Of the 81 children initially recruited (see Chapter 3 for a description of the recruitment process), one was excluded due to reading difficulties. Participants' IQs, assessed by the Wechsler Abbreviated Scale of Intelligence-2nd Edition (WASI-II; Wechsler, 2011), were all within the normal range (Full Scale IQ range 80-128, *M* = 108.2, *SD* = 10.6).

6.2.2 Measures

6.2.2.1 General Cognitive Ability

The Wechsler Abbreviated Scale of Intelligence-Second Edition (WASI-II; Wechsler, 2011) is a measure of general cognitive ability consisting of four subtests: Vocabulary, Similarities, Block Design, and Matrix Reasoning. When combined, these subtests form the Verbal Comprehension Index (VCI), Perceptual Reasoning Index (PRI), and Full Scale IQ (FSIQ). The FSIQ was used to measure participants' general cognitive ability, where a higher FSIQ score indicated greater general cognitive ability. The FSIQ composite has internal consistency ranging from .92 to .96 and test-retest reliability ranging from .79 to .92 for children aged 6 to 16 years (Wechsler, 2011).

6.2.2.2 Executive Functions

The inhibition condition of the Colour-Word Interference Test from the Delis-Kaplan Executive Functioning System (D-KEFS; Delis et al., 2001) was used to measure inhibition. Participants were presented with colour words printed in a different coloured ink. Children were asked to say the ink colour and not the colour word as quickly and accurately as possible. Participants' completion time was used as an index of inhibition, with slower completion times indicating a poorer ability to inhibit automatic responses. The D-KEFS Colour-Word Interference Test has internal consistency ranging from .72 to .79 for 8 to 12 year olds and test-retest reliability ranging from .77 to .90 for 8 to 19 year olds (Delis et al., 2001).

The number-letter switching condition of the Trail Making Test from D-KEFS was used to measure cognitive flexibility. Participants switched between drawing a line to connect numbers and letters in order as quickly and accurately as possible. Participants' completion time was used to index cognitive flexibility, with slower completion times indicating poorer cognitive flexibility. The D-KEFS Trail Making Test has internal consistency ranging from .57 to .79 for 8 to 12 year olds and test-retest reliability ranging from .20 to .82 for 8 to 19 year olds (Delis et al., 2001).

The Letter-Number Sequencing subtest from the Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V; Wechsler, 2014) was used as an index of working memory. Participants were verbally presented with a series of letters and numbers they were then asked to recall in numerical and alphabetical order. Sequences increased in length from two (one number and one letter) to eight (four numbers and four letters). Children received a score for the number of sequences recalled correctly (maximum = 30). A higher score indicated greater working memory capacity. The overall reliability for Letter-Number Sequencing is .86 (Wechsler, 2014).

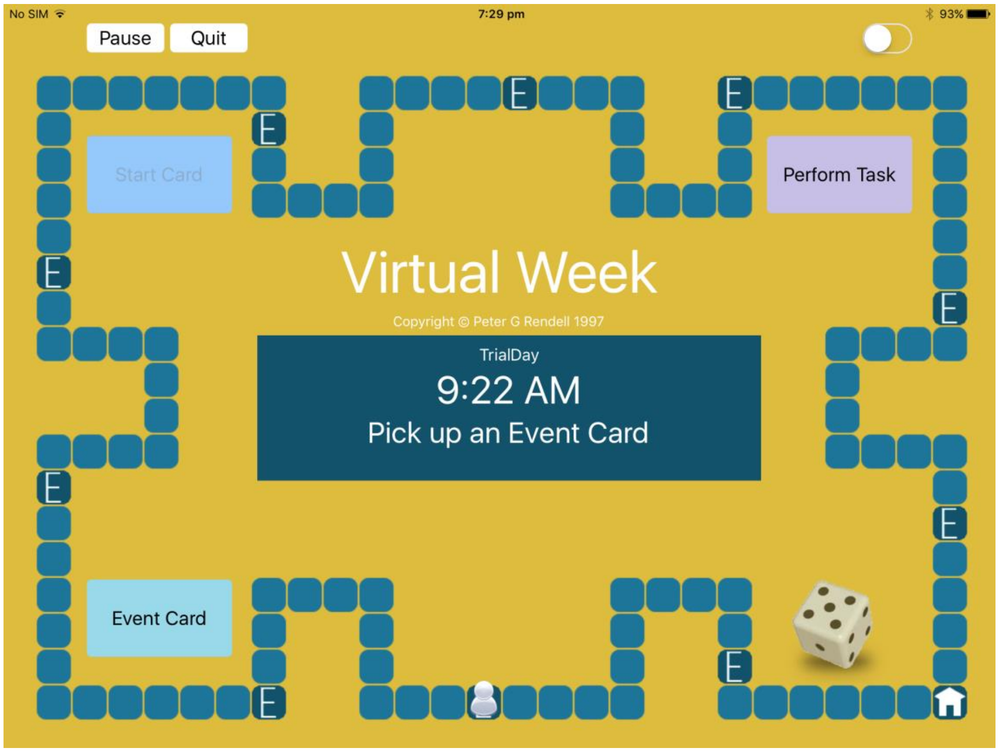
6.2.2.3 Prospective Memory

PM was measured using Virtual Week-Prospective Memory (VW-PM; Rendell & Craik, 2000), a computerised board game designed to represent PM in everyday life. The adapted version for children has been shown to have a split-half reliability between .78 and .84 for typically developing children aged 8 to 12 years (Henry et al., 2014). The current study utilised the 2-day version of VW-PM, which was administered to participants on an iPad (see Figure 1 for the VW-PM game interface). Rolling a die, participants moved a token around the board, where one circuit of the board represented one virtual day. The centre of the board displayed the day and time and for every two squares the token moved, 15 minutes of virtual time passed. Participants were prompted to pick up *Event Cards* each time they landed on or passed a square marked with an 'E'. Each virtual day consisted of ten *Event Cards* that presented a different activity that related to the time of the day and participants were required to choose from three options (e.g. their preferred option for breakfast). Each virtual day included eight PM tasks (four event-based and four time-based). Participants were first taken through a Trial Day to learn how to play the game before completing two virtual days (Monday and Tuesday). Event-based tasks were completed when the corresponding *Event Card* was selected, while time-based tasks were performed when the clock on the board indicated a specific time. Participants completed PM tasks by clicking on the *Perform Task* button. This presented a list from which they selected the required task given the relevant cue. Responses were considered correct if completed at the specified time or when the specific *Event Card* was encountered (i.e. directly after the token was moved on or past the corresponding square and before they rolled the die again). The proportion of correct responses for the different PM task types (event-based and time-based) was used to measure PM performance.

At the completion of each virtual day in VW-PM, participants were presented with *Task Review Cards* to assess retrospective memory for the content of PM tasks. This required each PM task completed on the day (e.g. buy some pencils) to be matched with the relevant PM cue (e.g. when shopping). Four distractor tasks were also included on the *Task Review Cards* and participants were expected to indicate that these actions were ‘not required’. This was used to index children’s retrospective memory for the content of PM tasks.

Figure 6.1

Children’s Virtual Week-Prospective Memory iPad Version Game Interface



6.2.2.4 Episodic Future Thinking

The adapted version of the Autobiographical Interview (AI; Addis et al., 2008) was used to measure EFT. In three minutes, participants were required to produce as many episodic details as they could about events they had experienced in the past and events they could imagine experiencing in the future in response to the cue word provided. Following the procedure of Terrett et al. (2013), two positive words (*friend* and *easy*) and two negative words (*naughty* and *tired*), were taken from the autobiographical memory test developed by Vrielynck et al. (2007) for 9 to 13 year old children. Participants then completed two trials (one positive and one negative word) in either the past or future condition, before completing the other condition. The order of temporal conditions, as well as positive and negative word selection, was counterbalanced across participants. Participants' responses for each of the four trials were audiotaped and transcribed for scoring by an independent scorer, trained in the standardised scoring procedure provided by Donna Rose Addis. This procedure involved identifying a main event in participants' responses for each trial. This was then divided into key details, categorised as either *internal* (episodic information specific to the main event described) or *external* (repetitions, non-episodic and semantic details, and details unrelated to the event described). The number of internal details participants produced for two future events combined was used as an index of EFT. In the current study, inter-rater reliability was .98 for internal details and .87 for external details.

6.2.3 Procedure

Informed consent was obtained from parents of participants before testing commenced. Participants completed the measures for Study 3 as part of a larger test battery completed across two, 2-hour sessions (see Chapter 3 for an overview of procedures). In the first session, participants completed the WASI-II. In the second session, participants completed VW-PM administered on an iPad, the AI, the D-KEFS subtests (Colour-Word Interference Test and Trail Making Test) and WISC-V Letter-Number Sequencing subtest. Regular breaks were provided between tasks. The research was conducted with the approval of the Human Research Ethics Committee of Australian Catholic University (HREC 2018-145H; “Future-oriented thinking in middle childhood”).

6.2.4 Data Analysis

All statistical tests were conducted using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp). All statistical tests were two-tailed and an alpha level of $p < .05$ was considered significant in all analyses. Raw scores were used on all measures, except for the WASI-II, where composite scores were used. Outliers with *z*-scores greater than 3.29 were brought in as per procedures outlined by Tabachnick and Fidell (2014). Normality was assessed and square root and log transformations were applied to reduce skewness where appropriate (Tabachnick & Fidell, 2014). Descriptive statistics are presented in Table 6.1.

Table 6.1

Descriptive Statistics for Prospective Memory, Retrospective Memory, Episodic Future Thinking, and Executive Functioning

	Min	Max	*M*	*SD*
Prospective memory task type[a]				
Event-based	0.0	1.0	0.6	0.3
Time-based	0.0	1.0	0.4	0.3
Retrospective memory for task content[b]				
Event-based	0.0	1.0	0.7	0.3
Time-based	0.0	1.0	0.7	0.3
Episodic future thinking[c]	17.0	93.0	45.4	16.6
Executive functioning				
Inhibition	49.0	180.0	83.5	25.2
Cognitive flexibility	43.0	240.0	114.2	50.7
Working memory	9.0	23.0	17.4	2.7

Note. Descriptive statistics were calculated for untransformed data for ease of interpretation.

[a]Virtual Week proportion correct for each PM task type.

[b]Virtual Week proportion correct for the content of each PM task type.

[c]Autobiographical Interview total future internal details.

6.3 Results

6.3.1 Correlational Analyses

The first part of the analyses was to investigate whether improvements in performance on event-based and time-based PM tasks was associated with age using Pearson bivariate correlations. Age was positively correlated with event-based PM performance ($r(80) = .56$, $p < .001$) and time-based PM performance ($r(80) = .48$, $p < .001$).

The next step was to explore relationships between each type of PM task and executive functions, retrospective memory, and EFT using partial correlations to control for age (Table 6.2). In relation to executive functioning, only working memory was significantly positively correlated with event-based PM performance and time-based PM performance. Retrospective memory for the content of event-based PM tasks was significantly correlated with event-based PM performance. For time-based PM, retrospective memory for the content of time-based PM tasks was significantly correlated with time-based PM performance. A significant positive correlation was found between EFT and event-based PM performance, but not time-based PM performance.

Table 6.2

Partial Correlations between each PM Task Type and Executive Functions, Retrospective Memory for each PM Task Type, and Episodic Future Thinking Controlling for Age

	Executive functioning				
	Inhibition	Cognitive flexibility	Working memory	Retrospective memory[a]	EFT
Prospective memory task type					
Event-based	-.22	-.17	.25*	.33**	.29**
Time-based	-.05	-.18	.26*	.60***	.06

Note. EFT= episodic future thinking.

[a] Virtual Week-Prospective Memory task recognition score for each respective PM task type.

* $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

6.3.2 Hierarchical Multiple Regression Analyses

Two hierarchical multiple regression analyses were conducted to examine the contributors to children's performance on each PM task type. The same predictor variables were used for each analysis. Age and IQ were first entered into each regression analysis. Retrospective memory for the content of each PM task type and executive functioning indexed by inhibition, cognitive flexibility, and working memory, were entered at step two to explore whether they accounted for unique variance in PM after accounting for the contribution of age and IQ. EFT was entered in the final step in order to examine the unique contribution of children's EFT ability to their PM performance over and above the other predictors.

6.3.2.1 Event-Based PM

Results are shown in Table 6.3. Age and IQ significantly contributed to event-based task performance, accounting for 33% of the variance, $R^2 = .33$, adjusted $R^2 = .32$, $F(2,77) = 19.21$, $p < .001$. The addition of retrospective memory, inhibition, cognitive flexibility, and working memory did not significantly improve the model, $\Delta R^2 = .08$, $\Delta F(4,73) = 2.40$, $p = .06$. EFT entered at step three explained a significant additional 5% of variance in children's event-based PM performance, $\Delta R^2 = .05$, $\Delta F(1,72) = 6.62$, $p < .01$. The combination of all seven variables explained 46% of the variance in children's event-based PM performance, $R^2 = .46$, adjusted $R^2 = .41$, $F(7,72) = 8.77$, $p < .001$. In the final model, age, retrospective memory for the content of event-based PM tasks, and EFT were identified as significant contributors to event-based PM performance.

Table 6.3

Hierarchical Multiple Regression Analysis Predicting Event-Based PM Performance from Age, IQ, Retrospective Memory, Executive Functioning, and Episodic Future Thinking

	β	sr^2	R^2	ΔR^2
Step 1			.33	
Age	.57***	.32		
FSIQ	.13	.02		
Step 2			.41	.08
Age	.38**	.09		
FSIQ	-.00	.00		
Retrospective memory	.26*	.04		
Inhibition	-.13	.01		
Cognitive flexibility	.08	.00		
Working memory	.12	.01		
Step 3			.46	.05
Age	.32**	.06		
FSIQ	.01	.00		
Retrospective memory	.27*	.04		
Inhibition	-.09	.00		
Cognitive flexibility	.02	.00		
Working memory	.07	.00		
Episodic future thinking	.24*	.05		

Note. FSIQ = Full Scale IQ.

* $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

6.3.2.2 Time-Based PM

Results are shown in Table 6.4. Age and IQ significantly contributed to time-based PM performance, accounting for 25% of the variance, $R^2 = .25$, adjusted $R^2 = .23$, $F(2,77) = 12.92$, $p < .001$. The addition of retrospective memory, inhibition, cognitive flexibility, and working memory significantly improved the model, explaining an additional 27% of the variance, $R^2 = .52$, $\Delta R^2 = .27$, $\Delta F(4,73) = 10.24$, $p < .001$. EFT, entered at step three, however, did not significantly improve the variance explained by the model, $\Delta R^2 = .00$, $\Delta F(1,72) = 0.15$, $p = .70$. The combination of all seven variables explained 52% of the variance in children's time-based PM performance, $R^2 = .52$, adjusted $R^2 = .48$, $F(7,72) = 11.20$, $p < .001$. The only significant predictor for time-based PM performance was retrospective memory for the content of time-based PM tasks.

Table 6.4

Hierarchical Multiple Regression Analysis Predicting Time-Based PM Performance from Age, IQ, Retrospective Memory, Executive Functioning, and Episodic Future Thinking

	β	sr^2	R^2	ΔR^2
Step 1			.25	
Age	.49***	.24		
FSIQ	.13	.02		
Step 2			.52	.27
Age	.17	.01		
FSIQ	-.04	.00		
Retrospective memory	.58***	.22		
Inhibition	.09	.00		
Cognitive flexibility	-.02	.00		
Working memory	.14	.01		
Step 3			.52	.00
Age	.16	.01		
FSIQ	-.04	.00		
Retrospective memory	.58***	.22		
Inhibition	.09	.00		
Cognitive flexibility	-.03	.00		
Working memory	.14	.01		
Episodic future thinking	.03	.00		

Note. FSIQ = Full Scale IQ.

* $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

6.4 Discussion

This study had two aims, (1) to examine whether PM performance was associated with age across middle childhood; and (2) to examine the cognitive abilities that may contribute to children's PM performance. A particular interest of this second aim was to explore the unique contribution of EFT to PM performance.

Regarding the first aim, both event-based and time-based PM performance were significantly, strongly, and very comparably correlated with age. These findings support previous studies of event-based PM (Mills et al., 2020; Rendell et al., 2009; Shum et al., 2008) and time-based PM (Kerns, 2000; Mills et al., 2020; Talbot & Kerns, 2014; Terrett et al., 2019) that also found age-related improvements in middle childhood. While some research has found children to be reasonably proficient at event-based tasks by the beginning of middle childhood (Guajardo & Best, 2000; Kliegel & Jäger, 2007; Talbot & Kerns, 2014; Terrett et al., 2019), the current findings demonstrate that children are still continuing to improve their event-based as well as their time-based PM abilities during this period. These findings provide important evidence that further clarifies how PM emerges developmentally across the middle childhood years.

In relation to the second aim, the findings aid in teasing out the cognitive abilities implicated in PM performance across middle childhood. As hypothesised, retrospective memory for PM task content was significantly correlated with children's performance on both PM task types. Furthermore, retrospective memory was the second strongest predictor of event-based PM performance (after age) and was the only significant predictor of time-based PM performance. This aligns with previous findings of a significant association and contribution of retrospective memory to PM in both adults (Cherry et al., 2001; Terrett, Rose, et al., 2016) and children (Terrett et al., 2019) and with theoretical models that regard retrospective memory as a crucial component of successful PM performance by supporting retention of the content of the PM task (Einstein & McDaniel, 1990; Graf & Uttl, 2001; Smith & Bayen, 2004).

In relation to executive functions, of the three measures used in this study (inhibition, cognitive flexibility, and working memory), only working memory was found to be associated with children's event-based and time-based PM performance. The lack of a relationship between PM and inhibition and cognitive flexibility aligns with most prior empirical studies involving children (e.g. Cottini et al., 2018; Kretschmer et al., 2014; Mahy & Moses, 2011). Moreover, it is of note that while working memory was significantly correlated with PM, it did not contribute to performance when other abilities such as retrospective memory were included in the regression models. Taken together, these data do not support the proposal that greater executive functioning is related to better PM performance (Mahy, Kliegel, et al., 2014; Mahy & Moses, 2011; Mahy, Moses, et al., 2014a) and instead show that PM cannot simply be regarded as a proxy for executive functions. Other predictors, such as retrospective memory, therefore appear to be more important factors in understanding PM performance in the middle childhood years.

In relation to EFT, as hypothesised, this was significantly positively associated with event-based PM. This finding aligns with previous studies that used a single index of PM in 7 year old children (Nigro et al., 2014) and adults (Terrett, Rose, et al., 2016), as well as with the only previous study to address this question using a specific measure of event-based PM in 8 to 12 year old children (Terrett et al., 2019). Furthermore, the current results indicate that children's EFT ability explained a significant unique portion of variance in children's event-based PM beyond the contribution of other cognitive processes. Together, these results align with Terrett et al.'s (2019) conclusions regarding the contribution of EFT to children's performance on event-based PM in this age range. The absence of an association between EFT and time-based PM in the present study is also consistent with Terrett et al. (2019), and may reflect the fact that time-based tasks are not as strongly linked to environmental cues (Einstein & McDaniel, 1990) and consequently are not as easy to visualise.

Given the results of the current study only identified retrospective memory as a significant partial contributor to children's time-based PM performance, this raises questions about other potential abilities that should be considered as contributors to time-based PM. For example, previous research has noted the role of time-monitoring ability in successful completion of time-based PM tasks among children (Ceci & Bronfenbrenner, 1985; Geurten et al., 2016; Kerns, 2000; Mackinlay et al., 2009; Mäntylä et al., 2007; Mioni, Santon, et al., 2017; Nigro et al., 2002; Voigt et al., 2011; Voigt et al., 2014; Zinke et al., 2010). It would therefore be useful for future studies to consider including a measure of time-monitoring ability in order to clarify the abilities involved in children's time-based PM performance.

One limitation of this study relates to the use of the 2-day version of Virtual Week-Prospective Memory (VW-PM) to assess children's PM performance. This version differs from longer versions (e.g. 3-day and 7-day) used in some previous PM studies, in that these versions allowed for further distinction of PM based on their degree of recurrence. *Irregular* tasks are different each day and reflect tasks that occasionally need to be performed in everyday life (e.g. buy pencils when shopping). By contrast, *regular* tasks are the same each day and are carried out daily in the game (e.g. take antibiotics every day at breakfast). This repetition is argued to lead to better encoding of task content and therefore reduces the demands on retrospective memory, making the regular tasks less cognitively demanding than the irregular tasks (Rendell et al., 2007; Rendell & Henry, 2009; Rose et al., 2010). However, given the 2-day version of the game restricts the opportunity for regular tasks to be overlearned due to the limited exposure in this shorter version of the game, the regular versus irregular task distinction was not addressed in the current study.

The findings of this study have important implications for children's development of PM abilities. First, evidence of ongoing improvements in both event-based and time-based PM with age has practical implications for children's everyday functioning. Given claims of the importance of PM in children's independence and academic achievement (Causey & Bjorklund, 2014; Kerns, 2000), awareness of their continued improvement in PM performance throughout middle childhood is an important consideration when creating expectations concerning children's ability to complete planned actions in both academic and everyday settings. Second, the cross-validation of Terrett et al.'s (2019) findings identifying EFT as a significant, unique contributor to event-based PM performance provides support for the potential use of future simulation as a strategy to improve PM performance in this age group. As previously noted, it has been argued that EFT may facilitate PM by reinforcing the connection between the ongoing task context and the specific cue to complete the intended action (Altgassen et al., 2017; Terrett et al., 2019).

To conclude, the current study provides an important addition and extension to current literature focused on PM in middle childhood and provides a more comprehensive understanding of factors that contribute to children's PM performance. Of those factors, the current study provides additional support for the critical role of retrospective memory in PM more broadly and for EFT in PM tasks that are event-based. As this study is one of the few to examine primary school aged children's performance across each type of PM task and only the second to include EFT as a predictor, it provides a valuable contribution to the current knowledge of the abilities that underpin children's performance across each type of PM task.

Chapter 7: General Discussion

Preamble

This chapter integrates the findings of the three empirical studies presented in chapters 4, 5, and 6 of the thesis. The aims and results of each study will first be summarised, followed by a discussion on the implications of their findings. Future directions for research investigating future-oriented thinking in children will then be presented. Lastly, this chapter will conclude by discussing the limitations and strengths of the research project as a whole.

7.1 Summary of Aims and Results of Empirical Studies

7.1.1 Study 1

Study 1 aimed to investigate whether EFT was associated with age across the middle childhood period. An additional aim of Study 1 was to examine the cognitive processes that underpin EFT in this age band, specifically episodic memory and executive functions (indexed by inhibition, cognitive flexibility, and working memory). The results firstly demonstrated greater EFT ability was associated with age, consistent with some of the limited studies previously conducted with this age group. Study 1 also extended the literature examining the mechanisms that may drive EFT, showing a strong and significant contribution from episodic memory, but no hint of a contribution from executive functions.

7.1.2 Study 2

The first aim of Study 2 was to investigate whether episodic foresight was associated with age in middle childhood. In addition, Study 2 aimed to examine the cognitive abilities that may be implicated in episodic foresight, with a particular interest in investigating whether EFT contributed to episodic foresight performance. This study provided the first evidence of a positive correlation between age and episodic foresight across the ages of 8 to 12 years. In addition, Study 2 identified age and IQ as contributors to successful episodic foresight performance, whereas retrospective memory, executive functions, and EFT were not found to contribute. The lack of contribution of EFT may have been due to the specific form of episodic foresight task measured in Virtual Week-Foresight, which did not require a specific scenario to be envisaged. However, it is possible that other types of episodic foresight task that do involve clear scenarios to be envisaged may find EFT to be a significant contributor to successful performance. The findings of this study therefore provide substantial direction for future research to delineate different forms of episodic foresight task and clarify what appears to be a lack of involvement from executive functions.

7.1.3 Study 3

The aim of Study 3 was to examine whether age was associated with children's PM performance, using a reliable measure, Virtual Week-Prospective Memory. A second aim of Study 3 was to examine the cognitive abilities that contributed to children's PM performance on both event-based and time-based PM tasks. A particular interest was whether children's EFT ability contributed to their PM performance, as this study is only the second in the literature to examine the contribution of EFT to performance on both types of PM task in this age group. Study 3 therefore aimed to extend this previous work by examining the contribution of EFT while concurrently examining a more comprehensive set of other predictors than was included in the previous study. The results of Study 3 indicated age was strongly associated with better performance on both event-based and time-based PM tasks. The findings also revealed age, retrospective memory, and EFT were significant contributors to event-based PM performance, while retrospective memory was the only significant contributor to time-based PM performance. Furthermore, executive functions were not found to contribute at all to performance on either task type. An important finding from Study 3 was the selective contribution of EFT to event-based PM performance, which is consistent with the only other study in this age group.

7.2 Contribution of Study Findings to the Future-Oriented Thinking Literature

The future-oriented thinking literature highlights the numerous and complex ways people engage in thoughts about the future (Szpunar et al., 2014, 2016). However, as noted in Chapter 2, conceptualisation of future-oriented thinking as a taxonomy of interrelated abilities is a relatively recent idea with most empirical investigations to date having focused on these abilities in isolation. The current research therefore sought to provide a concurrent investigation of three key future-oriented abilities, EFT, episodic foresight, and PM and their possible interrelations, as well as their predictors, in children aged 8 to 12 years.

7.2.1 Age-Related Improvements in Future-Oriented Thinking in Middle Childhood

This research provides an important extension to the current understanding of the development of future-oriented thinking. The empirical studies presented in this thesis help to bridge the gap in knowledge of the development of EFT, episodic foresight, and PM between their emergence in the preschool years and their presentation later in development. The relatively wide age range (i.e. children aged 8 to 12 years) used in the current thesis provides valuable additional insight into the developmental picture of these abilities, given that many previous studies of this period, particularly in the EFT literature, have often only examined and compared specific age groups (e.g. 5, 7, and 9 year olds) or narrower age ranges (e.g. 7 to 10 year olds). Using this approach, the current research project identified significant associations between age and the three future-oriented abilities studied. Understanding that children may still be improving in their capacity to display each of these abilities across the middle childhood period provides important insight into the developmental picture of future-oriented thinking as a broader taxonomy. In particular, an important and novel contribution of this research project was the investigation of age-related changes in episodic foresight which, as previously noted, is an aspect of future-oriented thinking that has only just begun to be examined in the literature. Specifically, Study 2 found evidence of better episodic foresight performance with increasing age across

8 to 12 years. This is a valuable addition to this growing body of literature, as this is the first empirical investigation of this ability in children over 5 years of age.

7.2.2 Cognitive Processes Underpinning Future-Oriented Thinking

Another important contribution of the current research project was the investigation of cognitive processes that may contribute to EFT, episodic foresight, and PM in this age band. Exploring a comprehensive set of contributors, as well as relationships between the future-oriented thinking constructs, provides an important extension to the literature exploring future-oriented thinking as a taxonomy of interrelated abilities. Furthermore, examining what may drive EFT, episodic foresight, and PM is important for fostering the development of these abilities across the middle childhood years.

The investigation of contributors to children's EFT ability in middle childhood in Study 1 is a valuable addition to the limited number of studies that have used similar methodological approaches to assess EFT in this developmental stage (Coughlin et al., 2014; Coughlin et al., 2019; Gott & Lah, 2014; Terrett et al., 2019; Wang et al., 2014). The current finding that episodic memory was a strong contributor to EFT supports theoretical claims regarding the role of episodic memory in constructing future scenarios in imagination (Buckner & Carroll, 2007; Schacter & Addis, 2007b; Schacter et al., 2007; Suddendorf & Corballis, 1997, 2007; Tulving, 2005). In addition, Study 1 provided an important test of theoretical claims regarding the role of the three executive functions described in Miyake's model (Miyake et al., 2000), as previous studies in this age band investigated only one or two executive function constructs (Gott & Lah, 2014; Terrett et al., 2019). Contrary to theoretical claims, the current research did not find executive functions, as indexed by inhibition, cognitive flexibility, and working memory, contributed to EFT performance. Indeed, Study 1 revealed a clear pattern of results that demonstrated no hint of a contribution from executive functions to children's EFT ability. This converges with other previous studies which also found no evidence of an association between EFT and the executive functions investigated (Addis et al., 2008; Brown et al., 2014; Hanson et al., 2014; Irish et al., 2013; Mercuri et al., 2015; Mercuri et al., 2018; Terrett et al., 2019; Terrett et al., 2013; Unal & Hohenberger, 2017). Together, these findings suggest that executive functions are not key determinants of EFT ability and that the role of executive functions in the construction of future scenarios in imagination may have been overstated in the literature. However, it is acknowledged that overall, there is still relatively limited research examining executive processes and EFT so the current findings will require replication.

An important novel contribution from the current research project was to provide the first empirical investigation of contributors to episodic foresight in middle childhood, using a novel measure of episodic foresight that complies with Suddendorf and colleagues' criteria (Suddendorf & Corballis, 2010; Suddendorf et al., 2011). The lack of contribution from retrospective memory was not consistent with theoretical claims and suggests that greater retrospective memory does not lead to better episodic foresight performance. However, as acknowledged in Study 2, the List Memory Delayed subtest used to index retrospective memory may not have captured the role of memory in episodic foresight, and further investigation is required. In relation to executive functions, the results revealed a lack of contribution to children's episodic foresight, suggesting that greater executive functioning does not lead to better episodic foresight performance. This adds to converging evidence suggesting that executive functions may not play a critical part in episodic foresight performance, as other studies of adults using VW-Foresight have also found no association between these constructs (Lyons et al., 2014; Lyons et al., 2016). However, it is acknowledged that further investigation will be required to replicate these findings in children. Importantly, the novel finding that age and IQ were strong contributors to episodic foresight performance extends understanding of what may drive episodic foresight in this age band. As noted in Study 2, these results suggest that greater experience that comes with age, coupled with better general knowledge and capacity to think and reason abstractly, may lead to a greater ability to identify future problems and take steps in the present to secure their solution. Given these findings, age and a measure of IQ should be included in further studies aimed at identifying contributors to children's episodic foresight across the middle childhood years.

In relation to PM, identification of retrospective memory as a strong contributor to children's performance on both event-based and time-based PM tasks converges with previous studies (e.g. Cherry et al., 2001; Terrett et al., 2019; Terrett, Rose, et al., 2016) and theoretical models of PM (Einstein & McDaniel, 1990; Graf & Uttl, 2001; Smith & Bayen, 2004). However, in stark contrast to the strong contribution of retrospective memory, the results from Study 3 clearly demonstrated that inhibition, working memory, and cognitive flexibility did not contribute at all to children's performance on either event-based or time-based PM tasks. This is consistent with a number of other studies that have failed to find an association between PM and specific executive functions (e.g. Cottini et al., 2018; Ford et al., 2012; Kretschmer et al., 2014; Mackinlay et al., 2009; Mahy & Moses, 2011; Mäntylä et al., 2007; Zuber et al., 2019). While previous evidence regarding the relationship between executive functions and PM has been mixed, the pattern of results from Study 3 provides strong support for the argument that PM may be considered a unique ability separate to core executive processes.

A final important contribution from the current research project was a test of the claim that future-oriented abilities may interact and build on one another (Szpunar et al., 2014). Regarding the relationship between EFT and PM, findings demonstrated EFT contributed to event-based but not time-based PM performance, which is consistent with the only other study to examine this relationship in this age band (Terrett et al., 2019). This provides an important extension of the study by Terrett and colleagues (2019), as the current research utilised a larger sample and explored a greater range of contributors. As noted in Study 3, the lack of a contribution from EFT to time-based PM performance is likely due to the fact that these tasks are not as strongly linked to environmental cues as event-based tasks, and therefore are not as easy to visualise. Inter-relationships between future-oriented abilities was also addressed through investigation of the relationship between EFT and episodic foresight. Contrary to expectations, EFT did not contribute to episodic foresight performance, suggesting that a greater capacity to imagine future events in detail does not contribute to greater episodic foresight. However, as noted in Study 2, the problems presented in VW-Foresight may only reflect one type of episodic foresight task, i.e. those that do not make reference to a specific future scenario which can be envisaged in imagination. In contrast, episodic foresight tasks where the specific details of a future scenario are known ahead of time may be more likely to benefit from a greater capacity to imagine future events. This proposal that the relationship between EFT and episodic foresight may vary depending on the exact nature of the episodic foresight task gains credence from the parallels that can be drawn with the findings from Study 3 showing EFT contributed to event-based PM but not time-based PM. Together, then, the findings regarding the relationship between EFT and episodic foresight, and EFT and PM, help extend Szpunar and colleagues' proposed taxonomy of future-oriented thinking (Szpunar et al., 2014, 2016) by emphasising the complexity of the relationships between different forms of this general capacity.

Overall, the pattern of results across the three studies provides clear evidence regarding contributors to the three aspects of future-oriented thinking investigated. Indeed, these findings provide a clearer picture than would have been anticipated from the literature to date, given that previous findings regarding the role of cognitive abilities, such as executive functions, have often been mixed. The stark contrast in magnitude of contribution from those variables identified as significant contributors to children's EFT, episodic foresight, and PM, and those that were not, suggests that the current results were not due to a lack of statistical power or lack of sensitivity in the measures used. The findings from the current research therefore bring greater clarity to the literature exploring cognitive processes which may underpin future-oriented thinking in children.

7.3 Implications of the Findings

As previously noted, EFT, episodic foresight, and PM have all been argued to be important for the development of independence, behavioural flexibility, and goal attainment (Causey & Bjorklund, 2014; Henry et al., 2014; Kvavilashvili et al., 2008; Suddendorf, 2006, 2017). As middle childhood has been noted as a developmental period of increasing independence (Sanders, 1985), the current findings that children are still continuing to develop these abilities across 8 to 12 years has particular significance in the context of children's daily lives.

In relation to EFT, the ability to imagine one-self experiencing future events has been linked to positive behavioural outcomes such as prosocial behaviour (Gaesser et al., 2015; Gaesser & Schacter, 2014) and flexible decision making (Bromberg et al., 2015). The findings from Study 1 regarding greater EFT ability with age across the ages of 8 to 12 years can provide some guidance regarding parents' and teachers' expectations of children's abilities. This may in turn inform the development of appropriate behaviour management strategies which take into account children's capacity to imagine themselves experiencing future scenarios. For example, it has been found that engaging in conversations with young children about their future selves improves their ability to delay gratification (Leech et al., 2019). Such an approach may therefore be beneficial in promoting positive behavioural outcomes in daily life.

In relation to episodic foresight, as previously noted, this ability allows us to mentally consider the consequences of future actions without experiencing any of the associated risks (Suddendorf, 2006; Suddendorf & Moore, 2011). The current findings that children's episodic foresight ability is still improving across middle childhood is an important consideration for parents and teachers. Assisting children to identify steps that may be taken in the present in order to achieve the most desirable future outcomes may promote future success and reduce future failure. Indeed, priming participants to engage in episodic foresight has consistently been shown to increase the capacity to delay gratification, and to reduce the rate at which the value of distant rewards are discounted (Bar, 2010; Bulley & Gullo, 2017; Daniel et al., 2015; Peters & Buchel, 2010). Encouraging children to consider future needs will help them achieve distant goals, such as saving their pocket money for a desired item, or planning and completing homework assignments with extended due dates in a timely fashion.

In relation to PM, proficiency in this ability becomes of greater importance as children progress through school as they are given increasing responsibility to remember to complete certain tasks on their own as the level of support provided by teachers decreases. As the current research demonstrates that children's PM performance is continuing to improve across the ages of 8 to 12 years, it is possible to inform parents and teachers about age appropriate demands on this skill. This in turn will help ensure that children are given PM tasks to complete that are consistent with their level of development. Furthermore, the finding that EFT contributed to children's PM performance, in addition to research indicating that future event simulation improves PM performance (Altgassen et al., 2017; Altgassen et al., 2015; Brewer et al., 2011; Brewer & Marsh, 2010; Kretschmer-Trendowicz et al., 2016; Kretschmer-Trendowicz et al., 2019; Neroni et al., 2014; Spreng et al., 2018), suggests that priming children to envisage themselves completing a PM action in the future is likely to be a useful strategy for parents and teachers to use to support children's capacity to remember to complete required tasks at the appropriate moment, and reduce the negative consequences of PM failures.

A final important implication of the current research is the use of these findings to inform future studies in clinical populations. Improved understanding of the typical development of EFT, episodic foresight, and PM across middle childhood provides a benchmark against which these abilities can be assessed, allowing deficits to be identified in clinical populations, such as children with autism spectrum disorder (Henry et al., 2014; Terrett et al., 2013) and attention-deficit/hyperactivity disorder (Talbot et al., 2018).

Furthermore, the current findings regarding the cognitive processes that contribute to future-oriented thinking will also help identify whether deficits in these processes are what drives the difficulties in future-oriented thinking that are observed in those clinical groups. This will in turn assist in developing the appropriate accommodations and interventions both in daily life and at school for these vulnerable populations.

7.4 Future Research Directions

A valuable extension of the current research would be the implementation of longitudinal designs for future investigation of these future-oriented abilities in children. The results of this cross-sectional research demonstrated improvements in EFT, episodic foresight, and PM across the middle childhood period, which can be built upon in longitudinal research that further teases out the trajectory of age-related improvements in future-oriented thinking. It is also suggested that a broader sampling range that extends from early childhood to adulthood be included to provide a thorough understanding of the peaks, plateaus, and declines across the lifespan.

In addition, another important target for future research would be increased focus on episodic foresight, given, as previously noted, research examining this ability has just begun to emerge. Part of the scarcity of research relates to the lack of appropriate measures of episodic foresight that adhere to the criteria set out by Suddendorf and Corballis (2010). In the current research, VW-Foresight reflected the essence of episodic foresight by indexing children's ability to acquire items in the present that would be useful for solving future problems and their ability to use those items at the appropriate time to achieve the most desirable outcome. Furthermore, VW-Foresight was shown to be sensitive to age-related changes in episodic foresight performance in the middle childhood years, which in turn assists knowledge of the developmental trajectory of this ability. Increased use of VW-Foresight would therefore be beneficial for future studies.

The findings in the current thesis also highlight the need for further exploration of the theoretical construct of episodic foresight, particularly in distinguishing different types of episodic foresight task. The value of such an exploration has been recently demonstrated in the PM literature, which found that further differentiation between types of time-based PM task (i.e. time-of-day versus time-interval) helped to explain the age-PM paradox observed in older adults' performance on naturalistic versus laboratory PM tasks (Haines et al., 2020). Similar investigation to delineate different types of episodic foresight task would assist in identifying whether different cognitive mechanisms may be implicated in different forms of this skill. Part of this investigation should also include the development of naturalistic measures of episodic foresight that capture children's use of this skill in their daily lives. This will allow a greater understanding of how children engage in episodic foresight in the context of daily living.

Further research is also required to determine the cognitive processes involved in each of the future-oriented abilities investigated in this thesis. For example, in relation to the cognitive abilities that underpin EFT, a recent shift in perspective driven by the neuroscience literature has hypothesised that mental simulation of past and future events may rely on the same underlying process of constructive simulation (Addis, 2018). Addis' proposed theoretical shift from previous definitions of the constructive episodic simulation hypothesis places greater emphasis on this underlying neurocognitive system, where representational content (i.e. schemas, episodic, and semantic content) is drawn upon to construct event representations of the past or future (Addis, 2018, 2020). Consideration of this new approach when investigating the cognitive mechanisms that underpin children's EFT ability will be a highly valuable focus for future studies.

Regarding episodic foresight, the current research is the first to examine a number of contributors to this ability in this age band and in particular provides valuable evidence regarding the important contribution of general intelligence. While neither retrospective memory nor executive functions were found to contribute to episodic foresight in the current study, it is suggested that further empirical investigation is conducted to replicate these findings. In addition, it would be valuable for further studies to investigate other potential contributors to episodic foresight. Indeed, a range of cognitive processes beyond those addressed in the present research have begun to be discussed in the literature. For example, it has been proposed that metacognition, which allows us to evaluate the limitations and strengths of our future predictions, may assist the preparatory aspect of episodic foresight, allowing more than one outcome to be considered such that contingency plans can be made (Bulley et al., 2020; Bulley & Schacter, 2020; Redshaw, 2014). For example, it has been shown that by 4 years of age, children were able to prepare for at least two potential future outcomes (Redshaw & Suddendorf, 2016), and by 9 years of age, children were able to choose to use external reminders when they anticipated that their future memory would be worse (Redshaw, Vandersee, et al., 2018). Further examination of metacognitive abilities in relation to children's episodic foresight performance may therefore be a valuable area for further empirical exploration. Another potential contributor to episodic foresight is semantic future thinking, which refers to one's general knowledge about the future (Atance & O'Neill, 2001). According to the semantic scaffolding hypothesis, semantic information, i.e. atemporal knowledge about the world, provides a framework that assists with the organisation of event details used to construct future scenarios in imagination (Irish & Piguet, 2013). Consequently, it may be that children's capacity to take preparatory action in service of a future outcome relies on their ability to envisage a generalised, non-personal image of the relevant future scenario. For example, a child going to school camp next week may imagine that school camps generally involve a lot of hiking, which then prompts them to pack their walking shoes. Future studies may therefore consider exploring whether semantic future thinking ability plays a role in children's episodic foresight performance. Finally, recent work has highlighted that anticipation of future outcomes also involves projection of current physiological states (Bulley et al., 2020). For example, research has found that current physiological states, such as hunger, influence predicted future physiological needs (Mahy, Grass, et al., 2014). In addition, it has been noted that bias towards exaggerated negative emotional responses to future outcomes may increase motivation to take action in the present to avoid negative future consequences (Gautam et al., 2019; Miloyan & Suddendorf, 2015; Morewedge & Buechel, 2013; Wilson & Gilbert, 2005). Examination of this type of affective forecasting bias in children, however, is currently limited to observations in preschool children (Gautam et al., 2017). Therefore, further consideration of other future-oriented processes, such as affective forecasting, would be highly beneficial in disentangling what may contribute to episodic foresight performance in the middle childhood years.

In relation to further work regarding contributors to PM, it has been suggested from a theoretical standpoint that executive functions may provide a developmental framework whereby age-related improvements in executive functions mediate age-related improvements in PM (Mahy & Moses, 2011; Mahy, Moses, et al., 2014a; Zhao et al., 2019). While the current research provides strong evidence to suggest that executive functioning does not play an integral part in PM across middle childhood, it is acknowledged that previous findings have been mixed. It is therefore recommended that future studies utilise longitudinal research designs to address this theoretical claim. One recent attempt to do this was conducted by Spiess et al. (2016), who assessed 8 year olds' event-based PM and executive function performance and reassessed their performance eight months later. Results indicated that children's performance on both PM and executive functions improved and that these abilities were significantly associated. Furthermore, structural equation modelling indicated a significant longitudinal link between executive functions and PM, which may suggest these abilities are not only cross-sectionally but longitudinally related (Spiess et al., 2016). However, this study only examined children's event-based PM performance and it therefore remains unclear if such a link may be found between executive functions and time-based PM. The development of appropriate longitudinal designs that include both types of PM task is therefore required to provide a more nuanced understanding of the role of executive functions in PM across development.

Further research is also still required to determine interrelations between the different future-oriented abilities, in particular between EFT and episodic foresight. While the current research provided additional support for previous findings indicating a role for EFT in PM (Nigro et al., 2014; Terrett et al., 2019; Terrett, Rose, et al., 2016), it was the first to explore the relationship between EFT and episodic foresight. While EFT was not found to contribute to children's episodic foresight performance, as previously noted, this may have been due to the type of episodic foresight task utilised in the current research, which did not involve a specific future scenario that could be envisaged ahead of time. This finding does provide a clear direction for future research to delineate children's performance across different types of episodic foresight task. It is therefore suggested that future studies aim to assess children's performance on episodic foresight tasks that do specify future scenarios that can be pre-experienced in imagination. This will help in determining whether greater EFT contributes to the successful resolution of different types of episodic foresight.

7.5 Limitations and Strengths of the Research Project

While this research project provided novel insights into future-oriented thinking in middle childhood, there are some limitations that should be acknowledged. The first relates to the use of cross-sectional data, which constrains the claims that can be made regarding the developmental trajectory of EFT, episodic foresight, and PM across middle childhood. Despite this, findings from the current thesis provide valuable direction and assist in the formulation of hypotheses for future research. As suggested earlier, the next step for future research will be to replicate the studies of the current thesis, utilising longitudinal research designs that allow for a more nuanced investigation of the developmental pathways of these future-oriented abilities across childhood.

A second limitation relates to the investigation of executive functions as potential contributors to EFT, episodic foresight, and PM. As previously noted, there is a paucity of research directly examining the role of executive functions in future-oriented thinking. This is compounded by the fact that tasks selected to measure executive functions vary greatly in the broader literature, and are often criticised for task impurity (for a review see Best & Miller, 2010). Furthermore, it has been acknowledged that the three executive functions in Miyake's model also comprise multiple subprocesses, and different task paradigms may measure different types of inhibition, cognitive flexibility, working memory (Zuber et al., 2019). As such, further work is required to determine the precise role of executive functions in each of the future-oriented constructs. Nevertheless, the current project provided an important examination of the executive processes most heavily implicated in the theoretical literature and included executive function tasks with strong psychometric properties that have been used in previous studies. These findings therefore provide substantial direction for further investigation.

Despite these limitations, a number of strengths were also present in this research project. First, this project included a relatively large sample size, and included a broad age range encompassing the middle childhood period. Second, the current research project utilised a comprehensive test battery that included a number of reliable and well-validated measures, which is relatively novel in the children's future-oriented thinking literature. In particular, VW-PM has been well validated and used in a number of published studies (for a review see Rendell & Henry, 2009) and the children's version of VW-PM has also been shown to have good reliability in this age range (Henry et al., 2014). In addition, it has been noted that VW-PM is particularly well suited for identifying individual differences, as in the current research, because it measures PM performance over a greater number of observations compared to other PM paradigms (Rose et al., 2010). Furthermore, use of VW-PM in the current project provided an important replication of the study by Terrett et al. (2019), similarly finding an association between EFT and event-based PM, using a larger sample and greater number of predictors than the previous study. In relation to episodic foresight, use of a novel behavioural measure of this construct, i.e. VW-Foresight, is an important strength of the current project, as no such measure has previously been available for children. As noted in the literature review in Chapter 2, previous tasks typically measure episodic foresight performance on only one episodic foresight problem (Lyons et al., 2014). In contrast, the children's version of VW-Foresight contains seven problems, therefore providing a more sensitive measure of episodic foresight ability. While it is acknowledged that further work is needed to determine the reliability of VW-Foresight with children, it has been shown to be sensitive to deficits in aging and clinical populations (Lyons et al., 2014; Lyons et al., 2016; Lyons et al., 2019; Terrett, Lyons, et al., 2016). The use of the children's version in the current project therefore provided a valuable first step that further investigations of children's episodic foresight beyond the preschool years can build upon.

7.6 Conclusions

The ability to think about and act with the future in mind and remember to execute plans we have made are important skills necessary for successful daily living. Research has mapped the acquisition of EFT, episodic foresight, and PM in the preschool years, however examination of these abilities in the middle childhood years has been relatively limited. This thesis extends our knowledge of future-oriented thinking in children aged 8 to 12 years as well as the cognitive processes that underpin these abilities. Indeed, the pattern of results regarding the cognitive mechanisms that contribute to EFT, episodic foresight, and PM in this age band provides much needed clarity to the previously mixed findings in the future-oriented thinking literature. This in turn provides a valuable stepping stone for future research to further delineate the cognitive abilities underpinning EFT, episodic foresight, and PM, as well as research investigating the relationships between these skills. Greater knowledge of children's abilities in this age group may guide parents and teachers in daily life, helping to create appropriate expectations about children's capacity to use these skills in their everyday functioning, thereby maximising success and minimising failure.

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Appendices

Appendix A. Recruitment Flyer

Cognition & Emotion Research Centre

ACU
AUSTRALIAN CATHOLIC UNIVERSITY

Participants Wanted!

Have you ever wondered why your child can't remember to take that notice out of their bag or why they can't seem to plan ahead? Well we are researching this very thing!

We are investigating children's ability to carry out future plans and intentions, imagine themselves in future scenarios and how this may affect their everyday living.

If you have a **primary school child aged between 8-12 years** we invite you both to participate in this study.

So what's involved?

- During two sessions your child will:
  - Play two computer games designed especially for children. The games simulate an actual week and represent tasks that occur in everyday life.
  - Engage in an interview that's a bit like story-telling, to either recreate a past event or create a future event.
  - Complete a series of memory and thinking tasks, which involve answering verbally presented questions and following instructions.
- You (parent/guardian) will be asked to complete two questionnaires about your child during the first session, which will take about 15 minutes to complete.
- We ask you to allow around 2 hours per session and that at least one parent/guardian be present during both sessions.
- The sessions can take place at a mutually convenient time and location - such as your home or at the Fitzroy campus at the Australian Catholic University.
- Parents/Guardians are able to receive a summary of the study's results on the completion of the project. Please note, individual results cannot be discussed.

How will we say thanks?

Parents and children will be reimbursed with a child and an adult movie ticket as a sincere thank you for your time.

So who's conducting this research?

This study is being conducted by Katherine Horner as part of her postgraduate degree in psychology. It is also part of an ongoing research into future thinking in children by Associate Professor Gill Terrett and Professor Peter Rendell and has been approved by the Humans Ethics Research Committee (HREC 2018-145H).

Interested? Like to find out more?

Please contact Katherine (Kate) Horner, email: katherine.horner2@myacu.edu.au, or phone/text our dedicated research line: 0406 577 615. (If leaving a message, please provide your name, phone number and the best time for us to call you back). Any questions regarding this project can also be directed to the Principal Supervisor, Associate Prof. Gill Terrett on 03-9953 3121 in the School of Psychology at ACU.

We look forward to hearing from you soon!

Appendix B. Background Questionnaire

Date: ___ /___ /____ ID: __________

Future-Oriented Thinking in Middle Childhood

BACKGROUND INFORMATION QUESTIONNAIRE

Section 1: Parent/Guardian #1 Demographics

1.1 Relationship to child: Mother ☐ Father ☐ Other ☐

1.1a *If Other please specify:* ____________________

1.2 Parent/guardian country of birth: _________________

1.3 Parent/guardian cultural background (e.g. Australian, Chinese, Indian etc):

____

1.4 Please indicate the highest level of schooling you have completed.

Please tick (✓) one:

☐ year 10 or less ☐ year 11 ☐ year 12

1.5 Please indicate the highest level of post-school qualifications you have completed.

Please tick (✓) one:

☐ trade apprenticeship ☐ technical diploma/certificate

☐ tertiary qualification ☐ post graduate degree

☐ no after school qualification

1.6 Please state your usual occupation: _____________________________

Cognition & Emotion Research Centre

ACU AUSTRALIAN CATHOLIC UNIVERSITY

Date: ____ /____ /_____ ID: _____________

Section 2: Parent/Guardian #2 (if applicable) Demographics

2.1 Relationship to child: Mother ☐ Father ☐ Other ☐

2.1a *If Other please specify:* ______________________

2.2 Parent/guardian country of birth:___________________

2.3 Parent/guardian cultural background (e.g. Australian, Chinese, Indian etc):

____

2.4 Please indicate the highest level of schooling you have completed.

Please tick (✓) one:

☐ year 10 or less ☐ year 11 ☐ year 12

2.5 Please indicate the highest level of post-school qualifications you have completed.

Please tick (✓) one:

☐ trade apprenticeship ☐ technical diploma/certificate

☐ tertiary qualification ☐ post graduate degree

☐ no after school qualification

2.6 Please state your usual occupation: ________________________________

Date: ___ /___ /____ ID: ___________

Section 3: Child Demographics

3.1 Child's age: _______ years

3.2 Child's date of birth: ____/____/_____

3.3 Child's gender: Male ☐ Female ☐ Other ☐

3.4 Child's country of birth: __________________

3.5 Child's cultural background (e.g. Australian, Chinese, Indian etc): ______________

3.6 First language spoken at home: ______________________

3.7 If English is not your child's first language, what was the age he/she started speaking English? ________________

Section 4: Child's Health and Wellbeing

4.1 Does your child have any speech or language problems? Please tick (✓) one:

☐ Yes, a lot ☐ Yes, a little ☐ No (go to question 4.2)

4.1a If Yes, has your child received help for their speech or language difficulties? Please tick (✓) one:

☐ Yes ☐ No (go to question 4.2)

4.1b If you ticked yes (to 4.1a) please describe what type of help:

____

____

____

Date: ____ /____ /_____ ID: _____________

4.2 Has your child ever been diagnosed with any of the following conditions?
Please tick (✓) all that apply:

- ☐ Anxiety
- ☐ Depression
- ☐ Intellectual disability (ID)
- ☐ Attention Deficit Hyperactivity Disorder (ADHD)
- ☐ Autism Spectrum Disorder (ASD)
- ☐ Other, please specify: ________________________________
- ☐ None of the above

4.3 How would you describe your child's state of health over the last month?

- ☐ excellent (no problems)
- ☐ very good (no major problems)
- ☐ good (occasional bad days)
- ☐ not very good (a number of problems)
- ☐ poor (persistent serious problems)

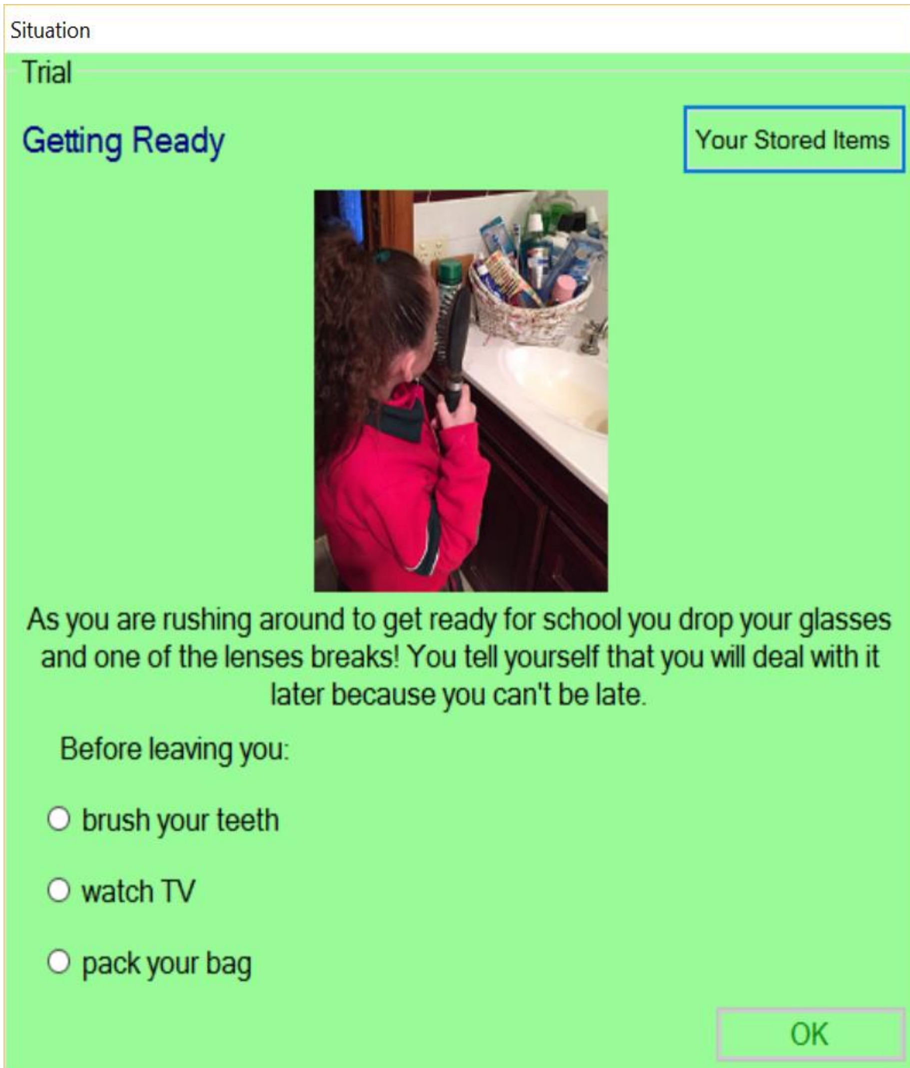
4.4 How well has your child been sleeping over the last few weeks?

- ☐ excellent (no problems)
- ☐ very good (no major problems)
- ☐ good (occasional bad nights)
- ☐ not very good (a number of problems)
- ☐ poor (persistent serious problems)

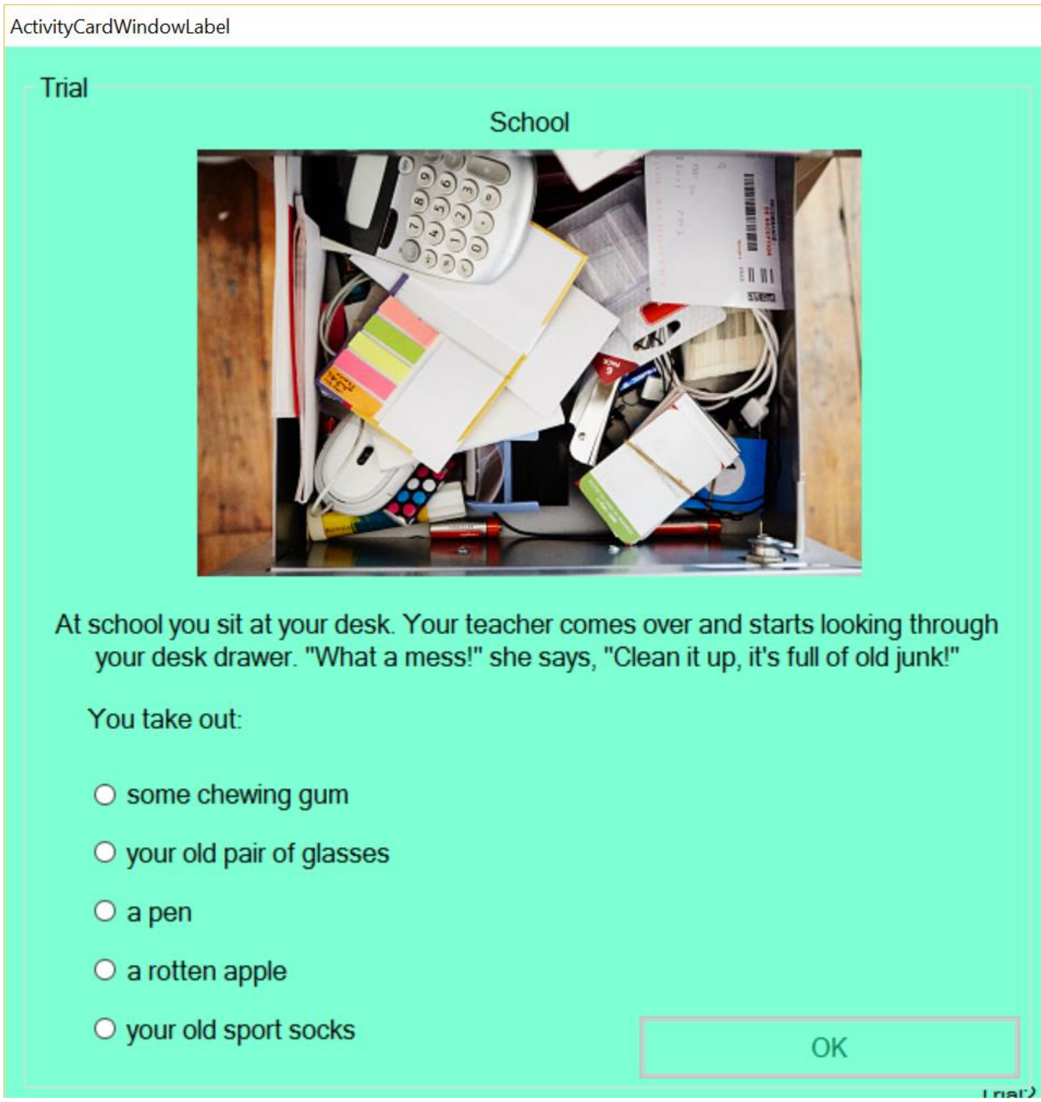
- THANK YOU FOR COMPLETING THIS QUESTIONNAIRE -

Appendix C. Virtual Week-Foresight

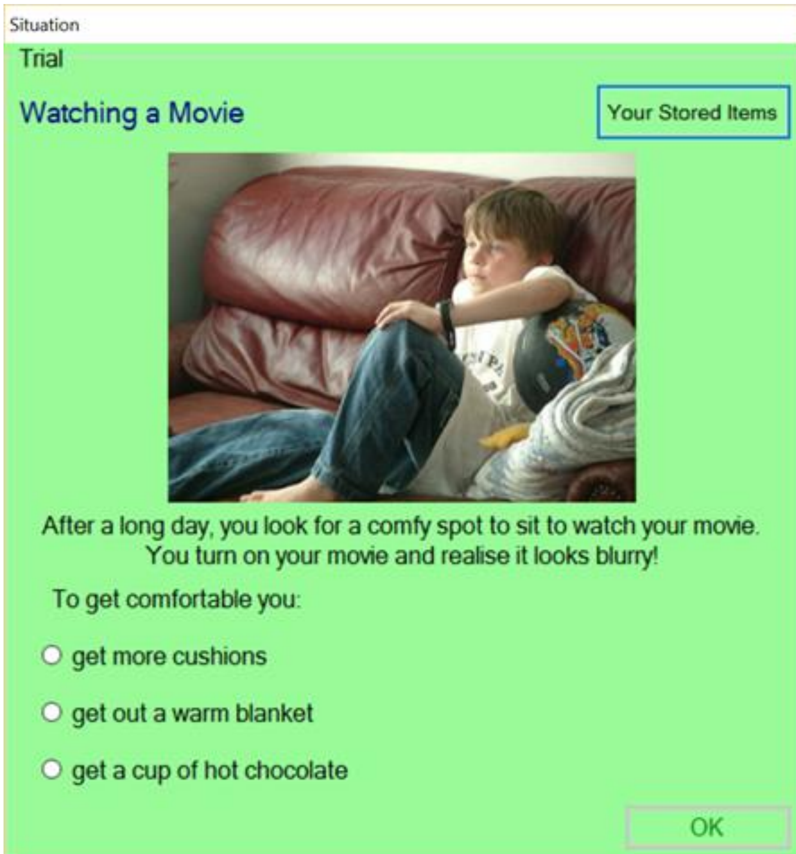
Appendix C – 1 Virtual Week-Foresight Example of a Situation Card Presenting a Problem



Appendix C – 2 Virtual Week-Foresight Example of a Daily Activity Card for Item Acquisition

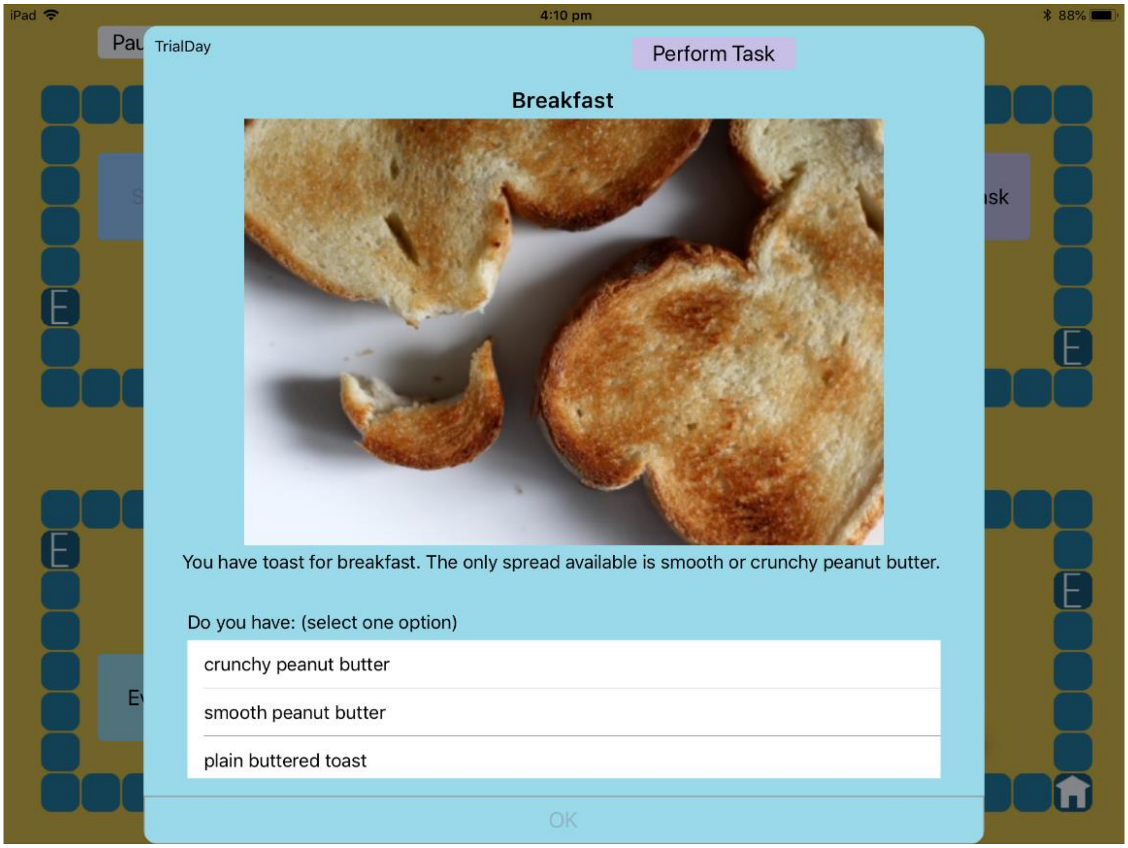


Appendix C – 3 Virtual Week-Foresight Example of a Situation Card for Item Use

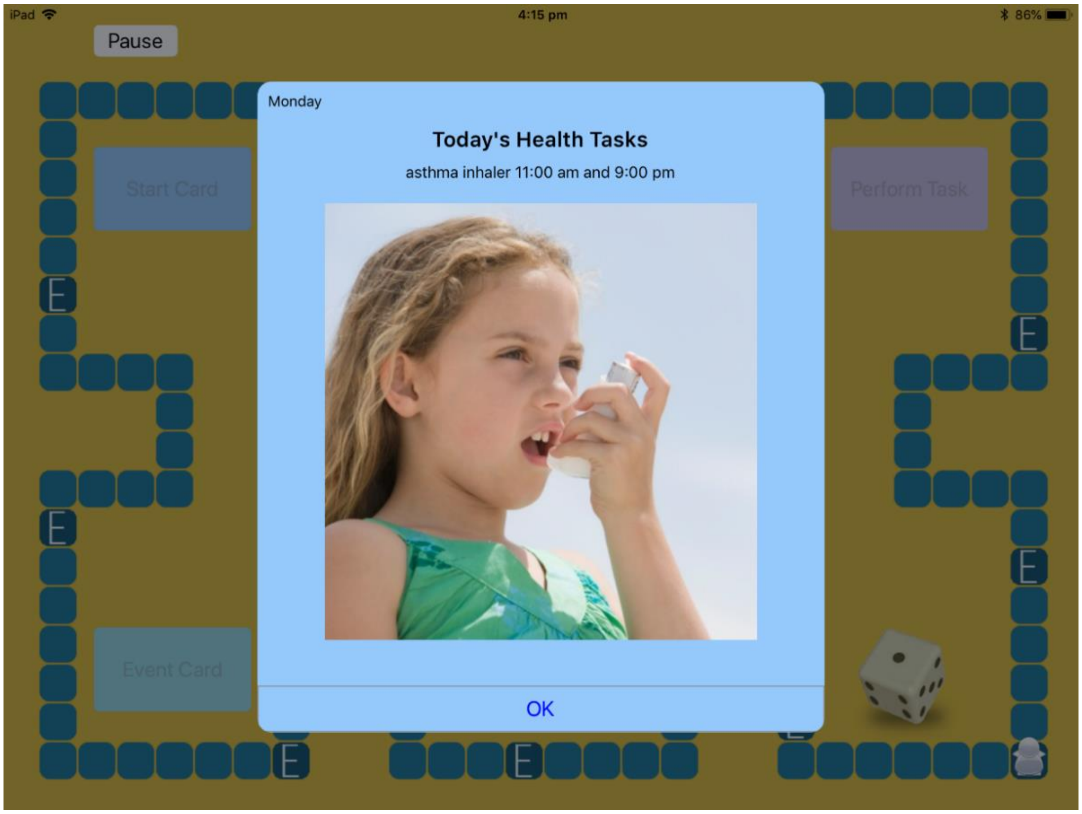


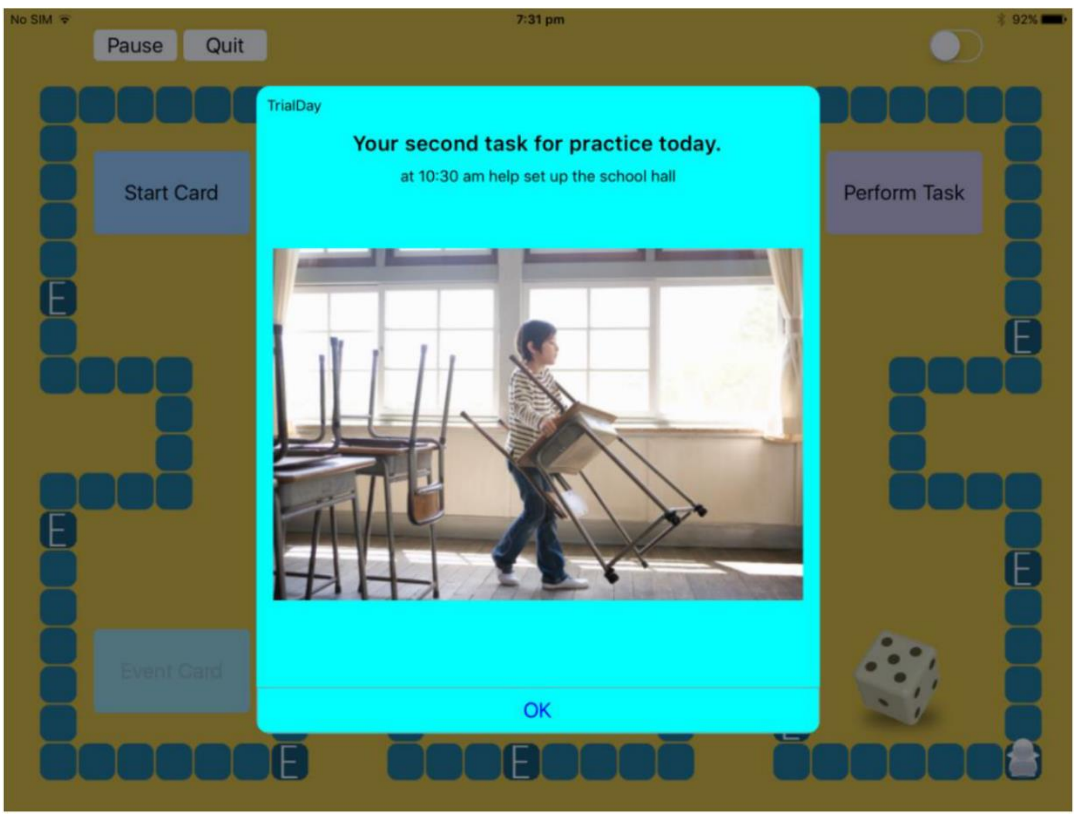
Appendix D. Virtual Week-Prospective Memory

Appendix D – 1 Virtual Week-Prospective Memory Example of an Event Card

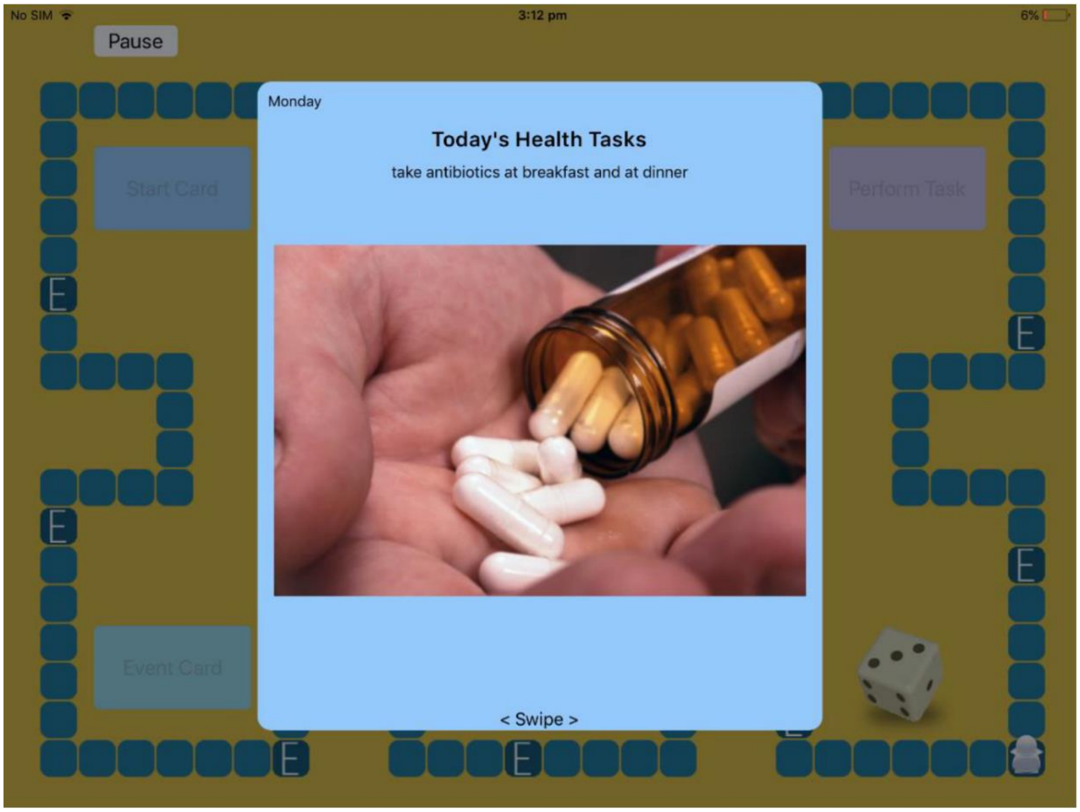


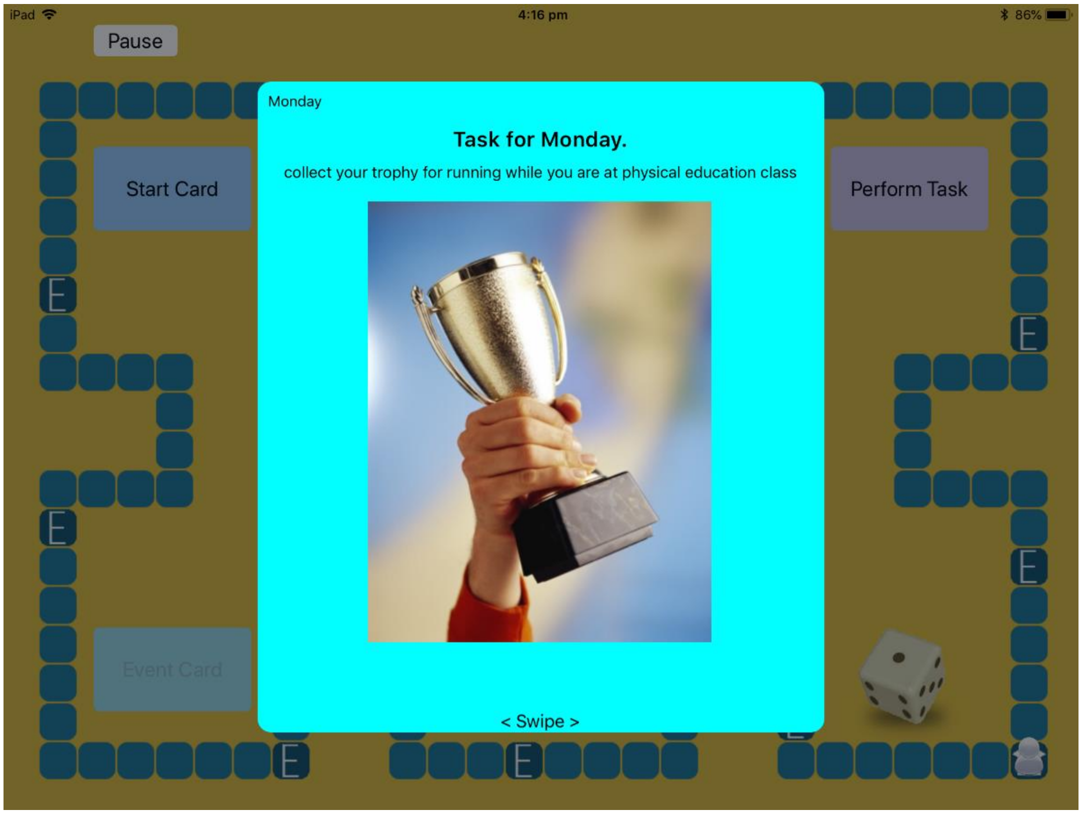
Appendix D – 2 Virtual Week-Prospective Memory Example Time-Based Tasks



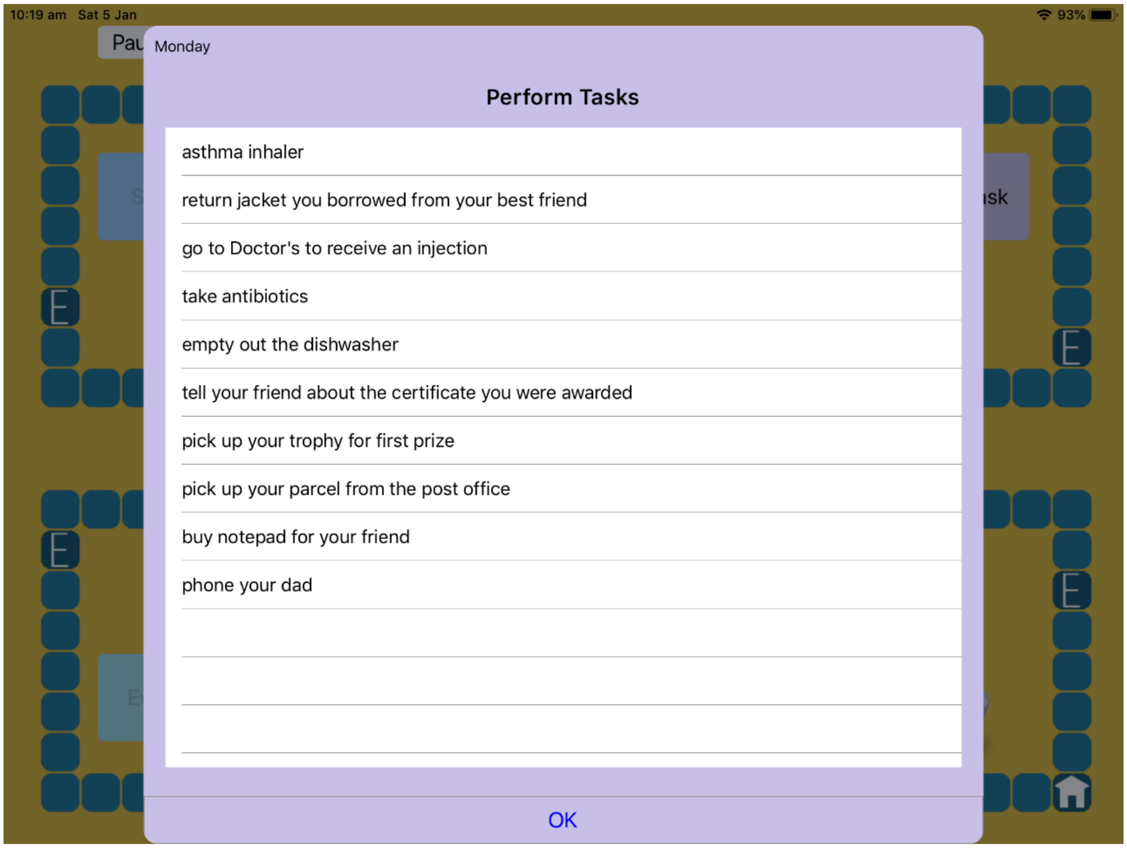


Appendix D – 3 Virtual Week-Prospective Memory Example Event-Based Tasks

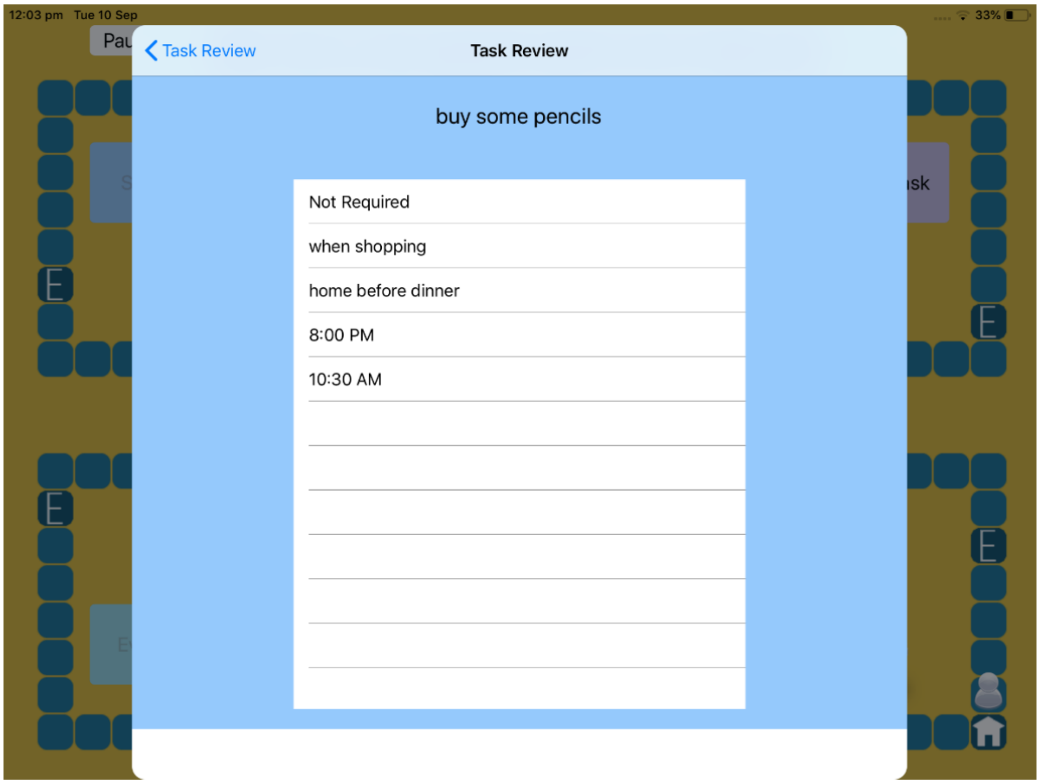




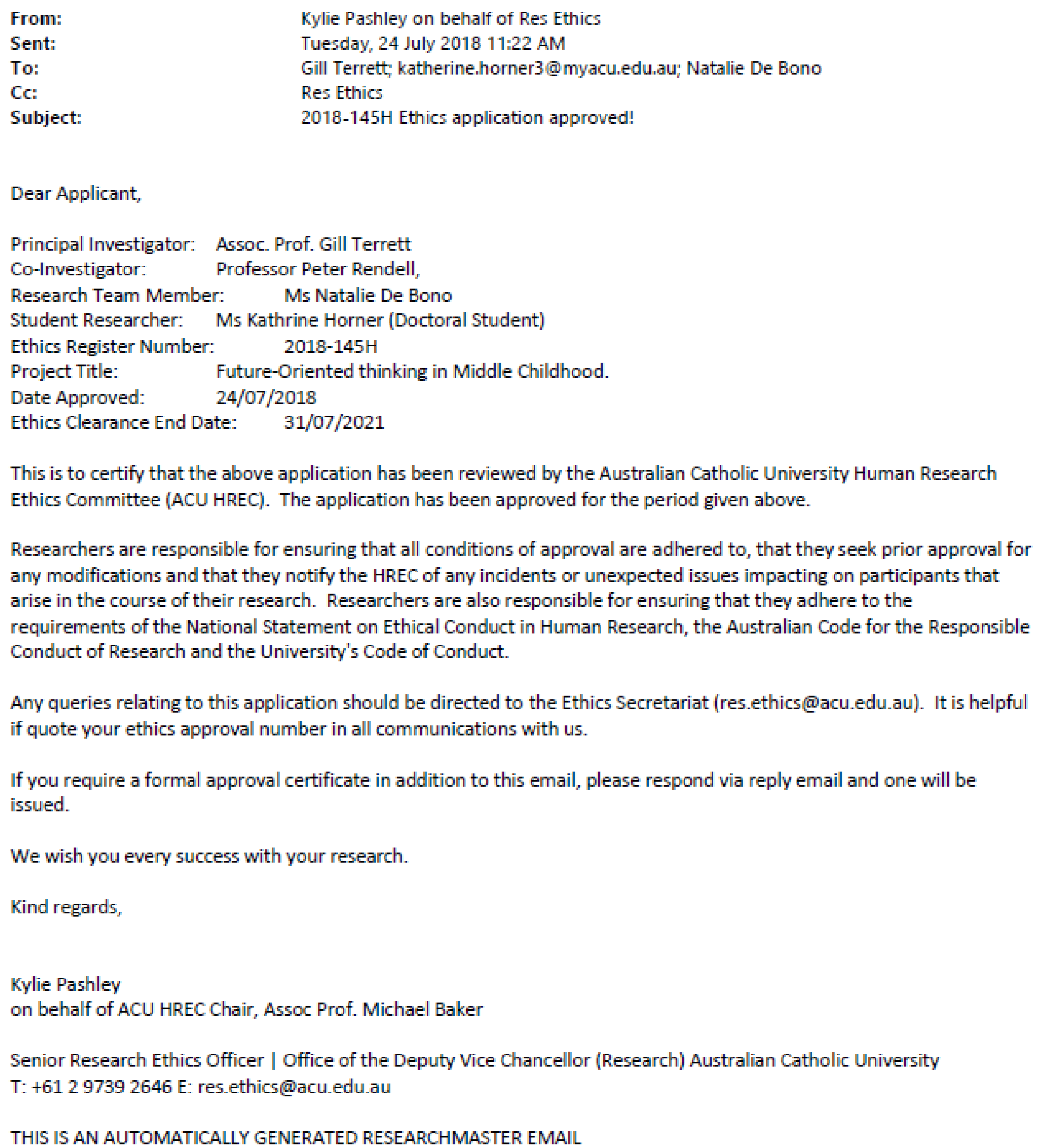
Appendix D – 4 Virtual Week-Prospective Memory Example of a Perform Task List



Appendix D – 5 Virtual Week Prospective Memory Example of a Task Review Card



Appendix E. Study Ethics Approval Email



From: Kylie Pashley on behalf of Res Ethics
Sent: Tuesday, 24 July 2018 11:22 AM
To: Gill Terrett; katherine.horner3@myacu.edu.au; Natalie De Bono
Cc: Res Ethics
Subject: 2018-145H Ethics application approved!

Dear Applicant,

Principal Investigator: Assoc. Prof. Gill Terrett
Co-Investigator: Professor Peter Rendell,
Research Team Member: Ms Natalie De Bono
Student Researcher: Ms Kathrine Horner (Doctoral Student)
Ethics Register Number: 2018-145H
Project Title: Future-Oriented thinking in Middle Childhood.
Date Approved: 24/07/2018
Ethics Clearance End Date: 31/07/2021

This is to certify that the above application has been reviewed by the Australian Catholic University Human Research Ethics Committee (ACU HREC). The application has been approved for the period given above.

Researchers are responsible for ensuring that all conditions of approval are adhered to, that they seek prior approval for any modifications and that they notify the HREC of any incidents or unexpected issues impacting on participants that arise in the course of their research. Researchers are also responsible for ensuring that they adhere to the requirements of the National Statement on Ethical Conduct in Human Research, the Australian Code for the Responsible Conduct of Research and the University's Code of Conduct.

Any queries relating to this application should be directed to the Ethics Secretariat (res.ethics@acu.edu.au). It is helpful if quote your ethics approval number in all communications with us.

If you require a formal approval certificate in addition to this email, please respond via reply email and one will be issued.

We wish you every success with your research.

Kind regards,

Kylie Pashley
on behalf of ACU HREC Chair, Assoc Prof. Michael Baker

Senior Research Ethics Officer | Office of the Deputy Vice Chancellor (Research) Australian Catholic University
T: +61 2 9739 2646 E: res.ethics@acu.edu.au

THIS IS AN AUTOMATICALLY GENERATED RESEARCHMASTER EMAIL

Appendix F. Information Letter

Cognition & Emotion Research Centre

ACU AUSTRALIAN CATHOLIC UNIVERSITY

PARTICIPANT INFORMATION LETTER

PROJECT TITLE: Future-Oriented Thinking in Middle Childhood
APPLICATION NUMBER: 2018-145H
PRINCIPAL INVESTIGATOR: Associate Professor Gill Terrett and Professor Peter Rendell
STUDENT RESEARCHER: Katherine Horner
STUDENT'S DEGREE: Master of Psychology (Education and Developmental) and Doctor of Philosophy (PhD)

Dear Participant (Parent/Guardian),

You and your child are invited to participate in the research project described below.

What is the project about?

This research project will investigate the relationship between children's ability to imagine themselves in the future, their memory for carrying out plans and intentions in the future, and their functioning in everyday life. The ability to imagine future events is sometimes referred to as mental time travel, which appears to be crucial for planning ahead in daily life. Your child is invited to participate in this study, as they are aged between 8 and 12 years and attending primary school.

Who is undertaking the project?

This project is being conducted by Katherine Horner and will form the basis for her research higher degree, Doctor of Philosophy (PhD) at Australian Catholic University, under the supervision of Associate Professor Gill Terrett who is an expert in the field of future thinking and cognitive processes in clinical and healthy populations and Professor Peter Rendell, Director of the CERC and internationally recognised researcher in the field of Prospective Memory. This research study follows well-established procedures of published and ongoing research into future thinking and prospective memory in children by Associate Professor Gill Terrett and Professor Peter Rendell.

Are there any risks associated with participating in this project?

We do not anticipate there to be any risks to you or your child by participating in this study. It is anticipated that children will find the tasks straight forward to complete.

What will I be asked to do?

- If you would like your child to take part in the study, you (the parent/guardian) will need to sign the attached consent form giving permission for your child's participation. Your child will also need to sign the assent section of the form. The researcher's copy of the consent form must be returned to us before or at the start of the first session.
- If you allow your child to take part in the study, he/she will participate in two sessions, with the second session, taking place four weeks after the first. Each session will take up to 2 hours to complete, including regular breaks between tasks. The two sessions will take place at a mutually

convenient date, time and location, such as your home or at the St Patrick's campus of ACU, in Fitzroy. At least one parent/guardian is required to be present throughout each session.

- During the sessions your child will play a computer game designed especially for children. The computer game simulates an actual week and represents tasks that occur in everyday life that require them to anticipate future events.
- During the two sessions, your child will also complete a set of tasks that measure cognitive abilities. For example during the first session your child will answer verbally presented questions and will point to the appropriate picture on a page according to instruction. Your child's memory will also be assessed by asking them to recall sequences of pictures. In the second session, future thinking will be assessed, by asking your child to imagine and describe future events (e.g. a holiday). This will be done in an interview format with the researcher. Please note that the two tasks requiring verbal responses will be audio-recorded for later scoring.
- Parents will be given two questionnaires to complete during the first session. The first questionnaire is a background questionnaire, which asks you (parent/guardian) to provide general information about you and your child, such as child's age, gender, grade, and other general demographic details. The second questionnaire is a 25-item rating scale about your child's daily living skills.
- To thank you and your child for your time and effort participating in this study, the researcher will offer an adult and child movie voucher at the completion of the second session.

How much time will the project take?

We ask you to allocate up to two hours for each session. The two questionnaires, to be completed by you (the parent/guardian), will take approximately 15 minutes.

What are the benefits of the research project?

There are no direct benefits to you or your child by participating in this study. However, you will have contributed to our understanding of future thinking in children and will have helped to further progress knowledge about children's cognitive development.

Can I withdraw from the study?

Participation in this study is completely voluntary. You and your child are not under any obligation to participate. If you agree to you and your child participating in this study and sign the consent form, you can still withdraw from the study at any time without adverse consequences.

Will anyone else know the results of the project?

To maintain confidentiality, your child's data will be allocated a numeric code and names will not be retained with the data so that information cannot be personally identified. Only the researchers directly involved in the study will have access to the data, which will be securely stored. Only results of group (aggregated) data will be reported and may be published in refereed psychological or scientific journals and presented at research conferences.

Will I be able to find out the results of the project?

If you are interested in finding out the results of the study, please tick the relevant box of the consent form. You will then receive a summary of the outcomes at the end of the study.

Who do I contact if I have questions about the project?

If you have any questions regarding this project, before or after participating, please contact the researcher, Katherine (Kate) Horner via email: katherine.horner2@myacu.edu.au or telephone our dedicated research line, 0406577615. If leaving a voice message, please provide your name, telephone number and/or email address and suggest a convenient time for us to call you back. Alternatively, you can contact the Principal Supervisor, Associate Professor Gill Terrett on 03 9953 3121, in the School of Psychology at the Australian Catholic University, to discuss your child's participation or the project in general.

What if I have a complaint or any concerns?

The study has been reviewed by the Human Research Ethics Committee at Australian Catholic University (HREC 2018-145H). If you have any complaints or concerns about the conduct of the project, you may write to the Manager of the Human Research Ethics Committee care of the Office of the Deputy Vice Chancellor (Research).

Manager, Ethics
c/o Office of the Deputy Vice Chancellor (Research)
Australian Catholic University
North Sydney Campus
PO Box 968
NORTH SYDNEY, NSW 2059
Ph.: 02 9739 2519
Fax: 02 9739 2870
Email: resethics.manager@acu.edu.au

Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

I want to participate! How do I sign up?

If you are willing to participate and willing to approve your child participating, please sign the attached informed consent form, and have your child complete the child assent section. You should sign both copies of the consent form and retain one copy for your records, and submit the other to the researcher before or at the start of the first session. If you have not already booked in a time for your first session, please contact Katherine Horner on our dedicated research line, 0406577615.

Thank you for your time.

Yours sincerely,

Gill Terrett & Peter Rendell
Principal Supervisors
Cognition and Emotion Research Centre
School of Psychology
Australian Catholic University
115 Victoria Pde, Fitzroy, VIC, 3065
E: gill.terrett@acu.edu.au
T: 03 9953 3121

Katherine Horner
Provisional Psychologist
Student Researcher
MPsych/PhD (Educational & Developmental) Candidate
E: katherine.horner2@myacu.edu.au
T: 0406577615

Appendix G. Consent Forms

Cognition & Emotion Research Centre

ACU
AUSTRALIAN CATHOLIC UNIVERSITY

PARENT/GUARDIAN CONSENT FORM

Copy for Researcher

TITLE OF PROJECT: Future-Oriented Thinking in Middle Childhood

APPLICATION NUMBER: 2018-145H

(NAME OF) PRINCIPAL INVESTIGATOR (or SUPERVISOR):
Associate Professor Gill Terrett and Professor Peter Rendell

(NAME OF) STUDENT RESEARCHER (if applicable): Katherine Horner

I .... (*the parent/guardian*) have read (*or, where appropriate*, have had read to me) and understood the information provided in the Participant Information Letter. Any questions I have asked have been answered to my satisfaction. I agree that my child, nominated below, may participate in this activity. As outlined in the Information Letter, this involves participating in two sessions, which will each take up to 2 hours to complete, with the second session taking place four weeks after the first session. During the two sessions, my child will play a computer game that simulates an actual week and represents tasks that occur in everyday life, requiring them to anticipate future events. It also involves my child completing a range of tasks measuring their cognitive and memory abilities. I agree to my child being audio recorded for the two tasks that require responses to be said aloud. In addition, I understand that I (or my child's other parent/guardian) must be present during both sessions and that during the first session, whilst my child is completing tasks, I will be required to fill out two questionnaires that ask general information about my child, their daily living skills and demographic background. I realise that at any time, I can withdraw my child from participating, without giving any reason.

I agree that research data collected for the study may be published or may be provided to other researchers in a form that does not identify my child in any way. Finally, I understand that a child and adult movie voucher will be provided at the end of the second session as an acknowledgement of our participation.

NAME OF PARENT/GUARDIAN: ____

SIGNATURE OF PARENT/GUARDIAN: _________________________________ DATE:_____________________

NAME OF CHILD: ____

SIGNATURE OF PRINCIPAL INVESTIGATOR (or SUPERVISOR): _____________________ DATE:______________

SIGNATURE OF STUDENT RESEARCHER (if applicable): __________________________ DATE: _____________

Cognition & Emotion Research Centre

AUSTRALIAN CATHOLIC UNIVERSITY

ASSENT OF PARTICIPANTS AGED UNDER 18 YEARS

I ……………………………………………………… (*the participant aged under 18 years*) understand what this research project is designed to explore. What I will be asked to do has been explained to me. I agree to take part in a research study that involves two sessions that will each take about 2 hours to complete. During the sessions, I will play a computer game and do some memory and thinking tasks. I agree that the two tasks that need me to say my answers aloud will be tape-recorded for the researcher to listen to later. I understand that my parent/guardian will be with me during both sessions, and realise that I can stop participating in the study at any time without having to give a reason for my decision. I agree that research data collected for the study may be published or may be provided to other researchers in a form that does not identify me in any way.

NAME OF PARTICIPANT AGED UNDER 18: ____

SIGNATURE OF PARTICIPANT: ______________________________ DATE:___________________

SIGNATURE OF PRINCIPAL INVESTIGATOR (or SUPERVISOR): ___________________ DATE:____________

SIGNATURE OF STUDENT RESEARCHER (if applicable): ________________________ DATE: ____________

Would you like to hear about the outcomes of this study?	*Please tick:*	Yes		No	
Are you interested in hearing about future research projects conducted by the Cognition and Emotion Research Centre at ACU?	*Please tick:*	Yes		No	
If you have ticked YES to either of the above please provide your contact details below:					
Email:					
Phone:					
Child's date of birth:					
Child's handedness (left, right, ambidextrous):					

Cognition & Emotion Research Centre

ACU AUSTRALIAN CATHOLIC UNIVERSITY

PARENT/GUARDIAN CONSENT FORM

Copy for the Participant

TITLE OF PROJECT: Future-Oriented Thinking in Middle Childhood

APPLICATION NUMBER: 2018-145H

(NAME OF) PRINCIPAL INVESTIGATOR (or SUPERVISOR):
Associate Professor Gill Terrett and Prof Peter Rendell

(NAME OF) STUDENT RESEARCHER (if applicable): Katherine Horner

I .... (*the parent/guardian*) have read (*or, where appropriate*, have had read to me) and understood the information provided in the Participant Information Letter. Any questions I have asked have been answered to my satisfaction. I agree that my child, nominated below, may participate in this activity. As outlined in the Information Letter, this involves participating in two sessions, which will each take up to 2 hours to complete, with the second session taking place four weeks after the first session. During the two sessions, my child will play a computer game that simulates an actual week and represents tasks that occur in everyday life, requiring them to anticipate future events. It also involves my child completing a range of tasks measuring their cognitive and memory abilities. I agree to my child being audio recorded for the two tasks that require responses to be said aloud. In addition, I understand that I (or my child's other parent/guardian) must be present during both sessions and that during the first session, whilst my child is completing tasks, I will be required to fill out two questionnaires that ask general information about my child, their daily living skills and demographic background. I realise that at any time, I can withdraw my child from participating, without giving any reason.

I agree that research data collected for the study may be published or may be provided to other researchers in a form that does not identify my child in any way. Finally, I understand that a child and adult movie voucher will be provided at the end of the second session as an acknowledgement of our participation.

NAME OF PARENT/GUARDIAN: ____

SIGNATURE OF PARENT/GUARDIAN: ________________________________ DATE:____________________

NAME OF CHILD: ____

SIGNATURE OF PRINCIPAL INVESTIGATOR (or SUPERVISOR): ____________________ DATE:_____________

SIGNATURE OF STUDENT RESEARCHER (if applicable): _________________________ DATE: ____________

Cognition & Emotion Research Centre

ACU
AUSTRALIAN CATHOLIC UNIVERSITY

ASSENT OF PARTICIPANTS AGED UNDER 18 YEARS

I .... (*the participant aged under 18 years*) understand what this research project is designed to explore. What I will be asked to do has been explained to me. I agree to take part in a research study that involves two sessions that will each take about 2 hours to complete. During the sessions, I will play a computer game and do some memory and thinking tasks. I agree that the two tasks that need me to say my answers aloud will be tape-recorded for the researcher to listen to later. I understand that my parent/guardian will be with me during both sessions, and realise that I can stop participating in the study at any time without having to give a reason for my decision. I agree that research data collected for the study may be published or may be provided to other researchers in a form that does not identify me in any way.

NAME OF PARTICIPANT AGED UNDER 18: ____

SIGNATURE OF PARTICIPANT: _______________________________ DATE:___________________

SIGNATURE OF PRINCIPAL INVESTIGATOR (or SUPERVISOR): ___________________ DATE:____________

SIGNATURE OF STUDENT RESEARCHER (if applicable): ________________________ DATE: ____________

Would you like to hear about the outcomes of this study?	*Please tick:*	Yes		No	
Are you interested in hearing about future research projects conducted by the Cognition and Emotion Research Centre at ACU?	*Please tick:*	Yes		No	

If you have ticked YES to either of the above please provide your contact details below:

Email:

Phone:

Child's date of birth:

Child's handedness (left, right, ambidextrous):

Appendix H. Intercorrelations

Table H.1

Intercorrelations for All Study Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.Age	-													
2.Full Scale IQ	-.03	-												
Autobiographical Interview														
3.Past internal[a]	.29**	.22*	-											
4.Future internal[b]	.26*	-.02	.58**	-										
Virtual Week-Foresight														
5.Item acquisition[c]	.43**	.31**	.29*	.12	-									
6.Item use[d]	.29**	.37**	.24*	.09	.64**	-								
Virtual Week-Prospective Memory														
7.Event-based[e]	.56**	.12	.38**	.38**	.32**	.25*	-							
8.Time-based[f]	.48**	.12	.27*	.18	.20	.26*	.59**	-						
9.Recall event-based[g]	.46**	.25*	.17	.11	.22*	.31**	.50**	.52**	-					
10.Recall time-based[h]	.51**	.23*	.25*	.17	.32**	.32**	.69**	.69**	.63**	-				
Executive Functioning														
11.Inhibition	-.46**	-.39**	-.27*	-.19	-.41**	-.35**	-.42**	-.26*	-.39**	-.34**	-			
12.Cognitive flexibility	-.49**	-.35**	-.08	-.05	-.30**	-.35**	-.39**	-.38**	-.52**	-.43**	.64**	-		
13.Working memory	.34**	.37**	.09	.15	.39**	.32**	.39**	.38**	.49**	.39**	-.52**	-.65**	-	
14. List memory[i]	.25*	.26*	.34**	.24*	.15	.14	.47**	.32**	.44**	.32**	-.36**	-.40**	.39**	-

Table H.1 (continued).

[a] Autobiographical Interview total past internal details.

[b] Autobiographical Interview total future internal details.

[c] Virtual Week-Foresight total number of items acquired.

[d] Virtual Week-Foresight total number of items used.

[e] Virtual Week-Prospective Memory proportion correct for event-based tasks.

[f] Virtual Week-Prospective Memory proportion correct for time-based tasks.

[g] Virtual Week-Prospective Memory task recognition proportion correct for event-based tasks.

[h] Virtual Week-Prospective Memory task recognition proportion correct for time-based tasks.

[i] NEPSY-II List Memory Delayed total score.

* $p \leq .05$. ** $p \leq .01$.